Regents Chemistry Solutions Book

This book contains the solutions to Regents360's practice problems

Please do not write in this book and use it solely to evaluate your learning

Teacher: Dr. Jordan Salhoobi

First Name	Last Name	Academic Year	Grade

Classification of Matter
Video #1

Name:__________________________ Class/Period:_______________________

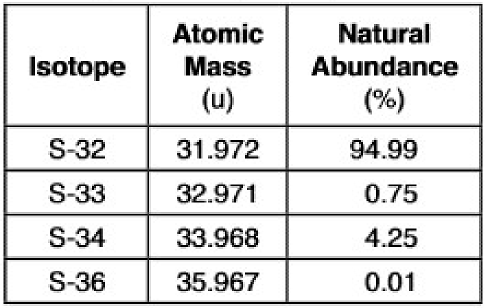
Assignment: Video 1. Classification of Matter: Substances/Mixtures, Isomers/Allotropes/Isotopes, Atomic Mass

Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 1/17 then answer the following questions.

1 The four naturally occurring isotopes of sulfur are S-32, S-33, S-34, and S-36. The table below shows the atomic mass and percent natural abundance for these isotopes.

Naturally Occurring Isotopes of Sulfur



Isotope	Atomic Mass (u)	Natural Abundance (%)
S-32	31.972	94.99
S-33	32.971	0.75
S-34	33.968	4.25
S-36	35.967	0.01

State both the number of protons and the number of neutrons in an S-33 atom.

Answer

An atom of S-33 contains ***16 protons and 17 neutrons***. Isotopes of the same element have the the same number of protons and different number of neutrons. All sulfur atoms have 16 protons. The dashed number represents the mass number of the isotope, the total number of protons and neutrons. Therefore, the number of neutrons can be calculated by subtracting the number of protons from the mass number.

2 The only naturally occurring isotopes of nitrogen are N-14 and N-15.
Based on the atomic mass of the element nitrogen on the Periodic Table, compare the relative abundance of the naturally occurring isotopes of nitrogen.

Answer

Since the atomic mass on the Periodic Table is the average of all naturally occurring isotopes and their relative abundance, an atomic mass of 14.0067 indicates that nitrogen-14 is more abundant than nitrogen-15, i.e. there are fewer N-15 atoms.

3 The only naturally occurring isotopes of nitrogen are N-14 and N-15.
State the number of protons in an atom of N-15.

Answer

The number of protons in an atom of N-15 is *7*, the atomic number of nitrogen as stated on the Periodic Table.

4 Cobalt-60 is an artificial isotope of Co-59. The incomplete equation for the decay of cobalt-60, including beta and gamma emissions, is shown below:

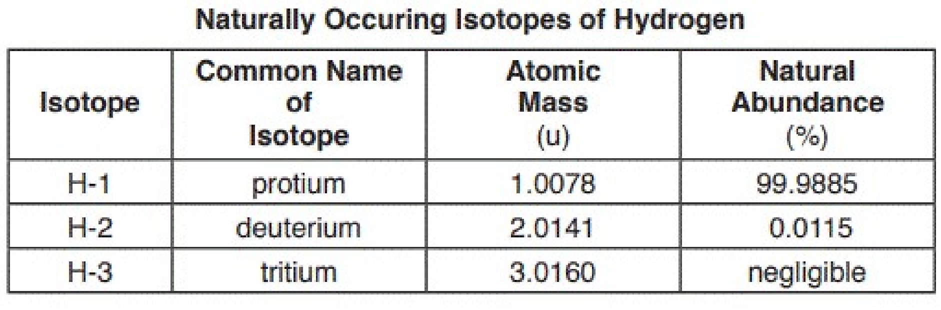
$$^{60}_{27}\mathrm{Co} \rightarrow X + {}^{0}_{-1}\mathrm{e} + {}^{0}_{0}\gamma$$

Explain, in terms of both proton and neutrons, why Co-59 and Co-60 are isotopes of cobalt.

Answer

Atoms of the same element have the same number of protons. Isotopes of the same element, therefore, have the ***same number of protons but different number of neutrons*** causing them to have different masses.

5 The atomic mass and natural abundance of the naturally occurring isotopes of hydrogen are shown in the table below.



Naturally Occuring Isotopes of Hydrogen

Isotope	Common Name of Isotope	Atomic Mass (u)	Natural Abundance (%)
H-1	protium	1.0078	99.9885
H-2	deuterium	2.0141	0.0115
H-3	tritium	3.0160	negligible

The isotope H-2, also called deuterium, is usually represented by the symbol "D". Heavy water forms when deuterium reacts with oxygen, producing molecules of D_2O.

Determine the formula mass of heavy water, D_2O.

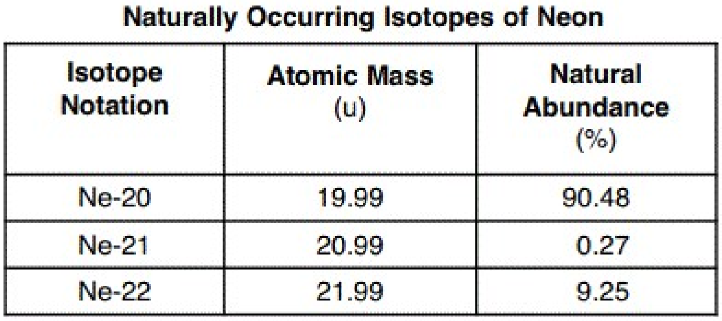
Answer

Formula mass is the total molar mass of all the atoms that make up a compound. In this case, on mole of D_2O is made up of 2 moles of Deuterium and 1 mole of oxygen. The mass of deuterium is listed in the table as approximately 2 g/mol. Therefore, the formula mass of D_2O is calculated as follows:

Formula Mass of D_2O ***= (2 x 2) + (1x16) = 20 u or 20g/mol***

Note: Any value from 19.999 u to 20.03 u, inclusive is correct.

6 Some isotopes of neon are Ne-19, Ne-20, Ne-21, Ne-22, and Ne-24. The neon-24 decays by beta emission. The atomic mass and natural abundance for the naturally occurring isotopes of neon are shown in the table below.



Naturally Occurring Isotopes of Neon

Isotope Notation	Atomic Mass (u)	Natural Abundance (%)
Ne-20	19.99	90.48
Ne-21	20.99	0.27
Ne-22	21.99	9.25

Show the numerical setup for calculating the atomic mass of neon.

Answer

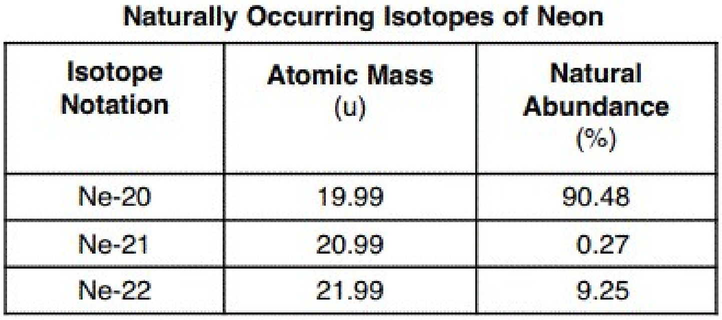
Possible answers include:

$$(19.99\ \text{u})(0.9048) + (20.99\ \text{u})(0.0027) + (21.99\ \text{u})(0.0925)$$

$$\frac{(19.99)(90.48) + (20.99)(0.27) + (21.99)(9.25)}{100}$$

$$(19.99)(90.48\%) + (20.99)(0.27\%) + (21.99)(9.25\%)$$

7 Some isotopes of neon are Ne-19, Ne-20, Ne-21, Ne-22, and Ne-24. The neon-24 decays by beta emission. The atomic mass and natural abundance for the naturally occurring isotopes of neon are shown in the table below.



Naturally Occurring Isotopes of Neon

Isotope Notation	Atomic Mass (u)	Natural Abundance (%)
Ne-20	19.99	90.48
Ne-21	20.99	0.27
Ne-22	21.99	9.25

State the number of neutrons in an atom of Ne-20 and the number of neutrons in an atom of Ne-22.

Answer

The number of neutrons in an isotope can be found by subtracting the number of protons from the isotope's mass number. All atoms and isotopes of Neon will have 10 protons. Therefore,

Ne-20: 10 neutrons

Ne-22: 12 neutrons

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

> When uranium-235 nuclei are bombarded with neutrons, many different combinations of smaller nuclei can be produced. The production of neodymium-150 and germanium-81 in one of these reactions is represented by the equation below.
>
> $${}^{1}_{0}\mathrm{n} + {}^{235}_{92}\mathrm{U} \rightarrow {}^{150}_{60}\mathrm{Nd} + {}^{81}_{32}\mathrm{Ge} + 5{}^{1}_{0}\mathrm{n}$$
>
> Germanium-81 and uranium-235 have different decay modes. Ge-81 emits betaparticles and has a half-life of 7.6 seconds.

Refer to Figure 1 and answer the following Question:

State the number of protons and number of neutrons in a neodymium-150 atom.

Answer

In the radioisotope neodymium-150 the atomic number determines the number of protons and the mass number is the total number of protons and neutrons.

Atomic Number = Number of Protons = 60

Mass Number = 150 = 60 + n

Number of Neutrons = 150 − 60 = 90

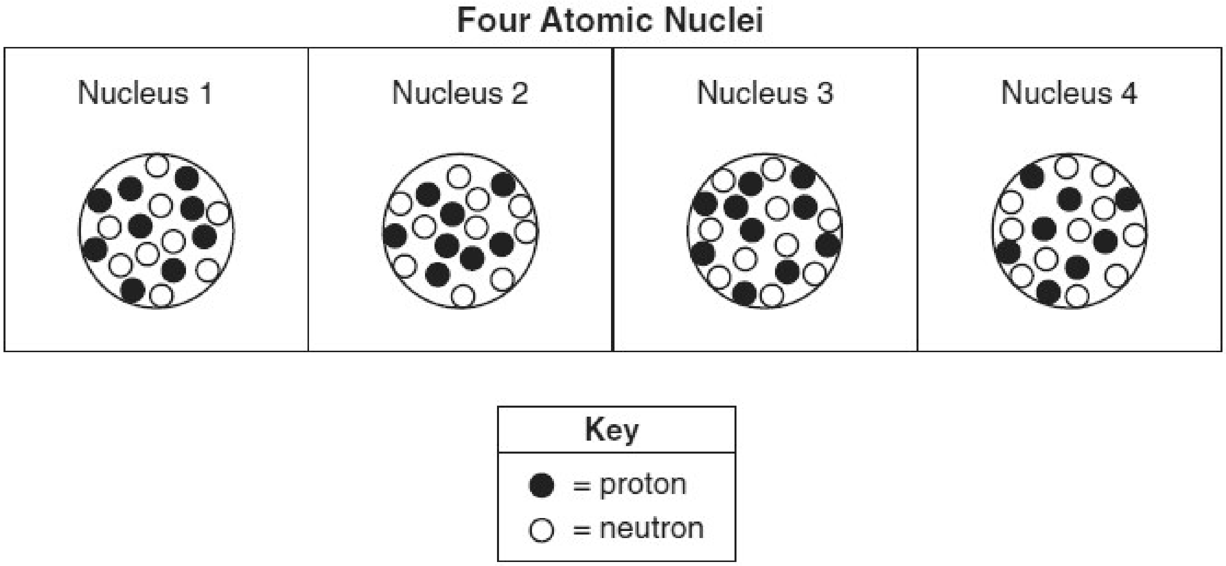
60 protons and 60 neutrons

9

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

The diagrams below represent four different atomic nuclei.



Refer to Figure 2 and answer the following Question:
Explain why nucleus 2 and nucleus 4 represent the nuclei of two different isotopes of the same element.

Answer

Acceptable responses include, but are not limited to:

- Both have 8 protons, but nucleus 2 has 10 neutrons while nucleus 4 has 11 neutrons.
- equal in protons, unequal in neutrons
- same atomic number, but different mass number

10 **Refer to Figure 2 and answer the following Question:**
Determine the mass number of the nuclide represented by nucleus 2.

Answer

8 protons + 10 neutrons = 18 atomic mass units

11

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

The radioisotope Mo-99 naturally decays to produce the metastable isotope Tc-99m, which is used in medical diagnosis. A doctor can obtain images of organs and bones by injecting a patient with a solution of Tc-99m. The half-life of the metastable Tc-99m is six hours.

Refer to Figure 3 and answer the following Question:

State *both* the number of protons and the number of neutrons in a Tc-99 nuclide.

Answer

Allow credit for 43 protons and 56 neutrons.

12

Figure 4

Base your answer to the question on the information below and on your knowledge of chemistry.

In 1896, Antoine H. Becquerel discovered that a uranium compound could expose a photographic plate wrapped in heavy paper in the absence of light. It was shown that the uranium compound was spontaneously releasing particles and high-energy radiation. Further tests showed the emissions from the uranium that exposed the photographic plate were *not* deflected by charged plates.

Refer to Figure 4 and answer the following Question:

Determine the number of neutrons in an atom of U-233.

Answer

Allow credit for 141.

13

Figure 5

Base your answer to the question on the information below and on your knowledge of chemistry.

Elements with an atomic number greater than 92 can be artificially produced in nuclear reactions by bombarding a naturally occurring nuclide with a different nuclide. One of these elements is roentgenium, Rg. The equation below represents a nuclear reaction that produces Rg-272.

$$^{209}_{83}\mathrm{Bi} + ^{64}_{28}\mathrm{Ni} \rightarrow ^{272}_{111}\mathrm{Rg} + ^{1}_{0}\mathrm{n}$$

Refer to Figure 5 and answer the following Question:

Determine the number of neutrons in an atom of Rg-272.

Answer

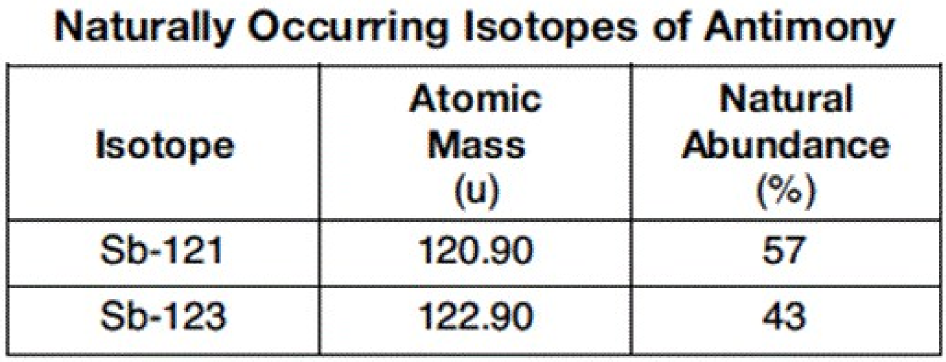
Allow credit for 161.

14

Figure 6

Base your answer to the question on the information below and on your knowledge of chemistry.

The two naturally occurring isotopes of antimony are Sb-121 and Sb-123. The table below shows the atomic mass and percent natural abundance for these isotopes.



Naturally Occurring Isotopes of Antimony

Isotope	Atomic Mass (u)	Natural Abundance (%)
Sb-121	120.90	57
Sb-123	122.90	43

Antimony and sulfur are both found in the mineral stibnite, Sb2S3. To obtain antimony, stibnite is roasted (heated in air), producing oxides of antimony and sulfur. The unbalanced equation below represents one of the reactions that occurs during the roasting.

$Sb_2S_3(s) + O_2(g) \rightarrow Sb_2O_3(s) + SO_2(g)$

Refer to Figure 6 and answer the following Question:

In the space below, show a correct numerical setup for calculating the atomic mass of antimony.

Answer

Acceptable responses include, but are not limited to:

- (0.57)(120.90 u) + (0.43)(122.90 u)
- $\frac{(57)(120.9)+(43)(122.9)}{100}$
- (57%)(120.9) + (43%)(122.9)

15 75.0% of the isotopes of an element have a mass of 35.0 amu and 25.0% of the isotopes have a mass of 37.0 amu. Calculate the atomic mass of the element.

Answer

The atomic mass of an element is a weighted average, in accordance to the proportions in which the isotopes occur. For the element in question, the atomic mass is calculated as:

35.0amu(0.75) + 37.0amu(0.25)
26.25amu + 9.25 amu
35.5amu

16 Element *X* has two isotopes. If 72.0% of the element has an isotopic mass of 84.9 atomic mass units, and 28.0% of the element has an isotopic mass of 87.0 atomic mass units, calculate the average atomic mass of element *X*.

Answer

The information gives percent abundance. The correct setup is:

84.9(0.72) + 87.0(0.28)

61.128 + 24.36

85.488

17

Figure 7

Base your answer to the question on the information.

Naturally occurring elemental carbon is a mixture of isotopes. The percent composition of the two most abundant isotopes is listed below.

- 98.93% of the carbon atoms have a mass of 12.00 atomic mass units.
- 1.07% of the carbon atoms have a mass of 13.00 atomic mass units.

Refer to Figure 7 and answer the following Question:

Calculate the average atomic mass of carbon.

Answer

The information gives percent abundance. The correct setup is:

12.00(0.9893) + 13.00(0.0107)

11.8716 + 0.1391

12.0107

18

Figure 8

Naturally occurring boron is composed of two isotopes. The percent abundance and the mass of each isotope are listed below.

- 19.9% of the boron atoms have a mass of 10.013 atomic mass units.
- 80.1% of the boron atoms have a mass of 11.009 atomic mass units.

Refer to Figure 8 and answer the following Question:

Calculating the atomic mass of boron.

Answer

The information gives percent abundance. The correct setup is:

(10.013)(0.199) + (11.009)(0.801)

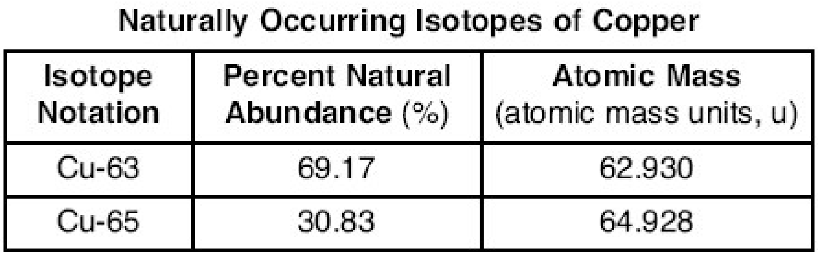
1.992587 + 8.818209

10.810796

19

Figure 9

Base your answer to this question on the information below.



Naturally Occurring Isotopes of Copper

Isotope Notation	Percent Natural Abundance (%)	Atomic Mass (atomic mass units, u)
Cu-63	69.17	62.930
Cu-65	30.83	64.928

Refer to Figure 9 and answer the following Question:
Calculate the atomic mass of copper.

Answer

The chart shows percent abundance. The correct setup is:

(0.6917)(62.930 u) + (0.3083)(64.928 u)

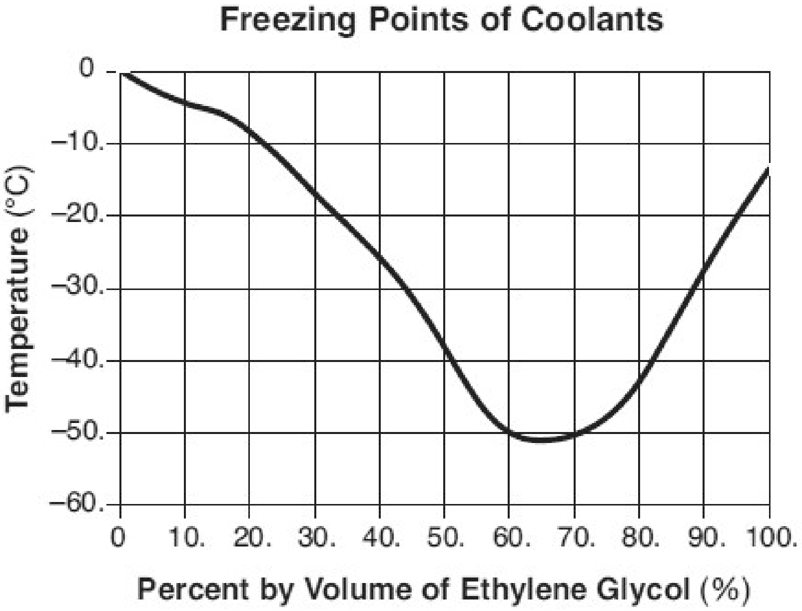
43.528681 u + 20.0173024 u

63.5459834 u

Figure 10

Base your answer to the question on the information below and on your knowledge of chemistry.

> A solution of ethylene glycol and water can be used as the coolant in an engine-cooling system. The ethylene glycol concentration in a coolant solution is often given as percent by volume. For example, 100. mL of a coolant solution that is 40.% ethylene glycol by volume contains 40. mL of ethylene glycol diluted with enough water to produce a total volume of 100. mL. The graph below shows the freezing point of coolants that have different ethylene glycol concentrations.



Refer to Figure 10 and answer the following Question:

Explain, in terms of particle distribution, why a coolant solution is a homogeneous mixture.

Answer

Acceptable responses include, but are not limited to:

- The particles are distributed uniformly throughout the coolant mixture.
- There is an even distribution of molecules in the solution.
- The water and ethylene glycol molecules mix uniformly.
- All particles are evenly dispersed.

21

Figure 11

Base your answer to the question on the information below.

A scientist makes a solution that contains 44.0 grams of hydrogen chloride gas, HCl(g), in 200. grams of water, $H_2O(\ell)$, at 20.°C. This process is represented by the balanced equation below.

$$HCl(g) \xrightarrow{H_2O} H^+(aq) + Cl\ (aq)$$

Refer to Figure 11 and answer the following Question:

Explain, in terms of the distribution of particles, why the solution is a homogeneous mixture.

Answer

Acceptable responses include, but are not limited to:

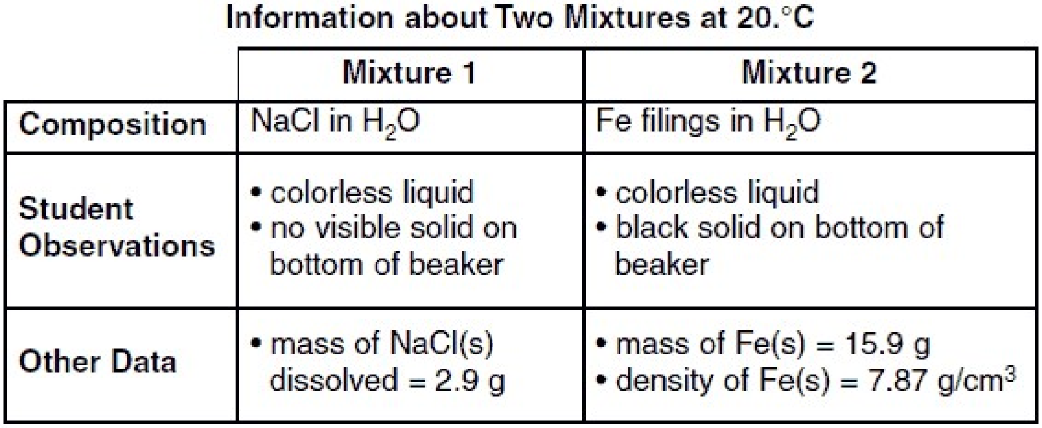
- The H^+ ions and the Cl^- ions are distributed uniformly throughout the solution.
- There is an even distribution of $H^+(aq)$ and $Cl^-(aq)$.

22

Figure 12

Base your answer to the question on the information below.

A student prepared two mixtures, each in a labeled beaker. Enough water at 20.°C was used to make 100 milliliters of each mixture.



Information about Two Mixtures at 20.°C

	Mixture 1	Mixture 2
Composition	NaCl in H_2O	Fe filings in H_2O
Student Observations	• colorless liquid • no visible solid on bottom of beaker	• colorless liquid • black solid on bottom of beaker
Other Data	• mass of NaCl(s) dissolved = 2.9 g	• mass of Fe(s) = 15.9 g • density of Fe(s) = 7.87 g/cm^3

Refer to Figure 12 and answer the following Question:

Classify *each* mixture using the term “homogeneous” or the term “heterogeneous.”

Answer

Mixture 1: homogeneous
Mixture 2: heterogeneous

23

Figure 13

Base your answer to this question on the information below.

> Cold packs are used to treat minor injuries. Some cold packs contain NH_4NO_3(s) and a small packet of water at room temperature before activation. To activate this type of cold pack, the small packet must be broken to mix the water and NH_4NO_3(s). The temperature of this mixture decreases to approximately 2°C and remains at this temperature for 10 to 15 minutes.

Refer to Figure 13 and answer the following Question:

Identify the type of mixture formed when the NH_4NO_3(s) is completely dissolved in the water.

Answer

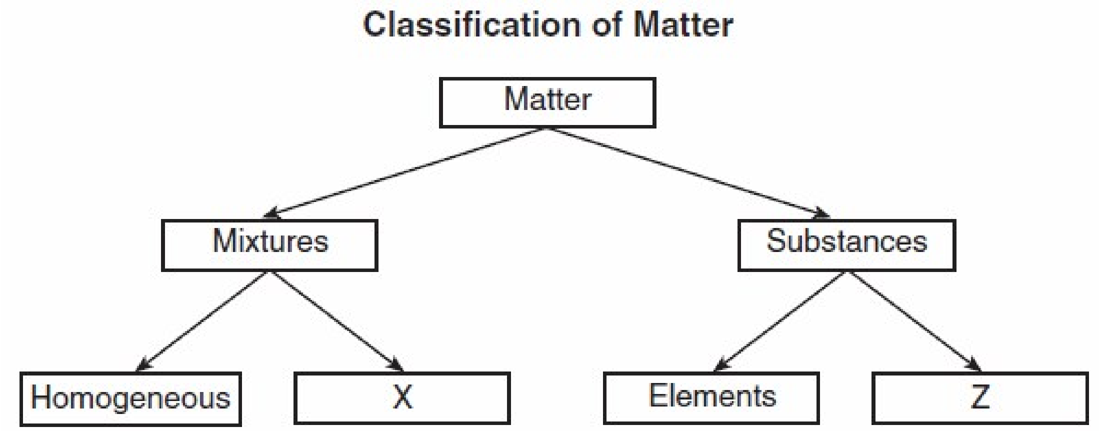
Acceptable responses include, but are not limited to:

- homogeneous
- solution

24

Figure 14

Base your answer to the question on the diagram below concerning the classification of matter.



Refer to Figure 14 and answer the following Question:

Explain, in terms of particle arrangement, why NaCl(aq) is a homogeneous mixture.

Answer

Acceptable responses include, but are not limited to:

- The water molecules, sodium ions, and chloride ions are uniformly mixed together.
- All particles distribute evenly.

25

Figure 15

Base your answer to the question on the information below and on your knowledge of chemistry.

A laboratory technician is given the table below and a sample of one of the three substances listed in the table. The technician makes an aqueous solution with a portion of the sample. When a conductivity tester is lowered into the solution, the lightbulb on the tester glows brightly. Another portion of the sample is placed in a heat-resistant container that is placed in an oven at 450°C. The sample melts.

Some Properties of Three Substances

Property	Substance		
	Sodium nitrate	**Potassium chromate**	**Sulfur**
solubility in water at 20.°C	soluble	soluble	insoluble
electrical conductivity of aqueous solution	good	good	not applicable
melting point (°C)	307	974	115

Refer to Figure 15 and answer the following Question:

Identify the substance given to the technician.

Answer

Acceptable responses include, but are not limited to:

- sodium nitrate
- $NaNO_3$

26 Sir William Ramsey is one scientist credited with identifying the noble gas argon. Sir Ramsey separated nitrogen gas from the air and reacted it with an excess of magnesium, producing solid magnesium nitride. However, a small sample of an unreactive gas remained with a density different from the density of the nitrogen gas. Sir Ramsey identified the unreactive gas as argon and later went on to discover neon, krypton, and xenon.

Compare the density of nitrogen gas to the density of argon gas when both gases are at 298 K and 101.3 kPa.

Answer

Acceptable responses include, but are not limited to:

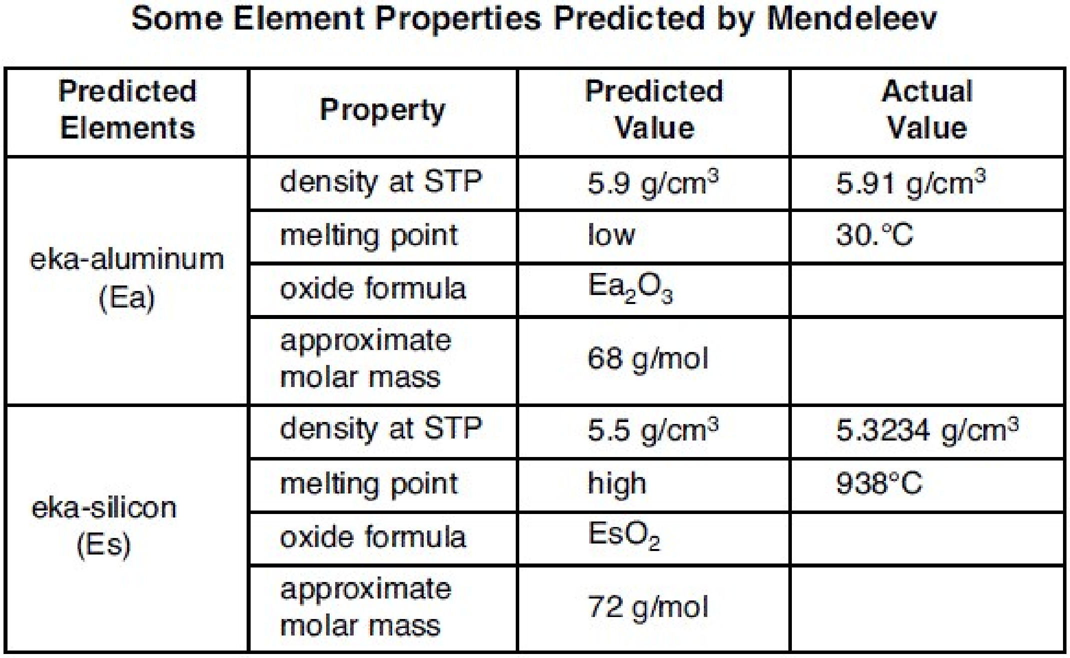
- The density of nitrogen gas is less than the density of argon gas.
- Argon is more dense.
- Nitrogen gas has a density of 0.001145 g/cm3, which is less than the density of argon.

27

Figure 16

Base your answer to the question on the information below and on your knowledge of chemistry.

In the late 1800s, Dmitri Mendeleev developed a periodic table of the elements known at that time. Based on the pattern in his periodic table, he was able to predict properties of some elements that had not yet been discovered. Information about two of these elements is shown in the table below.



Some Element Properties Predicted by Mendeleev

Predicted Elements	Property	Predicted Value	Actual Value
eka-aluminum (Ea)	density at STP	5.9 g/cm^3	5.91 g/cm^3
	melting point	low	30.°C
	oxide formula	Ea_2O_3	
	approximate molar mass	68 g/mol	
eka-silicon (Es)	density at STP	5.5 g/cm^3	5.3234 g/cm^3
	melting point	high	938°C
	oxide formula	EsO_2	
	approximate molar mass	72 g/mol	

Refer to Figure 16 and answer the following Question:

Show a numerical setup for calculating the percent error of Mendeleev's predicted density of Es.

Answer

Acceptable responses include, but are not limited to:

$$\frac{5.5\ \mathrm{g/cm^3} - 5.3234\ \mathrm{g/cm^3}}{5.3234\ \mathrm{g/cm^3}} \times 100$$

$$\frac{(5.5 - 5.3)(100)}{5.3}$$

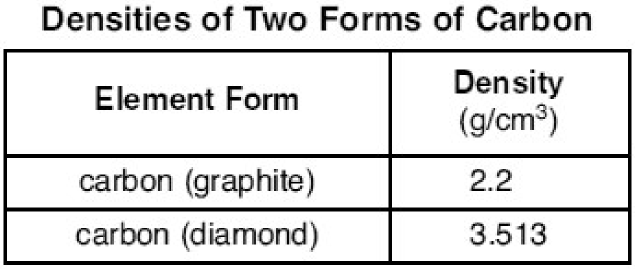
$$\frac{0.2}{5.3} \times 100$$

28

Figure 17

Base your answer to the question on the information below and on your knowledge of chemistry.

The densities for two forms of carbon at room temperature are listed in the table below.



Densities of Two Forms of Carbon

Element Form	Density (g/cm^3)
carbon (graphite)	2.2
carbon (diamond)	3.513

Refer to Figure 17 and answer the following Question:

A student calculated the density of a sample of graphite to be 2.3 g/cm^3. Show a numerical setup for calculating the student's percent error for the density of graphite.

Answer

Acceptable responses include, but are not limited to:

- $\frac{2.3\text{g/cm}^3 - 2.2\text{g/cm}^3}{2.2\text{g/cm}^3} \times 100$
- $\frac{2.3-2.2}{2.2} \times 100$
- $\frac{0.1(100)}{2.2}$

29

Figure 18

Base your answer to the question on the information below and on your knowledge of chemistry.

At standard pressure, water has unusual properties that are due to both its molecular structure and intermolecular forces. For example, although most liquids contract when they freeze, water expands, making ice less dense than liquid water. Water has a much higher boiling point than most other molecular compounds having a similar gram-formula mass.

Refer to Figure 18 and answer the following Question:

Explain why $H_2O(s)$ floats on $H_2O(\ell)$ when both are at 0°C.

Answer

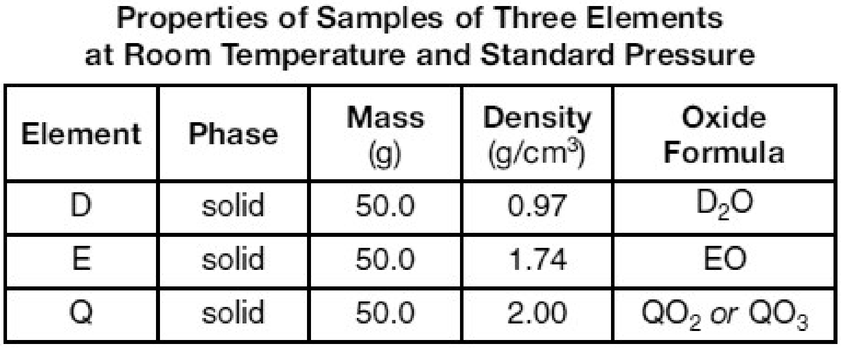
Acceptable responses include, but are not limited to:

- When water freezes it expands, making $H_2O(s)$ less dense than $H_2O(\ell)$.
- The distance between the H_2O molecules is greater in the solid phase.
- The density of liquid water is greater.
- The density of ice is less.

Figure 19

Base your answer to the question on the information below and on your knowledge of chemistry.

Three elements, represented by *D*, *E*, and *Q*, are located in Period 3. Some properties of these elements are listed in the table below. A student's experimental result indicates that the density of element *Q* is 2.10 g/cm^3, at room temperature and standard pressure.



Properties of Samples of Three Elements at Room Temperature and Standard Pressure

Element	Phase	Mass (g)	Density (g/cm^3)	Oxide Formula
D	solid	50.0	0.97	D_2O
E	solid	50.0	1.74	EO
Q	solid	50.0	2.00	QO_2 *or* QO_3

Refer to Figure 19 and answer the following Question:

Identify the physical property in the table that could be used to differentiate the samples of the three elements from each other.

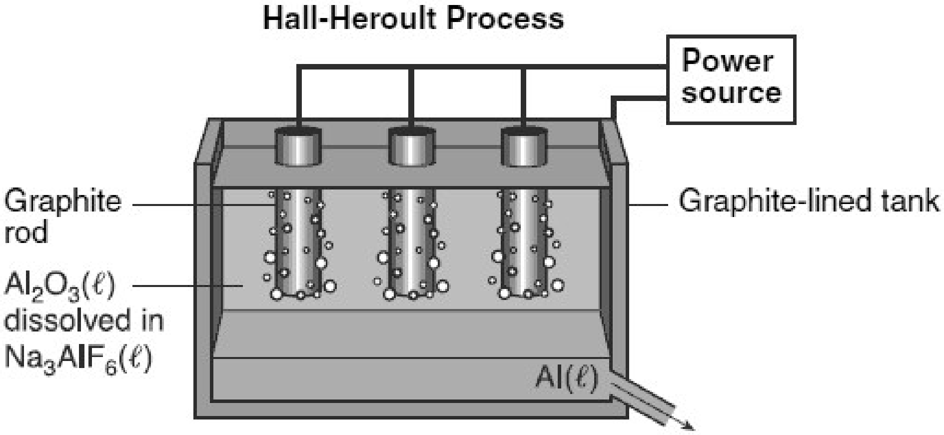
Answer

density

Figure 20

Base your answer to the question on the information below and on your knowledge of chemistry.

In the late 19th century, the Hall-Herroult process was invented as an inexpensive way to produce aluminum. In this process, $Al_2O_3(\ell)$ extracted from bauxite is dissolved in $Na_3AlF_6(\ell)$ in a graphite-lined tank, as shown in the diagram below. The products are carbon dioxide and molten aluminum metal.



Refer to Figure 20 and answer the following Question:

Compare the density of the $Al(\ell)$ with the density of the mixture of $Al_2O_3(\ell)$ and $Na_3AlF_6(\ell)$.

Answer

Acceptable responses include, but are not limited to:

- The density of the aluminum is greater than the density of the Al_2O_3 and Na_3AlF_6 mixture.
- The density of $Al(\ell)$ is greater.

32

Figure 21

Base your answer to the question on the information below.

> Arsenic is often obtained by heating the ore arsenopyrite, FeAsS. The decomposition of FeAsS is represented by the balanced equation below.
>
> $$\mathrm{FeAsS(s)} \xrightarrow{\text{heat}} \mathrm{FeS(s)} + \mathrm{As(g)}$$
>
> In the solid phase, arsenic occurs in two forms. One form, yellow arsenic, has a density of 1.97 g/cm^3 at STP. The other form, gray arsenic, has a density of 5.78 g/cm^3 at STP. When arsenic is heated rapidly in air, arsenic(III) oxide is formed.
>
> Although arsenic is toxic, it is needed by the human body in very small amounts. The body of a healthy human adult contains approximately 5 milligrams of arsenic.

Refer to Figure 21 and answer the following Question:

Explain, in terms of the arrangement of atoms, why the two forms of arsenic have different densities at STP.

Answer

Acceptable responses include, but are not limited to:

- In gray arsenic, the atoms are arranged closer together so there is more mass in a unit volume.
- The atoms in yellow As are farther apart; therefore, there is less mass per volume than in gray As.

33

Figure 22

Base your answer to the question on the information below.

> Archimedes (287-212 BC), a Greek inventor and mathematician, made several discoveries important to science today. According to a legend, Hiero, the king of Syracuse, commanded Archimedes to find out if the royal crown was made of gold, only. The king suspected that the crown consisted of a mixture of gold, tin, and copper.
>
> Archimedes measured the mass of the crown and the total amount of water displaced by the crown when it was completely submerged. He repeated the procedure using individual samples, one of gold, one of tin, and one of copper. Archimedes was able to determine that the crown was not made entirely of gold without damaging it.

Refer to Figure 22 and answer the following Question:

Identify *one* physical property that Archimedes used in his comparison of the metal samples.

Answer

Examples:

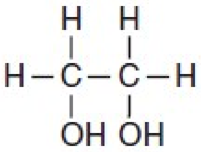
- density
- mass
- volume

Figure 23

Base your answer to the question on the information below.

Ethene (common name ethylene) is a commercially important organic compound. Millions of tons of ethene are produced by the chemical industry each year. Ethene is used in the manufacture of synthetic fibers for carpeting and clothing, and it is widely used in making polyethylene. Low-density polyethylene can be stretched into a clear, thin film that is used for wrapping food products and consumer goods. High-density polyethylene is molded into bottles for milk and other liquids.

Ethene can also be oxidized to produce ethylene glycol, which is used in antifreeze for automobiles. The structural formula for ethylene glycol is:



$$\begin{array}{ccccc} & H & & H & \\ & | & & | & \\ H- & C & - & C & -H \\ & | & & | & \\ & OH & & OH & \end{array}$$

At standard atmospheric pressure, the boiling point of ethylene glycol is 198°C, compared to ethene that boils at –104°C.

Refer to Figure 23 and answer the following Question:

According to the information in the reading passage, state *two* consumer products manufactured from ethene.

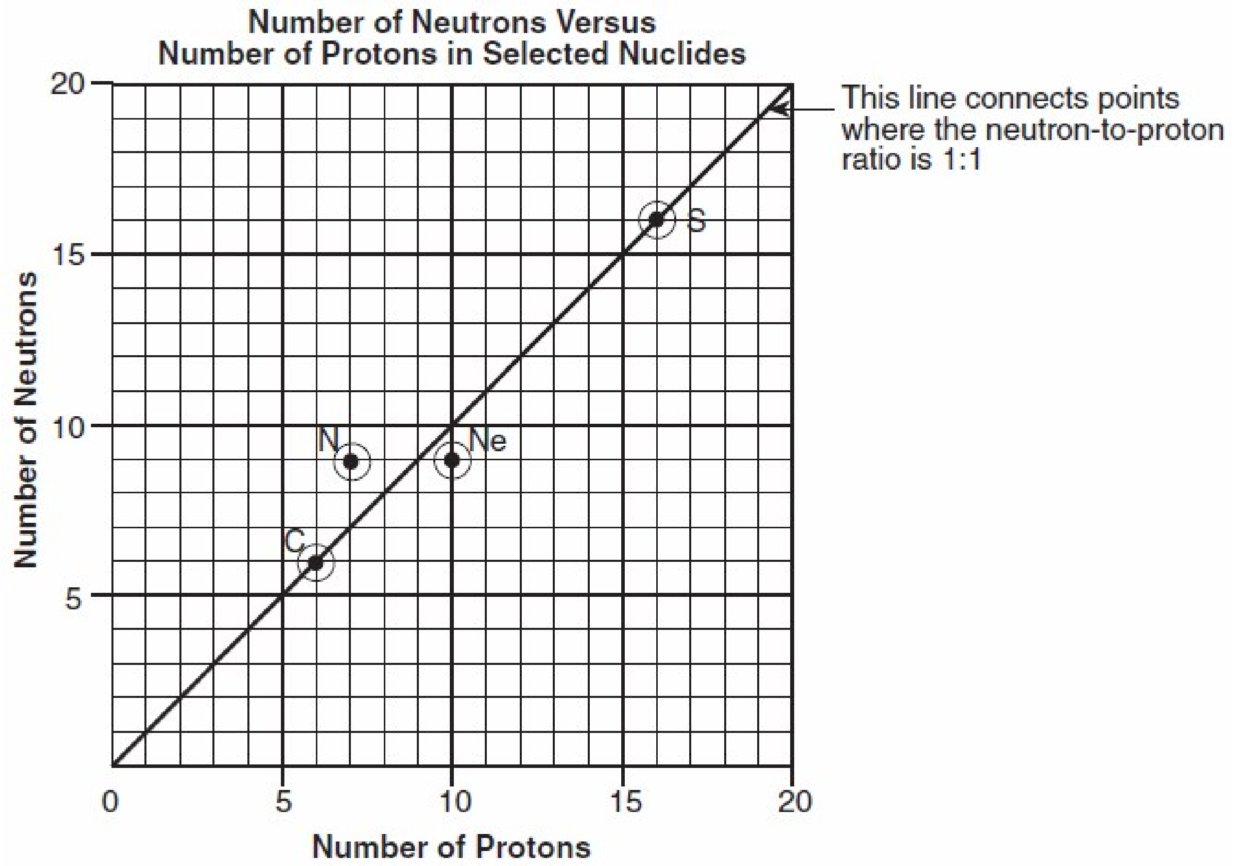
Answer

Acceptable responses include, but are not limited to, these examples:

- synthetic fibers
- clothing
- carpeting
- antifreeze (ethylene glycol)
- food wrap
- plastic bottles
- high-density polyethylene
- low-density polyethylene

Figure 24

Base your answer to the question on the information below, which relates the numbers of neutrons and protons for specific nuclides of C, N, Ne, and S.



Refer to Figure 24 and answer the following Question:

Explain, in terms of atomic particles, why S-32 is a stable nuclide.

Answer

Acceptable responses include, but are not limited to:

- The neutron-to-proton ratio causes the nuclide to be stable.
- The nuclide has an equal number of neutrons and protons.
- because of the neutron-proton ratio

36

Figure 25

Base your answer to the question on the information below and on your knowledge of chemistry.

A student prepares two 141-gram mixtures, *A* and *B*. Each mixture consists of NH_4Cl, sand, and H_2O at 15°C. Both mixtures are thoroughly stirred and allowed to stand. The mass of each component used to make the mixtures is listed in the data table below.

Mass of the Components in Each Mixture

Component	Mixture A (g)	Mixture B (g)
NH_4Cl	40.	10.
sand	1	31
H_2O	100.	100.

Refer to Figure 25 and answer the following Question:

State evidence from the table indicating that the proportion of the components in a mixture can vary.

Answer

Acceptable responses include, but are not limited to:

- The ratio by mass of NH_4Cl to H_2O in mixture *A* is 40. g/100. g, and the ratio in mixture *B* is 10. g/100. g.
- Both mixtures have the same total mass, but have different amounts of sand.
- Mixture *B* has more sand.
- The mixtures have different proportions of NH_4Cl.

37 The melting points and boiling points of five substances at standard pressure are listed on the table below.

Melting Points and Boiling Points of Five Substances

Substance	Melting Point (K)	Boiling Point (K)
HCl	159	188
NO	109	121
F_2	53	85
Br_2	266	332
I_2	387	457

Identify the substance in this table that is a liquid at STP.

Answer

The substance that is a liquid at STP would have a melting point that is lower than 273 K but a boiling point that is higher than 273 K. Therefore, Bromine, Br_2, listed in the table is a liquid at STP.

38

Figure 26

Base your answer to the question on the information below and on your knowledge of chemistry.

Some properties of the element sodium are listed below.

- is a soft, silver-colored metal
- melts at a temperature of 371 K
- oxidizes easily in the presence of air
- forms compounds with nonmetallic elements in nature
- forms sodium chloride in the presence of chlorine gas

Refer to Figure 26 and answer the following Question:
Convert the melting point of sodium to degrees Celsius.

Answer

Allow credit for 98°C.

39 Refer to Figure 20 and answer the following Question:
What is the melting point of the substance that collects at the bottom of the tank?

Answer

The substance at the bottom of the tank is molten aluminum. Reference Table *S* lists the melting point of aluminum as 933K.

40

Figure 27

Base your answer to the question on the information below.

At standard pressure, hydrogen peroxide, H_2O_2, melts at –0.4°C, boils at 151°C, and is very soluble in water. A bottle of aqueous hydrogen peroxide, $H_2O_2(aq)$, purchased from a pharmacy has a pressure-releasing cap. Aqueous hydrogen peroxide decomposes at room temperature, as represented by the balanced equation below.

$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g) + 196.0\text{ kJ}$

Refer to Figure 27 and answer the following Question:
State, in terms of *both* melting point and boiling point, why H_2O_2 is a liquid at room temperature.

Answer

Acceptable responses include, but are not limited to:

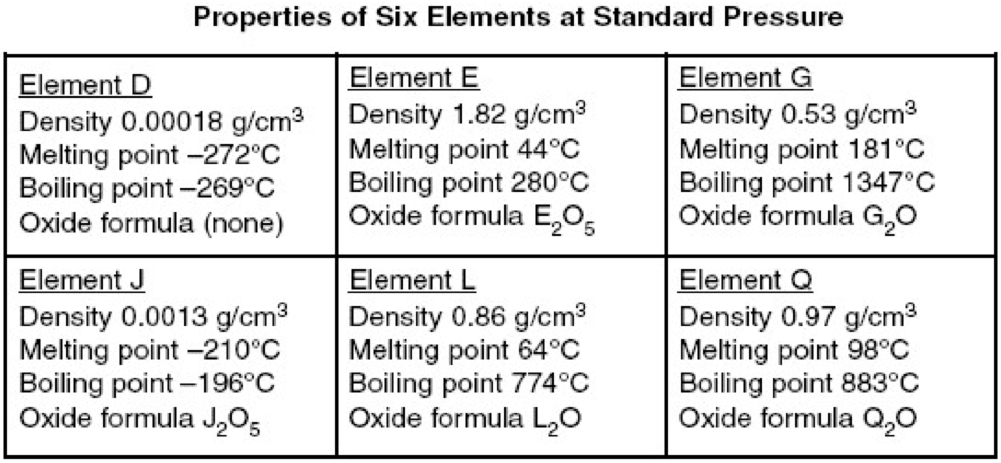
- Room temperature is above the melting point and below the boiling point of H_2O_2.
- Room temperature is between –0.4°C and 151°C.
- –0.4°C < room temperature < 151°C

41

Figure 28

Base your answer to the question on the information below.

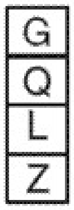
The table below lists physical and chemical properties of six elements at standard pressure that correspond to known elements on the Periodic Table. The elements are identified by the code letters, *D*, *E*, *G*, *J*, *L*, and *Q*.



Properties of Six Elements at Standard Pressure

Element D Density 0.00018 g/cm^3 Melting point –272°C Boiling point –269°C Oxide formula (none)	Element E Density 1.82 g/cm^3 Melting point 44°C Boiling point 280°C Oxide formula E_2O_5	Element G Density 0.53 g/cm^3 Melting point 181°C Boiling point 1347°C Oxide formula G_2O
Element J Density 0.0013 g/cm^3 Melting point –210°C Boiling point –196°C Oxide formula J_2O_5	Element L Density 0.86 g/cm^3 Melting point 64°C Boiling point 774°C Oxide formula L_2O	Element Q Density 0.97 g/cm^3 Melting point 98°C Boiling point 883°C Oxide formula Q_2O

Refer to Figure 28 and answer the following Question:



Letter *Z* corresponds to an element on the Periodic Table other than the six listed elements. Elements *G*, *Q*, *L*, and *Z* are in the same group on the Periodic Table, as shown in the diagram to the left.

Based on the trend in the melting points for elements *G*, *Q*, and *L* listed in the “Properties of Six Elements at Standard Pressure” table, estimate the melting point of element *Z*, in degrees Celsius.

Answer

The melting point of element *Z* is less than 64°C.

42

Figure 29

Base your answer to the question on the information below.

Testing of an unknown solid shows that it has the properties listed below.

(1) low melting point
(2) nearly insoluble in water
(3) nonconductor of electricity
(4) relatively soft solid

Refer to Figure 29 and answer the following Question:

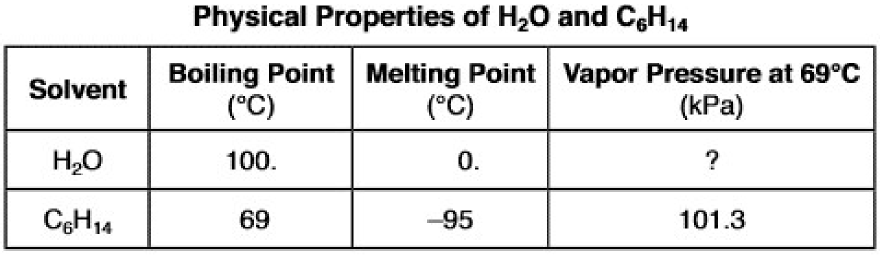
Explain in terms of attractions between particles why the unknown solid has a low melting point.

Answer

Acceptable responses include, but are not limited to, these examples:

- The intermolecular attractions between the particles of the solid are weak.
- weak intermolecular attractions

43 Water, H_2O, and hexane, C_6H_{14}, are commonly used as laboratory solvents because they have different physical properties and are able to dissolve different types of solutes. Some physical properties of water and hexane are listed on the table below.



Physical Properties of H_2O and C_6H_{14}

Solvent	Boiling Point (°C)	Melting Point (°C)	Vapor Pressure at 69°C (kPa)
H_2O	100.	0.	?
C_6H_{14}	69	–95	101.3

Explain, in terms of molecular formulas and structural formulas, why 2,2-dimethylbutane is an isomer of hexane.

Answer

Acceptable responses include, but are not limited to:

- The hexane and the 2,2-dimethylhexane have the same molecular formula but have different structural formulas.
- Both molecules have the same number of C atoms and the same number of H atoms but have a different arrangement of atoms.
- Both compounds are C_6H_{14}, but have different structures.

44

Figure 30

Base your answer to the question on the information below and on your knowledge of chemistry.

Molecules containing two carbon atoms and a functional group have many home and industrial uses. These compounds can be produced by a variety of reactions, as shown by the equations below.

Equation 1: $C_2H_4 + H2O \rightarrow CH_3CH_2OH$

Equation 2: $2\ CH_3CH_2OH + O_2 \rightarrow 2CH_3CHO + 2H_2O$

Equation 3: $2CH_3CHO + O_2 \rightarrow 2CH_3COOH$

Refer to Figure 30 and answer the following Question:

Explain, in terms of atoms, why CH_3CH_2OH and CH_3CHO are *not* isomers of each other.

Answer

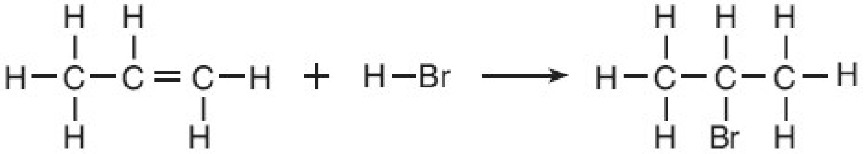
Acceptable responses include, but are not limited to:

- The CH_3CH_2OH has 2 carbon atoms, 6 hydrogen atoms, and 1 oxygen atom, while the CH_3CHO has 2 carbon atoms, 4 hydrogen atoms, and 1 oxygen atom.
- They don’t have the same number of H atoms.
- different molecular formulas

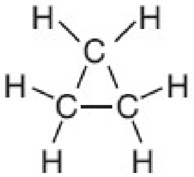
Figure 31

Base your answers to the question on the information below and on your knowledge of chemistry.

The equation below represents a reaction between propene and hydrogen bromide.



Cyclopropane, an isomer of propene, has a boiling point of –33ºC at standard pressure and is represented by the formula below.



Refer to Figure 31 and answer the following Question:

Explain, in terms of molecular formulas and structural formulas, why cyclopropane is an isomer of propene.

Answer

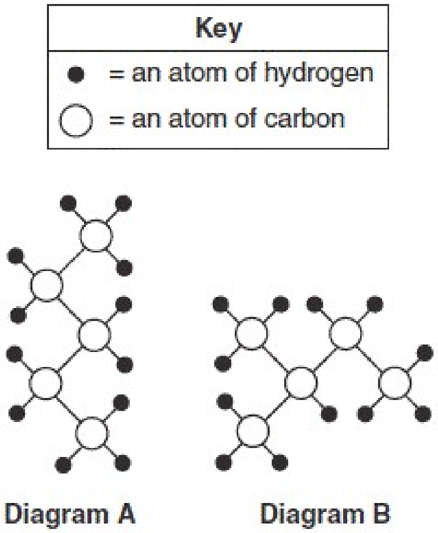
Acceptable responses include, but are not limited to:

- The molecular formulas for the two compounds are the same, but the structural formulas are different.
- Both molecules have the same number of C atoms and the same number of H atoms, but have a different arrangement of atoms.
- Both compounds are C_3H_6, but have different structures.
- Both compounds are C_3H_6, but one has a ring and one has a double bond.

Figure 32

Base your answer to the question on the information below and on your knowledge of chemistry.

The diagrams below represent ball-and-stick models of two molecules. In a ball-and-stick model, each ball represents an atom, and the sticks between balls represent chemical bonds.



Refer to Figure 32 and answer the following Question:

Explain why the molecules in diagrams *A* and *B* are isomers of each other.

Answer

Acceptable responses include, but are not limited to:

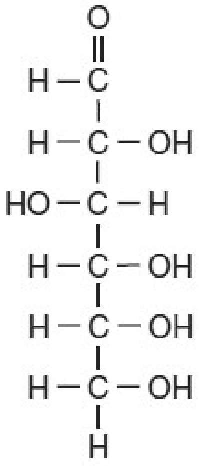
- Both molecules have the same molecular formula, but have different structural formulas.
- Both molecules are composed of 5 carbon atoms and 12 hydrogen atoms, but differ in the arrangement of their atoms.

47

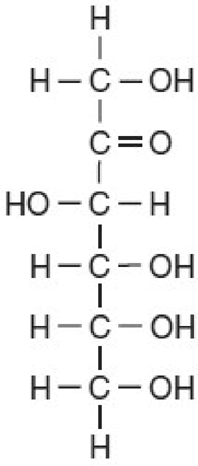
Figure 33

Base your answer to the question on the information below and on your knowledge of chemistry.

Table sugar, sucrose, is a combination of two simple sugars, glucose and fructose. The formulas below represent these simple sugars.



Glucose



Fructose

Refer to Figure 33 and answer the following Question:
Explain, in terms of atoms and molecular structure, why glucose and fructose are isomers of each other.

Answer

Acceptable responses include, but are not limited to:

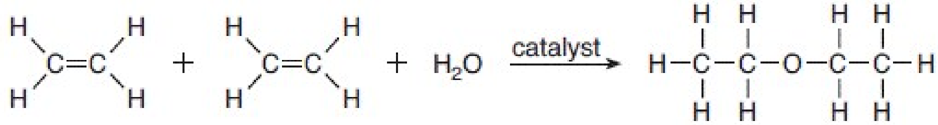
- The number of each kind of atom is the same in both, but their structures are not the same.
- Their molecular formulas are the same, but their structural arrangement of atoms is different.
- same molecular formula but different structural formulas
- The only difference is the arrangement of the atoms.

48

Figure 34

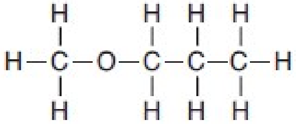
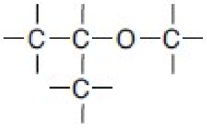
Base your answer to the question on the information below and on your knowledge of chemistry.

Diethyl ether is used as a laboratory and industrial solvent. The boiling point of diethyl ether at standard pressure is 34.6°C. The equation below represents a reaction that produces diethyl ether.



Refer to Figure 34 and answer the following Question:
Draw a structural formula for an isomer of the product that has the same functional group.

Answer

- 
- 

49

Figure 35

Base your answer to this question on the information below.

Biodiesel is an alternative fuel for vehicles that use petroleum diesel. Biodiesel is produced by reacting vegetable oil with CH_3OH. Methyl palmitate, $C_{15}H_{31}COOCH_3$, a compound found in biodiesel, is made from soybean oil. One reaction of methyl palmitate with oxygen is represented by the balanced equation below.

$$2C_{15}H_{31}COOCH_3 + 49O_2 \rightarrow 34CO_2 + 34H_2O + \text{energy}$$

Refer to Figure 35 and answer the following Question:
Explain, in terms of ***both*** atoms and molecular structure, why there is no isomer of CH_3OH.

Answer

Acceptable responses include, but are not limited to:

- With only one carbon atom bonded to one oxygen atom, there can be no rings or chains with branches in the molecular structure.
- There are too few atoms to create a different molecular structure.

50 Refer to Figure 25 and answer the following Question:

Which type of mixture is mixture *B*?

Answer

Acceptable responses include, but are not limited to:

- heterogeneous
- non-uniform mixture

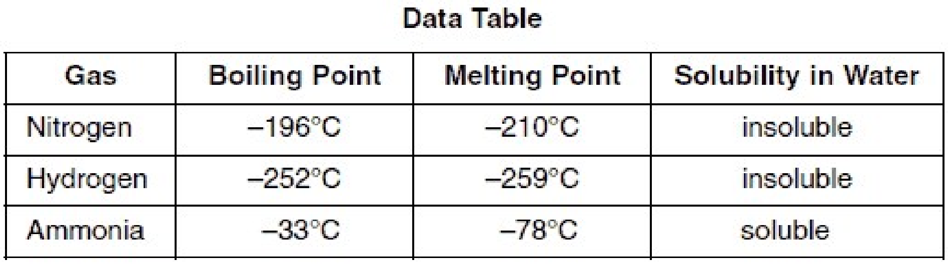
Separation Techniques
Video #2

Name:__________________________ Class/Period:_______________________

Assignment: Video 2. Chemical and Physical Separation Techniques. Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 2/17 then answer the following questions

1 At equilibrium, nitrogen, hydrogen, and ammonia gases form a mixture in a sealed container. The data table below gives some characteristics of these substances.



Data Table

Gas	Boiling Point	Melting Point	Solubility in Water
Nitrogen	–196°C	–210°C	insoluble
Hydrogen	–252°C	–259°C	insoluble
Ammonia	–33°C	–78°C	soluble

Describe how to separate ammonia from hydrogen and nitrogen.

Answer

Acceptable responses include, but are not limited to, these examples:

- Lower the temperature to condense ammonia.
- Place all three gases in water. Ammonia will dissolve (is soluble).
- distillation

2

Figure 1

Base your answer to the question on the information below.

Natural gas is a mixture that includes butane, ethane, methane, and propane. Differences in boiling points can be used to separate the components of natural gas. The boiling points at standard pressure for these components are listed in the table below.

Data Table

Component of Natural Gas	Boiling Point at Standard Pressure (°C)
butane	−0.5
ethane	−88.6
methane	−161.6
propane	−42.1

Refer to Figure 1 and answer the following Question:
Identify a process used to separate the components of natural gas.

Answer

Acceptable responses include, but are not limited to:

- fractional distillation
- distillation

3

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

Rubbing alcohol sold in stores is aqueous 2-propanol, $CH_3CHOHCH_3(aq)$. Rubbing alcohol is available in concentrations of 70.% and 91% 2-propanol by volume.

To make 100. mL of 70.% aqueous 2-propanol, 70. mL of 2-propanol is diluted with enough water to produce a total volume of 100. mL. In a laboratory investigation, a student is given a 132-mL sample of 91% aqueous 2-propanol to separate using the process of distillation.

Refer to Figure 2 and answer the following Question:
Identify the property of the components that makes it possible to use distillation to separate the 2-propanol from water.

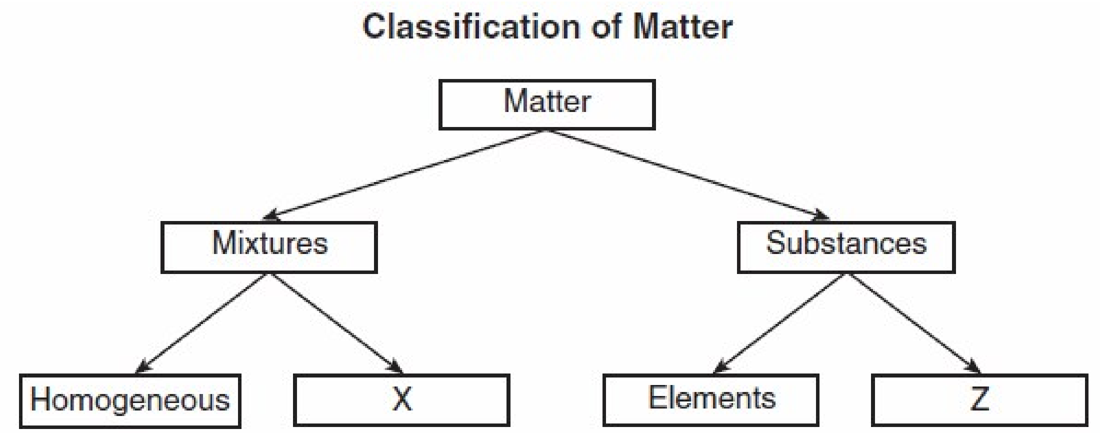
Answer

Acceptable responses include, but are not limited to:

- The water and the 2-propanol have different boiling points.
- strength of the intermolecular forces
- boiling point
- vapor pressure

Figure 3

Base your answer to the question on the diagram below concerning the classification of matter.



Refer to Figure 3 and answer the following Question:

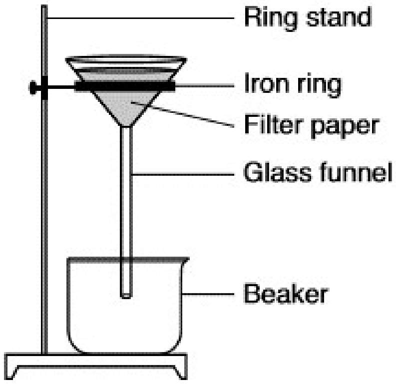
Given a mixture of sand and water, state *one* process that can be used to separate water from the sand.

Answer

Acceptable responses include, but are not limited to:

- Evaporate the water.
- Decant the water.
- filtration

5 During a laboratory activity, appropriate safety equipment is used and safety procedures are followed. A student separates a sample of rock salt that has two components; NaCl(s) and small insoluble rock particles. First, the student thoroughly stirs the sample of rock salt into a sample of water in a flask. The mixture in the flask is filtered using the lab apparatus shown below.



The water is evaporated from the beaker. The filter paper and its contents are dried. The data collected by the student are shown in the table below.

Rock Salt Separation Lab Data

Object or Material	Mass (g)
rock salt sample	16.4
filter paper	1.6
clean empty beaker	224.2
filter paper with dry rock particles	2.2
beaker with dry NaCl(s)	240.0

Explain, in terms of particle size, why the rock particles are trapped by the filter paper.

Answer

Acceptable responses include, but are not limited to:

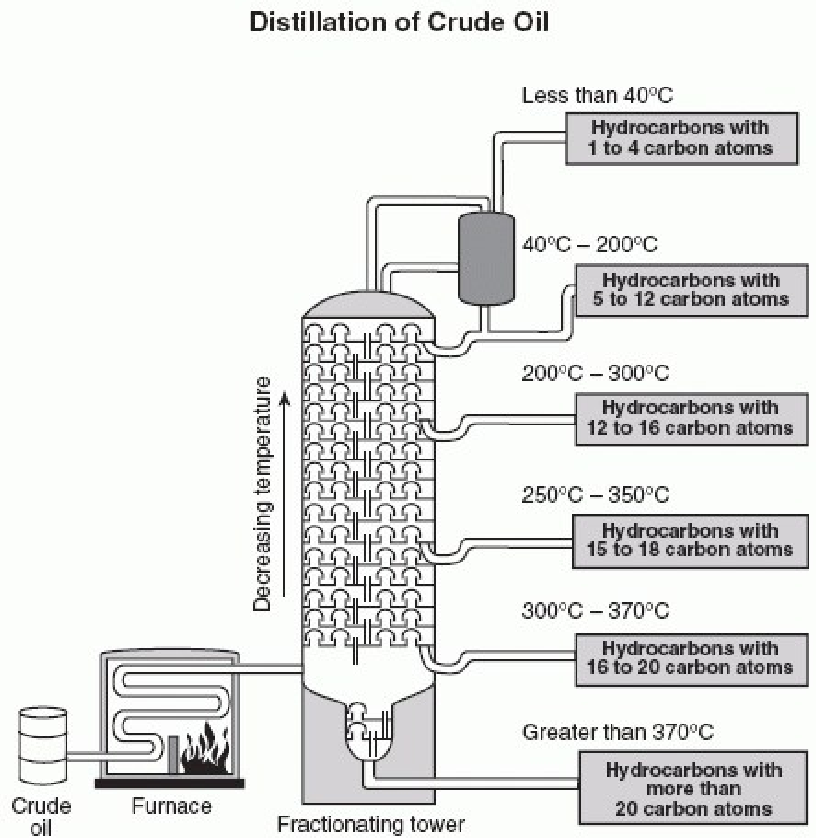
- The particles of the rock are much larger than the openings in the filter paper.
- The rock particles are too big to pass through the paper.

6 Answer => 3

Figure 4

Crude oil is a mixture of many hydrocarbons that have different numbers of carbon atoms. The use of a fractionating tower allows the separation of this mixture based on the boiling points of the hydrocarbons.

To begin the separation process, the crude oil is heated to about 400°C in a furnace, causing many of the hydrocarbons of the crude oil to vaporize. The vaporized mixture is pumped into a fractionating tower that is usually more than 30 meters tall. The temperature of the tower is highest at the bottom. As vaporized samples of hydrocarbons travel up the tower, they cool and condense. The liquid hydrocarbons are collected on trays and removed from the tower. The diagram below illustrates the fractional distillation of the crude oil and the temperature ranges in which the different hydrocarbons condense.



Refer to Figure 4 and answer the following Question:

Base your answer to the question on the information and diagram and on your knowledge of chemistry.

What is the trend between the boiling point of the hydrocarbons contained in the crude oil and the number of carbon atoms in these molecules?

1 As the number of carbon atoms in these molecules decreases, the boiling point increases.
2 As the number of carbon atoms in these molecules decreases, the boiling point stays the same.
3 As the number of carbon atoms in these molecules increases, the boiling point increases.
4 As the number of carbon atoms in these molecules increases, the boiling point decreases.

7 Answer => 4

Differences in which property allow the separation of a sample of sand and seawater by filtration?

1 concentration of ions
2 volume of sample
3 mass of sample
4 particle size

8 Answer => 3

A compound is broken down by chemical means during:

1 chromatography
2 distillation
3 electrolysis
4 filtration

9 Sir William Ramsey is one scientist credited with identifying the noble gas argon. Sir Ramsey separated nitrogen gas from the air and reacted it with an excess of magnesium, producing solid magnesium nitride. However, a small sample of an unreactive gas remained with a density different from the density of the nitrogen gas. Sir Ramsey identified the unreactive gas as argon and later went on to discover neon, krypton, and xenon.

Compare the density of nitrogen gas to the density of argon gas when both gases are at 298 K and 101.3 kPa.

Answer

Acceptable responses include, but are not limited to:

- The density of nitrogen gas is less than the density of argon gas.
- Argon is more dense.
- Nitrogen gas has a density of 0.001145 g/cm3, which is less than the density of argon.

10 Answer => 4

Table sugar can be separated from a mixture of table sugar and sand at STP by adding

1 sand, stirring, and distilling at 100.^{o}C
2 sand, stirring, and filtering
3 water, stirring, and distilling at 100.^{o}C
4 water, stirring, and filtering

11 Answer => 2

Paper chromatography is a method used in

1 comparing the shapes of plant leaves
2 separating mixtures of plant pigments
3 comparing habitats of different plants
4 separating individual DNA fragments of plants

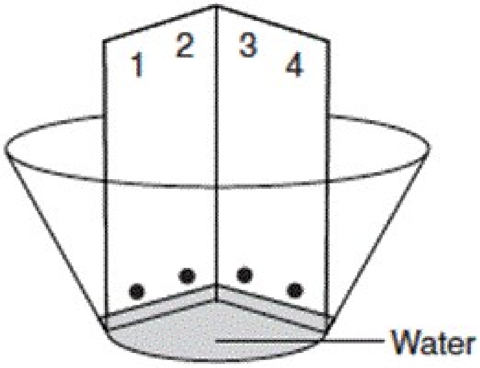
12 Answer <u>=> 4</u>

A mixture consists of sand and an aqueous salt solution. Which procedure can be used to separate the sand, salt, and water from each other?

1 Evaporate the water, then filter out the salt.
2 Evaporate the water, then filter out the sand.
3 Filter out the salt, then evaporate the water.
4 Filter out the sand, then evaporate the water.

13 Answer <u>=> 4</u>

A laboratory setup that can be used to provide information about relationships between four plant species is represented below.

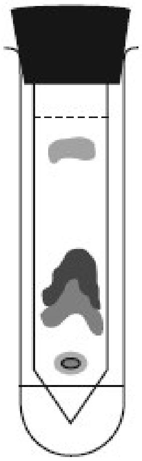


This setup is part of the technique known as

1 electrophoresis
2 biological staining
3 dissection
4 chromatography

14 Answer <u>=> 1</u>

The diagram below represents the results of a laboratory procedure.

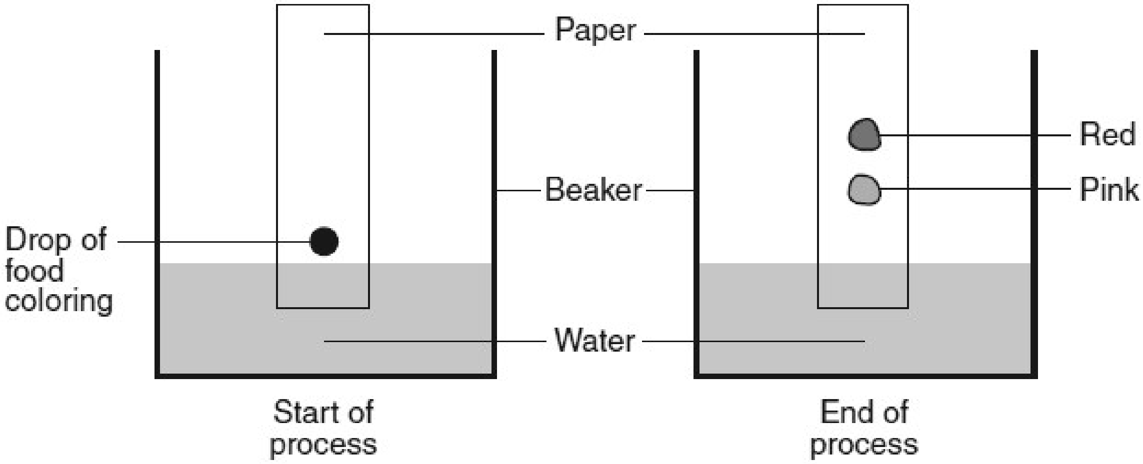


This procedure is used to

1 separate molecules in a liquid mixture
2 determine the rate of photosynthesis in plants
3 detect glucose in a solution
4 examine the gene sequences of organisms

15 Answer => 1

Given the diagram representing a process being used to separate the colored dyes in food coloring:



Which process is represented by this diagram?

1 chromatography
2 electrolysis
3 distillation
4 titration

16 Answer => 4

A mixture of sand and table salt can be separated by filtration because the substances in the mixture differ in

1 boiling point
2 density at STP
3 freezing point
4 solubility in water

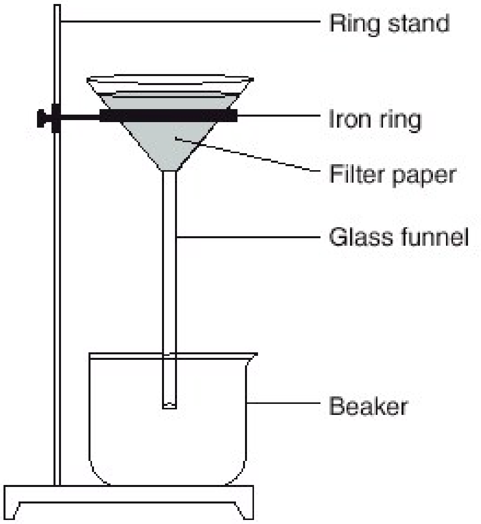
17 Answer => 1

A dry mixture of KNO_3 and sand could be separated by

1 adding water to the mixture and filtering
2 adding water to the mixture and evaporating
3 heating the mixture to a high temperature
4 cooling the mixture to a low temperature

18 Answer => 1

Which mixture can be separated by using the equipment shown in the diagram?



1 $NaCl(aq)$ and $SiO_2(s)$
2 $NaCl(aq)$ and $C_6H_{12}O_6(aq)$
3 $CO_2(aq)$ and $NaCl(aq)$
4 $CO_2(aq)$ and $C_6H_{12}O_6(aq)$

19 Answer => 1

In a laboratory investigation, a student separates colored compounds obtained from a mixture of crushed spinach leaves and water by using paper chromatography. The colored compounds separate because of differences in

1 molecular polarity
2 malleability
3 boiling point
4 electrical conductivity

20 Answer => 2

Which process requires energy for a nonspontaneous redox reaction to occur?

1 deposition
2 electrolysis
3 alpha decay
4 chromatography

21 Answer => 4

Which two physical properties allow a mixture to be separated by chromatography?

1 hardness and boiling point
2 density and specific heat capacity
3 malleability and thermal conductivity
4 solubility and molecular polarity

22 Answer => 3

Which procedure requires the use of an external electric current to force a redox reaction to occur?

1 polymerization
2 distillation
3 electrolysis
4 saponification

23 Answer => 4

Group 1 and Group 2 metals are obtained commercially from their fused compounds by

1 reduction with CO
2 reduction by heat
3 reduction with Al
4 electrolytic reduction

24 Answer => 2

Which metal is obtained commercially by the electrolysis of its salt?

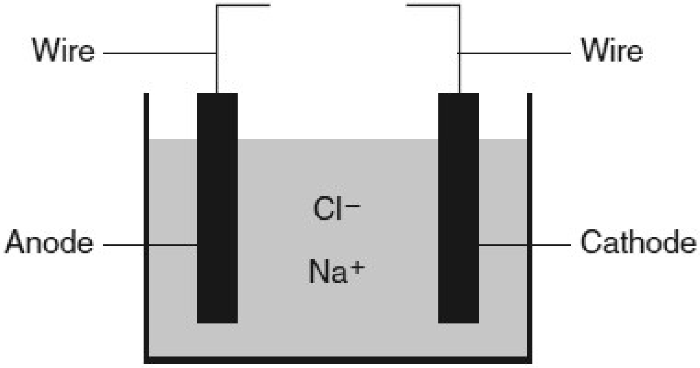
1 Zn
2 K
3 Fe
4 Ag

Figure 5

Base your answer to the question on the information below.

Metallic elements are obtained from their ores by reduction. Some metals, such as zinc, lead, iron, and copper, can be obtained by heating their oxides with carbon.

More active metals, such as aluminum, magnesium, and sodium, can *not* be reduced by carbon. These metals can be obtained by the electrolysis of their molten (melted) ores. The diagram below represents an incomplete cell for the electrolysis of molten NaCl. The equation below represents the reaction that occurs when the completed cell operates.



$$2NaCl(\ell) \rightarrow 2Na(\ell) + Cl_2(g)$$

Refer to Figure 5 and answer the following Question:

Identify the component required for the electrolysis of molten NaCl that is missing from the cell diagram.

Answer

Acceptable responses include, but are not limited to:

- source of electrical energy
- battery

Periodic Table
Video #3

Name:__________________________ Class/Period:_______________________

Assignment: Video 3. Periodic Table: Trends and Properties of Elements

Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 3/17 then answer the following questions.

1 Sir William Ramsey is one scientist credited with identifying the noble gas argon. Sir Ramsey separated nitrogen gas from the air and reacted it with an excess of magnesium, producing solid magnesium nitride. However, a small sample of an unreactive gas remained with a density different from the density of the nitrogen gas. Sir Ramsey identified the unreactive gas as argon and later went on to discover neon, krypton, and xenon.

State, in terms of valence electrons, why the noble gases that Sir Ramsey discovered have similar chemical properties.

Answer

Acceptable responses include, but are not limited to:

- Their atoms have the same number of valence electrons.
- These elements have similar chemical properties because their atoms have valence electron shells with a complete octet.
- Their outermost shells have 8 e.
- They have a full outermost shell of electrons.

2 Periodic trends are observed in the properties of the elements in Period 3 on the Periodic Table. These elements vary in physical properties, such as phase, and in chemical properties, such as their ability to lose or gain electrons during chemical reaction.

State the general trend in atomic radius as the elements in Period 3 are considered in order of increasing atomic number.

Answer

Possible answers include:

- As the atomic number of the elements in Period 3 increases, the atomic radius generally decreases.
- The radius gets smaller.

3 Periodic trends are observed in the properties of the elements in Period 3 on the Periodic Table. These elements vary in physical properties, such as phase, and in chemical properties, such as their ability to lose or gain electrons during chemical reaction.

Identify the element in Period 3 that requires the least amount of energy to remove the most loosely held electrons from a mole of gaseous atoms of the element in the ground state.

Answer

Na or sodium

Ionization energy is defined as the amount of energy to remove the most loosely held electrons from a mole of gaseous atoms of the element in the ground state. Ionization energy decreases moving down a group as the shielding effect increases, making it easier to remove the outermost electron. Therefore, ***sodium*** has the smallest ionization energy.

4 Periodic trends are observed in the properties of the elements in Period 3 on the Periodic Table. These elements vary in physical properties, such as phase, and in chemical properties, such as their ability to lose or gain electrons during chemical reaction. *Identify the metals in Period 3 on the Periodic Table.*

Answer

Na, Mg, Al

(Sodium, Magnesium, Aluminum)

Metals are located on the left hand side of the Periodic Table. Most tables have a bold stair-step line indicating the division of the metals and the nonmetals.

5

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

The elements in Group 2 on the Periodic Table can be compared in terms of first ionization energy, electronegativity, and other general properties.

Refer to Figure 1 and answer the following Question:

Describe the general trend in electronegativity as the metals in Group 2 on the Periodic Table are considered in order of increasing atomic number.

Answer

Electronegativity decreases as metals in Group 2 on the Periodic Table are considered in order of increasing atomic number. Electronegativity is defined as an atoms attraction for electrons when bonded to another atom. As an atom gets bigger and bigger with electrons added into additional energy levels, they are shielded from the positive pull from the nucleus and therefore not held as tightly.

6 Base your answer to the question on the elements in Group 2 on the Periodic Table.
State, in terms of the number of electron shells, why the radius of a strontium atom in the ground state is larger than the radius of a magnesium atom in the ground state.

Answer

Acceptable responses include, but are not limited to:

- A strontium atom in the ground state has two more electron shells than a magnesium atom in the ground state.
- An Mg atom has fewer electron shells.

7 Base your answer to the question on the elements in Group 2 on the Periodic Table.
Explain, in terms of atomic structure, why the elements in Group 2 have similar chemical properties.

Answer

Acceptable responses include, but are not limited to:

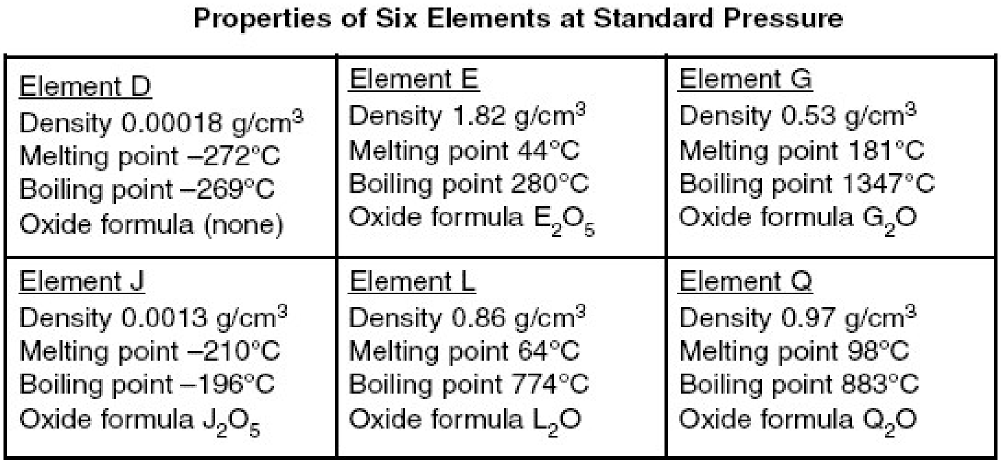
- In the ground state, an atom of each element has two valence electrons.
- The number of electrons in the outermost shell of each atom is the same.

8

Figure 2

Base your answer to the question on the information below.

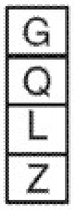
The table below lists physical and chemical properties of six elements at standard pressure that correspond to known elements on the Periodic Table. The elements are identified by the code letters, *D*, *E*, *G*, *J*, *L*, and *Q*.



Properties of Six Elements at Standard Pressure

Element D Density 0.00018 g/cm^3 Melting point –272°C Boiling point –269°C Oxide formula (none)	Element E Density 1.82 g/cm^3 Melting point 44°C Boiling point 280°C Oxide formula E_2O_5	Element G Density 0.53 g/cm^3 Melting point 181°C Boiling point 1347°C Oxide formula G_2O
Element J Density 0.0013 g/cm^3 Melting point –210°C Boiling point –196°C Oxide formula J_2O_5	Element L Density 0.86 g/cm^3 Melting point 64°C Boiling point 774°C Oxide formula L_2O	Element Q Density 0.97 g/cm^3 Melting point 98°C Boiling point 883°C Oxide formula Q_2O

Refer to Figure 2 and answer the following Question:



Letter *Z* corresponds to an element on the Periodic Table other than the six listed elements. Elements *G*, *Q*, *L*, and *Z* are in the same group on the Periodic Table, as shown in the diagram to the left.

Based on the trend in the melting points for elements *G*, *Q*, and *L* listed in the "Properties of Six Elements at Standard Pressure" table, estimate the melting point of element *Z*, in degrees Celsius.

Answer

The melting point of element *Z* is less than 64°C.

9

Figure 3

Base your answer to the question on the information below.

Element *X* is a solid metal that reacts with chlorine to form a water-soluble binary compound.

Refer to Figure 3 and answer the following Question:

State *one* physical property of element *X* that makes it a good material for making pots and pans.

Answer

Acceptable responses include, but are not limited to:

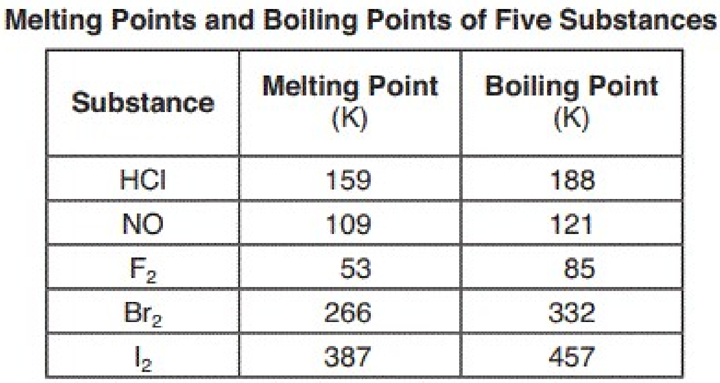
- conducts heat
- high melting point
- It is malleable.

10 **Refer to Figure 1 and answer the following Question:**
Explain, in terms of electron configuration, why the elements in Group 2 have similar chemical properties.

Answer

The elements in Group 2 all have 2 valence electrons. Because the number of valence electrons determines how an element reacts and with what other elements it will form compounds with, it ultimately determines the element's chemical properties. Therefore, ***elements in Group 2 have similar chemical properties due to the fact they all have 2 valence electrons.***

11 The melting points and boiling points of five substances at standard pressure are listed on the table below.



Melting Points and Boiling Points of Five Substances

Substance	Melting Point (K)	Boiling Point (K)
HCl	159	188
NO	109	121
F_2	53	85
Br_2	266	332
I_2	387	457

State, in terms of the strength of intermolecular forces, why I_2 has a higher boiling point than F_2.

Answer

The stronger the intermolecular forces the harder it is increase the distance between molecules in order to achieve the gas phase and boil. Acceptable responses include, but are not limited to:

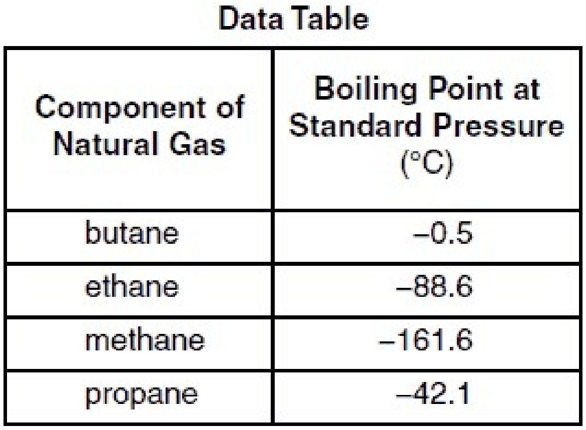
- The I_2 has stronger intermolecular forces than F_2.
- The F_2 has weaker IMF.

12

Figure 4

Base your answer to the question on the information below.

Natural gas is a mixture that includes butane, ethane, methane, and propane. Differences in boiling points can be used to separate the components of natural gas. The boiling points at standard pressure for these components are listed in the table below.



Data Table

Component of Natural Gas	Boiling Point at Standard Pressure (°C)
butane	–0.5
ethane	–88.6
methane	–161.6
propane	–42.1

Refer to Figure 4 and answer the following Question:
List the *four* components of natural gas in order of increasing strength of intermolecular forces.

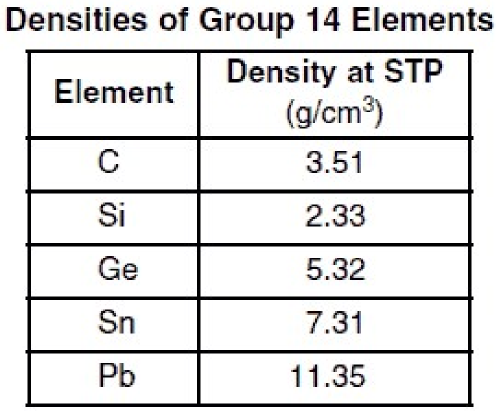
Answer

In order of weakest to strongest intermolecular forces:
methane, ethane, propane, butane

13

Figure 5

Base your answer to this question on the information below.



Densities of Group 14 Elements

Element	Density at STP (g/cm^3)
C	3.51
Si	2.33
Ge	5.32
Sn	7.31
Pb	11.35

Refer to Figure 5 and answer the following Question:
Identify *one* element from this table for *each* type of element: metal, metalloid, and nonmetal.

Answer

Metal: tin *or* Sn *or* lead *or* Pb
Metalloid: silicon *or* Si *or* germanium *or* Ge
Nonmetal: carbon *or* C

14

Figure 6

Base your answer to the question on the information below and on your knowledge of chemistry.

There are six elements in Group 14 on the Periodic Table. One of these elements has the symbol Uuq, which is a temporary, systematic symbol. This element is now known as flerovium.

Refer to Figure 6 and answer the following Question:

Identify an element in Group 14 that is classified as a metalloid.

Answer

Acceptable responses include, but are not limited to:

- Si
- germanium
- element 32

15

Figure 7

Base your answer to the question on the information below and on your knowledge of chemistry.

The elements in Group 17 are called halogens. The word "halogen" is derived from Greek and means "salt former."

Refer to Figure 7 and answer the following Question:

State the trend in electronegativity for the halogens as these elements are considered in order of increasing atomic number.

Answer

Acceptable responses include, but are not limited to:

- As atomic number increases, electronegativity decreases.
- Electronegativity decreases.

16 Explain, in terms of activity, why HCl(aq) reacts with Zn(s), but HCl(aq) does *not* react with Cu(s).

Answer

Acceptable responses include, but are not limited to:

- Zinc is more active than hydrogen, but copper is less active than hydrogen.
- On Table *J*, Zn is above H_2, and Cu is below H_2.

17

Figure 8

Base your answer to the question on the balanced equation below.

$Fe(s) + 2HNO_3(aq) \rightarrow Fe(NO_3)_2(aq) + H_2(g)$

Refer to Figure 8 and answer the following Question:

Explain, using information from Reference Table *J*, why this reaction is spontaneous.

Answer

Examples:

- Iron is more active than hydrogen.
- Fe is listed higher on Table *J* than H_2.

18 Explain, in terms of atomic structure, why Group 18 elements on the Periodic Table rarely form compounds.

Answer

Acceptable responses include, but are not limited to:

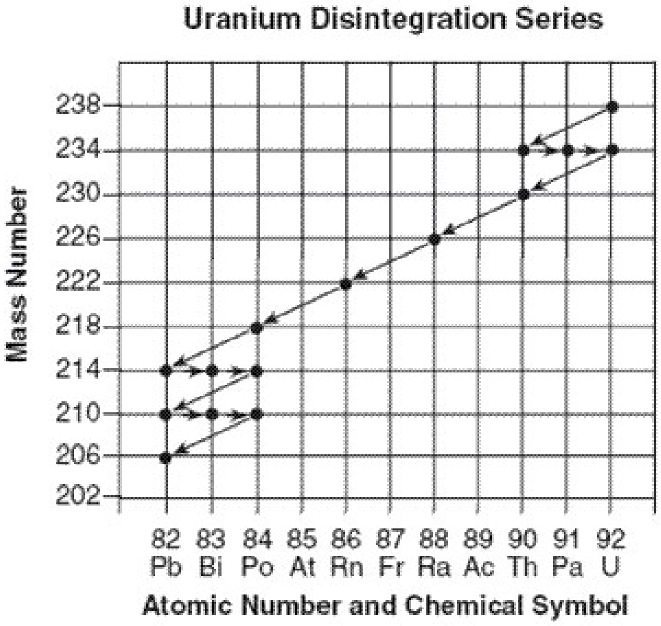
- Group 18 elements rarely form compounds because their atoms have stable electron configurations.
- Their valence shells are completely filled.
- All the elements have maximum numbers of valence electrons.
- Atoms of Group 18 have a stable octet except He, which is stable with two electrons.

19

Figure 9

Base your answer to the question on the information below.

A U-238 atom decays to a Pb-206 atom through a series of steps. Each point on the graph below represents a nuclide, and each arrow represents a nuclear decay mode.



Refer to Figure 9 and answer the following Question:

Explain why the U-238 disintegration series ends with the nuclide Pb-206.

Answer

Acceptable responses include, but are not limited to:

- The nucleus of Pb-206 is stable.
- Pb-206 is not radioactive.
- If Pb-206 were not stable, it would spontaneously decay.

20 Answer => 3

For most atoms with an atomic number less than 20, nuclear stability occurs when the ratio of neutrons to protons is 1:1. Which of the following atoms would be most likely to have an unstable nucleus?

1 $^{4}_{2}\mathrm{He}$

2 $^{12}_{6}\mathrm{C}$

3 $^{16}_{7}\mathrm{N}$

4 $^{24}_{12}\mathrm{Mg}$

Particle Diagrams
Video #4a

Name:__________________________ Class/Period:_______________________

Assignment: Video 4a. Particle Diagrams. Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 4a/17 then answer the following questions.

1

Figure 1

Base your answer to the question on the information below.

In an investigation, a dripless wax candle is massed and then lighted. As the candle burns, a small amount of liquid wax forms near the flame. After 10 minutes, the candle's flame is extinguished and the candle is allowed to cool. The cooled candle is massed.

Refer to Figure 1 and answer the following Question:

Identify *one* physical change that takes place in this investigation.

Answer

Acceptable responses include, but are not limited to:

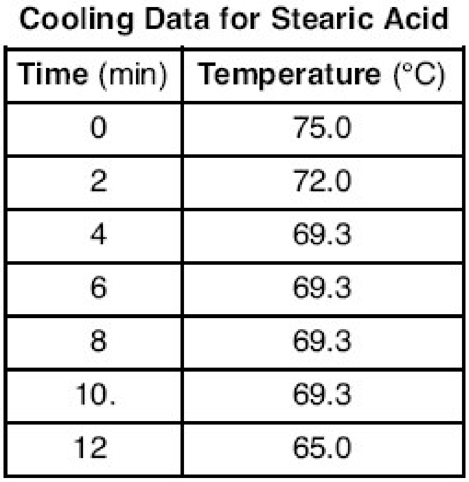
- melting
- vaporization
- solidification

2

Figure 2

Base your answer to the question on the information below.

A 150.-gram liquid sample of stearic acid, $C_{17}H_{35}COOH$, is cooled at a constant rate. The temperature of the sample is recorded at 2-minute intervals in the data table below.



Cooling Data for Stearic Acid

Time (min)	Temperature (°C)
0	75.0
2	72.0
4	69.3
6	69.3
8	69.3
10.	69.3
12	65.0

Refer to Figure 2 and answer the following Question:

Identify the physical change occurring during the time interval 4 minutes to 10. minutes.

Answer

Acceptable responses include, but are not limited to:

- solidification
- freezing
- crystallization

3

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

Wood is mainly cellulose, a polymer produced by plants. One use of wood is as a fuel in campfires, fireplaces, and wood furnaces. The molecules of cellulose are long chains of repeating units. Each unit of the chain can be represented as $C_6H_{10}O_5$.

The balanced equation below represents a reaction that occurs when $C_6H_{10}O_5$ is burned in air.

$C_6H_{10}O_5 + 6O_2 \rightarrow 6CO_2 + 5H_2O$ + heat

Refer to Figure 3 and answer the following Question:
Explain, in terms of substances in the reaction, why the equation represents a chemical change.

Answer

Acceptable responses include, but are not limited to:

- The products of the reaction are different substances than the reactants.
- The chemical properties of the reactants and the products are different.
- Bonds are broken in the reactants and new bonds are formed in the products.
- Different substances are formed.

4

Figure 4

Base your answer to the question on the information below.

The reaction between aluminum and an aqueous solution of copper(II) sulfate is represented by the unbalanced equation below.

$Al(s) + CuSO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + Cu(s)$

Refer to Figure 4 and answer the following Question:
Explain why the equation represents a chemical change.

Answer

Acceptable responses include, but are not limited to:

- The products are different substances with different properties from the reactants.
- There is a loss and gain of electrons by substances in the reaction.

5

Figure 5

Base your answer to the question on the information below.

Iron has been used for thousands of years. In the air, iron corrodes. One reaction for the corrosion of iron is represented by the balanced equation below.

Equation 1: $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$

In the presence of water, iron corrodes more quickly. This corrosion is represented by the unbalanced equation below.

Equation 2: $Fe(s) + O_2(g) + H_2O(\ell) \rightarrow Fe(OH)_2(s)$

Refer to Figure 5 and answer the following Question:

Identify *one* substance in the passage that can *not* be broken down by a chemical change.

Answer

Acceptable responses include, but are not limited to:

- Fe
- oxygen

6 **Refer to Figure 1 and answer the following Question:**

State *one* observation that indicates a chemical change has occurred in this investigation.

Answer

Acceptable responses include, but are not limited to:

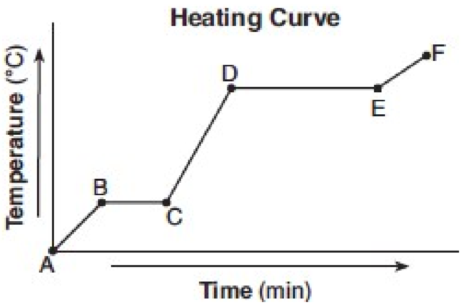
- The burning candle releases heat and light.
- A cobalt chloride test indicates water is produced.
- A limewater test indicates carbon dioxide gas is produced.

7

Figure 6

Base your answer to the question on the information below and on your knowledge of chemistry.

Starting as a solid, a sample of a molecular substance is heated, until the entire sample of the substance is a gas. The graph below represents the relationship between the temperature of the sample and the elapsed time.



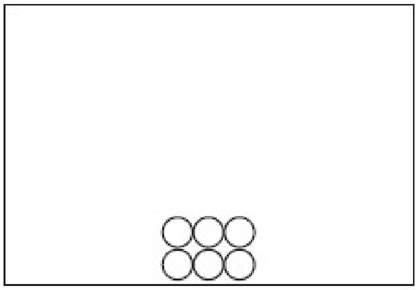
Refer to Figure 6 and answer the following Question:

Using the key, in the space below, draw a particle diagram to represent the sample during interval *AB*. Your response must include *at least six* molecules.

Key
○ = a molecule of the substance

Answer

The heating curve starts as a solid during interval *AB*. A correct particle diagram should show at least six particles touching and all packed together as solid particles would be. Examples of correct responses:



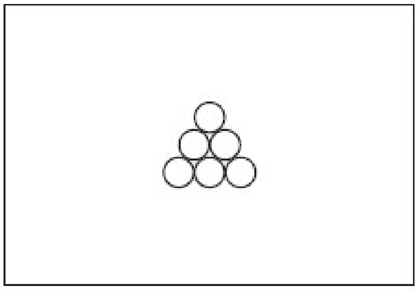


Figure 7

Base your answer to the question on the information below and on your knowledge of chemistry.

> Paintball is a popular recreational activity that uses a metal tank of compressed carbon dioxide or nitrogen to launch small capsules of paint. A typical tank has a volume of 508 cubic centimeters. A 340.-gram sample of carbon dioxide is added to the tank before it is used for paintball. At 20.°C, this tank contains both $CO_2(g)$ and $CO_2(\ell)$. After a paintball game, the tank contains only $CO_2(g)$.

Refer to Figure 7 and answer the following Question:

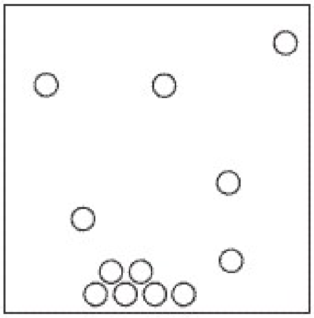
In the box below, use the key to draw a particle diagram to represent the two phases of CO_2 in a newly filled tank. Your response must include at least six molecules of CO_2 in each phase.

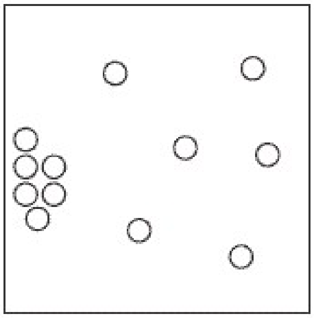
Key
○ = CO_2 molecule

Answer

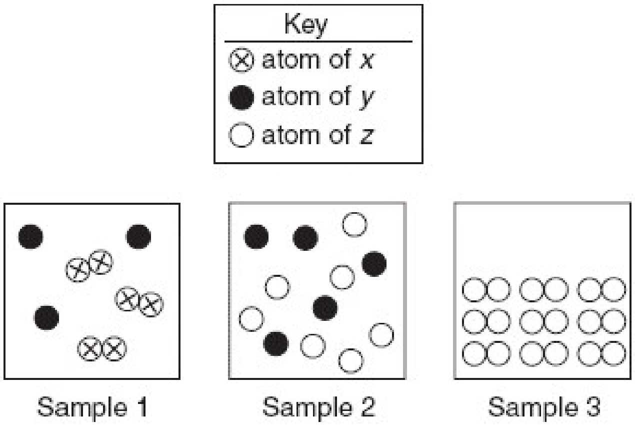
Molecules of the gas must be drawn farther apart than the molecules of the liquid.

Examples:





9 Base your answer to the question on the particle diagrams, which show atoms and/or molecules in three different samples of matter at STP.



Explain why ⊗⊗ does *not* represent a compound.

Answer

Acceptable responses include, but are not limited to, these examples:

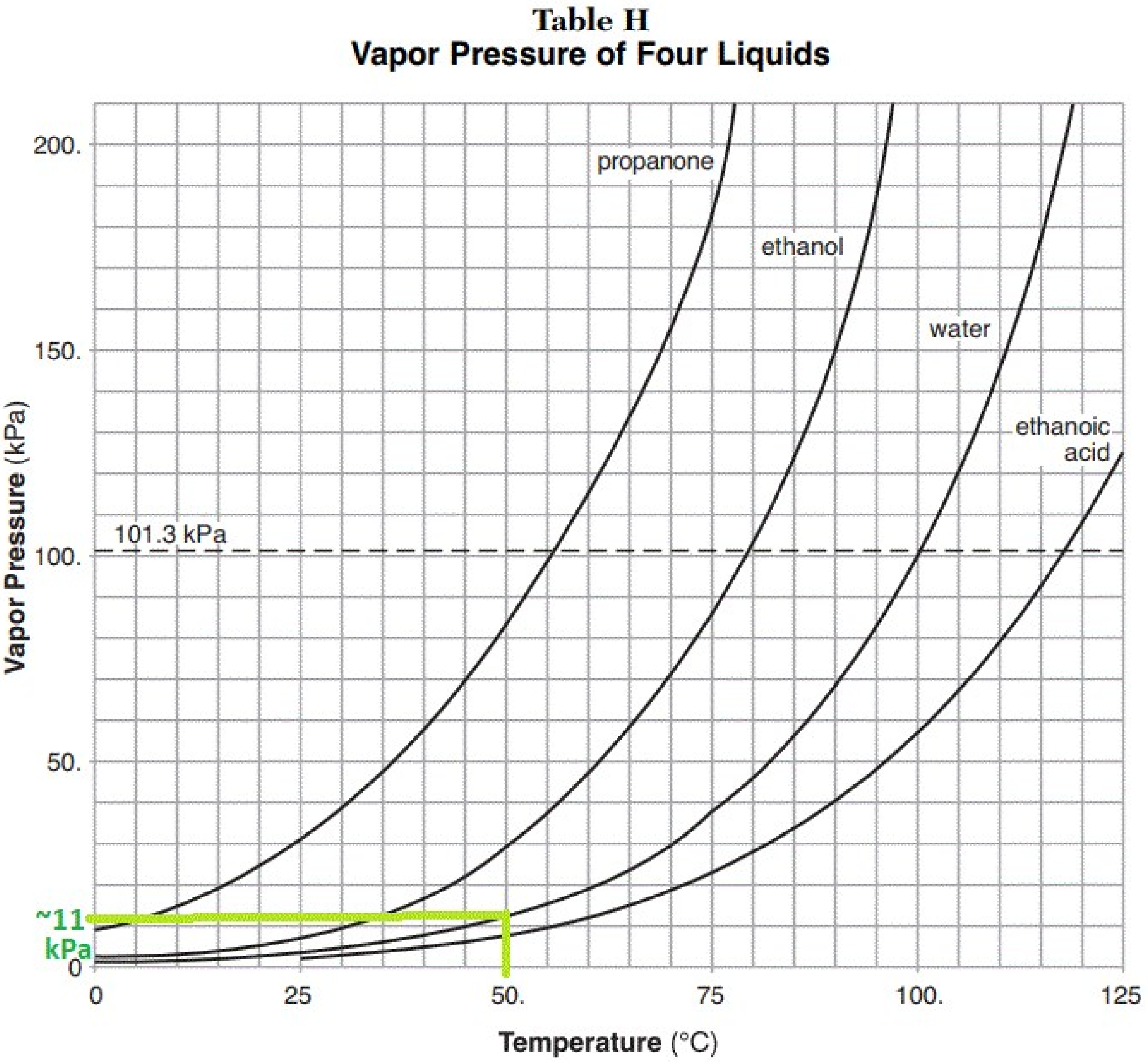
- A compound must contain two or more different elements.
- Only one kind of atom is present

10 A 100.-gram sample of liquid water is heated from 20.0°C to 50.0°C. Enough $KClO_3(s)$ is dissolved in the sample of water at 50.0°C to form a saturated solution.

Based on Table *H*, determine the vapor pressure of the water sample at its final temperature.

Answer

Any value from 11 kPa to 13 kPa, inclusive.



11 Water, H_2O, and hexane, C_6H_{14}, are commonly used as laboratory solvents because they have different physical properties and are able to dissolve different types of solutes. Some physical properties of water and hexane are listed on the table below.

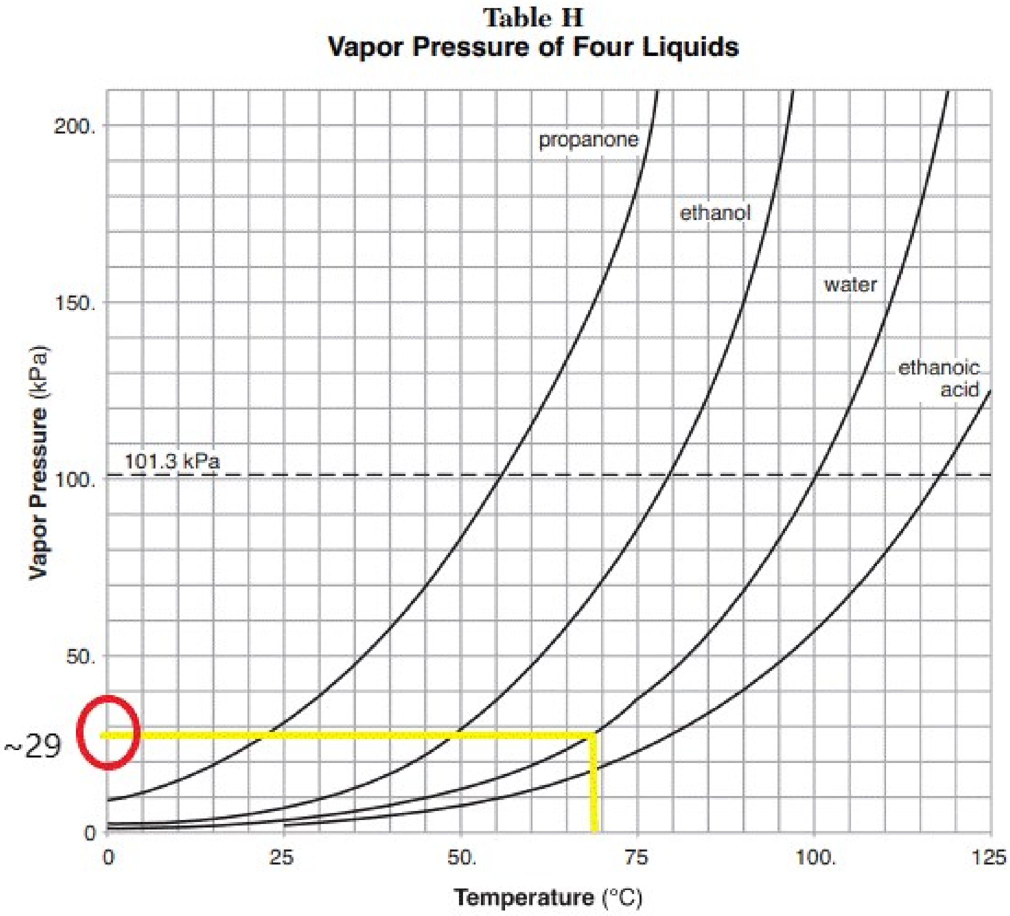
Physical Properties of H_2O and C_6H_{14}

Solvent	Boiling Point (°C)	Melting Point (°C)	Vapor Pressure at 69°C (kPa)
H_2O	100.	0.	?
C_6H_{14}	69	–95	101.3

Determine the vapor pressure of water at 69°C.

Answer

Any value from ***28 kPa to 30. kPa***, inclusive.



12 Base your answer to the question on the properties of propanone.

Explain, in terms of molecular energy, why the vapor pressure of propanone increases when its temperature increases.

Answer

Acceptable responses include, but are not limited to:

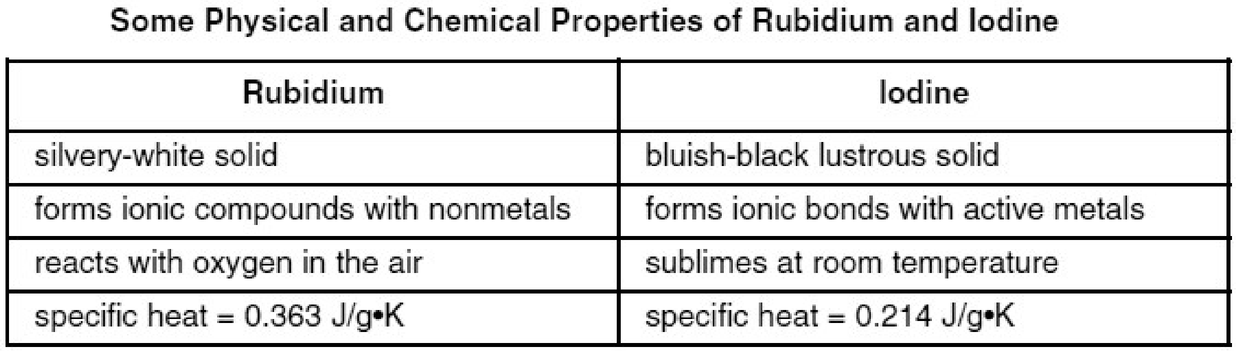
- As the temperature increases, more molecules have enough energy to escape the liquid phase.
- As the temperature increases, more molecules have the energy to become gases.

13

Figure 8

Base your answer to the question on the information below and on your knowledge of chemistry.

Rubidium and iodine have different chemical and physical properties. Some of these properties are shown in the table below.



Some Physical and Chemical Properties of Rubidium and Iodine

Rubidium	Iodine
silvery-white solid	bluish-black lustrous solid
forms ionic compounds with nonmetals	forms ionic bonds with active metals
reacts with oxygen in the air	sublimes at room temperature
specific heat = 0.363 J/g•K	specific heat = 0.214 J/g•K

Refer to Figure 8 and answer the following Question:

Compare the electrical conductivity of these two elements at STP.

Answer

Acceptable responses include, but are not limited to:

- Rubidium is a better electrical conductor than iodine at STP.
- I_2(s) is a poor conductor; Rb(s) is a good conductor.

14

Figure 9

Base your answer to the question on the information below.

Calcium reacts with water. This reaction is represented by the balanced equation below. The aqueous product of this reaction can be heated to evaporate the water, leaving a white solid, $Ca(OH)_2(s)$.

$Ca(s) + 2H_2O(\ell) \rightarrow Ca(OH)_2(aq) + H_2(g)$

Refer to Figure 9 and answer the following Question:
Compare the electrical conductivity of the aqueous product in the reaction to the electrical conductivity of the white solid that remains after the water is evaporated from the solution.

Answer

Acceptable responses include, but are not limited to:

- The solution can conduct an electric current better than the white solid.
- The $Ca(OH)_2(aq)$ is a good conductor and $Ca(OH)_2(s)$ is not.

15 The electrical conductivity of three aqueous solutions was tested at room temperature. A 0.1 M HCl(aq) solution conducted, but a 6.0 M HCl(aq) solution was a better conductor. A 0.1 M $C_6H_{12}O_6(aq)$ solution was also tested. During this laboratory activity, appropriate safety equipment was used and safety procedures were followed.
State, in terms of the concentration of ions, why the 6.0 M HCl(aq) is a better conductor of electricity than the 0.1 M HCl(aq).

Answer

Acceptable responses include, but are not limited to:

- There is a greater concentration of ions present in the 6.0 M HCl(aq) than in the 0.1 M HCl(aq).
- The 6.0 M HCl(aq) has a higher concentration of ions.

16

Figure 10

Base your answer to this question on the information below.

A phase change for carbon dioxide that occurs spontaneously at 20.°C and 1.0 atmosphere is represented by the balanced equation below.

$CO_2(s) + \text{energy} \rightarrow CO_2(g)$

Refer to Figure 10 and answer the following Question:
Write the name of this phase change.

Answer

Acceptable responses include, but are not limited to:

- sublimation

17

Figure 11

Base your answer to this question on the information below.

> At a pressure of 101.3 kilopascals and a temperature of 373 K, heat is removed from a sample of water vapor, causing the sample to change from the gaseous phase to the liquid phase. This phase change is represented by the equation below.
>
> $H_2O(g) \rightarrow H_2O(\ell) + \text{heat}$

Refer to Figure 11 and answer the following Question:

Explain, in terms of particle arrangement, why entropy *decreases* during this phase change.

Answer

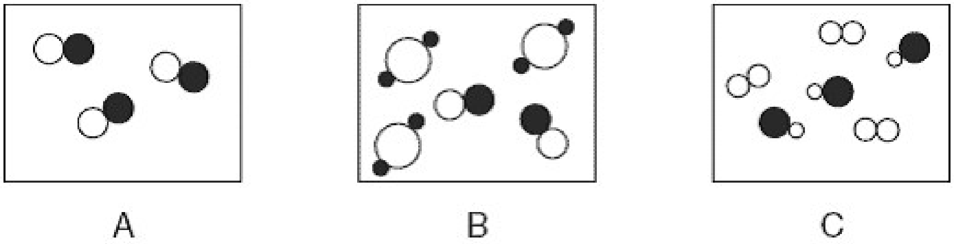
Acceptable responses include, but are not limited to:

- The arrangement of the H_2O molecules becomes more ordered as liquid water forms.
- As a liquid, the movement of the particles is less random.

18

Figure 12

Base your answer to the question on the particle diagrams. Samples *A*, *B*, and *C* contain molecules at STP.



Refer to Figure 12 and answer the following Question:

Explain why sample *C* could represent a mixture of fluorine and hydrogen chloride.

Answer

Acceptable responses include, but are not limited to, these examples:

- Sample *C* represents a diatomic element and a compound.
- shows an element and a compound mixed
- Sample *C* shows a compound made of two identical atoms that could be fluorine and a compound made of two different atoms that could be hydrogen chloride.

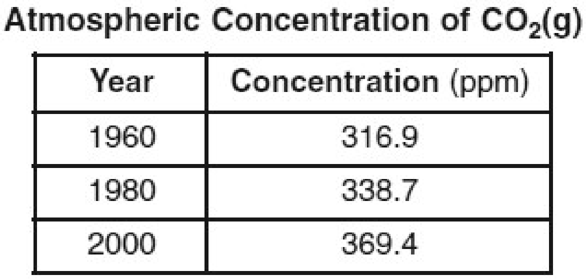
19

Figure 13

Base your answer to the question on the information below.

Nitrogen gas and oxygen gas make up about 99% of Earth's atmosphere. Other atmospheric gases include argon, carbon dioxide, methane, ozone, hydrogen, etc.

The amount of carbon dioxide in the atmosphere can vary. Data for the concentration of $CO_2(g)$ from 1960 to 2000 are shown in the table below.



Atmospheric Concentration of $CO_2(g)$

Year	Concentration (ppm)
1960	316.9
1980	338.7
2000	369.4

Refer to Figure 13 and answer the following Question:

Identify *one* diatomic element found in the atmosphere.

Answer

Acceptable answers include:

- H_2
- O_2
- N_2

20

Figure 14

Base your answer to the question on the information below.

Element *X* is a solid metal that reacts with chlorine to form a water-soluble binary compound.

Refer to Figure 14 and answer the following Question:

Explain, in terms of particles, why an aqueous solution of the binary compound conducts an electric current.

Answer

Acceptable responses include, but are not limited to:

- The aqueous solution has mobile ions.
- Charged particles can move in water.

21

Figure 15

Base your answer to the question on the data table below.

Formulas and Boiling Points of Selected Alkanes

Name	Formula	Boiling Point at 1 Atm (°C)
methane	CH_4	–162
ethane	C_2H_6	–89
propane	C_3H_8	–42
butane	C_4H_{10}	–0.5
pentane	C_5H_{12}	36

Refer to Figure 15 and answer the following Question:
What is the boiling point of propane at 1 atmosphere, in kelvins?

Answer: ☐K

Answer

231

22 Identify a type of strong intermolecular force that exists between water molecules, but does *not* exist between carbon dioxide molecules.

Answer

Acceptable responses include, but are not limited to:

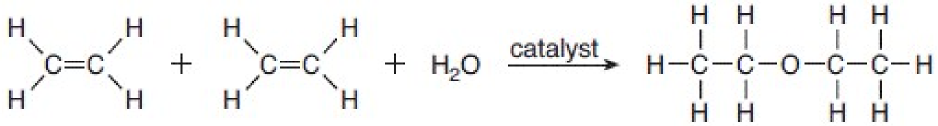
- hydrogen bonding
- dipole attractions
- dipole-dipole forces

23

Figure 16

Base your answer to the question on the information below and on your knowledge of chemistry.

Diethyl ether is used as a laboratory and industrial solvent. The boiling point of diethyl ether at standard pressure is 34.6°C. The equation below represents a reaction that produces diethyl ether.



Refer to Figure 16 and answer the following Question:
Explain, in terms of the strength of intermolecular forces, why the boiling point of diethyl ether at standard pressure is *lower* than the boiling point of water at standard pressure.

Answer

Acceptable responses include, but are not limited to:

- Diethyl ether has weaker intermolecular forces than water.
- Water has stronger intermolecular forces.
- Water has stronger IMFs due to its hydrogen bonding.

24

Figure 17

Base your answer to the question on the information below.

Each molecule listed below is formed by sharing electrons between atoms when the atoms within the molecule are bonded together.

Molecule A: Cl_2
Molecule B: CCl_4
Molecule C: NH_3

Refer to Figure 17 and answer the following Question:
Explain why NH_3 has stronger intermolecular forces of attraction than Cl_2 .

Answer

Acceptable responses include, but are not limited to, these examples:

- NH_3 has polar molecules that attract each other.
- NH_3 has an unshared pair of electrons around the center atom.
- NH_3 is capable of hydrogen bonding.
- unequal distribution of electrons - in strong attraction

Thermochemistry
Video #4b

Name:__________________________ Class/Period:_______________________

Assignment: Video 4b. Thermochemistry: Heating and Cooling Curves. Teacher: Dr. Salhoobi

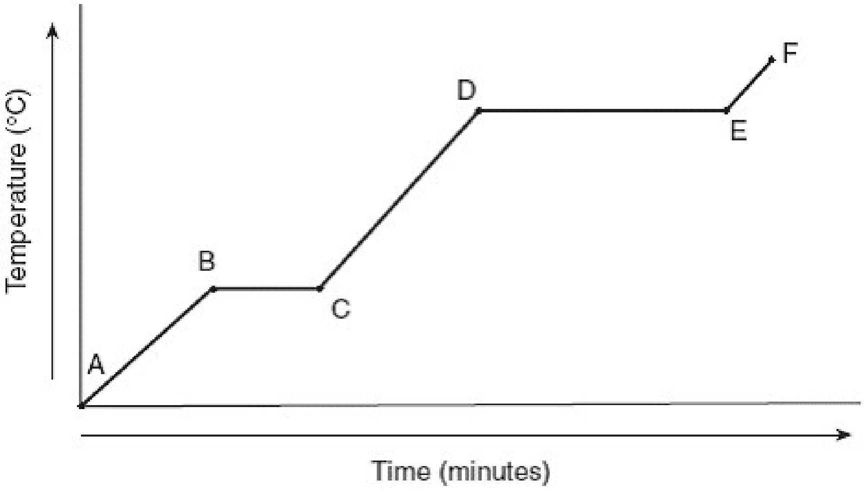
Instructions: Follow your teacher's directions to watch video # 4b/17 then answer the following questions.

1

Figure 1

Base your answer to the question on the information below.

Given the heating curve where substance *X* starts as a solid below its melting point and is heated uniformly.



Refer to Figure 1 and answer the following Question:

Identify the process that takes place during line segment $\overline{DE}$ of the heating curve.

Answer

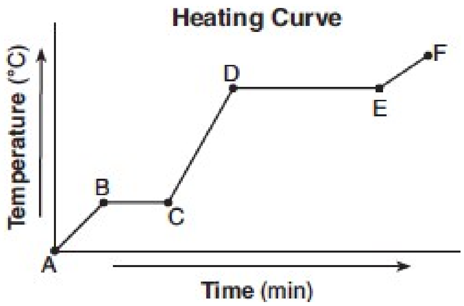
Acceptable responses include, but are not limited to, these examples:

- boiling
- vaporization
- liquid - vapor equilibrium
- phase change
- solid to a liquid

Figure 2

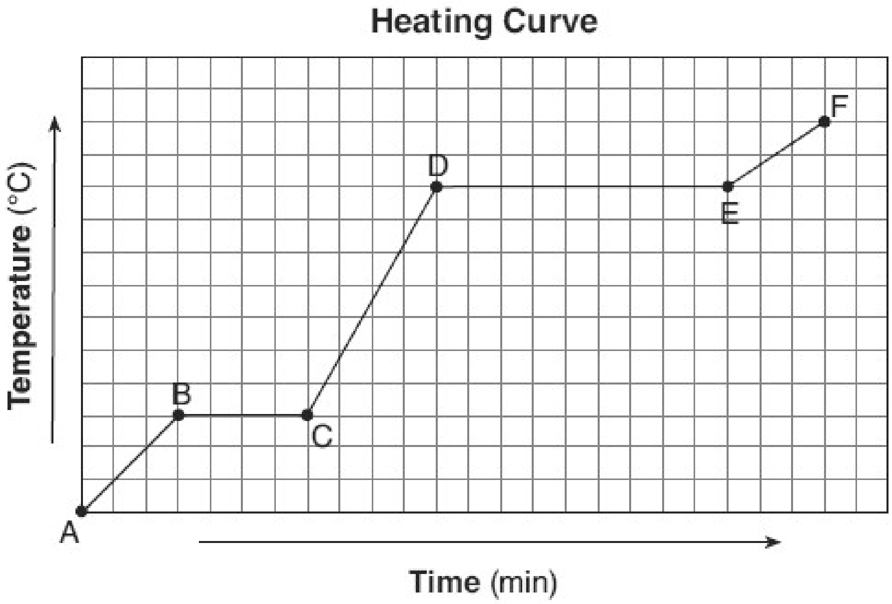
Base your answer to the question on the information below and on your knowledge of chemistry.

Starting as a solid, a sample of a molecular substance is heated, until the entire sample of the substance is a gas. The graph below represents the relationship between the temperature of the sample and the elapsed time.



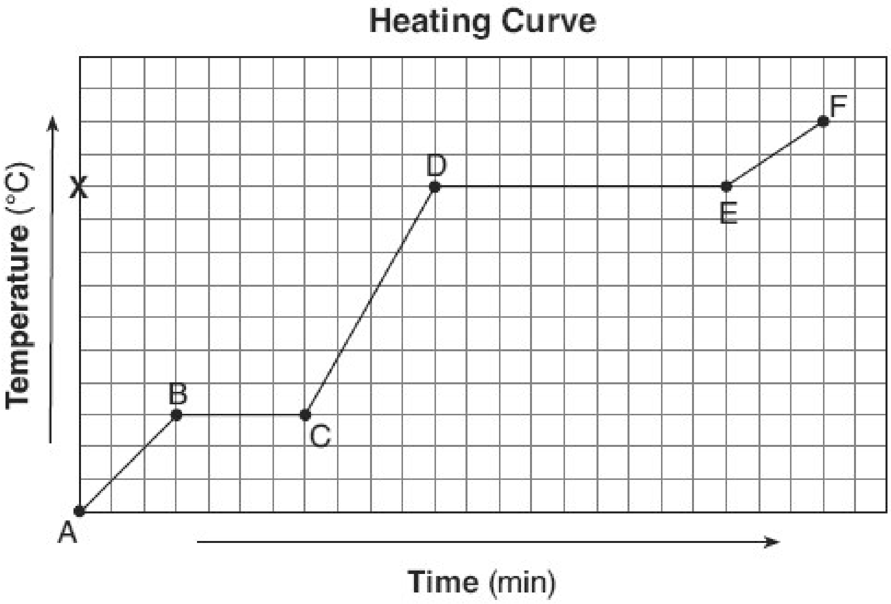
Refer to Figure 2 and answer the following Question:

On the graph below, mark an **X** on the axis labeled "Temperature (°C)"to indicate the boiling point of the substance.



Answer

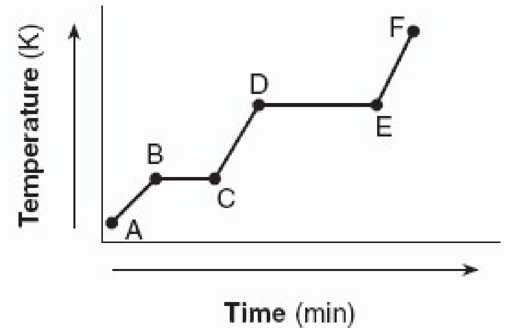
During phase changes there is no change in temperature or the average kinetic energy of the particles as the energy is all potential energy and being used to spread the particles out and actually change phase. In this heating curve, *AB* represents the solid phase being heated. *BC* is the interval in which the substance is melting. During *CD*, the substance is a liquid being heated. ***DE is the process of changing from a liquid to a gas, or boiling.*** *EF* is the heating of the vapor or gas phase.


Heating Curve
Temperature (°C)
X
A
B
C
D
E
F
Time (min)

3

Figure 3

Base your answer to the question on the heating curve below, which represents a substance starting as a solid below its melting point and being heated at a constant rate over a period of time.



Refer to Figure 3 and answer the following Question:

How does this heating curve illustrate that the heat of vaporization is greater than the heat of fusion?

Answer

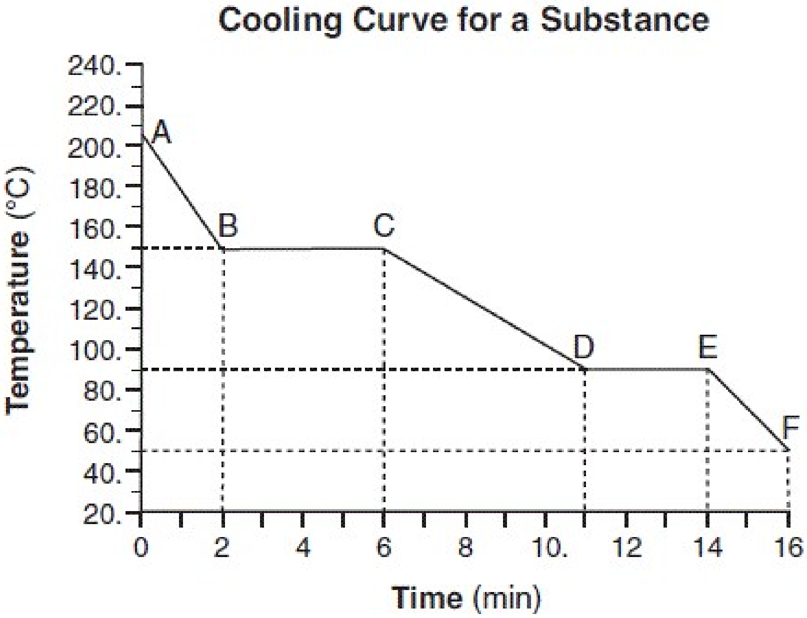
Acceptable responses include, but are not limited to, these examples:

- $\overline{DE}$ is longer than $\overline{BC}$.
- It takes more time to boil than to melt.

Figure 4

Base your answer to the question on the information below and on your knowledge of chemistry.

A sample of a molecular substance starting as a gas at 206°C and 1 atm is allowed to cool for 16 minutes. This process is represented by the cooling curve below.



Refer to Figure 4 and answer the following Question:

Describe what happens to the potential energy and the average kinetic energy of the molecules in the sample during interval *DE*.

Answer

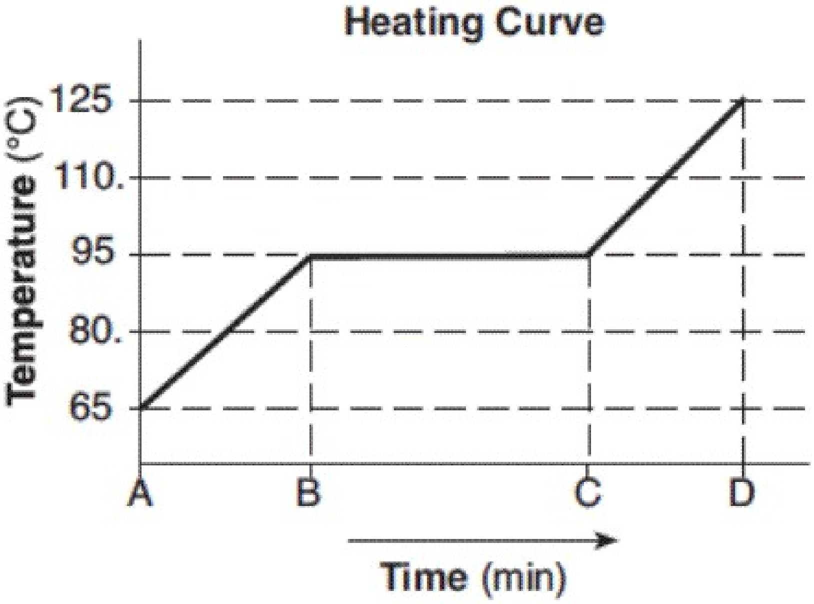
Acceptable responses include, but are not limited to:

- Potential energy: decreases
  Average kinetic energy: no change
- Potential energy: There is a decrease.
  Average kinetic energy: It remains the same

Figure 5

Base your answer to the question on the information below and on your knowledge of chemistry.

A sample of a substance is a liquid at 65°C. The sample is heated uniformly to 125°C. The heating curve for the sample at standard pressure is shown below.



Refer to Figure 5 and answer the following Question:
State what happens to the potential energy of the particles of the sample during time interval BC.

Answer

Acceptable responses include, but are not limited to:

- The potential energy of the particles increases during the interval BC.
- The particles of the sample gain potential energy.

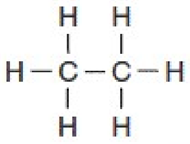
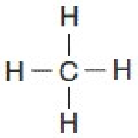
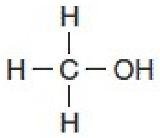
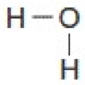
6

Figure 6

Base your answer to the question on the information below and on your knowledge of chemistry.

The formulas and the boiling points at standard pressure for ethane, methane, methanol, and water are shown in the table below.

Information for Four Compounds

Name	Formula	Boiling Point (°C)
ethane	 $\mathrm{H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H}$	–88.6
methane	 $\mathrm{H-\underset{H}{\overset{H}{C}}-H}$	–161.5
methanol	 $\mathrm{H-\underset{H}{\overset{H}{C}}-OH}$	64.6
water	 $\mathrm{H-\underset{H}{O}}$	100.0

Refer to Figure 6 and answer the following Question:

State the change in potential energy that takes place in a sample of methane as it boils at -161.5°C.

Answer

Acceptable responses include, but are not limited to:

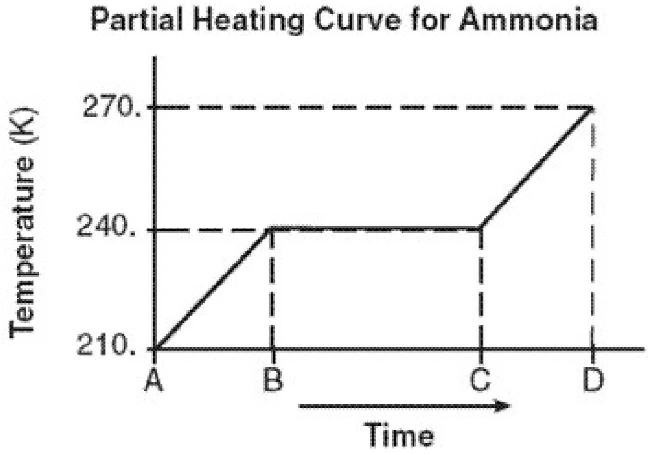
- As liquid methane boils, the potential energy of the sample increases.
- Potential energy increases.
- higher PE

7

Figure 7

Base your answer to the question on the information below.

A 5.00-gram sample of liquid ammonia is originally at 210. K. The diagram of the partial heating curve below represents the vaporization of the sample of ammonia at standard pressure due to the addition of heat. The heat is *not* added at a constant rate.



Some physical constants for ammonia are shown in the data table below.

Some Physical Constants for Ammonia

specific heat capacity of $NH_3(\ell)$	4.71 J/g•K
heat of fusion	332 J/g
heat of vaporization	1370 J/g

Refer to Figure 7 and answer the following Question:

Describe what is happening to *both* the potential energy and the average kinetic energy of the molecules in the ammonia sample during time interval *BC*. Your response must include *both* potential energy and average kinetic energy.

Answer

Acceptable responses include, but are not limited to:

- The potential energy of the ammonia molecules increases and the average kinetic energy of the ammonia molecules remains the same.
- PE increases and KE is constant.

Figure 8

Base your answer to the question on the information below and on your knowledge of chemistry.

> Fruit growers in Florida protect oranges when the temperature is near freezing by spraying water on them. It is the freezing of the water that protects the oranges from frost damage. When $H_2O(\ell)$ at 0°C changes to $H_2O(s)$ at 0°C, heat energy is released. This energy helps to prevent the temperature inside the orange from dropping below freezing, which could damage the fruit. After harvesting, oranges can be exposed to ethene gas, C_2H_4, to improve their color.

Refer to Figure 8 and answer the following Question:
Determine the quantity of heat released when 2.00 grams of $H_2O(\ell)$ freezes at 0°C.

Answer

668 J *or* –668 J

The formulas for heat is on Reference Table *T*. The Heat of Fusion for water listed on Reference Table *B* is 334 J/g.

$q = mH_f = 2.00 \text{ g} \times 334 \text{ J/g} = 668 \text{ J}$

9 Answer => 4

A 100.-gram sample of $H_2O(\ell)$ at 22.0°C absorbs 8360 joules of heat. What will be the final temperature of the water?

1 18.3°C
2 20.0°C
3 25.7°C
4 42.0°C

10 Answer => 3

A 10.0-gram sample of $H_2O(\ell)$ at 23.0°C absorbs 209 joules of heat. What is the final temperature of the $H_2O(\ell)$ sample?

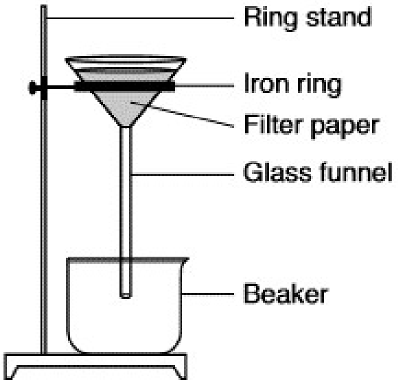
1 5.0°C
2 18.0°C
3 28.0°C
4 50.0°C

11 Answer => 3

A 36-gram sample of water has an initial temperature of 22°C. After the sample absorbs 1200 joules of heat energy, the final temperature of the sample is

1 8.0°C
2 14°C
3 30.°C
4 55°C

12 During a laboratory activity, appropriate safety equipment is used and safety procedures are followed. A student separates a sample of rock salt that has two components; NaCl(s) and small insoluble rock particles. First, the student thoroughly stirs the sample of rock salt into a sample of water in a flask. The mixture in the flask is filtered using the lab apparatus shown below.



The water is evaporated from the beaker. The filter paper and its contents are dried. The data collected by the student are shown in the table below.

Rock Salt Separation Lab Data

Object or Material	Mass (g)
rock salt sample	16.4
filter paper	1.6
clean empty beaker	224.2
filter paper with dry rock particles	2.2
beaker with dry NaCl(s)	240.0

State the number of significant figures in the mass of the beaker with dry NaCl(s).

Answer

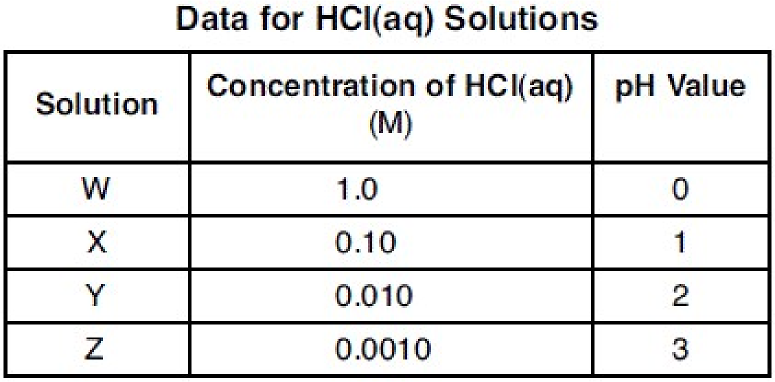
4 or four

13

Figure 9

Base your answer to the question on the information below and on your knowledge of chemistry.

In a laboratory investigation, a student compares the concentration and pH value of each of four different solutions of hydrochloric acid, HCl(aq), as shown in the table below.



Data for HCl(aq) Solutions

Solution	Concentration of HCl(aq) (M)	pH Value
W	1.0	0
X	0.10	1
Y	0.010	2
Z	0.0010	3

Refer to Figure 9 and answer the following Question:

State the number of significant figures used to express the concentration of solution Z.

Answer

- 2
- two

14

Figure 10

Base your answer to the question on the information below and on your knowledge of chemistry.

During a titration, 10.00 mL of acetic acid, $HC_2H_3O_2$(aq), is completely neutralized by adding 12.50 mL of 0.64 M sodium hydroxide, NaOH(aq).

Refer to Figure 10 and answer the following Question:

State the number of significant figures used to express the volume of the acetic acid.

Answer

Allow credit for 4 *or* four.

15

Figure 11

Base your answer to the question on the information below and on your knowledge of chemistry.

A NaOH(aq) solution and an acid-base indicator are used to determine the molarity of an HCl(aq) solution. A 25.0-milliliter sample of the HCl(aq) is exactly neutralized by 15.0 milliliters of 0.20 M NaOH(aq).

Refer to Figure 11 and answer the following Question:

Based on the data, the calculated molarity of the HCl(aq) solution should be expressed to what number of significant figures?

Answer

Allow credit for 2 *or* two.

16 Answer => 1

A reaction *must* be spontaneous if it is

1 exothermic and there is an increase in entropy
2 exothermic and there is a decrease in entropy
3 endothermic and there is an increase in entropy
4 endothermic and there is a decrease in entropy

17 Answer => 2

The change of reactants into products will always be spontaneous if the products, compared to the reactants, have

1 lower enthalpy and lower entropy
2 lower enthalpy and higher entropy
3 higher enthalpy and lower entropy
4 higher enthalpy and higher entropy

18 Answer => 1

Which substance has vibrating particles in regular, fixed positions?

1 $Ca(s)$
2 $Hg(l)$
3 $Cl_2(g)$
4 $CaCl_2(aq)$

19

Figure 12

Base your answer to the question on the information below and on your knowledge of chemistry.

Thermal energy is absorbed as chemical reactions occur during the process of baking muffins. The batter for muffins often contains baking soda, $NaHCO_3(s)$, which decomposes as the muffins are baked in an oven at 200.°C. The balanced equation below represents this reaction, which releases $CO_2(g)$ and causes the muffins to rise as they bake. The $H_2O(\ell)$ is released into the air of the oven as it becomes a vapor.

$$2NaHCO_3(s) + heat \rightarrow Na_2CO_3(s) + H_2O(\ell) + CO_2(g)$$

Refer to Figure 12 and answer the following Question:

State the direction of heat flow between the air in the oven and the muffin batter when the muffin batter is first placed in the preheated oven at 200.°C.

Answer

Acceptable responses include, but are not limited to:

- from oven air to muffin batter
- from air to muffin
- from air to batter

20

Figure 13

Base your answer to the question on the information below and on your knowledge of chemistry.

Carbon dioxide, CO_2, changes from the solid phase to the gas phase at 1 atm and 194.5 K. In the solid phase, CO_2 is often called dry ice. When dry ice sublimes in air at 298 K, the water vapor in the air can condense, forming a fog of small water droplets. This fog is often used for special effects at concerts and in movie-making.

Refer to Figure 13 and answer the following Question:

State the direction of heat flow between the dry ice and the water vapor in the air.

Answer

Acceptable responses include, but are not limited to:

- from water vapor to the dry ice
- from $H_2O(g)$ to $CO_2(s)$
- from water to CO_2

21

Figure 14

Base your answer to the question on the information below.

The balanced equation below represents the decomposition of potassium chlorate.

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

Refer to Figure 14 and answer the following Question:

State why the entropy of the reactant is less than the entropy of the products.

Answer

Acceptable responses include, but are not limited to:

- The gaseous product is more disordered than the solid reactant.
- The solid reactant is more ordered than the products.

Atomic Theories & Atomic Structure
Video #5

Name:__________________________ Class/Period:_______________________

Assignment: Video 5. Atomic Theories and Atomic Structure Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 5/17 then answer the following questions.

1 A bottled water label lists the ions dissolved in the water. The table below lists the mass of some ions dissolved in a 500.-gram sample of the bottled water.

Ions in 500. g of Bottled Water

Ion Formula	Mass (g)
Ca^{2+}	0.040
Mg^{2+}	0.013
Na^{+}	0.0033
SO_4^{2-}	0.0063
HCO_3^{-}	0.180

Compare the radius of a Mg^{2+} ion to the radius of a Mg atom.

Answer

Atoms lose or gain electrons to form ions. If an atom loses electrons, it becomes smaller and forms a positively charged ion. If an atom gains electrons, it becomes bigger and forms a negatively charged ion. Therefore, ***the radius of the Mg^{2+} ion is smaller than the radius of the Mg atom***, as the atom loses two electrons to form the ion.

2 The atomic mass and natural abundance of the naturally occurring isotopes of hydrogen are shown in the table below.

Naturally Occuring Isotopes of Hydrogen

Isotope	Common Name of Isotope	Atomic Mass (u)	Natural Abundance (%)
H-1	protium	1.0078	99.9885
H-2	deuterium	2.0141	0.0115
H-3	tritium	3.0160	negligible

The isotope H-2, also called deuterium, is usually represented by the symbol "D". Heavy water forms when deuterium reacts with oxygen, producing molecules of D_2O.

Explain, in terms of subatomic particles, why atoms of H-1, H-2, and H-3 are each electrically neutral.

Answer

Acceptable responses include, but are not limited to:

- The single proton in each nucleus has a charge of 1. The single electron in each atom has a charge of 1. The net charge is 0.
- Each atom has one proton and one electron.
- Each atom has an equal number of protons and electrons.
- The total charge of the subatomic particles is zero.

3

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

A student compares some models of the atom. These models are listed in the table below in order of development from top to bottom.

Models of the Atom

Model	Observation	Conclusion
Dalton model	Matter is conserved during a chemical reaction.	Atoms are hard, indivisible spheres of different sizes.
Thomson model	Cathode rays are deflected by magnetic/electric fields.	Atoms have small, negatively charged particles as part of their internal structure.
Rutherford model	Most alpha particles pass straight through gold foil but a few are deflected.	An atom is mostly empty space with a small, dense, positively charged nucleus.
Bohr model	Unique spectral lines are emitted by excited gaseous elements.	Packets of energy are absorbed or emitted by atoms when an electron changes shells.

Refer to Figure 1 and answer the following Question:

State *one* way in which the Bohr model agrees with the Thomson model.

Answer

Acceptable responses include, but are not limited to:

- Atoms have electrons.
- Atoms have small, negatively charged particles.
- Both models show an internal structure.
- Atoms are neutral.

4 **Refer to Figure 1 and answer the following Question:**

Using the conclusion from the Rutherford model, identify the charged subatomic particle that is located in the nucleus.

Answer

Acceptable responses include, but are not limited to:

- proton
- p
- p^+
- ^1_1H
- ^1_1p
- H^+

5 **Refer to Figure 1 and answer the following Question:**

State *one* conclusion about the internal structure of the atom that resulted from the gold foil experiment.

Answer

Acceptable responses include, but are not limited to:

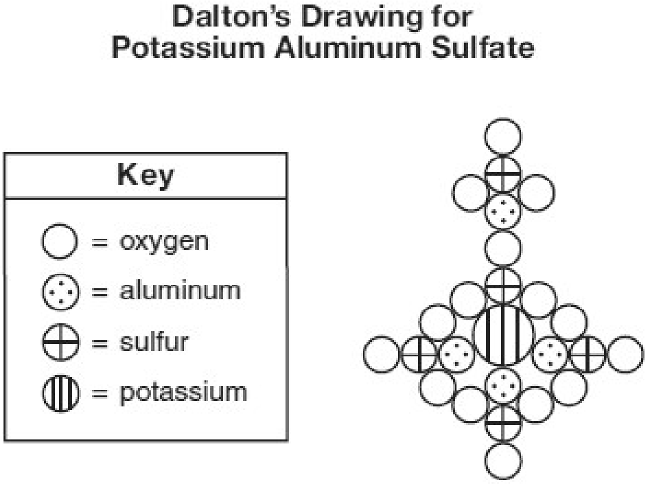
- An atom is mainly empty space.
- It has a nucleus.
- The small, dense nucleus is positively charged.

6

Figure 2

Base your answer to the question on the information below.

John Dalton, an early scientist, sketched the structure of compounds using his own symbols for the elements known at the time. Dalton's symbols for four elements and his drawing of potassium aluminum sulfate are represented by the diagram below.



Today, it is known that the chemical formula for potassium aluminum sulfate is $KAl(SO_4)_2 \bullet 12H_2O$. It is a hydrated compound because water molecules are included within its crystal structure. There are 12 moles of H_2O for every 1 mole of $KAl(SO_4)_2$. The compound contains two different positive ions. The gram-formula mass of $KAl(SO_4)_2 \bullet 12H_2O$ is 474 grams per mole.

Refer to Figure 2 and answer the following Question:

Identify *one* positive ion in the hydrated compound. Your response must include *both* the chemical symbol and charge of the ion.

Answer

Acceptable responses include, but are not limited to:

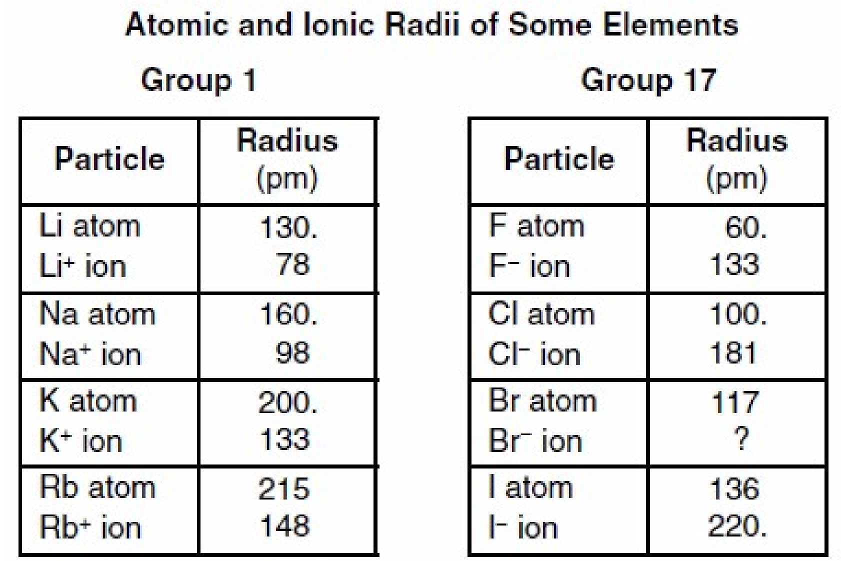
- K^+
- Al^{3+}

7

Figure 3

Base your answer to the question on the information below.

The atomic radius and the ionic radius for some Group 1 and some Group 17 elements are given in the tables below.



Atomic and Ionic Radii of Some Elements

Group 1

Particle	Radius (pm)
Li atom	130.
Li^+ ion	78
Na atom	160.
Na^+ ion	98
K atom	200.
K^+ ion	133
Rb atom	215
Rb^+ ion	148

Group 17

Particle	Radius (pm)
F atom	60.
F^- ion	133
Cl atom	100.
Cl^- ion	181
Br atom	117
Br^- ion	?
I atom	136
I^- ion	220.

Refer to Figure 3 and answer the following Question:

Write *both* the name and the charge of the particle that is gained by an F atom when the atom becomes an F ion.

Answer

Acceptable responses include, but are not limited to:

Particle: electron
Charge of particle: −1

Particle: electron
Charge of particle: negative

8

Figure 4

Base your answer to this question on the information below.

In the gold foil experiment, a thin sheet of gold was bombarded with alpha particles. Almost all the alpha particles passed straight through the foil. Only a few alpha particles were deflected from their original paths.

Refer to Figure 4 and answer the following Question:

Explain, in terms of charged particles, why some of the alpha particles were deflected.

Answer

Acceptable responses include, but are not limited to:

- Alpha particles are positive and are repelled by the nucleus that is also positive.
- Both protons and alpha particles are positively charged so they repel each other.
- Protons and alpha particles have the same charge.

9 Describe the electrons in an atom of carbon in the ground state. Your response must include:

- the charge of an electron
- the location of electrons based on the wave-mechanical model
- the total number of electrons in a carbon atom

Answer

Acceptable responses include:

- An electron has a negative charge.
- Electrons are located in orbitals, or regions of most probable location.
- A carbon atom has six electrons.

10

Figure 5

Base your answer to this question on the information below.

In 1897, J. J. Thomson demonstrated in an experiment that cathode rays were deflected by an electric field. This suggested that cathode rays were composed of negatively charged particles found in all atoms. Thomson concluded that the atom was a positively charged sphere of almost uniform density in which negatively charged particles were embedded. The total negative charge in the atom was balanced by the positive charge, making the atom electrically neutral.

In the early 1900s, Ernest Rutherford bombarded a very thin sheet of gold foil with alpha particles. After interpreting the results of the gold foil experiment, Rutherford proposed a more sophisticated model of the atom.

Refer to Figure 5 and answer the following Question:

State ***one*** aspect of the modern model of the atom that agrees with a conclusion made by Thomson.

Answer

Acceptable responses include, but are not limited to:

- An atom has equal amounts of negative and positive charge.
- An atom has an equal number of protons and electrons.
- All atoms contain electrons.
- Electrons are negatively charged.

11 In the early 1900s, experiments were conducted to determine the structure of the atom. One of these experiments involved bombarding gold foil with alpha particles. Most alpha particles passed directly through the foil. Some, however, were deflected at various angles.

Based on this alpha particle experiment, state *two* conclusions that were made concerning the structure of an atom.

Answer

Acceptable conclusions include, but are not limited to:

- The nucleus is small.
- The nucleus is positively charged.
- The atom is mostly empty space.
- The nucleus is dense.

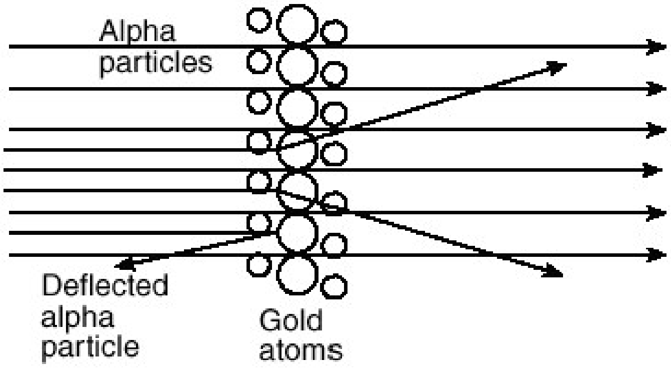
12

Figure 6

Base your answer to the question on the information and diagram below.

One model of the atom states that atoms are tiny particles composed of a uniform mixture of positive and negative charges. Scientists conducted an experiment where alpha particles were aimed at a thin layer of gold atoms.

Most of the alpha particles passed directly through the gold atoms. A few alpha particles were deflected from their straight-line paths. An illustration of the experiment is shown below.



Refer to Figure 6 and answer the following Question:
A few of the alpha particles were deflected. What does this evidence suggest about the structure of the gold atoms?

Answer

Acceptable responses include, but are not limited to, these examples:

- Alpha particles were deflected by the positively charged nucleus.
- nucleus - charged

13 **Refer to Figure 6 and answer the following Question:**
How should the original model be revised based on the results of this experiment?

Answer

Acceptable responses include, but are not limited to, these examples:

- The atom has a positively charged nucleus; negative electrons surround the outside.
- The positive charges are in the nucleus; electrons are not mixed in the nucleus.
- nucleus smaller than atom

14

Figure 7

Base your answer to the question on the information below.

In the modern model of the atom, each atom is composed of three major subatomic (or fundamental) particles.

Refer to Figure 7 and answer the following Question:
What is the net charge of the nucleus?

Answer

Acceptable responses include, but are not limited to, this example:

- positive or +

15 **Refer to Figure 7 and answer the following Question:**
State the charge associated with *each* type of subatomic particle contained in the nucleus of the atom.

Answer

Acceptable responses include, but are not limited to, this example:

- Protons are positively charged (+) and neutrons have no charge (0).

16 **Answer** => 4

Which statement describes a concept included in the wave-mechanical model of the atom?

1 Protons, neutrons, and electrons are located in the nucleus.
2 Electrons orbit the nucleus in shells at fixed distances.
3 Atoms are hard, indivisible spheres.
4 Electrons, are located in regions called orbitals.

17 **Answer** => 4

Which electron shell in an atom of calcium in the ground state has an electron with the greatest amount of energy?

1 1
2 2
3 3
4 4

18 **Answer** => 4

Strontium and barium have similar chemical properties because atoms of these elements have the same number of

1 protons
2 neutrons
3 electron shells
4 valence electrons

19 Answer => 4

Magnesium and calcium have similar chemical properties because their atoms in the ground state have

1 equal numbers of protons and electrons
2 equal numbers of protons and neutrons
3 two electrons in the first shell
4 two electrons in the outermost shell

20 Answer => 1

Compared to the energy of an electron in the second shell of an atom of sulfur, the energy of an electron in the

1 first shell is lower.
2 first shell is the same.
3 third shell is lower.
4 third shell is the same.

21 Answer => 2

In the ground state, the valence electrons of a krypton atom are found in

1 the first shell
2 the outermost shell
3 both the nucleus and the first shell
4 both the first shell and the outermost shell

22 Answer => 2

The part of an atom that has an overall positive charge is called

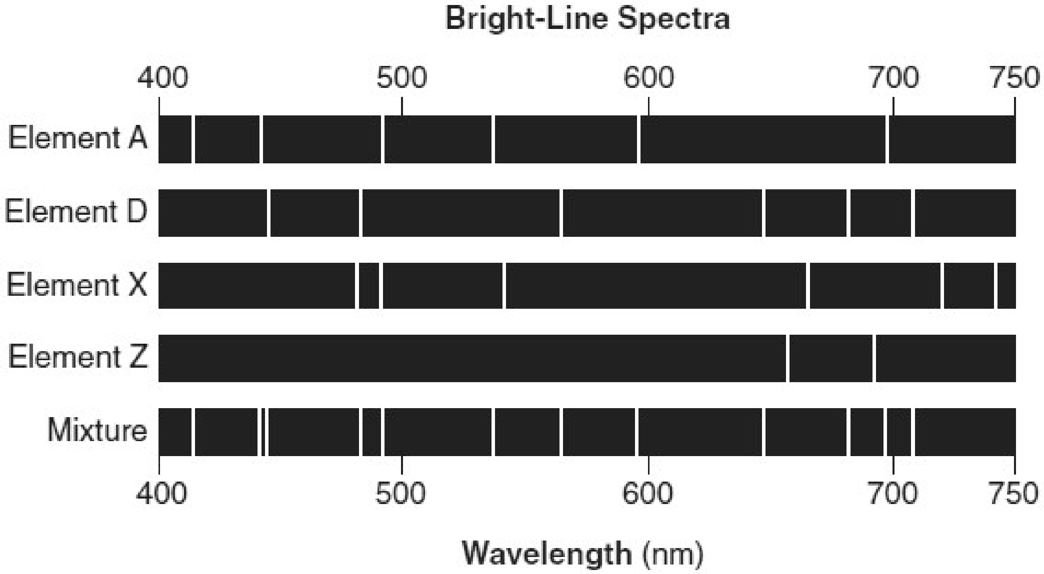
1 an electron
2 the nucleus
3 the first shell
4 the valence shell

23

Figure 8

Base your answer to the question on the information below and on your knowledge of chemistry.

The bright-line spectra for four elements and a mixture of elements are shown in the diagram below.



Refer to Figure 8 and answer the following Question:

Explain, in terms of electrons and energy states, how the light emitted by excited atoms is produced.

Answer

Acceptable responses include, but are not limited to:

- Electrons in the excited atoms release energy as they move from higher energy states to lower energy states.
- Electrons lose energy as they return to a lower energy state.
- Excited electrons emit energy in the form of light as they return to lower electron shells.

24 Answer => 3

Given a list of atomic model descriptions:

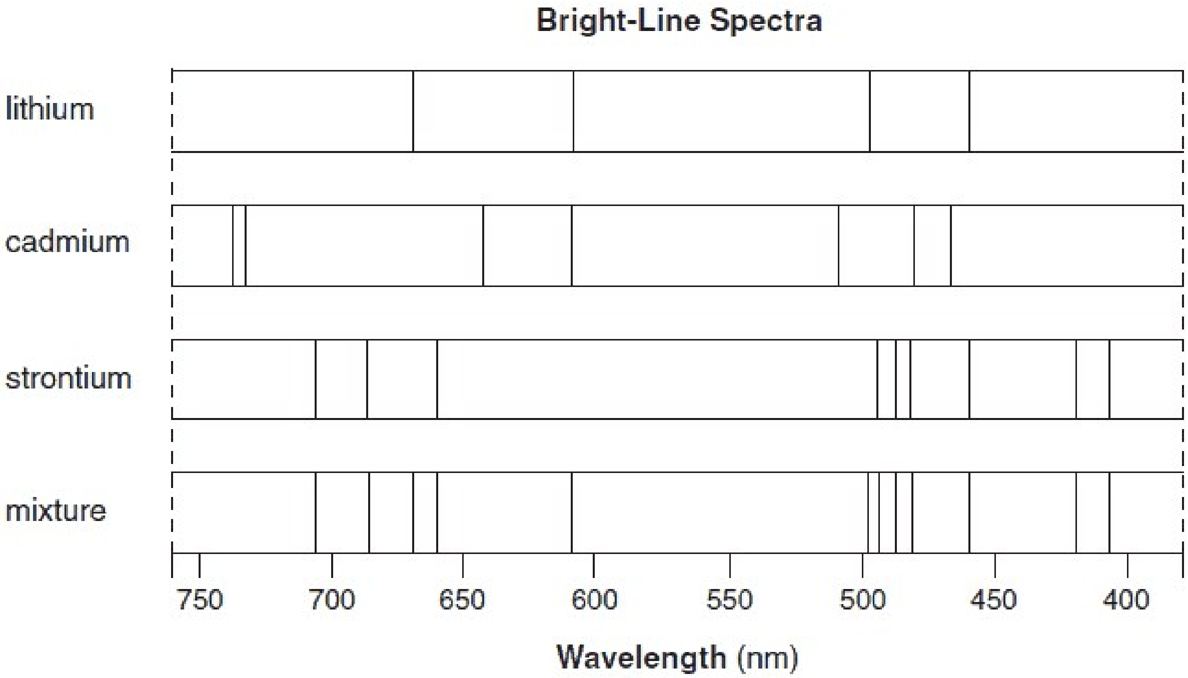
A: electron shells outside a central nucleus
B: hard, indivisible sphere
C: mostly empty space

Which list of atomic model descriptions represents the order of historical development from the earliest to most recent?

1 *A*, *B*, *C*
2 *A*, *C*, *B*
3 *B*, *C*, *A*
4 *B*, *A*, *C*

Figure 9

The bright-line spectra for three elements and a mixture of elements are shown below.



Refer to Figure 9 and answer the following Question:

Explain, in terms of *both* electrons and energy, how the bright-line spectrum of an element is produced.

Answer

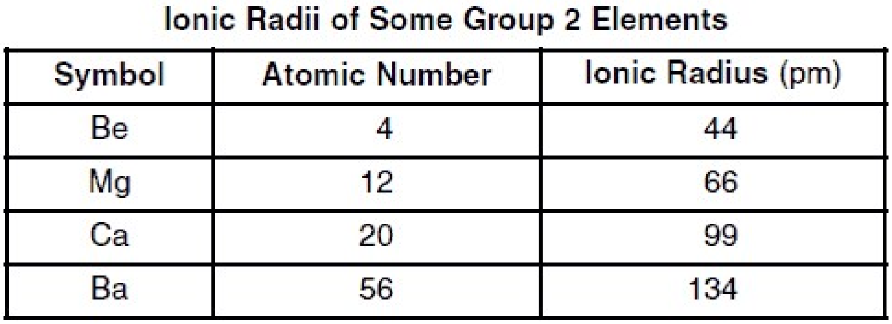
Acceptable responses include, but are not limited to:

- When electrons in an excited state return to a lower energy state, specific amounts of energy are emitted. These energies are associated with specific wavelengths of light that are characteristic of the bright-line spectrum of an element.
- Energy is emitted when excited electrons fall back to lower shells.

26

Figure 10

The ionic radii of some Group 2 elements are given in the table below.



Ionic Radii of Some Group 2 Elements

Symbol	Atomic Number	Ionic Radius (pm)
Be	4	44
Mg	12	66
Ca	20	99
Ba	56	134

Refer to Figure 10 and answer the following Question:
Explain, in terms of electrons, why the ionic radius of a Group 2 element is smaller than its atomic radius.

Answer

Acceptable responses include, but are not limited to:

- The valence electron shell of a Group 2 atom is lost when it becomes an ion.
- A Group 2 ion has two fewer electrons than the atom from which it was formed.

27 Explain, in terms of atomic structure, why Group 18 elements on the Periodic Table rarely form compounds.

Answer

Acceptable responses include, but are not limited to:

- Group 18 elements rarely form compounds because their atoms have stable electron configurations.
- Their valence shells are completely filled.
- All the elements have maximum numbers of valence electrons.
- Atoms of Group 18 have a stable octet except He, which is stable with two electrons.

28 Explain, in terms of atomic structure, why the atomic radius of iodine is greater than the atomic radius of fluorine.

Answer

Acceptable responses include, but are not limited to:

- An iodine atom has more electron shells than a fluorine atom.
- A fluorine atom has fewer electron shells.

29

Figure 11

Base your answer to the question on the information below.

An atom has an atomic number of 9, a mass number of 19, and an electron configuration of 2-6-1.

Refer to Figure 11 and answer the following Question:

Explain why the number of electrons in the second and third shells shows that this atom is in an excited state.

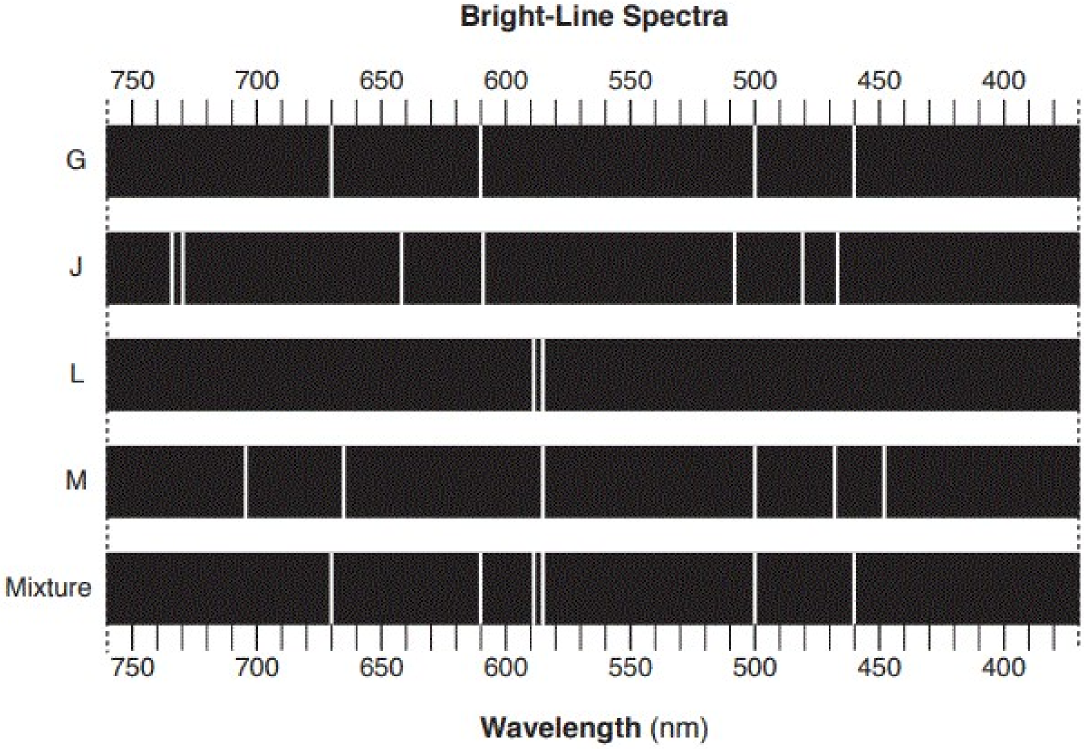
Answer

Examples:

- The third shell has one electron before the second shell is completely filled.
- The electron configuration is not 2-7, which is the ground state for an atom with atomic number 9.

30 Answer => 2

The bright-line spectra of four elements, G, J, L and M, and a mixture of *at least two* of these elements is given below.



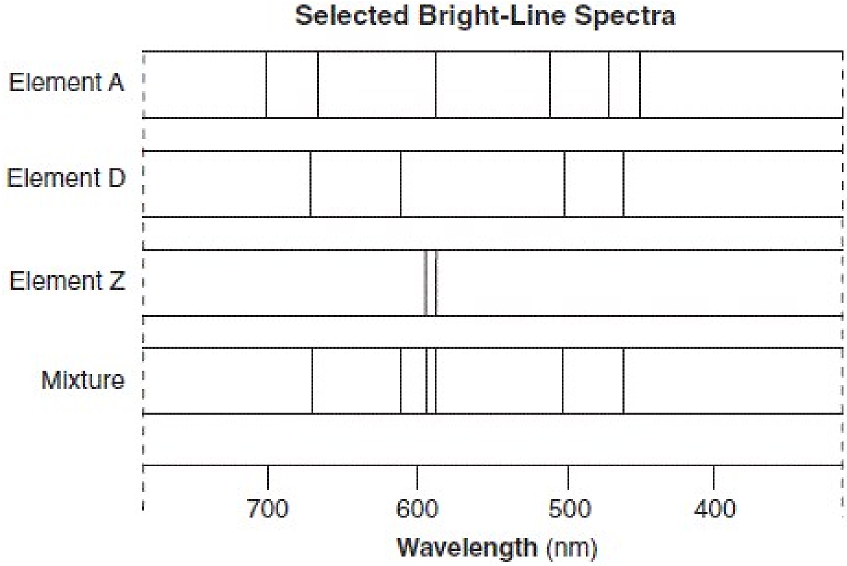
Which elements are present in the mixture?

1 G and J
2 G and L
3 M, J, and G
4 M, J, and L

Figure 12

Base your answer to the question on the information below and on your knowledge of chemistry.

The bright-line spectra observed in a spectroscope for three elements and a mixture of two of these elements are represented in the diagram below.



Refer to Figure 12 and answer the following Question:
State evidence from the bright-line spectra that indicates element *A* is *not* present in the mixture.

Answer

Acceptable responses include, but are not limited to:

- Not all of the wavelengths of element *A* are shown in the wavelengths of the mixture.
- The mixture has no spectral line at 700 nm.

32 Answer => 4

Figure 13

Base your answer to this question on the information below.

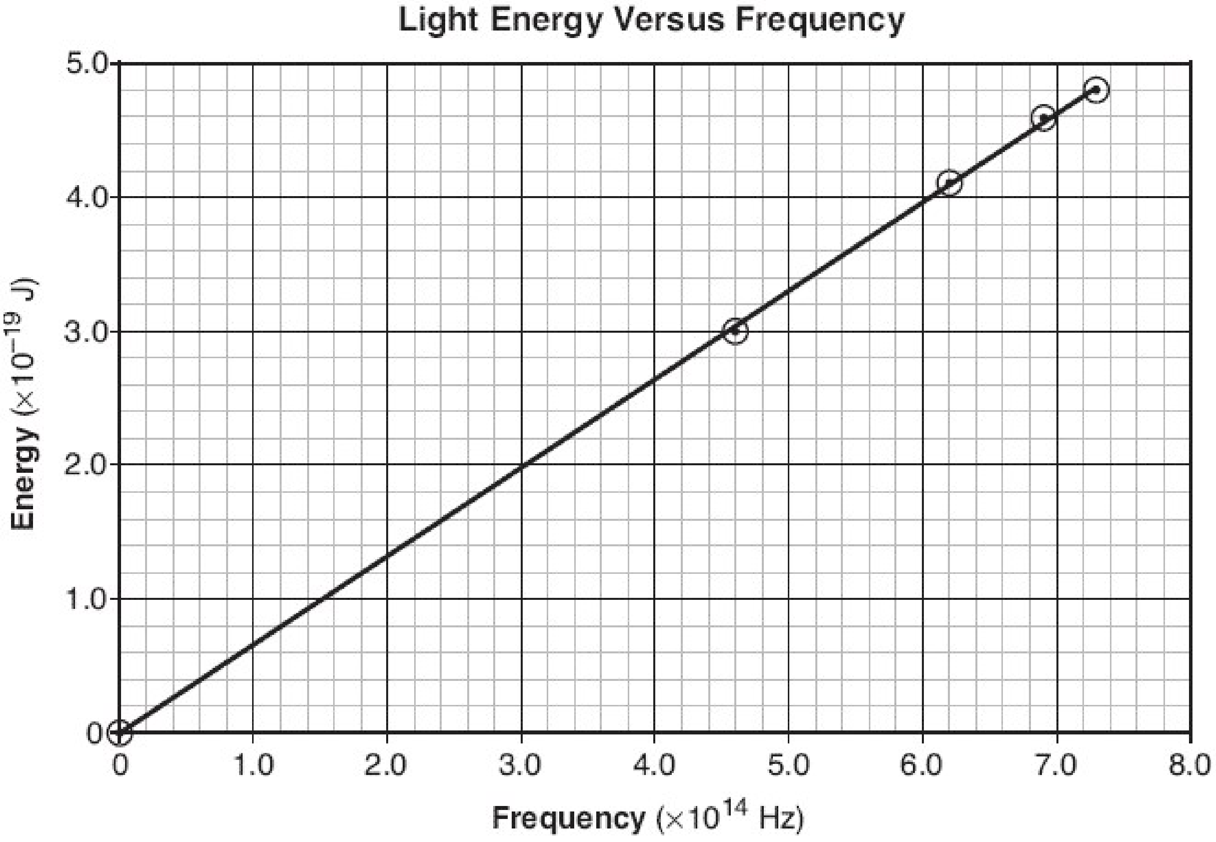
In a laboratory, a glass tube is filled with hydrogen gas at a very low pressure. When a scientist applies a high voltage between metal electrodes in the tube, light is emitted. The scientist analyzes the light with a spectroscope and observes four distinct spectral lines. The table below gives the color, frequency, and energy for each of the four spectral lines. The unit for frequency is hertz, Hz.

Visible Spectrum of Hydrogen

Color	Frequency ($\times 10^{14}$ Hz)	Energy ($\times 10^{-19}$ J)
red	4.6	3.0
blue green	6.2	4.1
blue	6.9	4.6
violet	7.3	4.8

Refer to Figure 13 and answer the following Question:

A spectral line in the infrared region of the spectrum of hydrogen has a frequency of 2.3 × 10^{14} hertz. Using the graph below, estimate the energy associated with this spectral line.



1 3.0 × 10^{-19} J

2 3.5 × 10^{-19} J

3 4.1 × 10^{-19} J

4 1.5 × 10^{-19} J

Chemical Formulas

Video #6a

Name:_________________________ Class/Period:______________________

Assignment: Video 6a. Chemical Formulas: Types of Formulas, Techniques for Writing and Naming Chemicals. Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 6a/17 then answer the following questions.

1 Answer => 4

What is the chemical formula for sodium oxalate?

1 NaO
2 Na_2O
3 NaC_2O_4
4 $Na_2C_2O_4$

2 Answer => 1

What is the chemical name of the compound NH_4SCN?

1 ammonium thiocyanate
2 ammonium cyanide
3 nitrogen hydrogen cyanide
4 nitrogen hydrogen sulfate

3

Figure 1

[q151700.mp4]

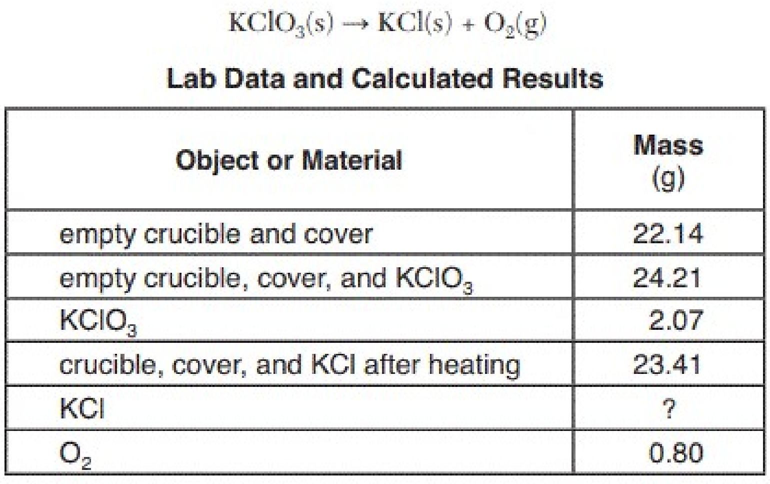
Refer to Figure 1 and answer the following Question:

Name each of the following molecules: CO_2, SO_2, CH_4, H_2O.

Answer

- CO_2 carbon dioxide
- SO_2 sulfur dioxide
- CH_4 methane
- H_2O water vapor

4 During a laboratory activity, appropriate safety equipment was used and safety procedures were followed. A laboratory technician heated a sample of solid $KClO_3$ in a crucible to determine the percent composition by mass of oxygen in the compound. The unbalanced equation and the data for the decomposition of solid $KClO_3$ are shown below.



$KClO_3(s) \rightarrow KCl(s) + O_2(g)$

Lab Data and Calculated Results

Object or Material	Mass (g)
empty crucible and cover	22.14
empty crucible, cover, and $KClO_3$	24.21
$KClO_3$	2.07
crucible, cover, and KCl after heating	23.41
KCl	?
O_2	0.80

Write a chemical name for the compound that decomposed.

Answer

The compound that decomposed was $KClO_3(s)$. The chemical name for the compound is ***potassium chlorate.*** The name of the ClO_3^- ion can be found on Table E of the Reference Tables.

5

Figure 2

Base your answer to question on the information below and on your knowledge of chemistry.

A sample of nitric acid contains both H_3O^+ ions and NO_3^- ions. This sample has a pH value of 1.

Refer to Figure 2 and answer the following Question:

Write a name of the positive ion present in this sample.

Answer

Acceptable responses include, but are not limited to:

- hydronium ion
- hydronium
- hydrogen ion
- hydrogen

6 Answer => 4

Element *X* reacts with copper to form the compounds Cu*X* and CuX_2. In which group on the Periodic Table is element *X* found?

1 Group 1
2 Group 2
3 Group 13
4 Group 17

7 Answer => 2

What is the chemical name for $H_2SO_3(aq)$?

1 sulfuric acid
2 sulfurous acid
3 hydrosulfuric acid
4 hydrosulfurous acid

8 Answer => 1

What is the chemical name for Na_2SO_3?

1 sodium sulfite
2 sodium sulfate
3 sodium sulfide
4 sodium thiosulfate

9 Answer => 1

In the formula for the compound $X\text{Cl}_4$, the *X* could represent

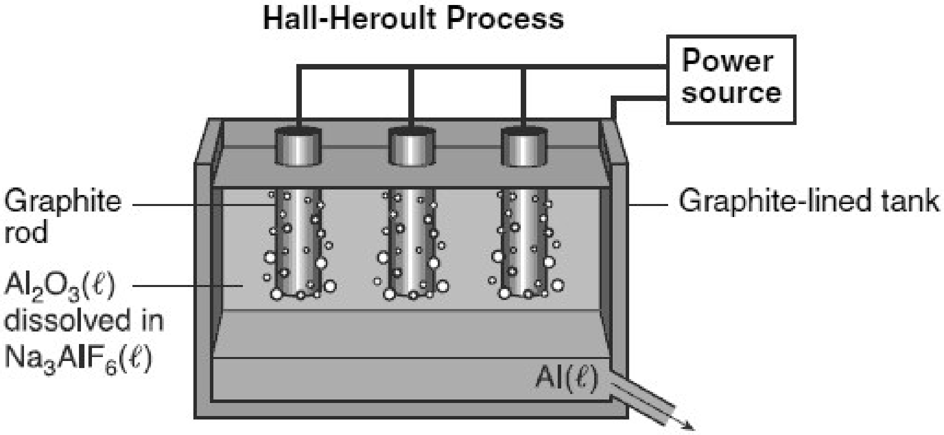
1 C
2 H
3 Mg
4 Zn

10

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

In the late 19th century, the Hall-Herroult process was invented as an inexpensive way to produce aluminum. In this process, $Al_2O_3(\ell)$ extracted from bauxite is dissolved in $Na_3AlF_6(\ell)$ in a graphite-lined tank, as shown in the diagram below. The products are carbon dioxide and molten aluminum metal.



Refer to Figure 3 and answer the following Question:
Write the chemical name for the liquid compound dissolved in the $Na_3AlF_6(\ell)$.

Answer

Acceptable responses include, but are not limited to:

- aluminum oxide

11

Figure 4

Base your answer to the question on the information below and on your knowledge of chemistry.

Baking soda, $NaHCO_3$, can be commercially produced during a series of chemical reactions called the Solvay process. In this process, $NH_3(aq)$, $NaCl(aq)$, and other chemicals are used to produce $NaHCO_3(s)$ and $NH_4Cl(aq)$.

To reduce production costs, $NH_3(aq)$ is recovered from $NH_4Cl(aq)$ through a different series of reactions. This series of reactions can be summarized by the overall reaction represented by the unbalanced equation below.

$NH_4Cl(aq) + CaO(s) \rightarrow NH_3(aq) + H_2O(\ell) + CaCl_2(aq)$

Refer to Figure 4 and answer the following Question:
Write a chemical name for baking soda.

Answer

Acceptable responses include, but are not limited to:

- sodium hydrogen carbonate
- sodium bicarbonate
- sodium acid carbonate
- monosodium carbonate
- bicarbonate of soda

12

Figure 5

Base your answer to the question on the information below.

Calcium reacts with water. This reaction is represented by the balanced equation below. The aqueous product of this reaction can be heated to evaporate the water, leaving a white solid, $Ca(OH)_2(s)$.

$Ca(s) + 2H_2O(\ell) \rightarrow Ca(OH)_2(aq) + H_2(g)$

Refer to Figure 5 and answer the following Question:
Write the chemical name of the base produced in the reaction.

Answer

Calcium hydroxide is the base produced in the reaction.

13 Answer => 1

What is the IUPAC name for the compound ZnO?

1 zinc oxide
2 zinc oxalate
3 zinc peroxide
4 zinc hydroxide

14

Figure 6

Base your answer to this question on the information below.

The Solvay process is a multistep industrial process used to produce washing soda, $Na_2CO_3(s)$. In the last step of the Solvay process, $NaHCO_3(s)$ is heated to 300°C, producing washing soda, water, and carbon dioxide. This reaction is represented by the balanced equation below.

$2NaHCO_3(s) + heat \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$

Refer to Figure 6 and answer the following Question:
Write the IUPAC name for washing soda.

Answer

sodium carbonate

15

Figure 7

Base your answer to the question on the information below.

A fluorescent light tube contains a noble gas and a drop of mercury. When the fluorescent light operates, the Hg is a vapor and there are free-flowing Hg ions and electrons in the tube. The electrons collide with Hg atoms that then emit ultraviolet (UV) radiation.

The inside of the tube is coated with a mixture of several compounds that absorbs UV radiation. Ions in the coating emit a blend of red, green, and blue light that together appears as white light. The compound that produces red light is Y_2O_3.

The compound that produces green light is $CeMgAl_{11}O_{19}$. The compound that produces blue light is $BaMgAl_{10}O_{17}$.

Refer to Figure 7 and answer the following Question:

Write the chemical name of the compound that produces red light.

Answer

Acceptable responses include, but are not limited to:

- yttrium oxide

16

Figure 8

Base your answer to this question on the information below.

Rust on an automobile door contains $Fe_2O(s)$. The balanced equation representing one of the reactions between iron in the door of the automobile and oxygen in the atmosphere is given below.

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$$

Refer to Figure 8 and answer the following Question:

Write the IUPAC name for Fe_2O_3.

Answer

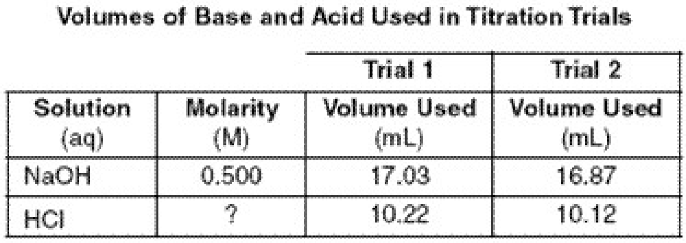
iron (III) oxide

17

Figure 9

Base your answer to the question on the information below.

> In preparing to titrate an acid with a base, a student puts on goggles and an apron. The student uses burets to dispense and measure the acid and the base in the titration. In each of two trials, a 0.500 M NaOH(aq) solution is added to a flask containing a volume of HCl(aq) solution of unknown concentration. Phenolphthalein is the indicator used in the titration. The calculated volumes used for the two trials are recorded in the table below.



Volumes of Base and Acid Used in Titration Trials

		Trial 1	Trial 2
Solution (aq)	Molarity (M)	Volume Used (mL)	Volume Used (mL)
NaOH	0.500	17.03	16.87
HCl	?	10.22	10.12

Refer to Figure 9 and answer the following Question:
Write a chemical name for the acid used in the titration.

Answer

hydrochloric acid

18 Answer => 4

What is the name of the polyatomic ion in the compound Na_2O_2?

1 hydroxide
2 oxalate
3 oxide
4 peroxide

19 Answer => 3

A compound is made up of iron and oxygen, only. The ratio of iron ions to oxide ions is 2:3 in this compound. The IUPAC name for this compound is

1 triiron dioxide
2 iron (II) oxide
3 iron (III) oxide
4 iron trioxide

20 Answer => 3

What is the correct formula for iron (III) phosphate?

1 FeP
2 Fe_3P_2
3 $FePO_4$
4 $Fe_3(PO_4)_2$

21 Answer => 3

What is the correct IUPAC name for the compound NH_4Cl?

1 nitrogen chloride
2 nitrogen chlorate
3 ammonium chloride
4 ammonium chlorate

22 Answer => 1

An example of a binary compound is

1 potassium chloride
2 ammonium chloride
3 potassium chlorate
4 ammonium chlorate

23 Answer => 3

Which term represents the fixed proportion of elements in a compound?

1 atomic mass
2 molar mass
3 chemical formula
4 density formula

24 Answer => 3

Which two terms represent types of chemical formulas?

1 mechanical and structural
2 mechanical and thermal
3 molecular and structural
4 molecular and thermal

25 Answer => 1

Which two terms represent types of chemical formulas?

1 empirical and molecular
2 polar and nonpolar
3 synthesis and decomposition
4 saturated and concentrated

26 Answer => 1

What is the chemical formula for ammonium sulfide?

1 $(NH_4)_2S$
2 $(NH_4)_2SO_3$
3 $(NH_4)_2SO_4$
4 $(NH_4)_2S_2O_3$

27 Answer => 1

What is the chemical formula of titanium(II) oxide?

1 TiO
2 Ti_2O
3 TiO_2
4 Ti_2O_3

28 Answer => 1

What is the chemical formula for lead(IV) oxide?

1 PbO_2
2 PbO_4
3 Pb_2O
4 Pb_4O

29 Answer => 1

What is the chemical formula for sodium sulfate?

1 Na_2SO_4
2 Na_2SO_3
3 $NaSO_4$
4 $NaSO_3$

30 Answer => 1

What is the chemical formula for zinc carbonate?

1 $ZnCO_3$
2 $Zn(CO_3)_2$
3 Zn_2CO_3
4 Zn_3CO_2

31

Figure 10

Base your answer to the question on the information below.

A total of 1.4 moles of sodium nitrate is dissolved in enough water to make 2.0 liters of an aqueous solution. The gram-formula mass of sodium nitrate is 85 grams per mole.

Refer to Figure 10 and answer the following Question:

Write the chemical formula for the solute in the solution.

Answer

$NaNO_3$

32 Answer => 4

What is the chemical formula for copper (II) hydroxide?

1 $CuOH$
2 $CuOH_2$
3 $Cu_2(OH)$
4 $Cu(OH)_2$

33 Answer => 1

Which formula represents lead (II) chromate?

1 $PbCrO_4$
2 $Pb(CrO_4)_2$
3 Pb_2CrO_4
4 $Pb_2(CrO_4)_3$

34 Answer => 3

The formula for calcium cyanide is

1 $CaCN_2$
2 $CaSCN_2$
3 $Ca(CN)_2$
4 $Ca(SCN)_2$

Lewis Dot Diagrams

Video #6b

Name:__________________________ Class/Period:_______________________

Assignment: Video 6b. Lewis Dot Diagrams: Atomic, Ionic, and Covalent Representations. Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 6b/17 then answer the following questions.

1 Answer => 2

Which part of a calcium atom in the ground state is represented by the dots in its Lewis electron-dot diagram?

1 the electrons in the first shell
2 the electrons in the fourth shell
3 the protons in the nucleus
4 the neutrons in the nucleus

2 Solid sodium chloride, also known as table salt, can be obtained by the solar evaporation of seawater and from underground mining. Liquid sodium chloride can be decomposed by electrolysis to produce liquid sodium and chlorine gas, as represented by the equation below.

$$2NaCl(l) \rightarrow 2Na(l) + Cl_2(g)$$

Draw a Lewis electron-dot diagram of a Cl_2 molecule.

Answer

Examples of 1-credit responses:

3 Base your answer to the following question on the information below and on your knowledge of chemistry.

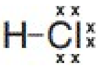
The formulas and names of four chloride compounds are shown in the table below.

Formula	Name
CCl_4	carbon tetrachloride
RbCl	rubidium chloride
CsCl	cesium chloride
HCl	hydrogen chloride

Draw a Lewis electron-dot diagram for a molecule of HCl.

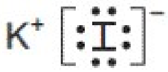
Answer

Possible answers include:



4 **Answer** => 1

Which Lewis electron-dot diagram represents the bonding in potassium iodide?

1 

2 

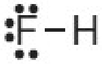
3 

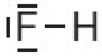
4 

5 Draw a Lewis electron-dot diagram for a molecule of hydrogen fluoride, HF.

Answer

Examples of correct responses:





6

Figure 1

Base your anwer to the question on the information below and on your knowledge of chemistry.

“Water gas,” a mixture of hydrogen and carbon monoxide, is an industrial fuel and source of commercial hydrogen. Water gas is produced by passing steam over hot carbono btained from coal. The equation below represents this system at equilibrium:

$$C(s) + H_2O(g) + heat \rightleftharpoons CO(g) + H_2(g)$$

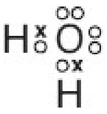
Refer to Figure 1 and answer the following Question:

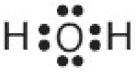
In the space below, draw a Lewis electron-dot diagram for a molecule of H_2O.

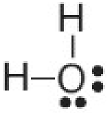
Answer

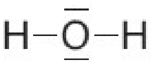
Remember to add up the total number of valence electrons contributed by each element. The oxygen atom contributes 6 valence electrons and each hydrogen atom contributes 1. Placement is done so that oxygen achieves a full "octet" when bonded to hydrogen atoms to form water.

Examples of correct responses:









7

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

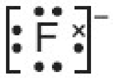
The radius of a lithium atom is 130. picometers, and the radius of a fluorine atom is 60. picometers. The radius of a lithium ion, Li^+, is 59 picometers, and the radius of a fluoride ion, F^-, is 133 picometers.

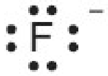
Refer to Figure 2 and answer the following Question:

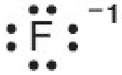
Draw a Lewis electron-dot diagram for a fluoride ion.

Answer

Examples of acceptable responses:







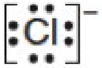
8

Draw a Lewis electron-dot diagram for a chloride ion, Cl^-.

Answer

The position of electrons may vary.

Examples of correct responses:



9

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

The Lewis electron-dot diagrams for three substances are shown below.

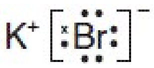


Diagram 1

Diagram 2

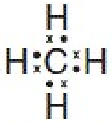


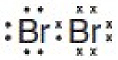
Diagram 3

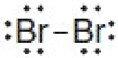
Refer to Figure 3 and answer the following Question:
Draw a Lewis electron-dot diagram for a molecule of Br_2.

Answer

The positions of the electrons can vary.

Examples of correct responses:





10

Figure 4

Base your answer to the question on the information below and on your knowledge of chemistry.

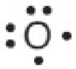
The balanced equation below represents a reaction.

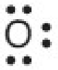
$O_2(g) + \text{energy} \rightarrow O(g) + O(g)$

Refer to Figure 4 and answer the following Question:
In the space below, draw a Lewis electron-dot diagram of one oxygen atom.

Answer

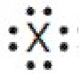
Examples of correct responses:





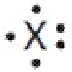
11 Answer => 3

Which Lewis electron-dot diagram represents an atom in the ground state for a Group 13 element?

1 

2 

3 

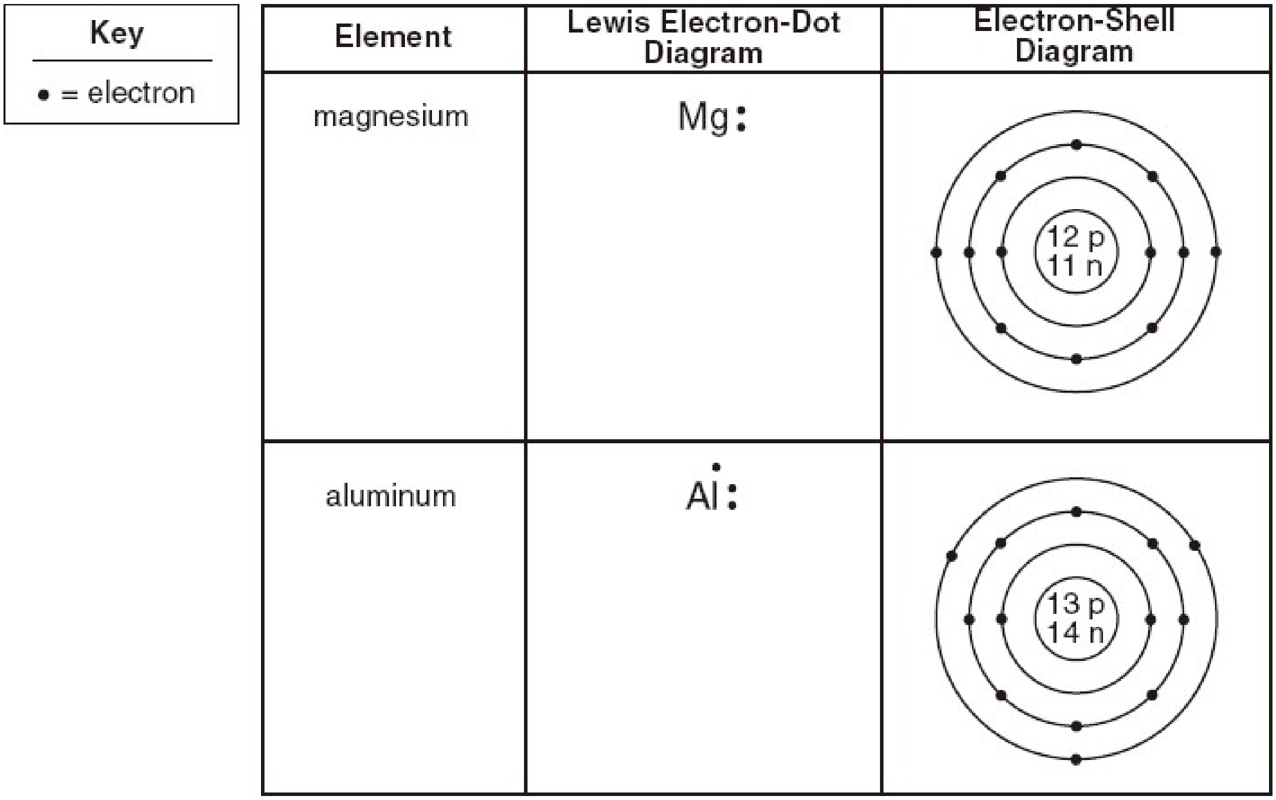
4 

12

Figure 5

Base your answer to the question on the information below.

Atomic Diagrams of Magnesium and Aluminum



Refer to Figure 5 and answer the following Question:

Identify *one* piece of information shown in the electron-shell diagrams that is *no*t shown in the Lewis electron-dot diagrams.

Answer

Acceptable responses include, but are not limited to:

- The electron-shell diagram shows the total number of protons and the total number of neutrons in an atom.
- shows number of electrons in each inner shell
- shows total number of protons in an atom
- shows the number of electron shells

13 Answer => 4

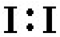
Figure 6

Base your answer to this question on the information below.

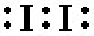
At STP, iodine, I_2, is a crystal, and fluorine, F_2, is a gas. Iodine is soluble in ethanol, forming a tincture of iodine. A typical tincture of iodine is 2% iodine by mass.

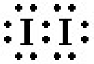
Refer to Figure 6 and answer the following Question:

Which Lewis electron-dot diagram is correct for a molecule of I_2?

1 

2 

3 

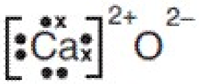
4 

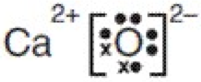
14 Answer => 4

Which Lewis electron-dot diagram represents calcium oxide?

1 

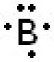
2 

3 

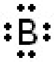
4 

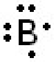
15 Answer => 2

Choose the correct Lewis electron-dot diagram for an atom of boron.

1 

2 

3 

4 

16 Answer => 3

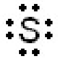
Figure 7

Base your answer to this question on the information below.

Naturally Occurring Isotopes of Sulfur

Isotope	Atomic Mass (atomic mass units, u)	Natural Abundance (%)
^{32}S	31.97	94.93
^{33}S	32.97	0.76
^{34}S	33.97	4.29
^{36}S	35.97	0.02

Refer to Figure 7 and answer the following Question:
What is the correct Lewis electron-dot diagram for an atom of sulfur-33?

1 

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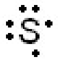
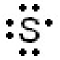
3 

4 

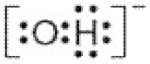
17 Answer => 1

Which Lewis electron-dot diagram correctly represents a hydroxide ion?

1 

2 

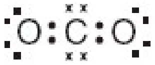
3 

4 

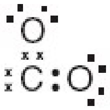
18 Answer => 3

Which Lewis electron-dot diagram is correct for CO_2?

1 

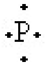
2 

3 

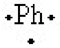
4 

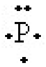
19 Answer => 4

Draw a Lewis electron-dot structure for an atom of phosphorus.

1 

2 

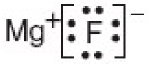
3 

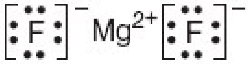
4 

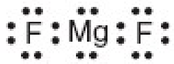
20 Answer => 3

What is the correct Lewis electron-dot structure for the compound magnesium fluoride?

1 

2 

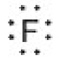
3 

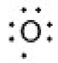
4 

21 Answer => 4

Which Lewis electron-dot structure is drawn correctly for the atom it represents?

1 

2 

3 

4 

22 Answer => 2

Figure 8

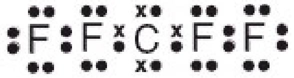
Base your answer to this question on the information below.

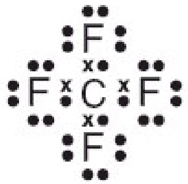
Physical Properties of CF_4 and NH_3 at Standard Pressure

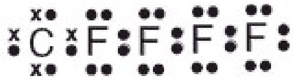
Compound	Melting Point (°C)	Boiling Point (°C)	Solubility in Water at 20.0°C
CF_4	–183.6	–127.8	insoluble
NH_3	–77.7	–33.3	soluble

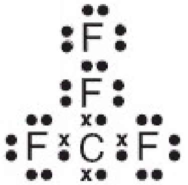
Refer to Figure 8 and answer the following Question:

What is the correct Lewis electron-dot diagram for CF_4?

1 

2 

3 

4 

Organic Compounds
Video #6c

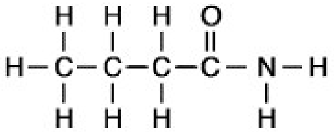
Name:__________________________ Class/Period:______________________

Assignment: Video 6c. Organic Chemistry: Naming and Writing Formulas of Organic Compounds. Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 6c/17 then answer the following questions.

1 Answer => 3

Given the formula for a compound:

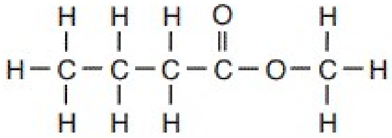


What is a chemical name for the compound?

1 1-butanamine
2 1-butanol
3 butanamide
4 butanoic acid

2 Answer => 1

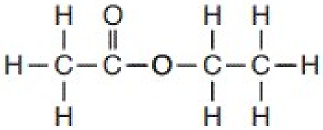
Given the formula for the compound:



What is the name of this compound?

1 methyl butanoate
2 methyl butyl ether
3 pentanone
4 pentanoic acid

3 Ethyl ethanoate is used as a solvent for varnishes and in the manufacture of artificial leather. The formula below represents a molecule of ethyl ethanoate.



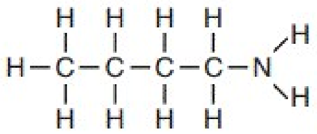
Write the name of the class of organic compounds to which this compound belongs.

Answer

Table R in the Reference Tables lists various organic functional groups. Besides matching the functional group structure, the ending *-oate* is used when naming esters. Therefore, ethyl ethanoate belongs to the ***ester class*** of organic compounds.

4 Answer => 3

Given the formula for a compound:

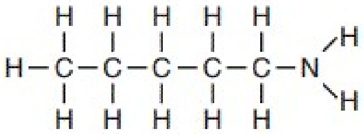


What is a chemical name for this compound?

1 1-butanamide
2 4-butanamide
3 1-butanamine
4 4-butanamine

5 Answer => 3

Given the formula representing a molecule:



A chemical name for this compound is

1 pentanone
2 1-pentanol
3 1-pentanamine
4 pentanamide

6 Answer => 1

Which compound is saturated?

1 butane
2 ethene
3 heptene
4 pentyne

7 Answer => 1

What is the chemical name for the compound $CH_3CH_2CH_2CH_3$?

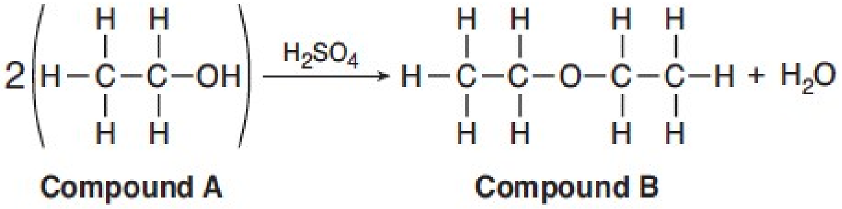
1 butane
2 butene
3 decane
4 decene

8

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

The equation below represents an industrial preparation of diethyl ether.



$$2\left(H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-OH\right)\xrightarrow{H_2SO_4}H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-O-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H+H_2O$$

Refer to Figure 1 and answer the following Question:

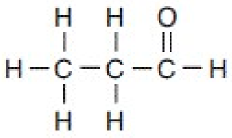
Write the name of the class of organic compounds to which compound *A* belongs.

Answer

Table *R* lists common classes of organic compounds or functional groups. Compound *A* has an –OH group classifying it as an ***alcohol.***

9 Answer => 2

Given the formula:



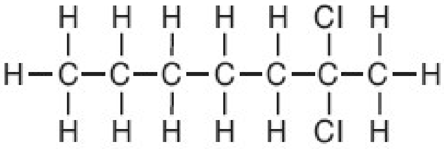
$$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\overset{O}{\overset{\|}{C}}-H$$

What is a chemical name of this compound?

1 propane
2 propanal
3 propanol
4 propanone

10 Answer => 3

Given the formula representing a compound:



$$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{Cl}{\overset{Cl}{C}}-\underset{H}{\overset{H}{C}}-H$$

What is the IUPAC name of this compound?

1 2-chloroheptane
2 6-chloroheptane
3 2,2-dichloroheptane
4 6,6-dichloroheptane

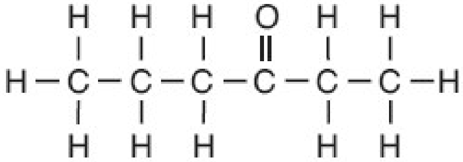
11 Answer => 2

What is the name of the compound with the formula $CH_3CH_2CH_2NH_2$?

1 1-propanol
2 1-propanamine
3 propanal
4 propanamide

12 Answer => 3

Given the formula representing a compound:

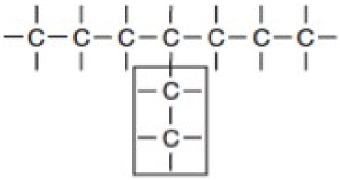


What is an IUPAC name for this compound?

1 ethyl propanoate
2 propyl ethanoate
3 3-hexanone
4 4-hexanone

13 Answer => 2

Given the formula for an organic compound:

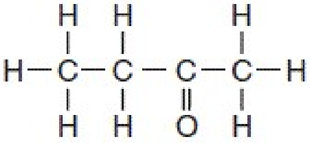


What is the name given to the group in the box?

1 butyl
2 ethyl
3 methyl
4 propyl

14 Answer => 3

Given the formula for a compound:



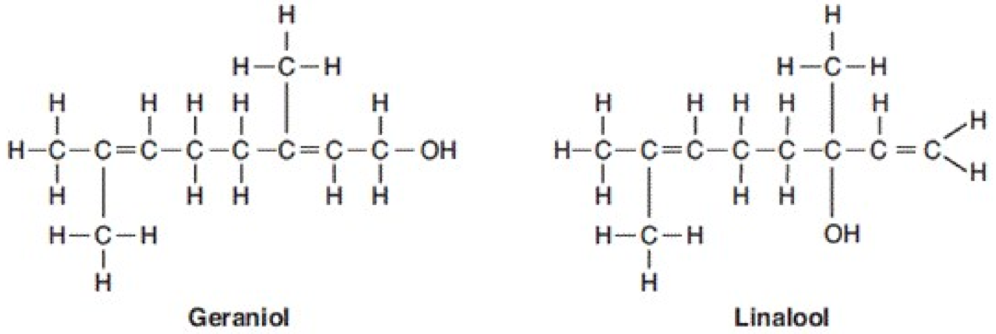
A chemical name for this compound is

1 butanal
2 butanol
3 butanone
4 butanoic acid

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

Two organic compounds, geraniol and linalool, can be represented by the molecular formula $C_{10}H_{18}O$. Geraniol has an odor similar to the scent of roses and linalool has an odor similar to the scent of citrus fruits. Both compounds are nearly insoluble in water. The structural formulas of geraniol and linalool are shown below.



Refer to Figure 2 and answer the following Question:

Write the name of the class of organic compound to which both geraniol and linalool belong.

Answer

Acceptable responses include, but are not limited to:

- alcohol
- alcohols

16 **Answer** => 3

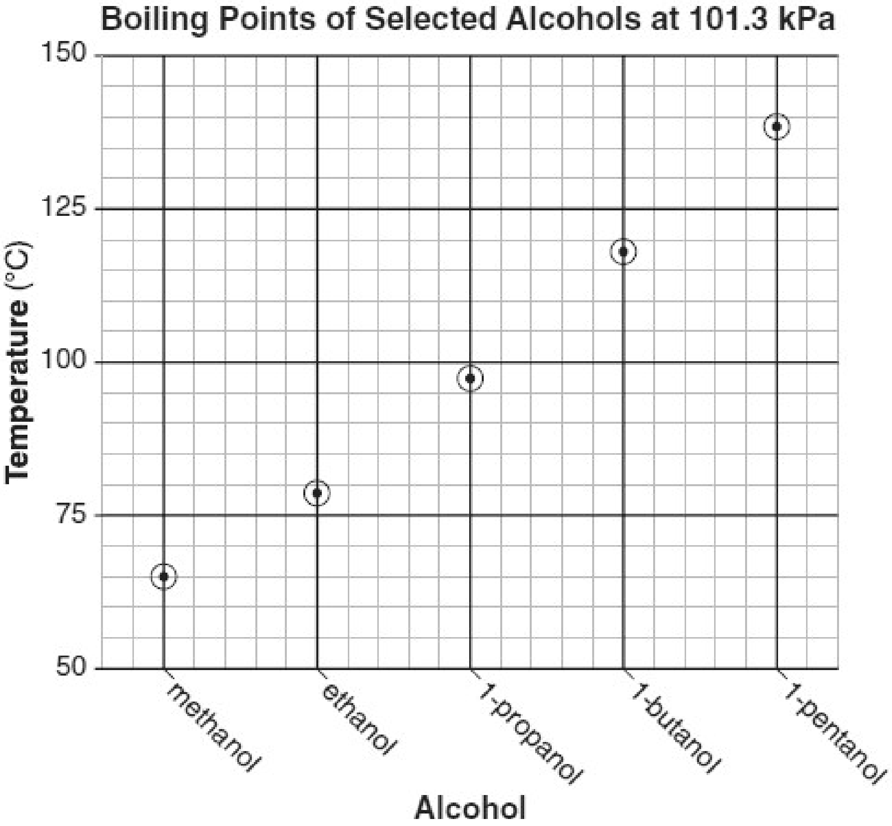
A hydrocarbon molecule has seven carbon atoms in a straight chain. There is a double bond between the third carbon atom and the fourth carbon atom in the chain. The IUPAC name for this hydrocarbon is

1 3-heptyne
2 4-heptyne
3 3-heptene
4 4-heptene

17 Answer <u>=> 3</u>

Figure 3

Base your answer to the question on the graph below and on your knowledge of chemistry.



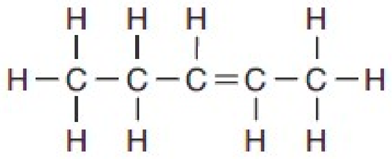
Refer to Figure 3 and answer the following Question:

What is represented by the number “1” in the IUPAC name for three of these alcohols?

1 the number of isomers for each alcohol
2 the number of –OH groups for each carbon atom in each alcohol molecule
3 the location of an –OH group on one end of the carbon chain in each alcohol molecule
4 the location of an –OH group in the middle of the carbon chain in each alcohol molecule

18 Answer <u>=> 1</u>

Given the formula representing a compound:



$$\mathrm{H{-}C{-}C{-}C{=}C{-}C{-}H}$$

What is a chemical name of this compound?

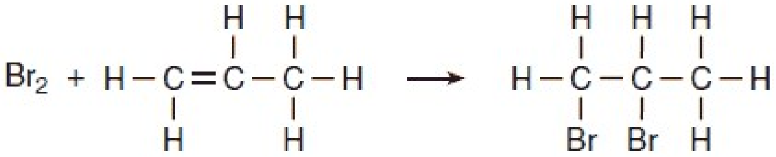
1 2-pentene
2 2-pentyne
3 3-pentene
4 3-pentyne

19

Figure 4

Base your answer to the question on the information below.

A reaction between bromine and a hydrocarbon is represented by the balanced equation below.



Refer to Figure 4 and answer the following Question:
Write the name of the homologous series to which the hydrocarbon belongs.

Answer

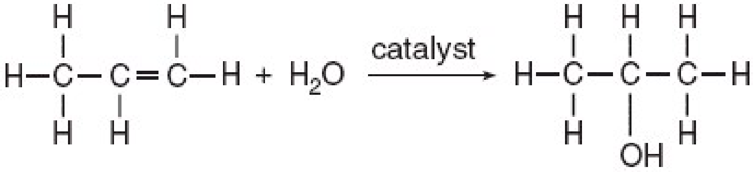
alkene *or* alkenes

20

Figure 5

Base your answer to this question on the information below.

In one industrial organic reaction, C_3H_6 reacts with water in the presence of a catalyst. This reaction is represented by the balanced equation below.



Refer to Figure 5 and answer the following Question:
Write the IUPAC name for the organic reactant.

Answer

propene

21

Figure 6

Base your answer to this question on the information below.

Biodiesel is an alternative fuel for vehicles that use petroleum diesel. Biodiesel is produced by reacting vegetable oil with CH_3OH. Methyl palmitate, $C_{15}H_{31}COOCH_3$, a compound found in biodiesel, is made from soybean oil. One reaction of methyl palmitate with oxygen is represented by the balanced equation below.

$$2C_{15}H_{31}COOCH_3 + 49O_2 \rightarrow 34CO_2 + 34H_2O + \text{energy}$$

Refer to Figure 6 and answer the following Question:
Write an IUPAC name for the compound that reacts with vegetable oil to produce biodiesel.

Answer

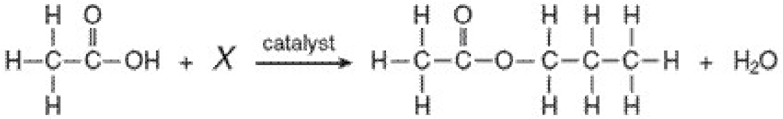
methanol ***or*** methyl alcohol

22

Figure 7

Base your answer to this question on the information below.

The incomplete equation below represents an esterification reaction. The alcohol reactant is represented by X.



Refer to Figure 7 and answer the following Question:
Write an IUPAC name for the reactant represented by its structural formula in this equation.

Answer

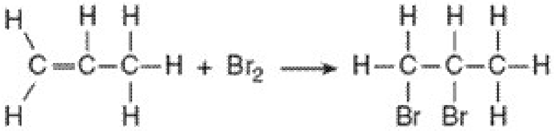
Acceptable responses include, but are not limited to:

- ethanoic acid
- acetic acid

23

Figure 8

Base your answer to the question on the equation below, which represents an organic compound reacting with bromine.



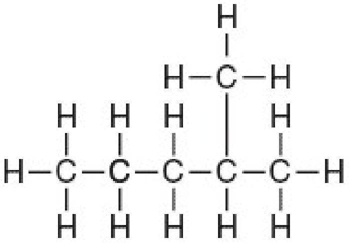
Refer to Figure 8 and answer the following Question:
What is the IUPAC name for the organic compound that reacts with Br_2?

Answer

propene

24 Answer => 2

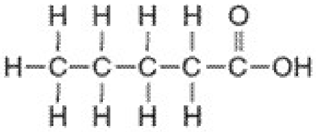
What is the IUPAC name of the organic compound that has the formula shown below?



1 1,1-dimethylbutane
2 2-methylpentane
3 hexane
4 4-methylpentane

25 Answer => 4

Given the structural formula:



What is the IUPAC name of this compound?

1 pentanal
2 pentanol
3 methyl pentanoate
4 pentanoic acid

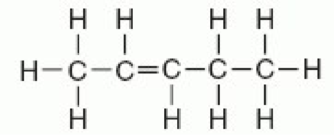
26 Answer => 1

What is the IUPAC name for the compound that has the condensed structural formula $CH_3CH_2CH_2CHO$?

1 butanal
2 butanol
3 propanal
4 propanol

27 Answer => 1

Given the formula:

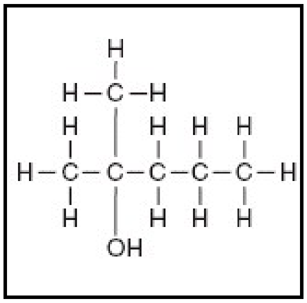


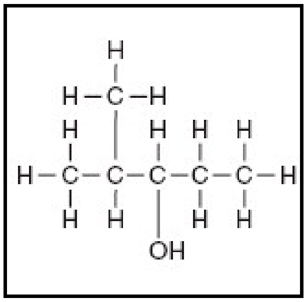
What is the IUPAC name of this compound?

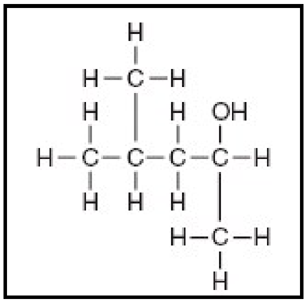
1 2-pentene
2 2-pentyne
3 2-butene
4 2-butyne

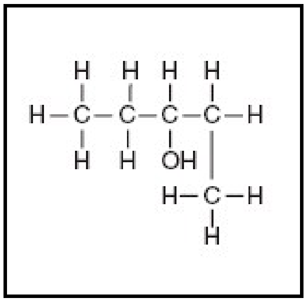
28 Answer => 2

Which structural formula is correct for 2-methyl-3-pentanol?

1 

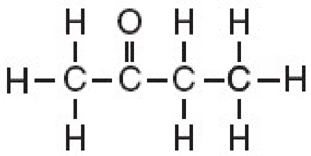
2 

3 

4 

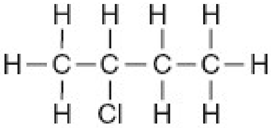
29 Answer => 3

What is the IUPAC name of the compound with the following structural formula?



1 propanone
2 propanal
3 butanone
4 butanal

30 The formula below represents a product formed when HCl reacts with $CH_3CH_2CHCH_2$



What is an IUPAC name for this product?

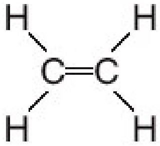
Answer:

Answer

2-chlorobutane or 2 chlorobutane

31 Answer => 3

What is the correct name for the substance represented by the structural formula?



1 acetylene
2 benzene
3 ethene
4 propene

32 Answer => 1

Which is the common name for the organic compound whose IUPAC name is methanal?

1 formaldehyde
2 acetaldehyde
3 formic acid
4 acetic acid

33 Answer => 4

Which is a saturated hydrocarbon?

1 ethene
2 ethyne
3 propene
4 propane

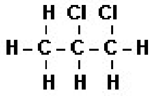
34 Answer => 2

When C_2H_4 molecules polymerize, the name of the polymer formed is

1 polymethylene
2 polyethylene
3 polypropylene
4 polybutylene

35 Answer <u>=> 3</u>

What is the correct IUPAC name for the molecule whose structure is shown in the diagram?



1 1,2-dichlorobutane
2 2,3-dichlorobutane
3 1,2-dichloropropane
4 2,3-dichloropropane

36 Answer <u>=> 1</u>

Which formula represents 1,2-ethanediol?

1 $C_2H_4(OH)_2$
2 $C_3H_5(OH)_3$
3 $Ca(OH)_2$
4 $Co(OH)_3$

37 Answer <u>=> 4</u>

If a hydrocarbon molecule contains a triple bond, its IUPAC name ends in

1 “ane”
2 “ene”
3 “one”
4 “yne”

Types of Reactions
Video #7

Name:__________________________ Class/Period:_______________________

Assignment: Video 7. Types of Reactions: Chemical, Organic, and Nuclear Reactions. Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 7/17 then answer the following questions.

1

Figure 1

Base your answer to the question on the information below.

The reaction between aluminum and an aqueous solution of copper(II) sulfate is represented by the unbalanced equation below.

$Al(s) + CuSO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + Cu(s)$

Refer to Figure 1 and answer the following Question:

Identify the type of chemical reaction represented by the equation.

Answer

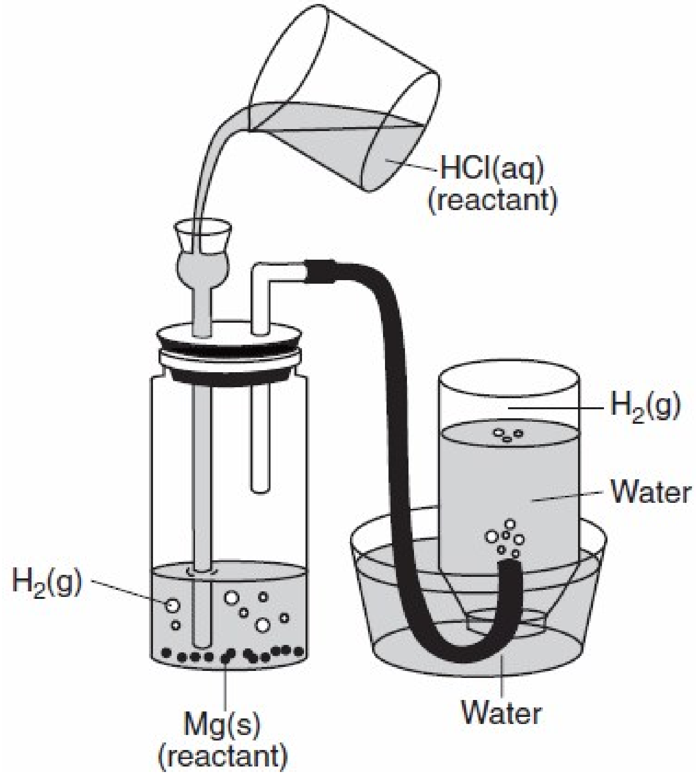
Acceptable responses include, but are not limited to:

- single replacement
- redox

Figure 2

Base your answer to the question on the information below.

A student places a 2.50-gram sample of magnesium metal in a bottle and fits the bottle with a 2-hole stopper as shown in the diagram. Hydrochloric acid is added to the bottle, causing a reaction. As the reaction proceeds, hydrogen gas travels through the tubing to an inverted bottle filled with water, displacing some of the water in the bottle.



Refer to Figure 2 and answer the following Question:

Identify the type of chemical reaction that occurs when magnesium reacts with hydrochloric acid.

Answer

Acceptable responses include, but are not limited to:

- The reaction is single replacement.
- single displacement
- redox

3 Answer => 4

In which type of reaction can two compounds exchange ions to form two different compounds?

1 synthesis
2 decomposition
3 single replacement
4 double replacement

4 Answer => 4

Given the balanced equation representing a reaction:

$K_2CO_3(aq) + BaCl_2(aq) \rightarrow 2KCl(aq) + BaCO_3(s)$

Which type of reaction is represented by this equation?

1 synthesis
2 decomposition
3 single replacement
4 double replacement

5 Answer => 1

Given the balanced equation representing a reaction:

$6Li + N_2 \rightarrow 2Li_3N$

Which type of chemical reaction is represented by this equation?

1 synthesis
2 decomposition
3 single replacement
4 double replacement

6 Answer => 2

Which list includes three types of chemical reactions?

1 decomposition, single replacement, and solidification
2 decomposition, single replacement, and double replacement
3 solidification, double replacement, and decomposition
4 solidification, double replacement, and single replacement

7 Answer => 3

Given the word equation:

sodium chlorate → sodium chloride + oxygen

Which type of chemical reaction is represented by this equation?

1 double replacement
2 single replacement
3 decomposition
4 synthesis

8

Figure 3

Base your answer to the question on the information below.

Some dry chemicals can be used to put out forest fires. One of these chemicals is $NaHCO_3$. When $NaHCO_3(s)$ is heated, one of the products is $CO_2(g)$, as shown in the balanced equation below.

$2NaHCO_3(s) + heat \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$

Refer to Figure 3 and answer the following Question:
Identify the type of chemical reaction represented by this equation.

Answer

Acceptable responses include, but are not limited to:

- decomposition
- endothermic

9

Figure 4

Base your answer to this question on the information below.

Hydrogen peroxide, H_2O_2, is a water-soluble compound. The concentration of an aqueous hydrogen peroxide solution that is 3% by mass H_2O_2 is used as an antiseptic. When the solution is poured on a small cut in the skin, H_2O_2 reacts according to the balanced equation below.

$2H_2O_2 \rightarrow 2H_2O + O_2$

Refer to Figure 4 and answer the following Question:
Identify the type of chemical reaction represented by the balanced equation.

Answer

Acceptable responses include, but are not limited to:

- decomposition
- redox

10

Figure 5

Base your answer to the question on the information below and on your knowledge of chemistry.

Given the unbalanced equation showing the reactants and product of a reaction occurring at 298 K and 100. kPa:

$P_4(s) + Cl_2(g) \rightarrow PCl_3(\ell) + \text{energy}$

Refer to Figure 5 and answer the following Question:
State why this reaction is a synthesis reaction.

Answer

Acceptable responses include, but are not limited to:

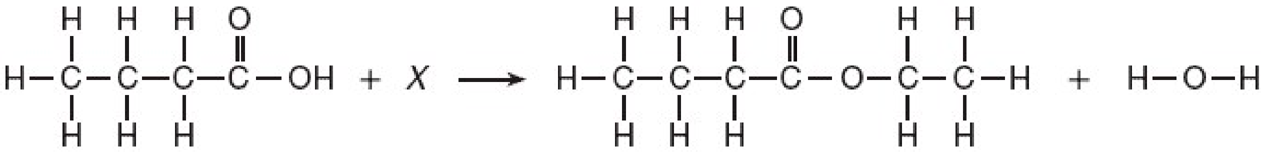
- Two elements are chemically combined to form a compound.
- Two reactants form only one product.
- Two substances react to form one substance.

11

Figure 6

Base your answer to this question on the information below.

The equation below represents the reaction between butanoic acid and an unidentified reactant, *X*.



Refer to Figure 6 and answer the following Question:
Identify the type of organic reaction represented by the equation.

Answer

Acceptable responses include, but are not limited to:

- esterification
- dehydration synthesis

12 Answer => 4

Which type of reaction is used in the production of nylon?

1 substitution
2 saponification
3 esterification
4 polymerization

13 Answer => 2

Given the equation for a reaction:

$C_4H_{10} + Cl_2 \rightarrow C_4H_9Cl + HCl$

Which type of reaction is represented by the equation?

1 addition
2 substitution
3 fermentation
4 polymerization

14 Answer => 4

Given the equation representing a reaction:

${}^{208}_{82}\text{Pb} + {}^{70}_{30}\text{Zn} \rightarrow {}^{277}_{112}\text{Cn} + {}^{1}_{0}\text{n}$

Which type of reaction is represented by this equation?

1 neutralization
2 polymerization
3 substitution
4 transmutation

15 Answer => 4

Two types of organic reactions are

1 addition and sublimation
2 deposition and saponification
3 decomposition and evaporation
4 esterification and polymerization

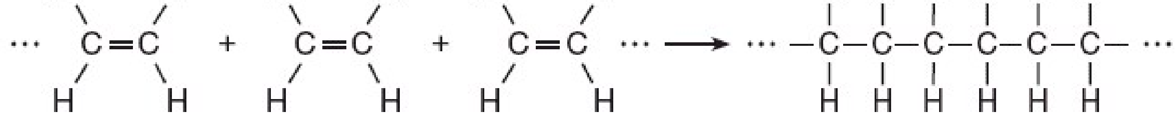
16 Answer => 3

Which reaction produces ethanol?

1 combustion
2 esterification
3 fermentation
4 polymerization

17 Answer => 3

Given the equation:



Which type of reaction is represented by this equation?

1 combustion
2 esterification
3 polymerization
4 substitution

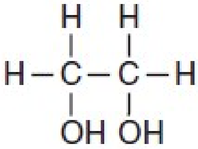
18

Figure 7

Base your answer to the question on the information below.

Ethene (common name ethylene) is a commercially important organic compound. Millions of tons of ethene are produced by the chemical industry each year. Ethene is used in the manufacture of synthetic fibers for carpeting and clothing, and it is widely used in making polyethylene. Low-density polyethylene can be stretched into a clear, thin film that is used for wrapping food products and consumer goods. High-density polyethylene is molded into bottles for milk and other liquids.

Ethene can also be oxidized to produce ethylene glycol, which is used in antifreeze for automobiles. The structural formula for ethylene glycol is:



At standard atmospheric pressure, the boiling point of ethylene glycol is 198°C, compared to ethene that boils at –104°C.

Refer to Figure 7 and answer the following Question:
Identify the type of organic reaction by which ethene (ethylene) is made into polyethylene.

Answer

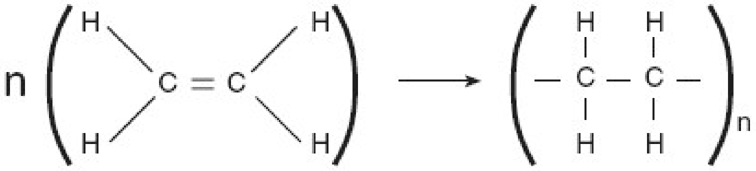
Acceptable responses include, but are not limited to, these examples:

- polymerization
- addition polymerization
- synthesis
- addition

19 Answer <u>=> 4</u>

Which type of reaction is represented by the equation below?

Note: *n* and *n* are very large numbers equal to about 2000.



1 esterification
2 fermentation
3 saponification
4 polymerization

20 Answer => 3

Given the equation:

$$C_6H_{12}O_6 \xrightarrow{\text{zymase}} 2C_2H_5OH + 2CO_2$$

The reaction represented by this equation is called

1 esterification
2 saponification
3 fermentation
4 polymerization

21 Answer => 2

An alcohol and an organic acid are combined to form water and a compound with a pleasant odor. This reaction is an example of

1 saponification
2 esterification
3 polymerization
4 fermentation

22 Answer => 2

Which type of organic reaction produces both water and carbon dioxide?

1 addition
2 combustion
3 esterification
4 fermentation

23 Answer => 4

Which reaction releases the greatest amount of energy per mole of reactant?

1 decomposition
2 esterification
3 fermentation
4 fission

24

Figure 8

Base your answer to the question on the information below.

Ethyl butanoate is an organic compound that contributes to the odor of pineapple. Ethyl butanoate is one of the products formed by the reaction of butanoic acid with ethanol.

Refer to Figure 8 and answer the following Question:

Identify the type of organic reaction that produces the compound that contributes to the odor of pineapple.

Answer

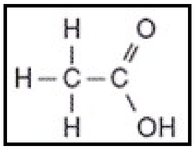
Acceptable responses include, but are not limited to:

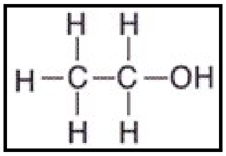
- esterification
- dehydration synthesis

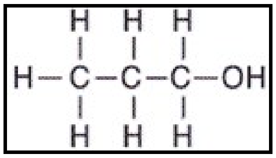
25 Answer => 2

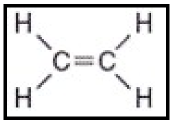
Refer to Figure 6 and answer the following Question:

What is the correct structural formula for the unidentified reactant, *X*, in the equation?

1 

2 

3 

4 

26 Answer => 2

Which alcohol reacts with C_2H_5COOH to produce the ester $C_2H_5COOC_2H_5$?

1 CH_3OH
2 C_2H_5OH
3 C_3H_7OH
4 C_4H_9OH

27 Answer => 3

What is the total number of carbon aoms in a molecule of glycerol?

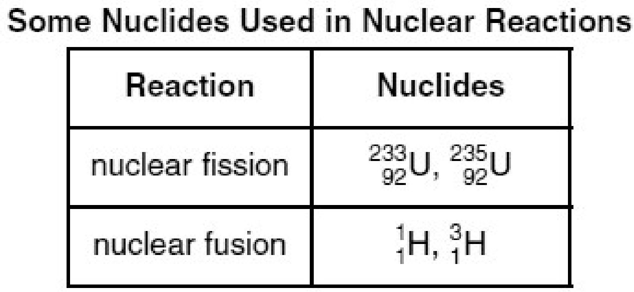
1 1
2 2
3 3
4 4

28

Figure 9

Base your answer to the question on the information below.

Nuclear fission has been used to produce electricity. However, nuclear fusion for electricity production is still under development. The notations of some nuclides used in nuclear reactions are shown in the table below.



Some Nuclides Used in Nuclear Reactions

Reaction	Nuclides
nuclear fission	$^{233}_{92}U$, $^{235}_{92}U$
nuclear fusion	$^{1}_{1}H$, $^{3}_{1}H$

Refer to Figure 9 and answer the following Question:
State *one* potential benefit of using nuclear fusion instead of the current use of nuclear fission to produce electricity.

Answer

Acceptable responses include, but are not limited to:

- Fusion produces more energy per gram of reactant.
- The fusion process produces less radioactive waste.
- The fusion reactant material is more readily available.

29

Figure 10

Base your answer to this question on the information below.

Scientists are investigating the production of energy using hydrogen-2 nuclei (deuterons) and hydrogen-3 nuclei (tritons). The balanced equation below represents one nuclear reaction between two deuterons.

$$^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He + ^{1}_{0}n + 5.23\times10^{-13}\ J$$

Refer to Figure 10 and answer the following Question:
Identify the type of nuclear reaction represented by the equation.

Answer

Acceptable responses include, but are not limited to:

- fusion
- thermonuclear fusion

30 Refer to Figure 9 and answer the following Question:

Compare the atomic masses of nuclides used in fusion to the atomic masses of nuclides used in fission.

Answer

Acceptable responses include, but are not limited to:

- The nuclides used for fusion have smaller atomic masses than nuclides used for fission.
- The nuclides used in fission are many times more massive.
- Fusion particles are lighter.

31

Figure 11

Given the nuclear equation:

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{142}_{56}\mathrm{Ba} + {}^{91}_{36}\mathrm{Kr} + 3\,^{1}_{0}\mathrm{n} + \text{energy}$$

Refer to Figure 11 and answer the following Question:

This process releases greater energy than an ordinary chemical reaction does. Name another type of nuclear reaction that releases greater energy than an ordinary chemical reaction.

Answer

Acceptable responses include, but are not limited to, these examples:

- fusion
- nuclear decay
- radioactive decay
- natural transmutation

32 Answer => 2

The energy released by a nuclear fusion reaction is produced when

1 energy is converted to mass
2 mass is converted to energy
3 heat is converted to temperature
4 temperature is converted to heat

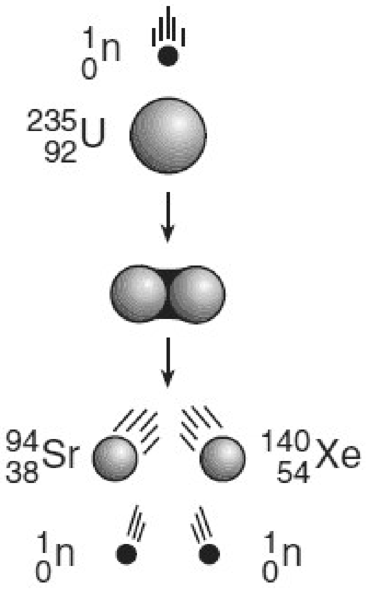
33 Answer => 1

An unstable nucleus spontaneously releases a positron. This is an example of

1 radioactive decay
2 nuclear fusion
3 chemical decomposition
4 thermal conductivity

34 Answer => 1

Given the diagram representing a reaction:



Which type of change is represented?

1 fission
2 fusion
3 deposition
4 evaporation

35 Answer => 3

Which balanced equation represents nuclear fusion?

1 $^{3}_{1}H \rightarrow {}^{3}_{2}He + {}^{0}_{-1}e$
2 $^{235}_{92}U \rightarrow {}^{231}_{90}Th + {}^{4}_{2}He$
3 $^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He$
4 $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{90}_{38}Sr + {}^{143}_{54}Xe + 3{}^{1}_{0}n$

36 Answer => 4

Which statement explains why nuclear waste materials may pose a problem?

1 They frequently have short half-lives and remain radioactive for brief periods of time.
2 They frequently have short half-lives and remain radioactive for extended periods of time.
3 They frequently have long half-lives and remain radioactive for brief periods of time.
4 They frequently have long half-lives and remain radioactive for extended periods of time.

37 Answer => 3

Which phrase describes a risk associated with producing energy in a nuclear power plant?

1 depletion of atmospheric hydrogen (H_2)
2 depletion of atmospheric carbon dioxide (CO_2)
3 production of wastes needing long-term storage
4 production of wastes that cool surrounding water supplies

38 Answer => 3

Which risk is associated with using nuclear fission to produce energy in a power plant?

1 depletion of hydrocarbons
2 depletion of atmospheric oxygen
3 exposure of workers to radiation
4 exposure of workers to sulfur dioxide

39 Answer => 4

One benefit of nuclear fission reactions is

1 nuclear reactor meltdowns
2 storage of waste materials
3 biological exposure
4 production of energy

Balancing Equations
Video #8

Name:__________________________ Class/Period:______________________

Assignment: Video 8. Balancing Reactions: Chemical, Redox, and Nuclear Reactions. Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 8/17 then answer the following questions.

1 Phosphorus-30 and phosphorus-32 are radioisotopes. Phosphorus-32 decays by positron emission. Complete the following equation for the decay of phosphorus-30:

$^{30}_{15}P \rightarrow {}^{0}_{+1}e +$ _____________

Answer

Possible answers include:

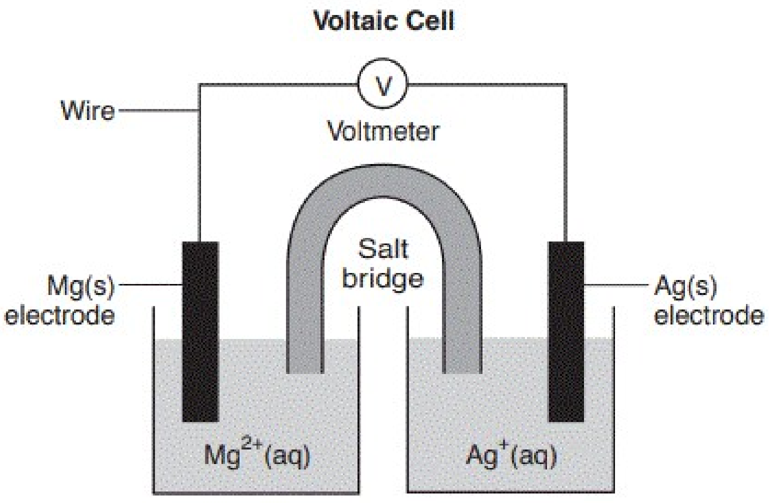
$^{30}_{14}Si$

^{30}Si

silicon-30

Si-30

2 An operating voltaic cell has magnesium and silver electrodes. The cell and the ionic equation representing the reaction that occurs in the cell are shown below.



$$Mg(s) + 2Ag^{+}(aq) \longrightarrow Mg^{2+}(aq) + 2Ag(s)$$

Write a balanced equation for the half-reaction that occurs at the magnesium electrode in this cell.

Answer

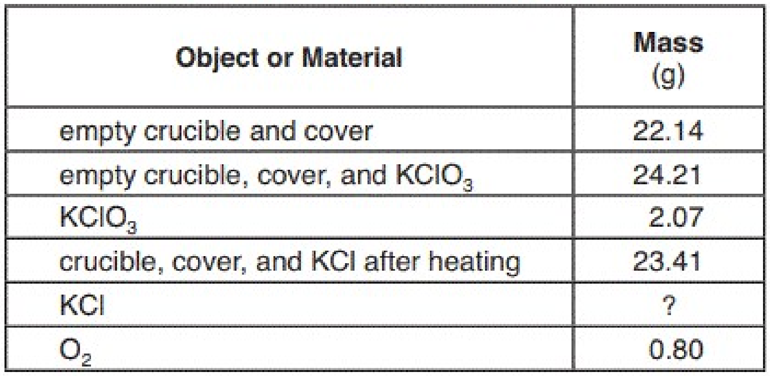
Oxidation occurs at the magnesium electrode as there is a loss of electrons when Mg atoms form Mg^{2+} ions. The balanced equation for the oxidation of magnesium is

$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^{-}$

3 During a laboratory activity, appropriate safety equipment was used and safety procedures were followed. A laboratory technician heated a sample of solid $KClO_3$ in a crucible to determine the percent composition by mass of oxygen in the compound. The unbalanced equation and the data for the decomposition of solid $KClO_3$ are shown below.

$$KClO_3(s) \rightarrow KCl(s) + O_2(g)$$

Lab Data and Calculated Results



Object or Material	Mass (g)
empty crucible and cover	22.14
empty crucible, cover, and $KClO_3$	24.21
$KClO_3$	2.07
crucible, cover, and KCl after heating	23.41
KCl	?
O_2	0.80

Balance the equation for the decomposition of $KClO_3$, using the smallest whole-number coefficients.

Answer

In chemical reactions, atoms are never created or destroyed. The same atoms that were present in the reactants are present in the products - they are merely reorganized into different arrangements. In a complete balanced chemical equation, the two sides of the equation must have equal numbers of each element on the reactant and the product sides of the equation.

$2\ KClO_3(s) \rightarrow 2\ KCl(s) + 3\ O_2(g)$

4 Cobalt-60 is an artificial isotope of Co-59. The incomplete equation for the decay of cobalt-60, including beta and gamma emissions, is shown below:

$$^{60}_{27}\text{Co} \rightarrow X + {}^{0}_{-1}\text{e} + {}^{0}_{0}\gamma$$

Complete the nuclear equation for the decay of Cobalt-60 by writing the notation for the missing product, X.

Answer

Both mass and charge must be conserved when balancing or completing a nuclear equation, like the following:

$$^{60}_{27}\text{Co} \rightarrow X + {}^{0}_{-1}\text{e} + {}^{0}_{0}\gamma$$

The total mass (top number) on the left is 60 and therefore the right must also be 60. The total charge (bottom number) on the left is 27. This means that the missing nuclide must have a mass of 28 to account for the -1 of the beta particle on the right. Therefore, the missing nuclide must be:

$^{60}_{28}\text{Ni}$

Ni-60

nickel-60

^{60}Ni

5 In the past, some paints that glowed in the dark contained zinc sulfide and salts of Ra-226. As the radioisotope Ra-226 decayed, the energy released caused the zinc sulfide in these paints to emit light. The half-lives for Ra-226 and two other radioisotopes used in these paints are listed on the table below.

Radioisotopes in the Paints

Radioisotope	Half-Life (y)
Pm-147	2.6
Ra-226	1599
Ra-228	5.8

Complete the following equation for the beta decay of Pm-147 by writing the isotopic notation for the missing product.

$^{147}_{61}\mathrm{Pm} \rightarrow {}^{0}_{-1}\mathrm{e} +$ ____________

Answer

Possible answers include:

$^{147}_{62}\mathrm{Sm}$

Sm-147

$^{147}\mathrm{Sm}$

samarium-147

Recall that when balancing a nuclear equation both the sum of the top numbers (mass) and the sum of the bottom numbers (charge) need to equal on each side of the equation.

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

When uranium-235 nuclei are bombarded with neutrons, many different combinations of smaller nuclei can be produced. The production of neodymium-150 and germanium-81 in one of these reactions is represented by the equation below.

$$^{1}_{0}\mathrm{n} + ^{235}_{92}\mathrm{U} \rightarrow ^{150}_{60}\mathrm{Nd} + ^{81}_{32}\mathrm{Ge} + 5^{1}_{0}\mathrm{n}$$

Germanium-81 and uranium-235 have different decay modes. Ge-81 emits betaparticles and has a half-life of 7.6 seconds.

Refer to Figure 1 and answer the following Question:

Complete the equation in the space below for the decay of Ge-81 by writing a notation for the missing nuclide.

$$^{81}_{32}\mathrm{Ge} \rightarrow ^{0}_{-1}\mathrm{e} + \underline{\hspace{4cm}}$$

Answer

When balancing a nuclear reaction both the mass (top numbers) and charge (bottoms numbers) on each side of the equation must total the same amount showing a conservation of mass and charge. The beta decay of a Germanium-81 nuclide produces a beta particle and ***Arsenic-81*** nuclide.

As-81 or $^{81}\mathrm{As}$

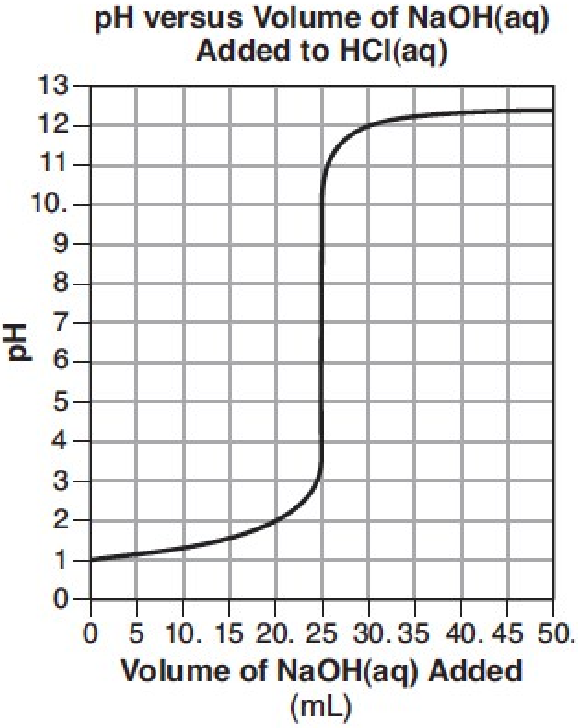
7

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

A student is to determine the concentration of an NaOH(aq) solution by performing two different titrations. In a first titration, the student titrates 25.0 mL of 0.100 M H_2SO_4(aq)with NaOH(aq) of unknown concentration.

In a second titration, the student titrates 25.0 mL of 0.100 M HCl(aq) with a sample of the NaOH(aq). During this second titration, the volume of the NaOH(aq) added and the corresponding pH value of the reaction mixture is measured. The graph below represents the relationship between pH and the volume of the NaOH(aq) added for this second titration.



Refer to Figure 2 and answer the following Question:

Complete the equation below for the neutralization that occurs in the first titration by writing a formula of the missing product.

$2NaOH(aq) + H_2SO_4(aq) \rightarrow 2H_2O(\ell) +$ _________ (aq)

Answer

A neutralization reaction is when an acid and a base react to form water and a salt.

$2NaOH(aq) + H_2SO_4(aq) \rightarrow 2H_2O(\ell) +$ **2NaSO4** (aq)

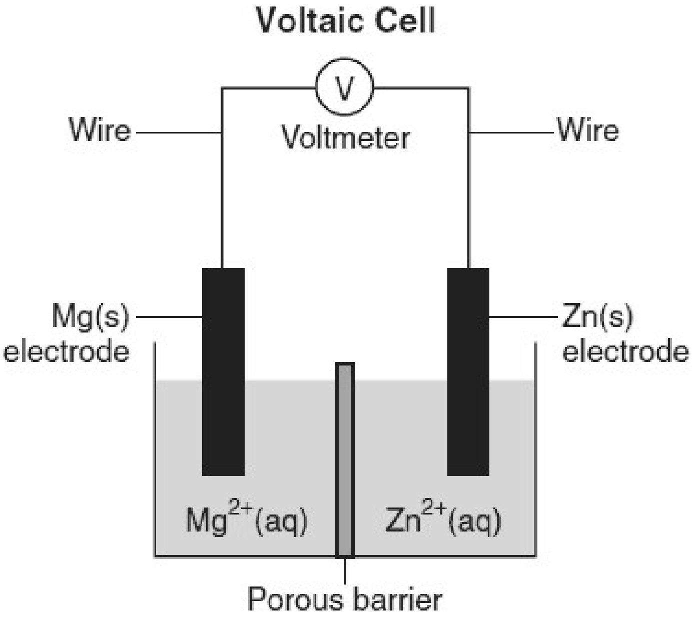
base acid water ***SALT***

Salt is missing. In this case, it is a salt comprised of Na+ and SO_4^{2-} ions, making it Na_2SO_4, sodium sulfate. The coefficient 2 out in front is necessary to completely balance the equation.

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

A student sets up a voltaic cell using magnesium and zinc electrodes. The porous barrier in the cell has the same purpose as a salt bridge. The diagram and the ionic equation below represent this operating cell.



$$Mg(s) + Zn^{2+}(aq) \rightarrow Zn(s) + Mg^{2+}(aq)$$

Refer to Figure 3 and answer the following Question:

Write a balanced half-reaction equation for the oxidation that occurs in this operating cell.

Answer

Acceptable responses include, but are not limited to:

- $Mg(s) \rightarrow Mg^{2+}(aq) + 2e^{-}$
- $Mg \rightarrow 2e^{-} + Mg^{+2}$

Figure 4

Base your answer to the question on the information below and on your knowledge of chemistry.

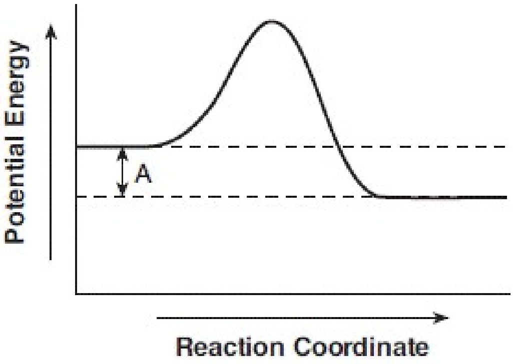
Millions of tons of ammonia are produced each year for use as fertilizer to increase food production. Most of the hydrogen needed to produce ammonia comes from methane gas reacting with steam. This reaction, which occurs in a container under controlled conditions, is shown below in unbalanced equation 1.

Equation 1: $CH_4(g) + H_2O(g) + \text{energy} \rightarrow CO(g) + H_2(g)$

The reaction that produces ammonia is represented by balanced equation 2, shown below. A catalyst can be used to increase the rate of the reaction.

Equation 2: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) + \text{energy}$

A potential energy diagram for equation 2 is shown below.



Refer to Figure 4 and answer the following Question:
Balance equation 1 using the smallest whole-number coefficients.
______ $CH_4(g)$ + ______ $H_2O(g)$ + energy → ______ $CO(g)$ + ______ $H_2(g)$

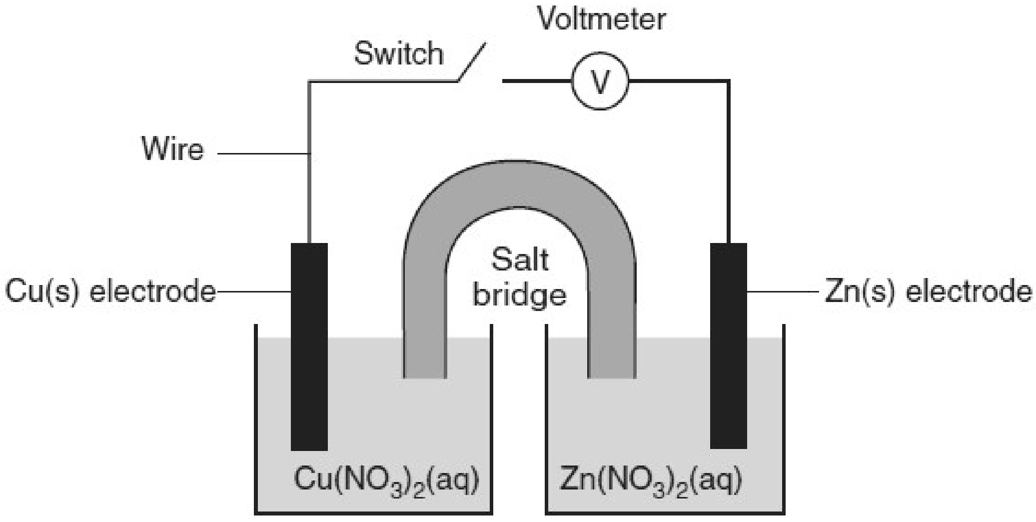
Answer

$CH_4(g) + H_2O(g) + \text{energy} \rightarrow CO(g) + 3\ H_2(g)$

Figure 5

Base your answer to the question on the information below and on your knowledge of chemistry.

A student constructs an electrochemical cell during a laboratory investigation. When the switch is closed, electrons flow through the external circuit. The diagram and ionic equation below represent this cell and the reaction that occurs.



$Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$

Refer to Figure 5 and answer the following Question:
Write a balanced equation for the half-reaction that occurs in the Cu half-cell when the cell operates.

Answer

Acceptable responses include, but are not limited to:

- $Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$
- $2e^{-} + Cu^{+2} \rightarrow Cu$

Figure 6

Base your answer to the question on the information below and on your knowledge of chemistry.

Stamping an identification number into the steel frame of a bicycle compresses the crystal structure of the metal. If the number is filed off, there are scientific ways to reveal the number.

One method is to apply aqueous copper(II) chloride to the number area. The Cu^{2+} ions react with some iron atoms in the steel frame, producing copper atoms that show the pattern of the number. The ionic equation below represents this reaction.

$$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$$

Another method is to apply hydrochloric acid to the number area. The acid reacts with the iron, producing bubbles of hydrogen gas. The bubbles form faster where the metal was compressed, so the number becomes visible. The equation below represents this reaction.

$$2HCl(aq) + Fe(s) \rightarrow FeCl_2(aq) + H_2(g)$$

Refer to Figure 6 and answer the following Question:

Write a balanced half-reaction equation for the reduction of the hydrogen ions to hydrogen gas.

Answer

Acceptable responses include, but are not limited to:

- $2H^{+}(aq) + 2e^{-} \rightarrow H_2(g)$
- $2H^{+} + 2e^{-} \rightarrow H_2$
- $2e^{-} + 2H^{+1} \rightarrow H_2$

12

Figure 7

Base your answer to the question on the information below and on your knowledge of chemistry.

A student develops the list shown below that includes laboratory equipment and materials for constructing a voltaic cell.

Laboratory Equipment and Materials

- a strip of zinc
- a strip of copper
- a 250-mL beaker containing 150 mL of 0.1 M zinc nitrate
- a 250-mL beaker containing 150 mL of 0.1 M copper(II) nitrate
- wires
- a voltmeter
- a switch
- a salt bridge

Refer to Figure 7 and answer the following Question:

Complete and balance the half-reaction equation for the oxidation of the Zn(s) that occurs in the voltaic cell.

Zn(s) → ____________________ + ____________________

Answer

Acceptable responses include, but are not limited to:

- $Zn^{2+} + 2e^{-}$
- $2e^{-}$ + Zn2_(aq)
- $Zn^{+2} + 2e^{-}$

13

Figure 8

Base your answer to the question on the information below and on your knowledge of chemistry.

At STP, Cl_2 is a gas and I_2 is a solid. When hydrogen reacts with chlorine, the compound hydrogen chloride is formed. When hydrogen reacts with iodine, the compound hydrogen iodide is formed.

Refer to Figure 8 and answer the following Question:

Balance the equation for the reaction between hydrogen and chlorine, using the smallest whole-number coefficients.

_______ H_2(g) + _______ Cl_2(g) → _______ HCl(g)

Answer

Allow credit for:

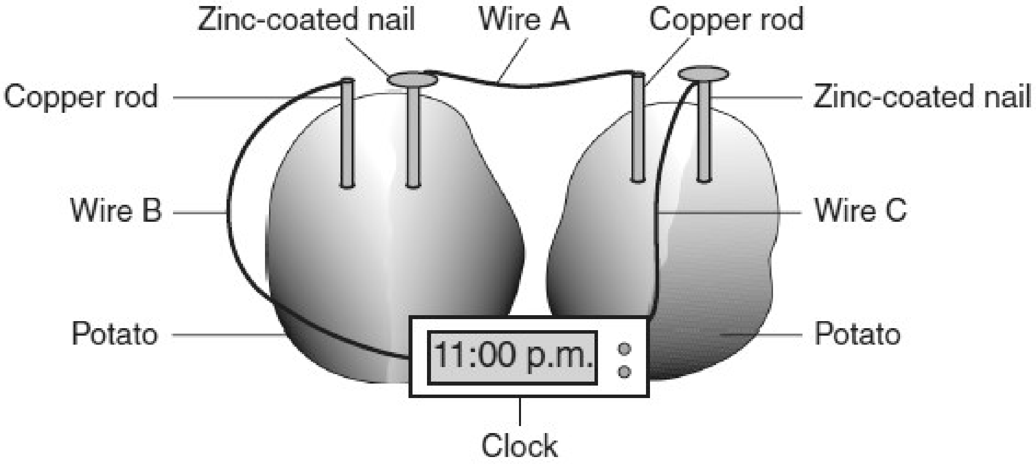
_______ H_2(g) + _______ Cl_2(g) → ___**2**___ HCl(g).

Allow credit even if the coefficient “1” is written in front of H_2(g) and/or Cl_2(g).

Figure 9

Base your answer to the question on the information below and on your knowledge of chemistry.

A small digital clock can be powered by a battery made from two potatoes and some household materials. The “potato clock” battery consists of two cells connected in a way to produce enough electricity to allow the clock to operate. In each cell, zinc atoms react to form zinc ions. Hydrogen ions from phosphoric acid in the potatoes react to form hydrogen gas. The labeled diagram and balanced ionic equation below show the reaction, the materials, and connections necessary to make a “potato clock” battery.



$$Zn(s) + 2H^{+}(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$$

Refer to Figure 9 and answer the following Question:
Write a balanced half-reaction equation for the oxidation that occurs in the “potato clock” battery.

Answer

Acceptable responses include, but are not limited to:

- $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^{-}$
- $Zn - 2e^{-} \rightarrow Zn^{+2}$

Figure 10

Base your answer to the question on the information below and on your knowledge of chemistry.

Early scientists defined oxidation as a chemical reaction in which oxygen combined with another element to produce an oxide of the element. An example of oxidation based on this definition is the combustion of methane. This reaction is represented by the balanced equation below.

Equation 1: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

The definition of oxidation has since been expanded to include many reactions that do not involve oxygen. An example of oxidation based on this expanded definition is the reaction between magnesium ribbon and powdered sulfur when heated in a crucible. This reaction is represented by the balanced equation below.

Equation 2: $Mg(s) + S(s) \rightarrow MgS(s)$

Refer to Figure 10 and answer the following Question:

Write a balanced half-reaction equation for the oxidation that occurs in the reaction represented by equation 2.

Answer

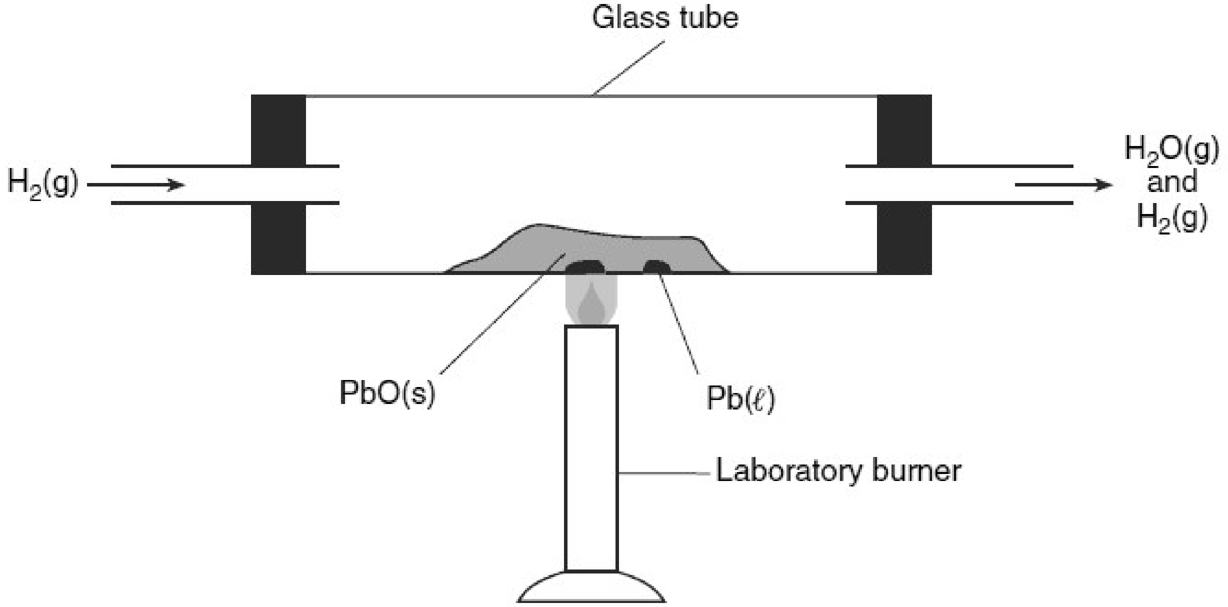
Acceptable responses include, but are not limited to:

- $Mg \rightarrow Mg^{2+} + 2e^-$
- $Mg - 2e^- \rightarrow Mg^{+2}$

Figure 11

Base your answer to the question on the information below and on your knowledge of chemistry.

In a laboratory apparatus, a sample of lead(II) oxide reacts with hydrogen gas at high temperature. The products of this reaction are liquid lead and water vapor. As the reaction proceeds, water vapor and excess hydrogen gas leave the glass tube. The diagram and balanced equation below represent this reaction.



$$PbO(s) + H_2(g) + \text{heat} \longrightarrow Pb(\ell) + H_2O(g)$$

Refer to Figure 11 and answer the following Question:

Write a balanced half-reaction equation for the reduction of the Pb^{2+} ions in this reaction.

Answer

Acceptable responses include, but are not limited to:

- $Pb^{2+} + 2e^{-} \rightarrow Pb$

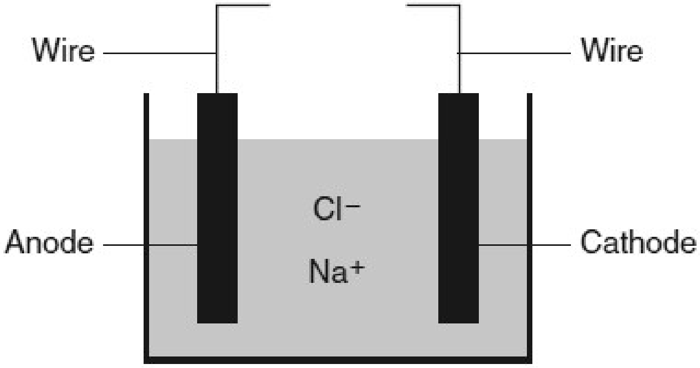
17

Figure 12

Base your answer to the question on the information below.

Metallic elements are obtained from their ores by reduction. Some metals, such as zinc, lead, iron, and copper, can be obtained by heating their oxides with carbon.

More active metals, such as aluminum, magnesium, and sodium, can *not* be reduced by carbon. These metals can be obtained by the electrolysis of their molten (melted) ores. The diagram below represents an incomplete cell for the electrolysis of molten NaCl. The equation below represents the reaction that occurs when the completed cell operates.



$$2NaCl(\ell) \rightarrow 2Na(\ell) + Cl_2(g)$$

Refer to Figure 12 and answer the following Question:
Write a balanced half-reaction equation for the reduction of the iron ions in iron(III) oxide to iron atoms.

Answer

$Fe^{3+} + 3e^{-} \rightarrow Fe$

18

Figure 13

Base your answer to the question on the information below and on your knowledge of chemistry.

Given the unbalanced equation showing the reactants and product of a reaction occurring at 298 K and 100. kPa:

$P_4(s) + Cl_2(g) \rightarrow PCl_3(\ell) + \text{energy}$

Refer to Figure 13 and answer the following Question:
Balance the equation below for the reaction, using the smallest whole number coefficients.

☐ $P_4(s)$ + ☐ $Cl_2(g) \rightarrow$ ☐ $PCl_3(\ell)$

Answer

1, 6, 4

19

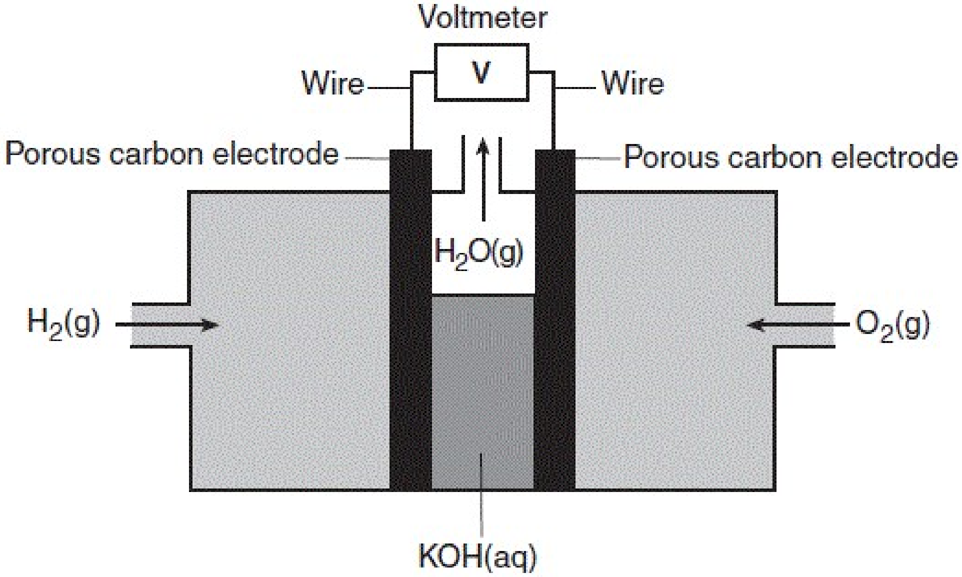
Figure 14

Base your answer to the question on the information below and on your knowledge of chemistry.

Fuel cells are voltaic cells. In one type of fuel cell, oxygen gas, $O_2(g)$, reacts with hydrogen gas, $H_2(g)$, producing water vapor, $H_2O(g)$, and electrical energy. The unbalanced equation for this redox reaction is shown below.

$H_2(g) + O_2(g) \rightarrow H_2O(g)$ + energy

A diagram of the fuel cell is shown below. During operation of the fuel cell, hydrogen gas is pumped into one compartment and oxygen gas is pumped into the other compartment. Each compartment has an inner wall that is a porous carbon electrode through which ions flow. Aqueous potassium hydroxide, KOH(aq), and the porous electrodes serve as the salt bridge.



Refer to Figure 14 and answer the following Question:
Balance the equation for the reaction in this fuel cell, using the smallest whole-number coefficients.

______ $H_2(g)$ + ______ $O_2(g) \rightarrow$ ______ $H_2O(g)$ + energy

Answer

2, 1, 2

20

Figure 15

Base your answer to the question on the information below and on your knowledge of chemistry.

Ammonia, $NH_3(g)$, can be used as a substitute for fossil fuels in some internal combustion engines. The reaction between ammonia and oxygen in an engine is represented by the unbalanced equation below.

$NH_3(g) + O_2(g) \rightarrow N_2(g) + H_2O(g)$ + energy

Refer to Figure 15 and answer the following Question:
Balance the equation below for the reaction of ammonia and oxygen, using the smallest whole-number coefficients.

______ $NH_3(g)$ + ______ $O_2(g) \rightarrow$ ______ $N_2(g)$ + ______ $H_2O(g)$ + energy

Answer

4, 3, 2, 6

21

Figure 16

Base your answer to the question on the information below and on your knowledge of chemistry.

The nuts, bolts, and hinges that attach some gates to a playground fence can be made of iron. The iron can react with oxygen in the air. The unbalanced equation representing this reaction is shown below.

$Fe(s) + O_2(g) \rightarrow Fe_2O_3(s)$

Refer to Figure 16 and answer the following Question:
Balance the equation below for the reaction, using the smallest whole-number coefficients.

☐ $Fe(s) +$ ☐ $O_2(g) \rightarrow$ ☐ $Fe_2O_3(s)$

Answer

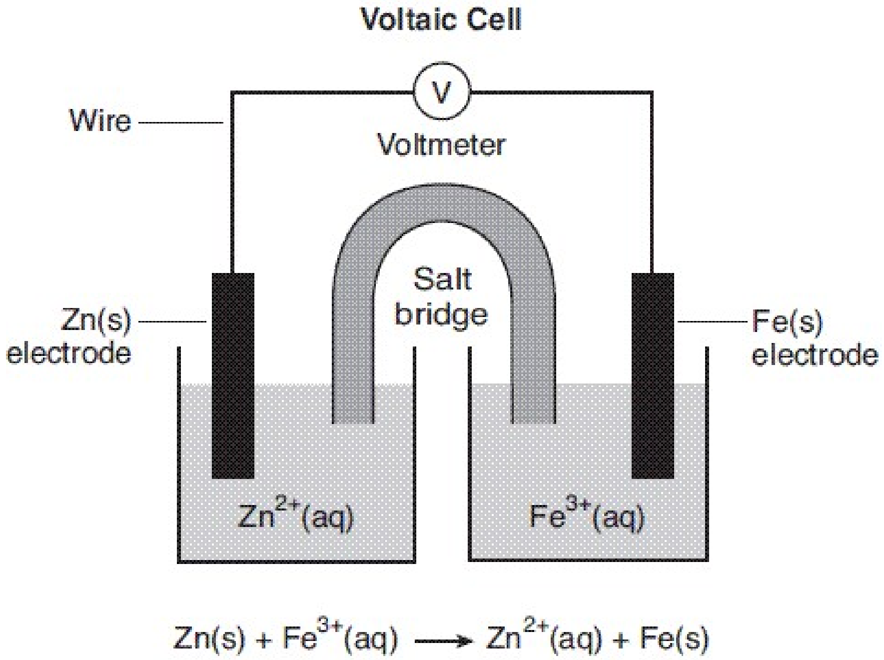
4, 3, 2

22

Figure 17

Base your answer to the question on the information below and on your knowledge of chemistry.

An operating voltaic cell has zinc and iron electrodes. The cell and the unbalanced ionic equation representing the reaction that occurs in the cell are shown below.



$Zn(s) + Fe^{3+}(aq) \longrightarrow Zn^{2+}(aq) + Fe(s)$

Refer to Figure 17 and answer the following Question:
Balance the equation below for the redox reaction that occurs in this cell, using the smallest whole-number coefficients.

☐ $Zn(s) +$ ☐ $Fe^{3+}(aq) \rightarrow$ ☐ $Zn^{2+}(aq) +$ ☐ $Fe(s)$

Answer

3, 2, 3, 2

23

Figure 18

Base your answer to the question on the information below and on your knowledge of chemistry.

Baking soda, $NaHCO_3$, can be commercially produced during a series of chemical reactions called the Solvay process. In this process, $NH_3(aq)$, $NaCl(aq)$, and other chemicals are used to produce $NaHCO_3(s)$ and $NH_4Cl(aq)$.

To reduce production costs, $NH_3(aq)$ is recovered from $NH_4Cl(aq)$ through a different series of reactions. This series of reactions can be summarized by the overall reaction represented by the unbalanced equation below.

$NH_4Cl(aq) + CaO(s) \rightarrow NH_3(aq) + H_2O(\ell) + CaCl_2(aq)$

Refer to Figure 18 and answer the following Question:
Balance the equation below for the overall reaction used to recover $NH_3(aq)$, using the smallest whole-number coefficients.

☐ NH_4Cl + ☐ CaO → ☐ NH_3 + ☐ H_2O +
☐ $CaCl_2$

Answer

2, 1, 2, 1, 1

24

Figure 19

Base your answer to the question on the information below and on your knowledge of chemistry.

When magnesium is ignited in air, the magnesium reacts with oxygen and nitrogen. The reaction between magnesium and nitrogen is represented by the unbalanced equation below.

$Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$

Refer to Figure 19 and answer the following Question:
Balance the equation for the reaction between magnesium and nitrogen, using the smallest whole-number coefficients.

☐ Mg(s) + ☐ $N_2(g)$ → ☐ $Mg_3N_2(s)$

Answer

3, 1, 1

25

Figure 20

Base your answer to the question on the information below.

The reaction between aluminum and an aqueous solution of copper(II) sulfate is represented by the unbalanced equation below.

$Al(s) + CuSO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + Cu(s)$

Refer to Figure 20 and answer the following Question:
Balance the equation using the smallest whole-number coefficients.

☐ Al(s) + ☐ $CuSO_4(aq)$ → ☐ $Al_2(SO_4)_3(aq)$ + ☐
Cu(s)

Answer

2, 3, 1, 3

26 Answer => 2

Figure 21

Base your answer to the question on the information below.

Ozone, $O_3(g)$, is produced from oxygen, $O_2(g)$, by electrical discharge during thunderstorms. The unbalanced equation below represents the reaction that forms ozone.

$$O_2(g) \xrightarrow{\text{electricity}} O_3(g)$$

Refer to Figure 21 and answer the following Question:

Which of the following uses the smallest whole-number coefficients to correctly balance the equation for the reaction that forms ozone?

1 $O_2(g) \rightarrow O_3(g)$
2 $3O_2(g) \rightarrow 2O_3(g)$
3 $4O_2(g) \rightarrow 3O_3(g)$
4 $6O_2(g) \rightarrow 4O_3(g)$

27

Figure 22

Base your answer to this question on the information below.

In a laboratory investigation, magnesium reacts with hydrochloric acid to produce hydrogen gas and magnesium chloride. This reaction is represented by the **unbalanced** equation below.

$$Mg(s) + HCl(aq) \rightarrow H_2(g) + MgCl_2(aq)$$

Refer to Figure 22 and answer the following Question:

Balance the equation below, using the smallest whole-number coefficients. Fill in all answer fields, using "1" where a coefficient could be left blank.

☐ Mg(s) + ☐ HCl(aq) → ☐ $H_2(g)$ + ☐ $MgCl_2(aq)$

Answer

1, 2, 1, 1

28

Figure 23

Base your answer to this question on the information below.

A 1.0-gram strip of zinc is reacted with hydrochloric acid in a test tube. The *unbalanced* equation below represents the reaction.

$$Zn(s) + HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq)$$

Refer to Figure 23 and answer the following Question:

Balance the equation below for the reaction of zinc and hydrochloric acid, using the smallest whole-number coefficients.

☐ Zn(s) + ☐ HCl(aq) → ☐ $H_2(g)$ + ☐ $ZnCl_2(aq)$

Answer

1, 2, 1, 1

29

Figure 24

Base your answer to this question on the information below.

> During a bread-making process, glucose is converted to ethanol and carbon dioxide, causing the bread dough to rise. Zymase, an enzyme produced by yeast, is a catalyst needed for this reaction.

Refer to Figure 24 and answer the following Question:
Balance the equation for the reaction that causes bread dough to rise, using the smallest whole-number coefficients.

☐ $C_6H_{12}O_6 \xrightarrow{zymase}$ ☐ C_2H_5OH + ☐ CO_2 + energy

Answer

1, 2, 2

30

Figure 25

Base your answer to this question on the information below.

> A piece of magnesium ribbon is reacted with excess hydrochloric acid to produce aqueous magnesium chloride and hydrogen gas. The volume of the dry hydrogen gas produced is 45.6 milliliters. The temperature of the gas is 293 K, and the pressure is 99.5 kilopascals.

Refer to Figure 25 and answer the following Question:
Balance the equation below, using the smallest whole-number coefficients. Fill in all answer fields; use the coefficient “1” instead of leaving a field blank.

☐ Mg(s) + ☐ HCl(aq) → ☐ $MgCl_2$(aq) + ☐ H_2(g)

Answer

1, 2, 1, 1

31 The unbalanced equation below represents the decomposition of potassium chlorate.
$KClO_3(s) \rightarrow KCl(s) + O_2(g)$
Balance the equation using the smallest whole-number coefficients.

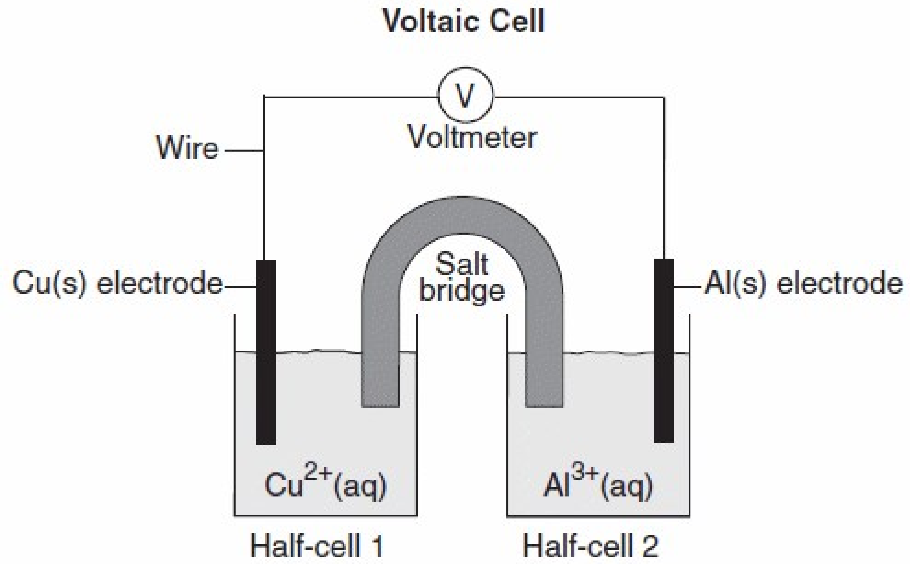
Answer: ☐ $KClO_3$(s) → ☐ KCl(s) + ☐ O_2(g)

Answer

2, 2, 3

Figure 26

Base your answer to the question on the diagram below. The diagram shows a voltaic cell with copper and aluminum electrodes immediately after the external circuit is completed.



Refer to Figure 26 and answer the following Question:
Balance the redox equation using the smallest whole-number coefficients.

☐ Cu^{2+}(aq) + ☐ Al(s) → ☐ Cu(s) + ☐ Al^{3+}(aq)

Answer

3, 2, 3, 2

33

Figure 27

Base your answer to the question on the information below.

> "Hand Blasters" is a toy that consists of a set of two ceramic balls, each coated with a mixture of sulfur and potassium chlorate, $KClO_3$. When the two balls are struck together, a loud popping noise is produced as sulfur and potassium chlorate react with each other.

Refer to Figure 27 and answer the following Question:
Balance the equation below for the "Hand Blaster" reaction, using the smallest whole-number coefficients.

Answer: ☐ S(s) + ☐ $KClO_3$(s) → ☐ SO_2(g) + ☐ KCl(s) + energy

Answer

3, 2, 3, 2

Figure 28

Base your answer to this question on the information below.

> A flashlight can be powered by a rechargeable nickel-cadmium battery. In the battery, the anode is Cd(s) and the cathode is $NiO_2(s)$. The unbalanced equation below represents the reaction that occurs as the battery produces electricity. When a nickel-cadmium battery is recharged, the reverse reaction occurs.
>
> $Cd(s) + NiO_2(s) + H_2O(\ell) \rightarrow Cd(OH)_2(s) + Ni(OH)_2(s)$

Refer to Figure 28 and answer the following Question:

Balance the equation below for the reaction that produces electricity, using the smallest whole-number coefficients.

☐ Cd(s) + ☐ $NiO_2(s)$ + ☐ $H_2O(\ell)$ → ☐ $Cd(OH)_2(s)$ + ☐ $Ni(OH)_2(s)$

Answer

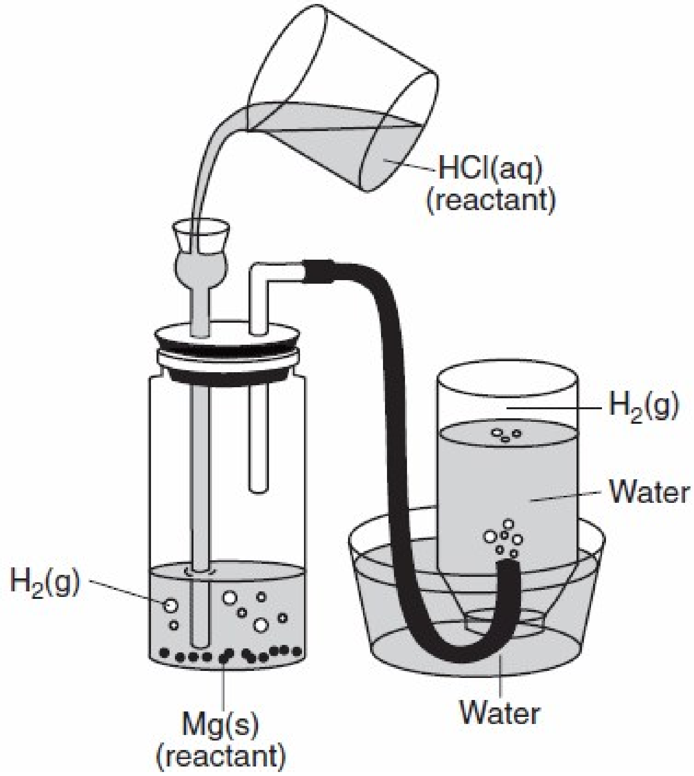
1, 1, 2, 1, 1

35

Figure 29

Base your answer to the question on the information below.

A student places a 2.50-gram sample of magnesium metal in a bottle and fits the bottle with a 2-hole stopper as shown in the diagram. Hydrochloric acid is added to the bottle, causing a reaction. As the reaction proceeds, hydrogen gas travels through the tubing to an inverted bottle filled with water, displacing some of the water in the bottle.



Refer to Figure 29 and answer the following Question:
Balance the equation for the reaction of magnesium and hydrochloric acid, using the smallest whole-number coefficients.

☐ Mg(s) + ☐ HCl(aq) → ☐ $MgCl_2$(aq) + ☐ H_2(g)

Answer

1, 2, 1, 1

36

Figure 30

Base your answer to the question on the information below.

The decomposition of sodium azide, NaN_3(s), is used to inflate airbags. On impact, the NaN_3(s) is ignited by an electrical spark, producing N_2(g) and Na(s). The N_2(g) inflates the airbag.

Refer to Figure 30 and answer the following Question:
Balance the equation below using the smallest whole-number coefficients.

☐ NaN_3(*s*) → ☐ Na(*s*) + ☐ N_2(*g*)

Answer

2, 2, 3

37 Answer => 2

Given the nuclear equation: ${}^{1}_{1}\mathrm{H} + X \rightarrow {}^{6}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$

The particle represented by *X* is

1 ${}^{9}_{4}\mathrm{Li}$
2 ${}^{9}_{4}\mathrm{Be}$
3 ${}^{10}_{5}\mathrm{Be}$
4 ${}^{10}_{6}\mathrm{C}$

38 Answer => 2

Given the incomplete equation: $4\mathrm{Fe} + 3\mathrm{O}_2 \rightarrow 2X$

Which compound is represented by *X*?

1 FeO
2 $\mathrm{Fe_2O_3}$
3 $\mathrm{Fe_3O_2}$
4 $\mathrm{Fe_3O_4}$

39 Answer => 3

Given the reaction: $2\mathrm{Cr}(s) + \_\_\mathrm{Sn}^{2+}(aq) \rightarrow 2\mathrm{Cr}^{3+}(aq) + \_\_\mathrm{Sn}(s)$

When the reaction is correctly balanced using the smallest whole numbers, the coefficient of $\mathrm{Sn}^{2+}(aq)$ is

1 1
2 2
3 3
4 4

40 Answer => 4

Given the unbalanced equation:
$\_\_\mathrm{MnO_2} + \_\_\mathrm{HCl} \rightarrow \_\_\mathrm{MnCl_2} + \_\_\mathrm{H_2O} + \_\_\mathrm{Cl_2}$
When the equation is balanced using the smallest whole number coefficients, the coefficient of HCl is

1 1
2 2
3 3
4 4

41 Answer => 3

When the equation
$\_\_\mathrm{Pb}^{2+} + \_\_\mathrm{Au}^{3+} \rightarrow \_\_\mathrm{Pb}^{4+} + \_\_\mathrm{Au}$
is correctly balanced using the smallest whole-number coefficients, the coefficient of Pb^{2+} will be

1 1
2 2
3 3
4 4

42 Answer =>1

When the equation: __$Al_2(SO_4)_3$ + __$ZnCl_2$ → __$AlCl_3$ + __$ZnSO_4$

is correctly balanced using the smallest whole number coefficients, the sum of the coefficients is

1 9
2 8
3 5
4 4

Nuclear Reactions
Video #9a

Name:__________________________ Class/Period:______________________

Assignment: Video 9a HW. Nuclear Chemistry: Fission vs. Fusion and Uses of Isotopes

Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 9a/17 then answer the following questions.

1 Answer => 1

Which emission causes the atomic number of a nuclide to decrease by 2 and its mass number to decrease by 4?

1 an alpha particle
2 a beta particle
3 gamma radiation
4 a positron

2 Answer => 1

Which nuclear emission is listed with its notation?

1 gamma radiation, ${}^{0}_{0}\gamma$
2 proton, ${}^{4}_{2}\mathrm{He}$
3 neutron, ${}^{0}_{-1}\beta$
4 alpha particle, ${}^{1}_{1}\mathrm{H}$

3 Answer => 4

Which list of nuclear emissions is arranged in order from the greatest penetrating power to the least penetrating power?

1 alpha particle, beta particle, gamma ray
2 alpha particle, gamma ray, beta particle
3 gamma ray, alpha particle, beta particle
4 gamma ray, beta particle, alpha particle

4 Answer => 3

Which radioactive emission has the greatest penetrating power, but the *least* ionizing power?

1 alpha particle
2 beta particle
3 gamma ray
4 positron

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

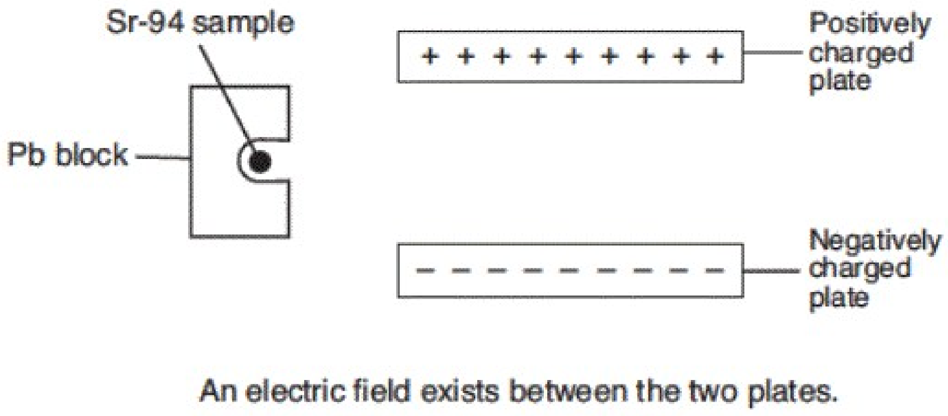
One fission reaction for U-235 is represented by the balanced nuclear equation below.

$$^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{140}_{54}\text{Xe} + ^{94}_{38}\text{Sr} + 2^{1}_{0}\text{n}$$

Both radioisotopes produced by this fission reaction undergo beta decay. The half-life of Xe-140 is 13.6 seconds and the half-life of Sr-94 is 1.25 minutes.

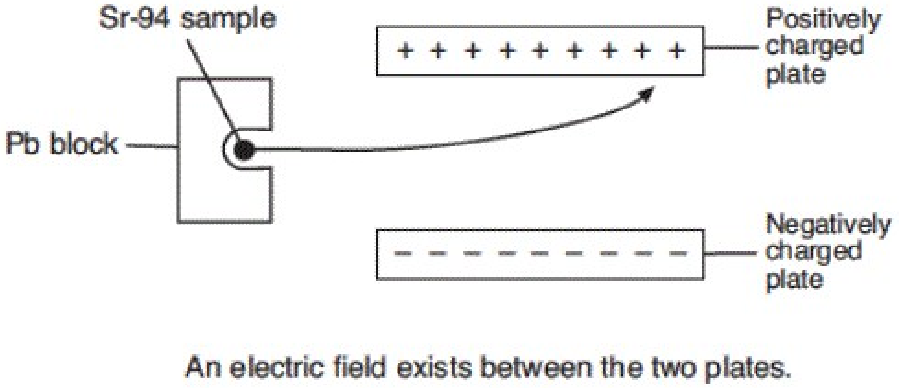
Refer to Figure 1 and answer the following Question:

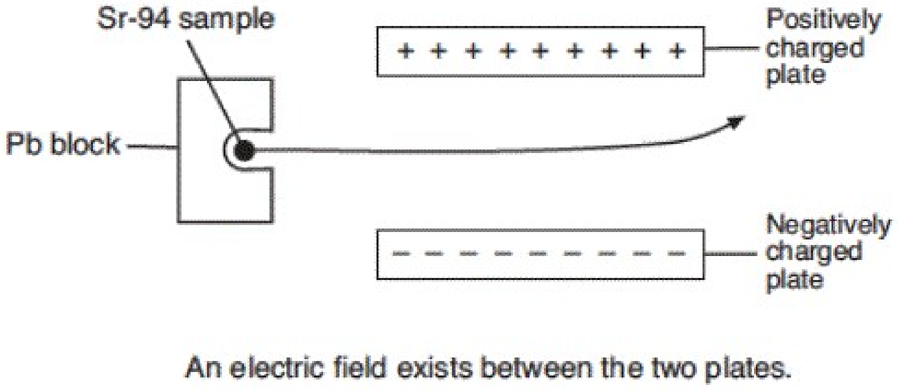
On the diagram below, draw an arrow to represent the path of an emitted beta particle in the electric field between two oppositely charged metal plates.



Answer

Examples:





6

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

When uranium-235 nuclei are bombarded with neutrons, many different combinations of smaller nuclei can be produced. The production of neodymium-150 and germanium-81 in one of these reactions is represented by the equation below.

$${}^{1}_{0}\mathrm{n} + {}^{235}_{92}\mathrm{U} \rightarrow {}^{150}_{60}\mathrm{Nd} + {}^{81}_{32}\mathrm{Ge} + 5{}^{1}_{0}\mathrm{n}$$

Germanium-81 and uranium-235 have different decay modes. Ge-81 emits betaparticles and has a half-life of 7.6 seconds.

Refer to Figure 2 and answer the following Question:

Explain, in terms of nuclides, why the reaction represented by the nuclear equation is a fission reaction.

Answer

A fission reaction is the splitting of a large atom into two smaller ones. The U-235 nuclide splits into two different smaller nuclides.

7

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

A breeder reactor is one type of nuclear reactor. In a breeder reactor, uranium-238 is transformed in a series of nuclear reactions into plutonium-239.

The plutonium-239 can undergo fission as shown in the equation below. The *X* represents a missing product in the equation.

$${}^{1}_{0}\mathrm{n} + {}^{239}_{94}\mathrm{Pu} \rightarrow X + {}^{94}_{36}\mathrm{Kr} + 2{}^{1}_{0}\mathrm{n}$$

Refer to Figure 3 and answer the following Question:

Compare the amount of energy released by 1 mole of completely fissioned plutonium-239 to the amount of energy released by the complete combustion of 1 mole of methane.

Answer

Acceptable responses include, but are not limited to:

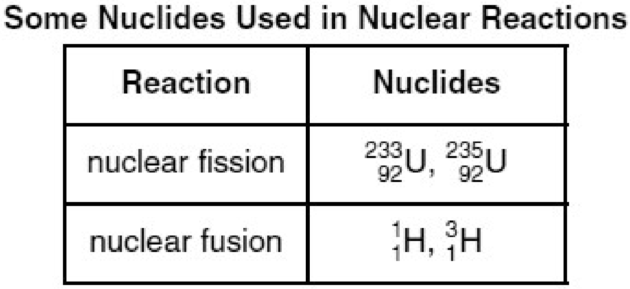
- The fission of one mole of Pu-239 releases much more energy than the combustion of one mole of CH_4.
- The energy released during the chemical reaction is less than the energy released during the nuclear reaction.
- greater for ${}^{239}_{94}\mathrm{Pu}$

8

Figure 4

Base your answer to the question on the information below.

Nuclear fission has been used to produce electricity. However, nuclear fusion for electricity production is still under development. The notations of some nuclides used in nuclear reactions are shown in the table below.



Some Nuclides Used in Nuclear Reactions

Reaction	Nuclides
nuclear fission	$^{233}_{92}U$, $^{235}_{92}U$
nuclear fusion	$^{1}_{1}H$, $^{3}_{1}H$

Refer to Figure 4 and answer the following Question:
State *one* potential benefit of using nuclear fusion instead of the current use of nuclear fission to produce electricity.

Answer

Acceptable responses include, but are not limited to:

- Fusion produces more energy per gram of reactant.
- The fusion process produces less radioactive waste.
- The fusion reactant material is more readily available.

9 **Refer to Figure 4 and answer the following Question:**
Compare the atomic masses of nuclides used in fusion to the atomic masses of nuclides used in fission.

Answer

Acceptable responses include, but are not limited to:

- The nuclides used for fusion have smaller atomic masses than nuclides used for fission.
- The nuclides used in fission are many times more massive.
- Fusion particles are lighter.

10

Figure 5

Base your answer to this question on the information below.

When a uranium-235 nucleus absorbs a slow-moving neutron, different nuclear reactions may occur. One of these possible reactions is represented by the complete, balanced equation below.

Equation 1: ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{92}_{36}\text{Kr} + {}^{142}_{56}\text{Ba} + 2{}^{1}_{0}\text{n} + \text{energy}$

For this reaction, the sum of the masses of the products is slightly less than the sum of the masses of the reactants. Another possible reaction of U-235 is represented by the incomplete, balanced equation below.

Equation 2: ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{92}_{38}\text{Sr} + \underline{\hspace{1.5cm}} + 2{}^{1}_{0}\text{n} + \text{energy}$

Refer to Figure 5 and answer the following Question:
Identify the type of nuclear reaction represented by equation 1.

Answer

Acceptable responses include, but are not limited to:

- fission
- transmutation

11

Figure 6

Base your answer to this question on the information below.

Scientists are investigating the production of energy using hydrogen-2 nuclei (deuterons) and hydrogen-3 nuclei (tritons). The balanced equation below represents one nuclear reaction between two deuterons.

$${}^{2}_{1}\text{H} + {}^{2}_{1}\text{H} \rightarrow {}^{3}_{2}\text{He} + {}^{1}_{0}\text{n} + 5.23\times10^{-13}\,\text{J}$$

Refer to Figure 6 and answer the following Question:
Identify the type of nuclear reaction represented by the equation.

Answer

Acceptable responses include, but are not limited to:

- fusion
- thermonuclear fusion

12 **Answer** => 3

Cobalt-60 and iodine-131 are radioactive isotopes that are used in

1 dating geologic formations
2 industrial measurements
3 medical procedures
4 nuclear power

13 Answer => 4

The dating of geological formations is an example of a beneficial use of

1 isomers
2 electrolytes
3 organic compounds
4 radioactive nuclides

14 Answer => 1

Which nuclides are used to date the remains of a once-living organism?

1 C-14 and C-12
2 Co-60 and Co-59
3 I-131 and Xe-131
4 U-238 and Pb-206

15 Answer => 2

Which radioisotope is used to treat thyroid disorders?

1 Co-60
2 I-131
3 C-14
4 U-238

16 Answer => 2

Which radioisotope is used in dating geological formations?

1 I-131
2 U-238
3 Ca-37
4 Fr-220

17 Answer => 3

Which isotope is used to treat cancer?

1 C-14
2 U-238
3 Co-60
4 Pb-206

18 Answer => 3

The ratio of the mass of U-238 to the mass of Pb-206 can be used to

1 diagnose thyroid disorders
2 diagnose kidney function
3 date geological formations
4 date once-living things

19

Figure 7

Base your answer to the question on the article, the *Reference Tables for Physical Setting/Chemistry*,and your knowledge of chemistry.

Radioactivity at home

> You may be surprised to learn that you do not need to visit a nuclear power plant or a hospital X-ray laboratory to find sources of radioactivity. They are all around us. In fact, it is likely that you'll find a few at home. Your front porch may incorporate cinder blocks or granite blocks. Both contain uranium. Walk through the front door, look up, and you'll see a smoke detector that owes its effectiveness to the constant source of alpha particle emissions from Americium-241. As long as the gases remain ionized within the shielded container, electricity flows, and all is calm. When smoke enters the chamber, it neutralizes the charges on these ions. In the absence of these ions, the circuit breaks and the alarm goes off.
>
> Indicator lights on your appliances may use Krypton-85; electric blankets, promethium-147; and fluorescent lights, thorium-229. Even the food we eat is radioactive. The more potassium-rich the food source, the more potassium-40—a radioactive isotope that makes up about 0.01% of the natural supply of this mineral—is present. Thus, brazil nuts, peanuts, bananas, potatoes, and flour, all rich in potassium, are radiation sources.
>
> —*Chem Matters*, April 2000

Refer to Figure 7 and answer the following Question:
State one benefit or useful application of radioactivity *not* mentioned in this article.

Answer

Acceptable responses include, but are not limited to, these examples:

- Radioactivity can be used in medical diagnosis and/or treatment
- Food irradiation
- Radioactive dating
- Radioactive tracing of chemical and biological reactions

20 Answer => 3

Radioisotopes used for medical diagnosis must have

1 long half-lives and be quickly eliminated by the body
2 long half-lives and be slowly eliminated by the body
3 short half-lives and be quickly eliminated by the body
4 short half-lives and be slowly eliminated by the body

Half-life Calculations

Video #9b

Name:__________________________ Class/Period:_______________________

Assignment: Video 9b. Nuclear Chemistry: Calculating Half-life Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 9b/17 then answer the following questions.

1 Phosphorus-30 and phosphorus-32 are radioisotopes. Phosphorus-32 decays by positron emission.
Based on Table N, determine the time required for an original 100.-milligram sample of P-32 to decay until only 25 milligrams of the sample remain unchanged.

Answer

According to Table N the half-life of P-32 is 14.28 days. If a sample decays from 100.-milligrams to 25 milligrams, that is two half-lives (100→50→25). Each half-life is 14.28 days so the total time elapsed for two half-life periods is ***28.56 days***.

2 Answer => 1

Which radioisotope requires long-term storage as the method of disposal, to protect living things from radiation exposure over time?

1 Pu-239
2 Fr-220
3 Fe-53
4 P-32

3 Cobalt-60 is an artificial isotope of Co-59. The incomplete equation for the decay of cobalt-60, including beta and gamma emissions, is shown below:

$$^{60}_{27}\mathrm{Co} \rightarrow X + {}^{0}_{-1}\mathrm{e} + {}^{0}_{0}\gamma$$

Based on Table N, determine the total time required for an 80.00-gram sample of cobalt-60 to decay until only 10.00 grams of the sample remain unchanged.

Answer

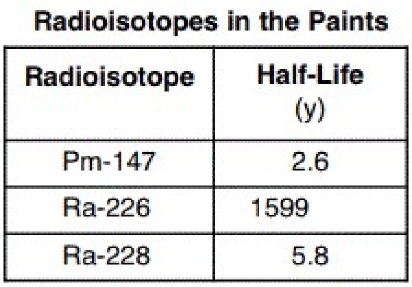
In order to determine the total time required for an 80.0 g sample of Co-60 to decay until only 10 grams remains, it is necessary to calculate the number of half-lives it undergoes as follows:

80 g →40 g→ 20 g → 10g

3 half-lives are required to decay 80 g until only 10 g remains.

According to Table N, the half-life of Co-60 is 5.271 years. Therefore, 3 half-lives would take a total time of ***15.813 years.***

4 In the past, some paints that glowed in the dark contained zinc sulfide and salts of Ra-226. As the radioisotope Ra-226 decayed, the energy released caused the zinc sulfide in these paints to emit light. The half-lives for Ra-226 and two other radioisotopes used in these paints are listed on the table below.



Radioisotopes in the Paints

Radioisotope	Half-Life (y)
Pm-147	2.6
Ra-226	1599
Ra-228	5.8

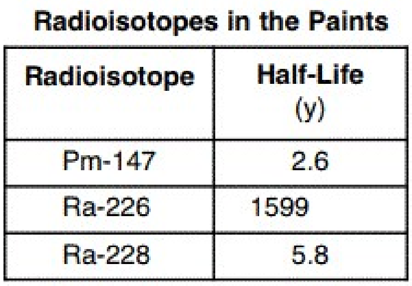
Explain, in terms of half-lives, why Ra-226 may have been used more often than the other isotopes in these paints.

Answer

Possible answers include:

- Paint with Ra-226 will glow for a longer time than paint containing the other isotopes because Ra-226 has the longest half-life of these isotopes.
- The other isotopes have shorter half-lives, so paint containing them will not glow for as many years.

5 In the past, some paints that glowed in the dark contained zinc sulfide and salts of Ra-226. As the radioisotope Ra-226 decayed, the energy released caused the zinc sulfide in these paints to emit light. The half-lives for Ra-226 and two other radioisotopes used in these paints are listed on the table below.



Radioisotopes in the Paints

Radioisotope	Half-Life (y)
Pm-147	2.6
Ra-226	1599
Ra-228	5.8

What fraction of an original Ra-228 sample remains unchanged after 17.4 years?

Answer

number of half lives = Total time / half life

number of half lives = 17.4 years / 5.8 years = 3 half lives

Fraction remaining = $1/2^n$

where n = number of half lives

$1/2^3 = 1/8$

$1 \rightarrow 1/2 \rightarrow 1/4 \rightarrow 1/8$

1/8 or 0.125 or 12.5%

6

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

When uranium-235 nuclei are bombarded with neutrons, many different combinations of smaller nuclei can be produced. The production of neodymium-150 and germanium-81 in one of these reactions is represented by the equation below.

$$^{1}_{0}\text{n} + ^{235}_{92}\text{U} \rightarrow ^{150}_{60}\text{Nd} + ^{81}_{32}\text{Ge} + 5^{1}_{0}\text{n}$$

Germanium-81 and uranium-235 have different decay modes. Ge-81 emits betaparticles and has a half-life of 7.6 seconds.

Refer to Figure 1 and answer the following Question:

Determine the time required for a 16.00-gram sample of Ge-81 to decay until only 1.00 gram of the sample remains unchanged.

Answer

Determine the number of half-lives that must occur for 16.0 grams to decay to 1.00 grams by dividing 16 in half until 1.00 gram is reached.

16 → 8 → 4 → 2 → 1

4 half lives must have occurred.

If each half life takes 7.6 seconds the total time for decay is

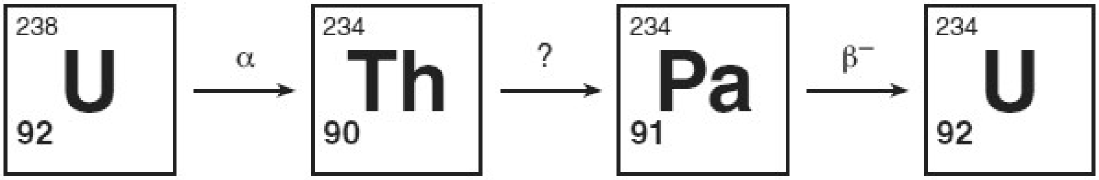
(4 × 7.6 seconds) = ***30.4 seconds.***

7

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

The diagram below shows the first three steps in the uranium-238 radioactive decay series.



The decay mode for the first and third steps is shown above the arrows. The decay mode for the second step is not shown in the diagram. Thorium-234 has a half-life of 24.10 days.

Refer to Figure 2 and answer the following Question:

Determine the total time that must elapse until only 1/16 of an original sample of Th-234 remains unchanged.

Answer

- 96.40 d
- $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{16}$ 4 half-lives pass to have 1/16th remaining. Each Th-234 half life is 24.10 days. 4 half-lives is 96.40 days

8 Answer <u>=> 2</u>

What is the mass of an original 5.60-gram sample of iron-53 that remains unchanged after 25.53 minutes?

1 0.35 g
2 0.70 g
3 1.40 g
4 2.80 g

9 Answer <u>=> 4</u>

A radioactive isotope has a half-life of 2.5 years. Which fraction of the original mass remains unchanged after 10. years?

1 $\frac{1}{2}$
2 $\frac{1}{4}$
3 $\frac{1}{8}$
4 $\frac{1}{16}$

10 Answer <u>=> 3</u>

Which phrase describes the decay modes and the half-lives of K-37 and K-42?

1 the same decay mode but different half-lives
2 the same decay mode and the same half-life
3 different decay modes and different half-lives
4 different decay modes but the same half-life

11

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

> The radioisotope Mo-99 naturally decays to produce the metastable isotope Tc-99m, which is used in medical diagnosis. A doctor can obtain images of organs and bones by injecting a patient with a solution of Tc-99m. The half-life of the metastable Tc-99m is six hours.

Refer to Figure 3 and answer the following Question:

Determine the fraction of an original sample of metastable Tc-99m that remains unchanged after 24 hours.

Answer

Acceptable responses include, but are not limited to:

- $\frac{1}{16}$
- 0.0625
- 6.25%

The half-life of the metastable Tc-99m is six hours. 24 hours is 4 half-lives. $\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}=\frac{1}{16}$

Figure 4

Base your answer to the question on the information below and on your knowledge of chemistry.

One fission reaction for U-235 is represented by the balanced nuclear equation below.

$$^{235}_{92}\mathrm{U} + ^{1}_{0}\mathrm{n} \rightarrow ^{140}_{54}\mathrm{Xe} + ^{94}_{38}\mathrm{Sr} + 2^{1}_{0}\mathrm{n}$$

Both radioisotopes produced by this fission reaction undergo beta decay. The half-life of Xe-140 is 13.6 seconds and the half-life of Sr-94 is 1.25 minutes.

Refer to Figure 4 and answer the following Question:

Determine the time required for an original 24.0-gram sample of Sr-94 to decay until only 1.5 grams of the sample remains unchanged.

Answer

Half-life is the time required for 1/2 of a radioactive element to decay.

Initial sample = 24.0 grams

12.0 grams remain after 1.25 mins

6.0 grams after another 1.25 mins

3.0 grams after another 1.25 mins

1.5 grams after another 1.25 mins

Adding the time to reach 1.5 grams = 5.0 mins

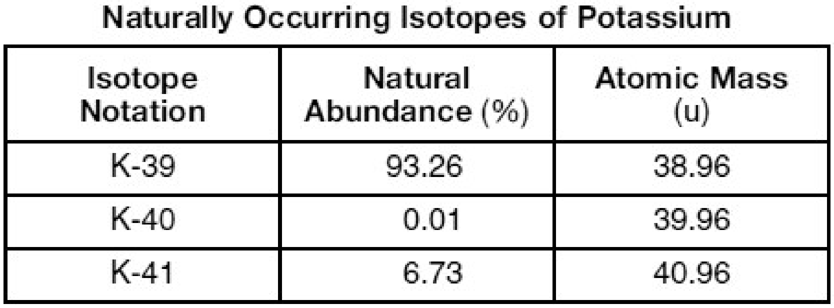
Allow credit for 5.00 min. Significant figures do *not* need to be shown.

13

Figure 5

Base your answer to the questions on the information below and on your knowledge of chemistry.

Some isotopes of potassium are **K**-37, **K**-39, **K**-40, **K**-41, and **K**-42. The natural abundance and the atomic mass for the naturally occurring isotopes of potassium are shown in the table below.



Naturally Occurring Isotopes of Potassium

Isotope Notation	Natural Abundance (%)	Atomic Mass (u)
K-39	93.26	38.96
K-40	0.01	39.96
K-41	6.73	40.96

Refer to Figure 5 and answer the following Question:

Determine the fraction of an original sample of K-42 that remains unchanged after 24.72 hours.

Answer

According to Reference Table *N*, the half-life of K-42 is 12.36 hours. 24.72 hours is two half-lives, so $\frac{1}{4}$ of the original sample remains.

Acceptable responses include, but are not limited to:

- $\frac{1}{4}$
- 25%
- 0.25

14

Figure 6

Base your answer to the question on the information below and on your knowledge of chemistry.

Illuminated **EXIT** signs are used in public buildings such as schools. If the word **EXIT** is green, the sign may contain the radioisotope tritium, hydrogen-3. The tritium is a gas sealed in glass tubes. The emissions from the decay of the tritium gas cause a coating on the inside of the tubes to glow.

Refer to Figure 6 and answer the following Question:

Determine the fraction of an original sample of tritium that remains unchanged after 24.62 years.

Answer

The half-life of tritium (H-3) is 12.31 years. So 24.62 years = 2 half-lives. After 1 half-life, one-half of the radioactive sample remains; after 2 half-lives, one-quarter of the radioactive sample remains.

Acceptable responses include, but are not limited to:

- $\frac{1}{4}$
- 0.25
- 25%

15

Figure 7

Base your answer to the question on the information below and on your knowledge of chemistry.

> Iodine has many isotopes, but only iodine-127 is stable and is found in nature. One radioactive iodine isotope, I-108, decays by alpha particle emission. Iodine-131 is also radioactive and has many important medical uses.

Refer to Figure 7 and answer the following Question:
Determine the total time required for an 80.0-gram sample of I-131 to decay until only 1.25 grams of the sample remains unchanged.

Answer

Allow credit for 48 d, 48.0 d, 48.1 d, or for any value from 48.12 d to 48.13 d, inclusive.

According to Reference Table *N*, the half-life of I-131 is 8.021 days.

Original sample: 80.0 g
After 1 half-life: 40.0 g
After 2 half-lives: 20.0 g
After 3 half-lives: 10.0 g
After 4 half-lives: 5.00 g
After 5 half-lives: 2.50 g
After 6 half-lives: 1.25 g

6 half-lives × 8.021 days/half-life = 48.1 days

16 Answer => 3

After decaying for 48 hours, $\frac{1}{16}$ of the original mass of a radioisotope sample remains unchanged. What is the half-life of this radioisotope?

1 3.0 h
2 9.6 h
3 12 h
4 24 h

17

Figure 8

Base your answer to the question on the information below.

Nuclear radiation is harmful to living cells, particularly to fast-growing cells, such as cancer cells and blood cells. An external beam of the radiation emitted from a radioisotope can be directed on a small area of a person to destroy cancer cells within the body.

Cobalt-60 is an artificially produced radioisotope that emits gamma rays and beta particles. One hospital keeps a 100.0-gram sample of cobalt-60 in an appropriate, secure storage container for future cancer treatment.

Refer to Figure 8 and answer the following Question:

Determine the total time that will have elapsed when 12.5 grams of the original Co-60 sample at the hospital remains unchanged.

Answer

Acceptable responses include, but are not limited to:

- 15.813 y
- 15.8 y

100.0 g → 50.0 g → 25.0 g → 12.5 g
3 half-lives, half-life of Co-60 is 5.271 y
3 × 5.271 y = 15.813 y

18

Figure 9

Base your answer to the question on the information below.

Polonium-210 occurs naturally, but is scarce. Polonium-210 is primarily used in devices designed to eliminate static electricity in machinery. It is also used in brushes to remove dust from camera lenses.

Polonium-210 can be created in the laboratory by bombarding bismuth-209 with neutrons to create bismuth-210. The bismuth-210 undergoes beta decay to produce polonium-210. Polonium-210 has a half-life of 138 days and undergoes alpha decay.

Refer to Figure 9 and answer the following Question:

Determine the total mass of an original 28.0-milligram sample of Po-210 that remains unchanged after 414 days.

Answer: ☐ mg

Answer

3.5

19 Answer => 3

What is the total number of years that must pass before only 25.00 grams of an original 100.0-gram sample of C-14 remains unchanged?

1 2,857 y
2 5,715 y
3 11,430 y
4 17,145 y

Figure 10

Base your answer to this question on the information below.

> The radioisotope uranium-238 occurs naturally in Earth's crust. The disintegration of this radioisotope is the first in a series of spontaneous decays.
>
> The sixth decay in this series produces the radioisotope radon-222. The decay of radon-222 produces the radioisotope polonium-218 that has a half life of 3.04 minutes. Eventually, the stable isotope lead-206 is produced by the alpha decay of an unstable nuclide.

Refer to Figure 10 and answer the following Question:
Determine the original mass of a sample of Po-218, if 0.50 milligram of the sample remains unchanged after 12.16 minutes.

Answer: ☐ mg

Answer

8.00

Figure 11

Base your answer on the information below and on your knowledge of chemistry.

Nuclear Waste Storage Plan for Yucca Mountain

In 1978, the U.S. Department of Energy began a study of Yucca Mountain which is located 90 miles from Las Vegas, Nevada. The study was to determine if Yucca Mountain would be suitable for a long-term burial site for high-level radioactive waste. A three-dimensional (3-D) computer scale model of the site was used to simulate the Yucca Mountain area. The computer model study for Yucca Mountain included such variables as: the possibility of earthquakes, predicted water flow through the mountain, increased rainfall due to climate changes, radioactive leakage from the waste containers, and increased temperatures from the buried waste within the containers.

The containers that will be used to store the radioactive waste are designed to last 10,000 years. Within the 10,000-year time period, cesium and strontium, the most powerful radioactive emitters, would have decayed. Other isotopes found in the waste would decay more slowly, but are not powerful radioactive emitters.

In 1998, scientists discovered that the compressed volcanic ash making up Yucca Mountain was full of cracks. Because of the arid climate, scientists assumed that rainwater would move through the cracks at a slow rate. However, when radioactive chlorine-36 was found in rock samples at levels halfway through the mountain, it was clear that rainwater had moved quickly down through Yucca Mountain. It was only 50 years earlier when this chlorine-36 isotope had contaminated rainwater during atmospheric testing of the atom bomb.

Some opponents of the Yucca Mountain plan believe that the uncertainties related to the many variables of the computer model result in limited reliability of its predictions. However, advocates of the plan believe it is safer to replace the numerous existing radioactive burial sites around the United States with the one site at Yucca Mountain. Other opponents of the plan believe that transporting the radioactive waste to Yucca Mountain from the existing 131 burial sites creates too much danger to the United States. In 2002, after years of political debate, a final legislative vote approved the development of Yucca Mountain to replace the existing 131 burial sites.

Refer to Figure 11 and answer the following Question:

If a sample of cesium-137 is stored in a waste container in Yucca Mountain, how much time must elapse until only $^1/_{32}$ of the original sample remains unchanged?

Answer

Acceptable responses include, but are not limited to, these examples:

- any response from 150 to 152
- 5 half-lives

22

Figure 12

Base your answer to the question on the information, the *Reference Tables for Physical Setting/Chemistry*, and your knowledge of chemistry.

> Radioactivity and radioactive isotopes have the potential for both benefiting and harming living organisms. One use of radioactive isotopes is in radiation therapy as a treatment for cancer. Cesium-137 is sometimes used in radiation therapy.
>
> A sample of cesium-137 was left in an abandoned clinic in Brazil in 1987. Cesium-137 gives off a blue glow because of its radioactivity. The people who discovered the sample were attracted by the blue glow and had no idea of any danger. Hundreds of people were treated for overexposure to radiation, and four people died.

Refer to Figure 12 and answer the following Question:

Suppose a 40-gram sample of iodine-131 and a 40-gram sample of cesium-137 were both abandoned in the clinic in 1987. Explain why the sample of iodine-131 would *not* pose as great a radiation risk to people today as the sample of cesium-137 would.

Answer

Acceptable responses include, but are not limited to, these examples:

- Iodine-131 would decay faster.
- Iodine has a much shorter half-life.
- Most of the I-131 would be gone.

23 **Answer** => 2

What is the half-life of a radioisotope if 25.0 grams of an original 200.-gram sample of the isotope remains unchanged after 11.46 days?

1 2.87 d
2 3.82 d
3 11.46 d
4 34.38 d

24 Determine the total time that must elapse until only $\frac{1}{4}$ of an original sample of the radioisotope Rn-222 remains unchanged.

Answer: ☐ d

Answer

7.64 or 7.646

25

Figure 13

Base your answer to this question on the information below.

When a uranium-235 nucleus absorbs a slow-moving neutron, different nuclear reactions may occur. One of these possible reactions is represented by the complete, balanced equation below.

Equation 1: $^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{92}_{36}\text{Kr} + ^{142}_{56}\text{Ba} + 2^{1}_{0}\text{n} + \text{energy}$

For this reaction, the sum of the masses of the products is slightly less than the sum of the masses of the reactants. Another possible reaction of U-235 is represented by the incomplete, balanced equation below.

Equation 2: $^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{92}_{38}\text{Sr} + \_\_\_\_\_ + 2^{1}_{0}\text{n} + \text{energy}$

Refer to Figure 13 and answer the following Question:
Determine the half-life of krypton-92 if only 6.0 milligrams of an original 96.0-milligram sample remains unchanged after 7.36 seconds.

Answer: ☐ s

Answer

1.84

26

Figure 14

Base your answer to this question the information below.

Cobalt-60 is commonly used as a source of radiation for the prevention of food spoilage. Bombarding cobalt-59 nuclei with neutrons produces the nuclide cobalt-60. A food irradiation facility replaces the cobalt-60, a source of gamma rays, when the radioactivity level falls to $\frac{1}{8}$ of its initial level. The nuclide cesium-137 is also a source of radiation for the prevention of food spoilage.

Refer to Figure 14 and answer the following Question:
Determine the total number of years that elapse before an original cobalt-60 source in an irradiation facility must be replaced.

Answer: ☐ y

Answer

15.813 or 15.78

27 Answer => 3

An original sample of the radioisotope fluorine-21 had a mass of 80.0 milligrams. Only 20.0 milligrams of this original sample remain unchanged after 8.32 seconds. What is the half-life of fluorine-21?

1 1.04 s
2 2.08 s
3 4.16 s
4 8.32 s

28 Answer => 1

An original sample of K-40 has a mass of 25.00 grams. After 3.9 × 10^9 years, 3.125 grams of the original sample remains unchanged. What is the half-life of K-40?

1 1.3 × 10^9 y
2 2.6 × 10^9 y
3 3.9 × 10^9 y
4 1.2 × 10^{10} y

29 Answer => 4

Which fraction of an original 20.00-gram sample of nitrogen-16 remains unchanged after 35.65 seconds?

1 $\frac{1}{5}$
2 $\frac{1}{8}$
3 $\frac{1}{16}$
4 $\frac{1}{32}$

30

Figure 15

Base your answer to this question on the information below.

The fossilized remains of a plant were found at a construction site. The fossilized remains contain $\frac{1}{16}$ the amount of carbon-14 that is present in a living plant.

Refer to Figure 15 and answer the following Question:
Determine the approximate age of these fossilized remains.

Answer: ☐ y

Answer

22920 or 22860

31 Answer => 1

If $\frac{1}{8}$ of an original sample of krypton-74 remains unchanged after 34.5 minutes, what is the half-life of krypton-74?

1 11.5 min
2 23.0 min
3 34.5 min
4 46.0 min

32 Answer => 2

What is the half-life of sodium-25 if 1.00 gram of a 16.00-gram sample of sodium-25 remains unchanged after 237 seconds?

1 47.4 s
2 59.3 s
3 79.0 s
4 118 s

33 Answer => 3

How many days are required for 200. grams of radon-222 to decay to 50.0 grams?

1 1.91 days
2 3.823 days
3 7.646 days
4 11.5 days

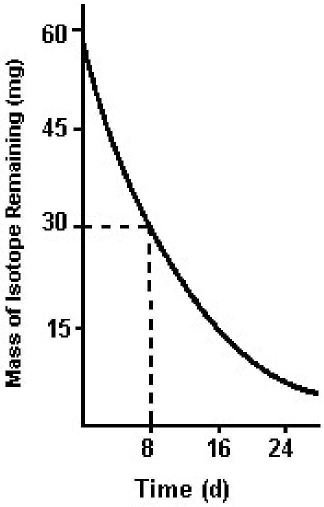
34 Answer => 4

Which radioactive sample would contain the greatest remaining mass of the radioactive isotope after 10 years?

1 2.0 grams of ^{198}Au
2 2.0 grams of ^{42}K
3 4.0 grams of ^{32}P
4 4.0 grams of ^{60}Co

35 Answer => 2

The graph represents the decay of a radioactive isotope.



Based on **Reference Table *N*,** which radioactive isotope is best represented by the graph?

1 ^{32}P
2 ^{131}I
3 ^{198}Au
4 ^{222}Rn

36 Answer => 3

Exactly how much time must elapse before 16 grams of potassium-42 decays, leaving 2 grams of the original isotope?

1 8 ×12.36 hours
2 2 ×12.36 hours
3 3 ×12.36 hours
4 4 ×12.36 hours

Stoichiometry
Video #10

Name:__________________________ Class/Period:_______________________

Assignment: Video 10. Stoichiometry: Mole Conversions Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 10/17 then answer the following questions.

1 Answer => 3

When a sample of Mg(s) reacts completely with O_2(g), the Mg(s) loses 5 moles of electrons. How many moles of electrons are gained by the O_2(g)?

1 1.0 mol
2 2.5 mol
3 5.0 mol
4 10.0 mol

2 Answer => 3

Given the balanced equation for the reaction of butane and oxygen:

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O + \text{energy}$$

How many moles of carbon dioxide are produced when 5.0 moles of butane react completely?

1 5.0 mol
2 10. mol
3 20. mol
4 40. mol

3 Answer => 4

Given the reaction:

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

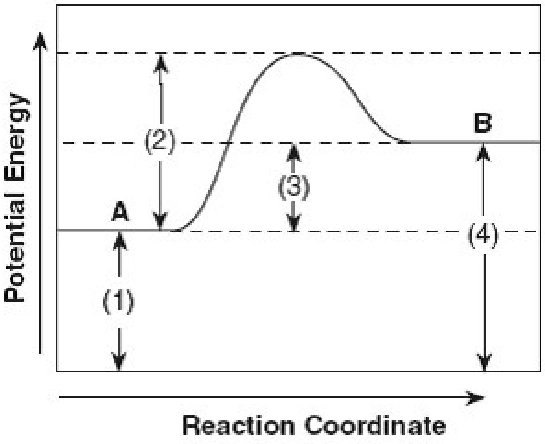
How many moles of $KClO_3$ must completely react to produce 6 moles of O_2?

1 1 mole
2 2 moles
3 6 moles
4 4 moles

4

Figure 1

Base your answer to the question on the potential energy diagram and the equation.



$2\ C(s) + H_2(g) + 227.4\ kJ \rightarrow C_2H_2(g)$

Refer to Figure 1 and answer the following Question:
If 682.2 kilojoules are absorbed, how many moles of $C_2H_2(g)$ are produced?

Answer: ☐ mol

Answer

3

5 Antacids can be used to neutralize excess stomach acid. Brand *A* antacid contains the acid neutralizing agent magnesium hydroxide, $Mg(OH)_2$. It reacts with HCl(*aq*) in the stomach, according to the following balanced equation:

$2HCl(aq) + Mg(OH)_2(s) \rightarrow MgCl_2(aq) + 2H_2O(\ell)$

If a person produces 0.050 mole of excess HCl in the stomach, how many moles of $Mg(OH)_2$ are needed to neutralize this excess hydrochloric acid?

Answer: ☐ mole(s)

Answer

0.025

6 **Answer** => 1

Given the equation: $2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$

How many moles of oxygen are required to react completely with 1.0 mole of C_2H_2?

1 2.5
2 2.0
3 5.0
4 10

7 Answer => 4

Given the reaction: $C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2(l)$

How many moles of $C_6H_{12}O_6(s)$ are needed to produce 24 moles of carbon dioxide?

1 1.0 mole
2 12 moles
3 24 moles
4 4.0 moles

8 Answer => 2

Given the balanced equation: $2Al(s) + 6H^+(aq) \rightarrow 3Al^{3+}(aq) + 3H_2(g)$

When 2 moles of Al(*s*) completely reacts, what is the total number of moles of electrons transferred from Al(*s*) to $H^+(aq)$?

1 5
2 6
3 3
4 4

9 Answer => 3

A compound contains 53% Al and 47% O by mass. What is the empirical formula of the compound?

1 AlO
2 AlO_2
3 Al_2O_3
4 Al_3O_2

10 Answer => 4

Given the reaction: $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

How many moles of H_2O are needed to react completely with 2.0 moles of Ca?

1 1.0 mole
2 2.0 moles
3 0.50 mole
4 4.0 moles

11 Answer => 4

Given the reaction:

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

What is the total number of liters of $O_2(g)$, measured at STP, that will react completely with 4.00 moles of SO_2?

1 1.00 L
2 0.500 L
3 22.4 L
4 44.8 L

12 Answer => 3

A compound consists of 40.% sulfur and 60.% oxygen by mass. What is the empirical formula of this compound?

1 SO
2 SO_2
3 SO_3
4 SO_4

13 Answer => 1

A compound contains 16% carbon and 84% sulfur by mass. What is the empirical formula of this compound?

1 CS_2
2 C_2S_2
3 CS
4 C_2S

14 Answer => 1

What is the total mass of oxygen in 1.00 mole of $Al_2(CrO_4)_3$?

1 192 g
2 112 g
3 64.0 g
4 48.0 g

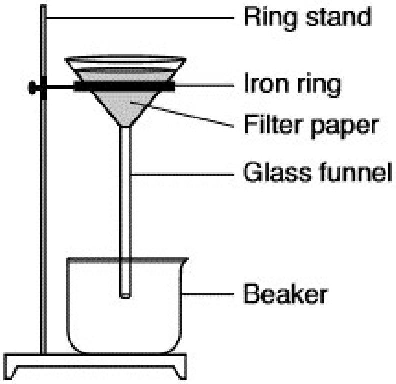
15 Answer => 1

Given the reaction: $4Na + O_2 \rightarrow 2Na_2O$

How many grams of oxygen are completely consumed in the production of 1.00 mole of Na_2O?

1 16.0
2 32.0
3 62.0
4 124

16 During a laboratory activity, appropriate safety equipment is used and safety procedures are followed. A student separates a sample of rock salt that has two components; NaCl(s) and small insoluble rock particles. First, the student thoroughly stirs the sample of rock salt into a sample of water in a flask. The mixture in the flask is filtered using the lab apparatus shown below.



The water is evaporated from the beaker. The filter paper and its contents are dried. The data collected by the student are shown in the table below.

Rock Salt Separation Lab Data

Object or Material	Mass (g)
rock salt sample	16.4
filter paper	1.6
clean empty beaker	224.2
filter paper with dry rock particles	2.2
beaker with dry NaCl(s)	240.0

Show a numerical setup for calculating the percent by mass of NaCl in the rock salt sample.

Answer

$$\frac{(240.0\text{ g} - 224.2\text{ g})}{16.4\text{ g}} \times 100$$

$$\frac{(100)(15.8)}{16.4}$$

$$\frac{16.4 - 0.6}{16.4} \times 100$$

$$\frac{15.8}{16.4} = \frac{x}{100}$$

17 Answer => 2

Which sample of gas at STP has the same number of molecules as 6 liters of $Cl_2(g)$ at STP?

1 3 liters of $O_2(g)$
2 6 liters of $N_2(g)$
3 3 moles of $O_2(g)$
4 6 moles of $N_2(g)$

18 Answer => 2

At STP, a 12.0-liter sample of $CH_4(g)$ has the same total number of molecules as

1 6.0 L of $H_2(g)$ at STP
2 12.0 L of $CO_2(g)$ at STP
3 18.0 L of HCl(g) at STP
4 24.0 L of $O_2(g)$ at STP

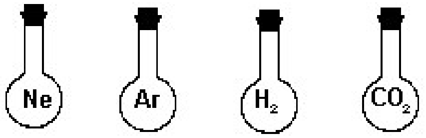
19 Answer => 1

How many molecules are in 0.25 mole of CO?

1 1.5×10^{23}
2 6.0×10^{23}
3 3.0×10^{23}
4 9.0×10^{23}

20 Answer => 2

The diagram represents four 500-milliliter flasks. Each contains the gas represented by the symbol.



All gas samples are at STP. Each flask contains the same number of

1 atoms, only
2 molecules, only
3 atoms and molecules
4 atoms but different number of molecules

21 Answer => 2

A 10.0-liter flask at a given temperature and pressure contains 6.0×10^{23} molecules of hydrogen gas. Under the same conditions of temperature and pressure, how many molecules would a 10-liter flask of nitrogen gas contain?

1 1.0×10^{23}
2 6.0×10^{23}
3 1.0×10^{24}
4 6.0×10^{24}

Potential Energy Diagrams

Video #11

Name:__________________________ Class/Period:______________________

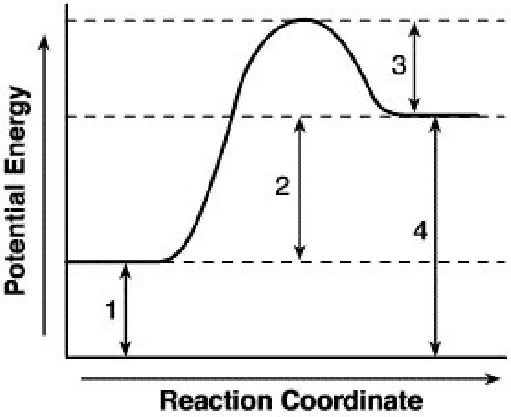
Assignment: Video 11. Potential Energy Diagrams: Endothermic vs. Exothermic Reactions.

Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 11/17 then answer the following questions.

1 Answer => 2

Given the potential energy diagram representing a reaction:



Which numbered interval represents the heat of reaction?

1 1
2 2
3 3
4 4

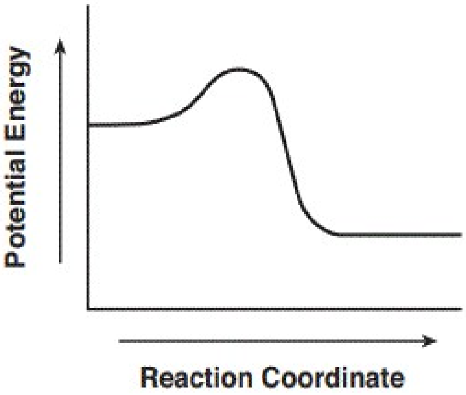
2 Automobile catalytic converters use a platinum catalyst to reduce air pollution by changing emissions such as carbon monoxide, CO(g), into carbon dioxide, CO2(g). The uncatalyzed reaction is represented by the balanced equation below.

$2CO(g) + O_2(g) \rightarrow 2CO_2(g) + \text{heat}$

Draw a potential energy diagram for the reaction represented by this equation.

Answer

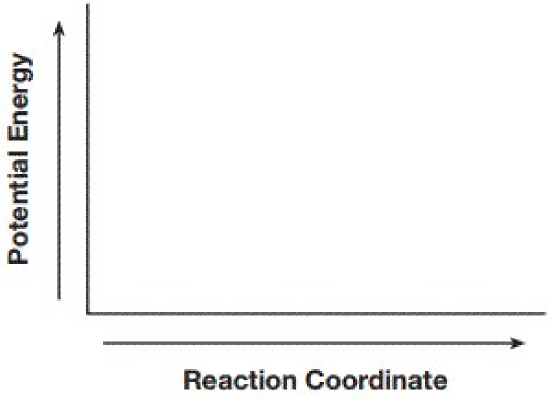
Exothermic reactions release heat. Therefore, the products should end up at a lower potential energy than the reactants. One example of a potential energy diagram for this reaction is as follows:



3 The balanced equation below represents the reaction between a 5.0-gram sample of zinc metal and a 0.5 M solution of hydrochloric acid. The reaction takes place in an open test tube at 298 K and 1 atm in a laboratory activity.

$Zn(s) + 2HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq)$ + energy

Using the labeled axes below, draw a potential energy diagram for this reaction.



Answer

Graphs should show the PE of the products is lower that the PE of the reactants.

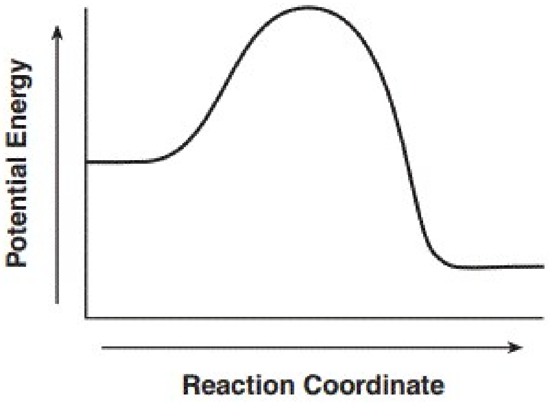


Figure 1

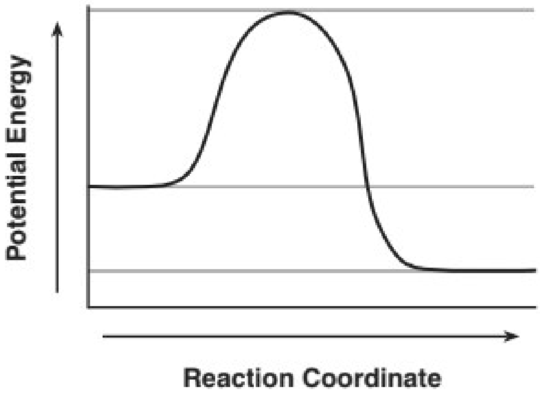
Base your answer to the question on the information below and on your knowledge of chemistry.

The balanced equation below represents the reaction between carbon monoxide and oxygen to produce carbon dioxide.

$2CO(g) + O_2(g) \rightarrow 2CO_2(g) + \text{energy}$

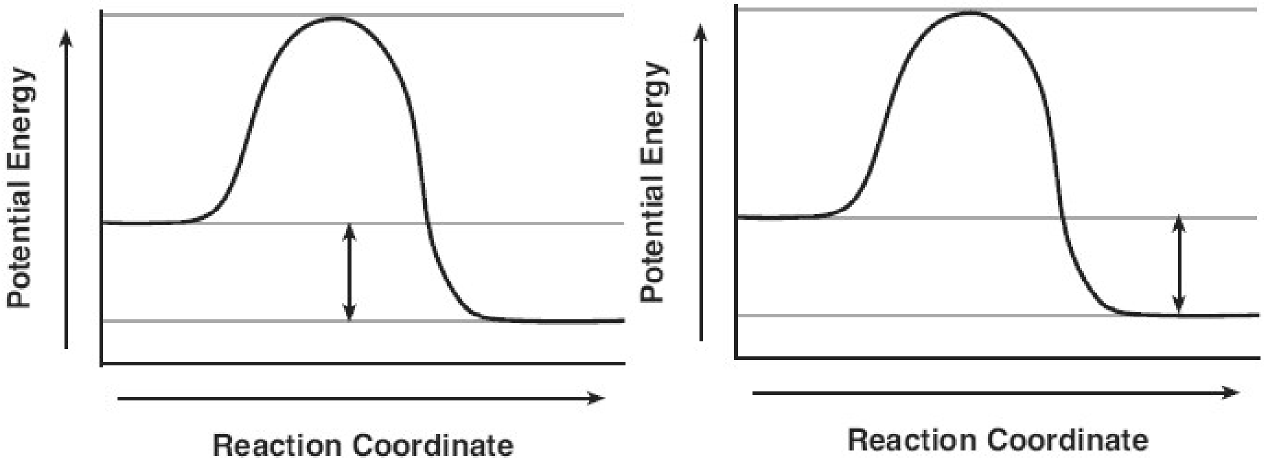
Refer to Figure 1 and answer the following Question:

On the potential energy diagram below, draw a double-headed arrow (↕) to indicate the interval that represents the heat of reaction.



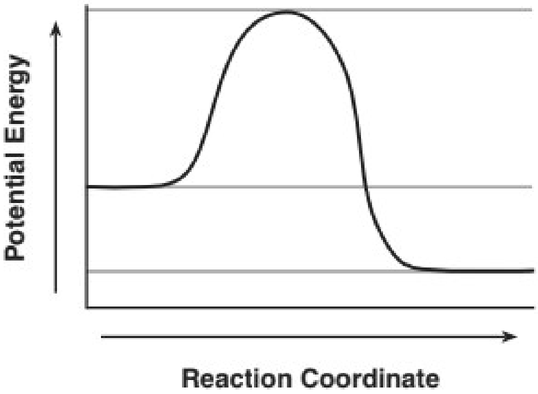
Answer

The heat of reaction is the difference between the potential energy of the products and the potential energy of the reactants. The difference from where the graph starts and where it ends in the potential energy diagram. Examples of correct responses:



5 Refer to Figure 1 and answer the following Question:

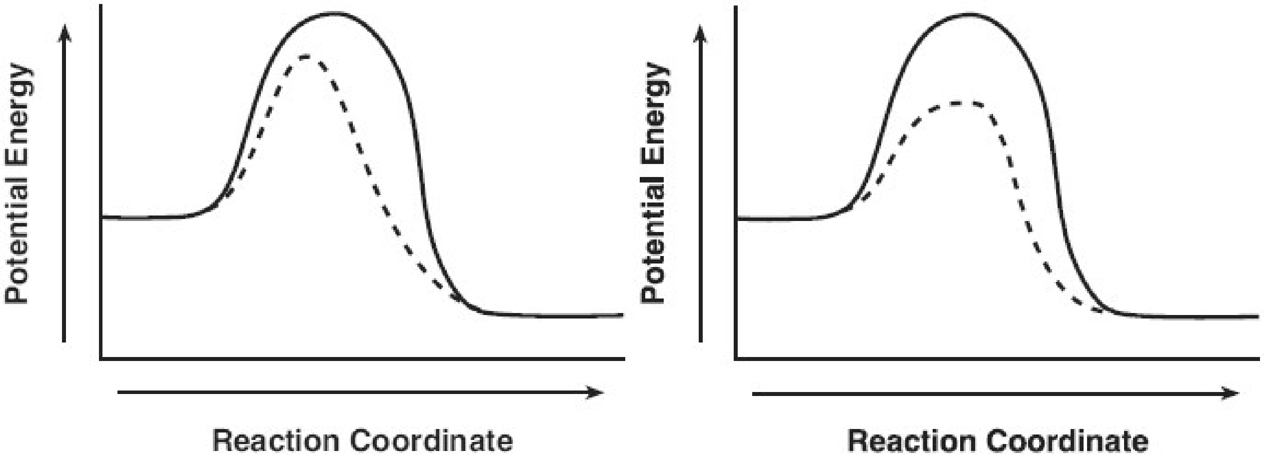
On the potential energy diagram below, draw a dashed line to show how the potential energy diagram changes when the reaction is catalyzed.



Answer

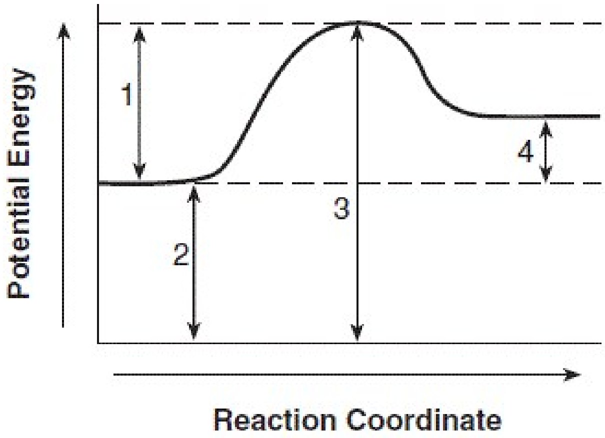
A catalyst provides an alternate pathway for the reaction which results in lowering the activation energy. This means that the peak of the reaction on the potential energy diagram is lowered. The potential energy of the products and reactants, however, remain the same.

Examples of correct responses:



6 Answer _=> 2_

Given the potential energy diagram for a reaction:

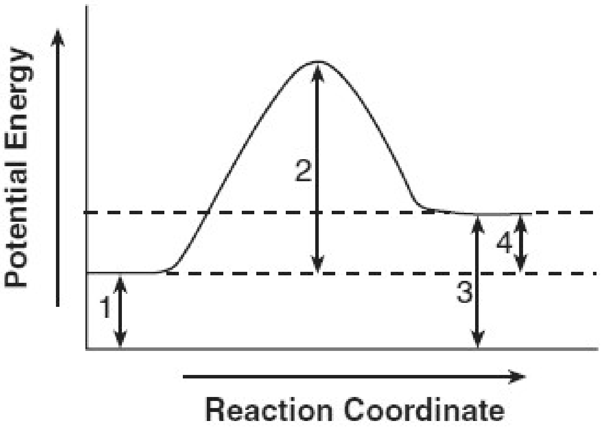


Which intervals are affected by the addition of a catalyst?

1 1 and 2
2 1 and 3
3 2 and 4
4 3 and 4

7 Answer _=> 4_

Given the potential energy diagram for a chemical reaction:

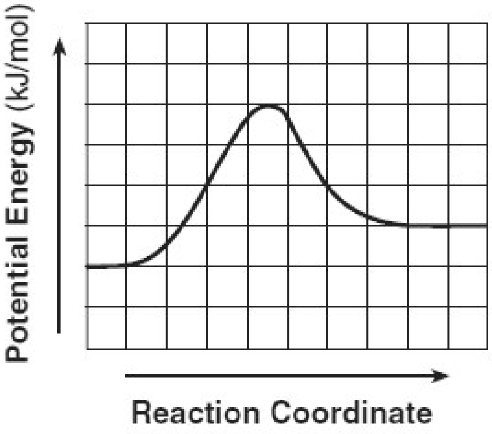


Which numbered interval represents the heat of reaction?

1 1
2 2
3 3
4 4

8 Answer => 3

Given the potential energy diagram for a reversible chemical reaction:

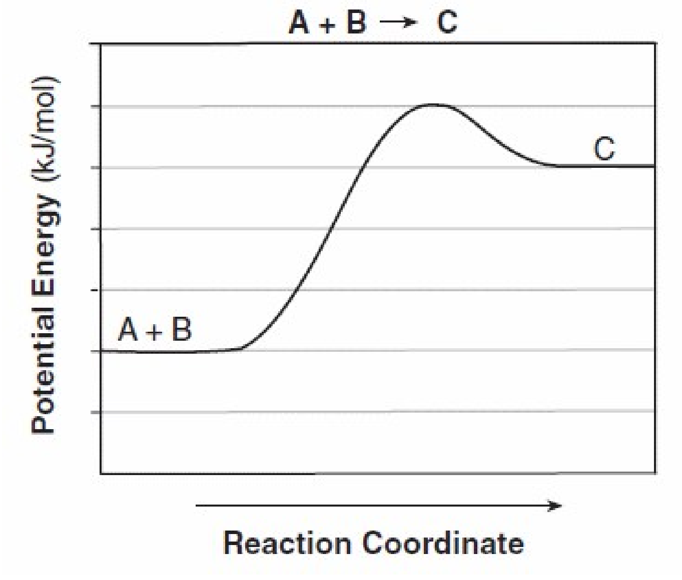


Each interval on the axis labeled "Potential Energy (kJ/mol)" represents 10. kilojoules per mole. What is the activation energy of the forward reaction?

1 10. kJ/mol
2 30. kJ/mol
3 40. kJ/mol
4 60. kJ/mol

9 Answer => 3

Given the equation and potential energy diagram representing a reaction:

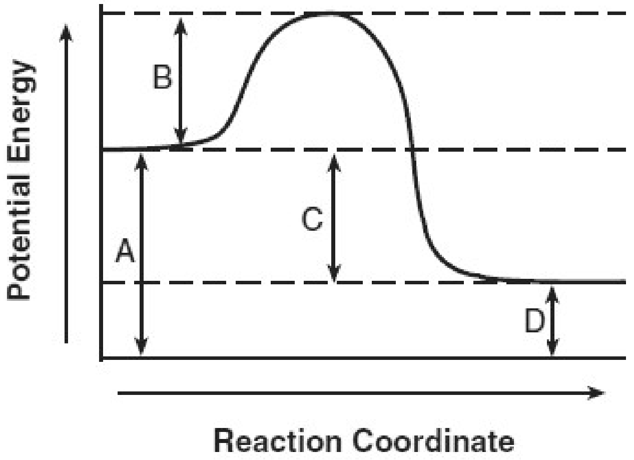


If each interval on the axis labeled "Potential Energy (kJ/mol)" represents 10. kJ/mol, what is the heat of reaction?

1 +60. kJ/mol
2 +20. kJ/mol
3 +30. kJ/mol
4 +40. kJ/mol

10 Answer => 2

Given the potential energy diagram representing a reversible reaction:



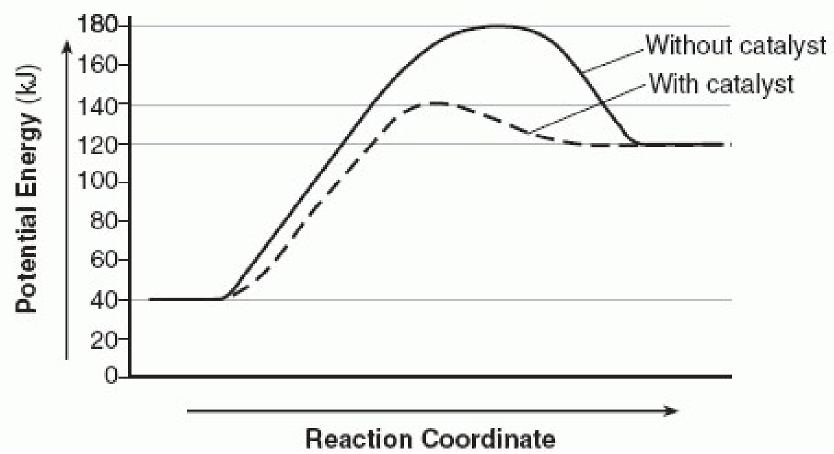
The activation energy for the reverse reaction is represented by

1 $A + B$
2 $B + C$
3 $B + D$
4 $C + D$

11

Figure 2

Base your answer to the questions on the potential energy diagram.



Refer to Figure 2 and answer the following Question:

Explain, in terms of the function of a catalyst, why the curves on the potential energy diagram for the catalyzed and uncatalyzed reactions are different.

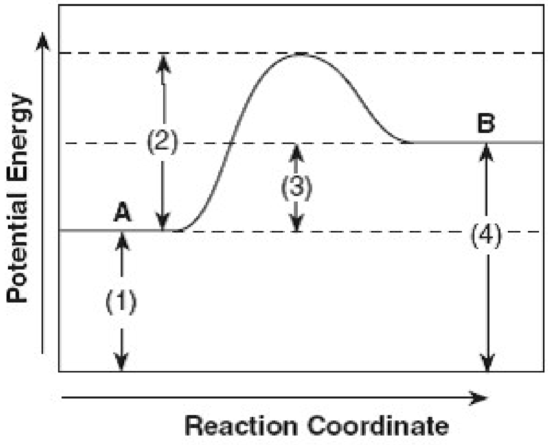
Answer

Acceptable responses include, but are not limited to:

- A catalyst provides an alternate reaction pathway with a lower activation energy than an uncatalyzed reaction.
- A catalyst speeds up the reaction.
- lower activation energy

Figure 3

Base your answer to the question on the potential energy diagram and the equation.



$$2\ C(s) + H_2(g) + 227.4\ kJ \rightarrow C_2H_2(g)$$

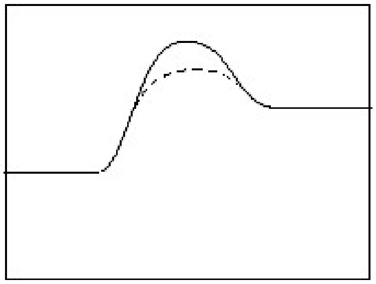
Refer to Figure 3 and answer the following Question:

Describe how the potential energy diagram will change if a catalyst is added.

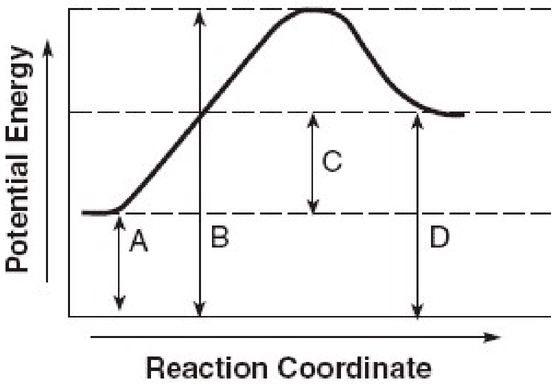
Answer

Acceptable responses include, but are not limited to, these examples:

- Arrow 2 gets shorter.
- The activation energy would be lower.
- The peak of the curve is lower.



13 Base your answer to the question on the information and potential energy diagram.



Chemical cold packs are often used to reduce swelling after an athletic injury. The diagram represents the potential energy changes when a cold pack is activated.

Identify a reactant listed in Reference Table *I* that could be mixed with water for use in a chemical cold pack.

Answer

Acceptable responses include these examples:

- KNO_3
- NaCl
- NH_4Cl
- NH_4NO3
- Potassium nitrate
- Sodium chloride
- Ammonium chloride
- Ammonium nitrate

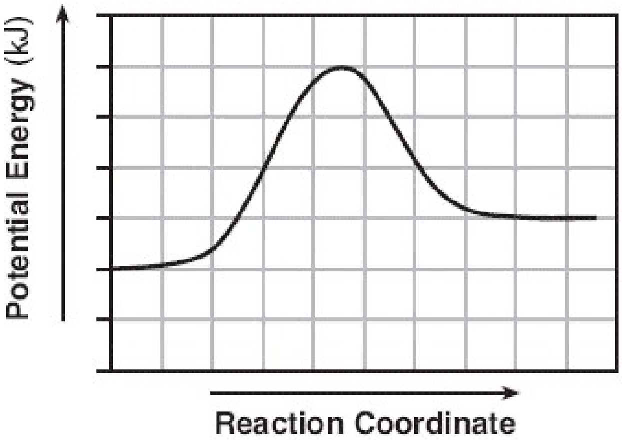
14 Answer => 1

A catalyst lowers the activation energy of a reaction by

1 providing an alternate reaction pathway
2 decreasing the heat of reaction
3 increasing the mass of the reactants
4 changing the mole ratio of the reactants

15 Answer => 3

The potential energy diagram for a chemical reaction is shown below.



Each interval on the axis labeled “Potential Energy (kJ)” represents 40 kilojoules. What is the heat of reaction?

1 -120 kJ
2 -40 kJ
3 +40 kJ
4 +160 kJ

16 Answer => 1

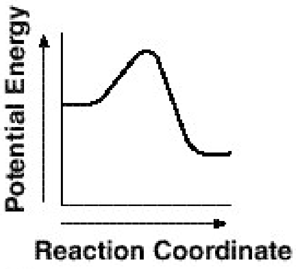
Figure 4

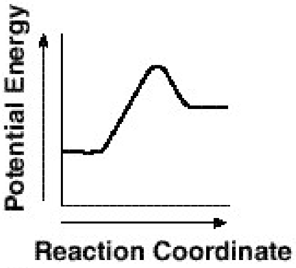
Base your answer to this question on the reaction represented by the balanced equation below.

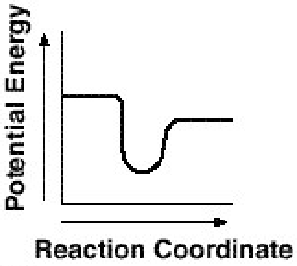
$2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell) + 571.6$ kJ

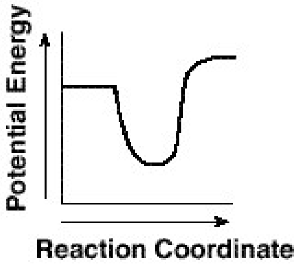
Refer to Figure 4 and answer the following Question:

Which potential energy diagram for the reaction correctly represents this equation?

1 

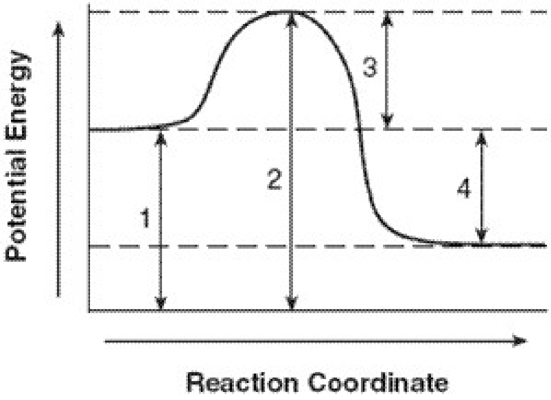
2 

3 

4 

17 Answer <u>=> 4 </u>

Given the potential energy diagram for a reaction:

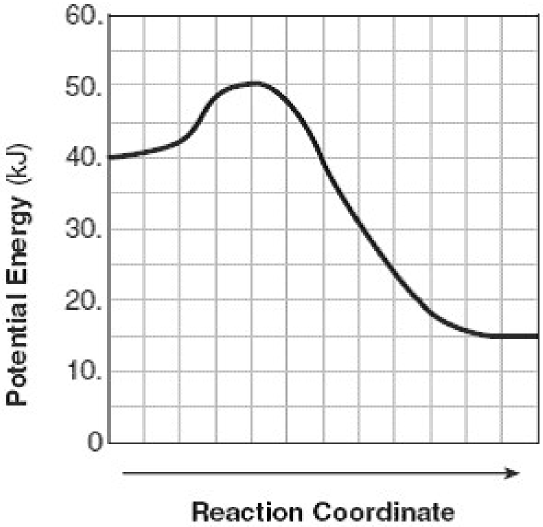


Which interval on this diagram represents the difference between the potential energy of the products and the potential energy of the reactants?

1 line 1
2 line 2
3 line 3
4 line 4

18 Answer <u>=> 2 </u>

Given the potential energy diagram for a chemical reaction:



Which statement correctly describes the energy changes that occur in the forward reaction?

1 The activation energy is 10. kJ and the reaction is endothermic.
2 The activation energy is 10. kJ and the reaction is exothermic.
3 The activation energy is 50. kJ and the reaction is endothermic.
4 The activation energy is 50. kJ and the reaction is exothermic.

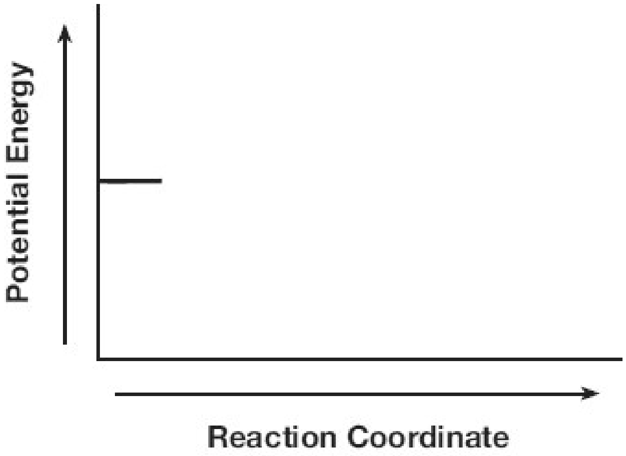
Figure 5

Base your answer to the questions on the information below and on your knowledge of chemistry.

> One process used to manufacture sulfuric acid is called the contact process. One step in this process, the reaction between sulfur dioxide and oxygen, is represented by the forward reaction in the system at equilibrium shown below.
>
> $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) + 394\ kJ$
>
> A mixture of platinum and vanadium(V) oxide may be used as a catalyst for this reaction. The sulfur trioxide produced is then used to make sulfuric acid.

Refer to Figure 5 and answer the following Question:

On the labeled axes below, complete the potential energy diagram for the forward reaction represented by this equation.



Answer

Example:

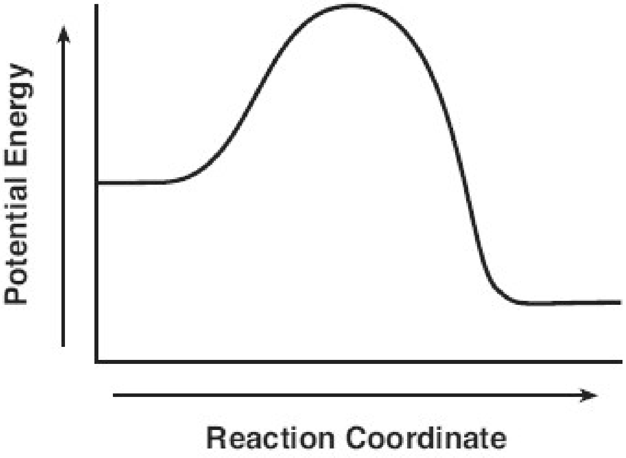


Figure 6

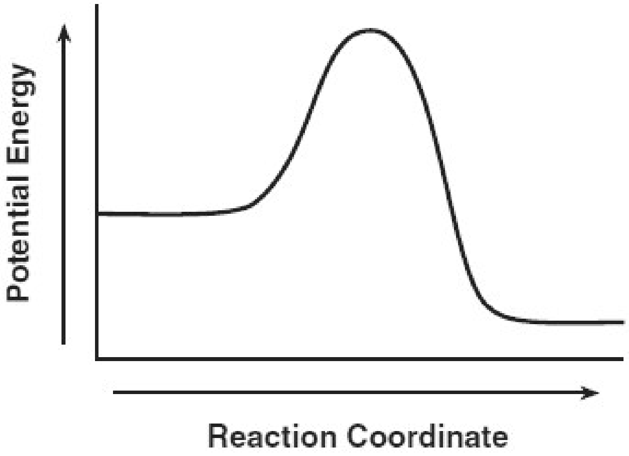
Base your answer to the question on the information below and on your knowledge of chemistry.

The equation below represents an equilibrium system of $SO_2(g)$, $O_2(g)$, and $SO_3(g)$. The reaction can be catalyzed by vanadium or platinum.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) + \text{energy}$

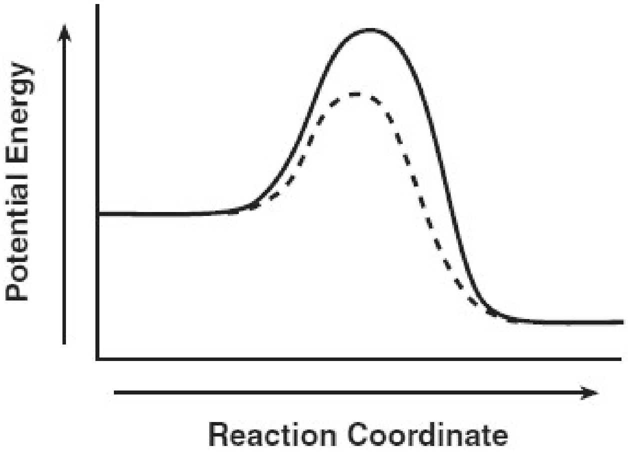
Refer to Figure 6 and answer the following Question:

A potential energy diagram for the forward reaction is shown below. On this diagram, draw a dashed line to show how the potential energy changes when the reaction occurs by the catalyzed pathway.



Answer

Example:



21 **Answer** => 1

Based on Table *I*, which equation represents a reaction with the greatest difference between the potential energy of the products and the potential energy of the reactants?

1 $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$
2 $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
3 $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$
4 $C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$

22 Answer => 2

Based on Table *I*, which compound dissolves in water by an exothermic process?

1 NaCl
2 NaOH
3 NH_4Cl
4 NH_4NO_3

23 Answer => 1

Based on Table *I*, what is the Δ*H* value for the production of 1.00 mole of $NO_2(g)$ from its elements at 101.3 kPa and 298 K?

1 33.2 kJ
2 -33.2 kJ
3 132.8 kJ
4 -132.8 kJ

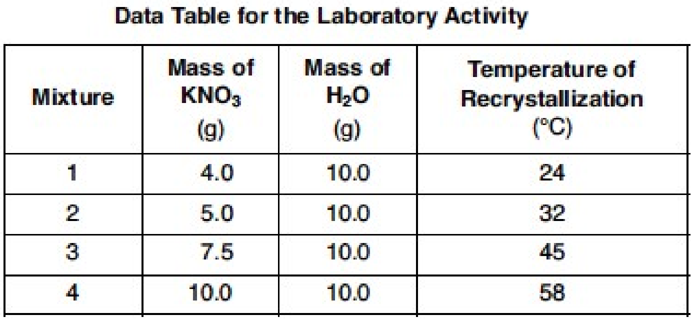
24

Figure 7

Base your answer to the question on the information below and on your knowledge of chemistry.

In a laboratory activity, each of four different masses of $KNO_3(s)$ is placed in a separate test tube that contains 10.0 grams of H_2O at 25°C.

When each sample is first placed in the water, the temperature of the mixture decreases. The mixture in each test tube is then stirred while it is heated in a hot water bath until all of the $KNO_3(s)$ is dissolved. The contents of each test tube are then cooled to the temperature at which KNO_3 crystals first reappear. The procedure is repeated until the recrystallization temperatures for each mixture are consistent, as shown in the table below.



Data Table for the Laboratory Activity

Mixture	Mass of KNO_3 (g)	Mass of H_2O (g)	Temperature of Recrystallization (°C)
1	4.0	10.0	24
2	5.0	10.0	32
3	7.5	10.0	45
4	10.0	10.0	58

Refer to Figure 7 and answer the following Question:

Based on Table *I*, explain why there is a *decrease* in temperature when the $KNO_3(s)$ was first dissolved in the water.

Answer

Table *I* lists the heats of reaction for various chemical reactions. The table shows that the dissolving of KNO_3 is endothermic. It has a ΔH = 34.89 kJ. This means that 34.89 kJ of heat are required to dissolve 1 mole of KNO_3. It absorbs this heat from the water it is dissolving in causing the temperature of the water to decrease when it first dissolves.

25 Answer => 2

Given the balanced equation representing a reaction occurring at 101.3 kilopascals and 298 K:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell) + \text{energy}$

What is the net amount of energy released when *one* mole of $H_2O(\ell)$ is produced?

1 241.8 kJ
2 285.8 kJ
3 483.6 kJ
4 571.6 kJ

26 Answer => 4

What is the net amount of heat released when two moles of $C_2H_6(g)$ are formed from its elements at 101.3 kPa and 298 K?

1 42.0 kJ
2 84.0 kJ
3 126.0 kJ
4 168.0 kJ

27 Answer => 4

At 101.3 kPa and 298 K, a 1.0-mole sample of which compound absorbs the greatest amount of heat as the entire sample dissolves in water?

1 LiBr
2 NaCl
3 NaOH
4 NH_4Cl

28 Answer => 1

Given the reaction at 101.3 kilopascals and 298 K:

hydrogen gas + iodine gas → hydrogen iodide gas

This reaction is classified as

1 endothermic, because heat is absorbed
2 endothermic, because heat is released
3 exothermic, because heat is absorbed
4 exothermic, because heat is released

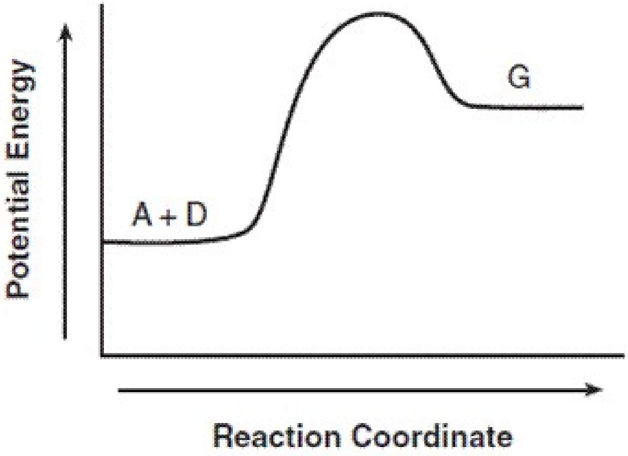
29 Answer => 3

At 101.3 kPa and 298 K, what is the total amount of heat released when one mole of aluminum oxide, $Al_2O_3(s)$, is formed from its elements?

1 393.5 kJ
2 837.8 kJ
3 1676 kJ
4 3351 kJ

30 Answer => 1

Given the potential energy diagram and equation representing the reaction between substances *A* and *D*:



$A + D \longrightarrow G$

According to Table *I*, substance *G* could be

1 $HI(g)$
2 $H_2O(g)$
3 $CO_2(g)$
4 $C_2H_6(g)$

31 Answer => 4

Which balanced equation represents an endothermic reaction?

1 $C(s) + O_2(g) \rightarrow CO_2(g)$
2 $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$
3 $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
4 $N_2(g) + O_2(g) \rightarrow 2NO(g)$

32 Answer => 2

Which equation represents an exothermic reaction at 298 K?

1 $N_2(g) + O_2(g) \rightarrow 2NO(g)$
2 $C(s) + O_2(g) \rightarrow CO_2(g)$
3 $KNO_3(s) \xrightarrow{H_2O} K^+(aq) + NO_3^-(aq)$
4 $NH_4Cl(s) \xrightarrow{H_2O} NH_4^+(aq) + Cl^-(aq)$

Kinetics & Equilibrium
Video #12

Name:__________________________ Class/Period:_______________________

Assignment: Video 12. Kinetics and Equilibrium: Reaction Rate and Le-Chatelier Principle
Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 12/17 then answer the following questions.

1 Answer => 2

An open flask is half filled with water at 25°C. Phase equilibrium can be reached after

1 more water is added to the flask
2 the flask is stoppered
3 the temperature is decreased to 15°C
4 the temperature is increased to 35°C

2 Answer => 3

Which type of equilibrium exists in a sealed flask containing $Br_2(\ell)$ and $Br_2(g)$ at 298 K and 1.0 atm?

1 static phase equilibrium
2 static solution equilibrium
3 dynamic phase equilibrium
4 dynamic solution equilibrium

3 Answer => 2

A sample of water in a sealed flask at 298 K is in equilibrium with its vapor. This is an example of

1 chemical equilibrium
2 phase equilibrium
3 solution equilibrium
4 static equilibrium

4 Answer => 3

For a chemical system at equilibrium, the concentration of both the reactants and the products must

1 decrease
2 increase
3 be constant
4 be equal

5 Answer => 2

Which equation represents a chemical equilibrium?

1 $N_2(\ell) \rightleftharpoons N_2(g)$
2 $2NO_2(g) \rightleftharpoons N_2O_4(g)$
3 $CO_2(s) \rightleftharpoons CO_2(g)$
4 $NH_3(\ell) \rightleftharpoons NH_3(g)$

6 Answer => 2

In which reaction will the point of equilibrium shift to the left when the pressure on the system is increased?

1 $C(s) + O_2(g) \leftrightarrow CO_2(g)$
2 $CaCO_3(s) \leftrightarrow CaO(s) + CO_2(g)$
3 $2Mg(s) + O_2(g) \leftrightarrow 2MgO(s)$
4 $2H_2(g) + O_2(g) \leftrightarrow 2H_2O(g)$

7 Answer => 4

Given the equation representing a system at equilibrium:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

Which statement describes the concentration of the two gases in this system?

1 The concentration of $N_2O_4(g)$ must be less than the concentration of $NO_2(g)$.
2 The concentration of $N_2O_4(g)$ must be greater than the concentration of $NO_2(g)$.
3 The concentration of $N_2O_4(g)$ and the concentration of $NO_2(g)$ must be equal.
4 The concentration of $N_2O_4(g)$ and the concentration of $NO_2(g)$ must be constant.

8

Figure 1

Base your anwer to the question on the information below and on your knowledge of chemistry.

"Water gas," a mixture of hydrogen and carbon monoxide, is an industrial fuel and source of commercial hydrogen. Water gas is produced by passing steam over hot carbono btained from coal. The equation below represents this system at equilibrium:

$$C(s) + H_2O(g) + heat \rightleftharpoons CO(g) + H_2(g)$$

Refer to Figure 1 and answer the following Question:

Explain, in terms of collisions, why increasing the surface area of the hot carbon increases the rate of the forward reaction.

Answer

Increasing the surface area of a solid reactant like carbon exposes more of its particles to come in contact with the other reactants. This results in an increased chance of collisions between reactant particles, so there are ***more collisions*** in any given time and the rate of the forward reaction increases.

9

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

Nitrogen dioxide, NO_2, is a dark brown gas that is used to make nitric acid and to bleach flour. Nitrogen dioxide has a boiling point of 294 K at 101.3 kPa. In a rigid cylinder with a movable piston, nitrogen dioxide can be in equilibrium with colorless dinitrogen tetroxide, N_2O_4. This equilibrium is represented by the equation below.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) + 58\text{ kJ}$$

Refer to Figure 2 and answer the following Question:

Compare the rate of the forward reaction to the rate of the reverse reaction when the system has reached equilibrium.

Answer

Acceptable responses include, but are not limited to:

- The rate of the forward reaction is equal to the rate of the reverse reaction at equilibrium.
- The rates are the same.

10

Figure 3

Base your answer to the question on the information below and your knowledge of chemistry.

Methanol can be manufactured by a reaction that is reversible. In the reaction, carbon monoxide gas and hydrogen gas react using a catalyst. The equation below represents this system at equilibrium.

$$CO(g) + 2H_2(g) \leftrightarrow CH_3OH(g) + \text{energy}$$

Refer to Figure 3 and answer the following Question:

Compare the rate of the forward reaction to the rate of the reverse reaction in this equilibrium system.

Answer

Acceptable responses include, but are not limited to:

- The rate of the forward reaction equals the rate of the reverse reaction.
- Both reactions occur at the same rate.

11

Figure 4

Base your answer to the question on the information below and on your knowledge of chemistry.

The equation below represents an equilibrium system of $SO_2(g)$, $O_2(g)$, and $SO_3(g)$. The reaction can be catalyzed by vanadium or platinum.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) + \text{energy}$

Refer to Figure 4 and answer the following Question:

State how the equilibrium shifts when $SO_3(g)$ is removed from the system.

Answer

Acceptable responses include, but are not limited to:

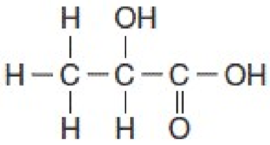
- The equilibrium will shift to favor the formation of SO_3.
- The rate of the forward reaction is greater than the rate of the reverse reaction.
- The equilibrium will shift to favor the forward reaction.
- The equilibrium will shift to the right.
- The concentrations of the reactants will decrease.

12

Figure 5

Base your answer to the question on the information below and on your knowledge of chemistry.

A student makes an aqueous solution of lactic acid. A formula for one form of lactic acid is shown below.



The solution is placed in a sealed flask to be used in a laboratory investigation. The equation below represents the lactic acid equilibrium system in the flask.

$CH_3CHOHCOOH(aq) \rightleftharpoons H^+(aq) + CH_3CHOHCOO^-(aq)$

lactic acid lactate ion

Refer to Figure 5 and answer the following Question:

Explain, in terms of the reaction rates, why the concentrations of the reactants and products remain constant in this system.

Answer

Acceptable responses include, but are not limited to:

- The rate of the forward reaction equals the rate of the reverse reaction.
- The reaction rates are the same at equilibrium.

13 **Answer** => 1

Some solid KNO_3 remains at the bottom of a stoppered flask containing a saturated $KNO_3(aq)$ solution at 22°C. Which statement explains why the contents of the flask are at equilibrium?

1 The rate of dissolving is equal to the rate of crystallization.
2 The rate of dissolving is greater than the rate of crystallization.
3 The concentration of the solid is equal to the concentration of the solution.
4 The concentration of the solid is greater than the concentration of the solution.

14

Figure 6

Base your answer to the question on the information below.

Several steps are involved in the industrial production of sulfuric acid. One step involves the oxidation of sulfur dioxide gas to form sulfur trioxide gas. A catalyst is used to increase the rate of production of sulfur trioxide gas. In a rigid cylinder with a movable piston, this reaction reaches equilibrium, as represented by the equation below.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) + 392 \text{ kJ}$$

Refer to Figure 6 and answer the following Question:

Explain, in terms of collision theory, why increasing the pressure of the gases in the cylinder increases the rate of the forward reaction.

Answer

Acceptable responses include, but are not limited to:

- When the pressure in the cylinder is increased, the $SO_2(g)$ molecules and $O_2(g)$ molecules collide more frequently, producing more $SO_3(g)$.

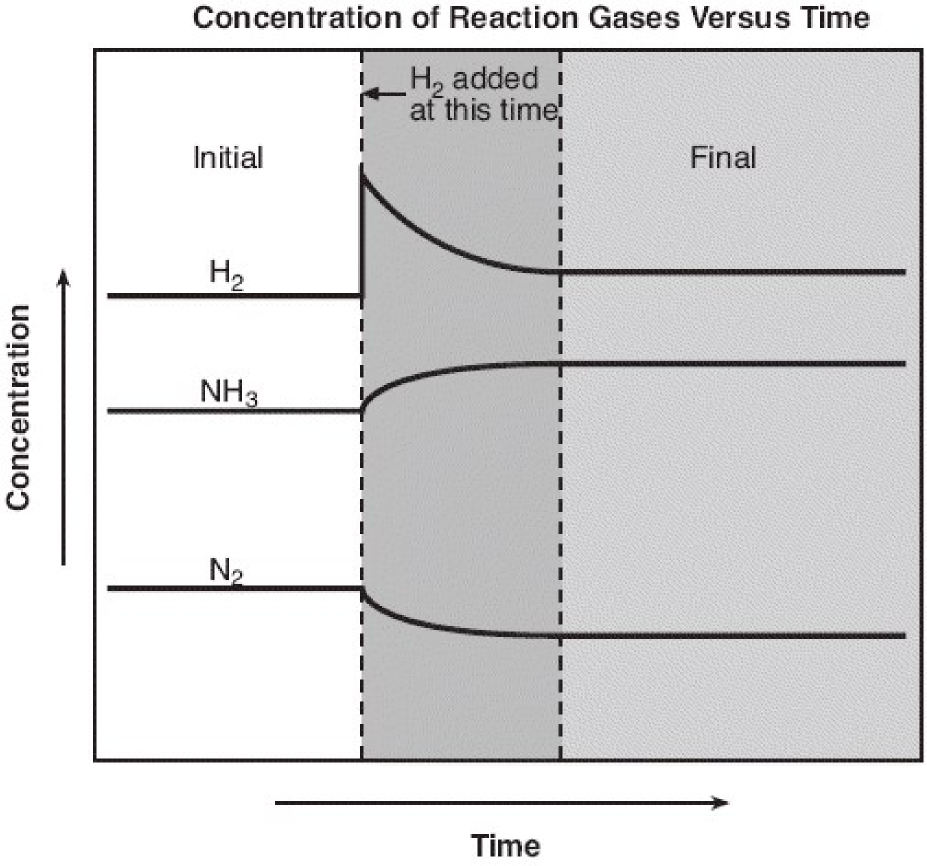
Figure 7

Base your answer to this question on the information below.

Nitrogen gas, hydrogen gas, and ammonia gas are in equilibrium in a closed container at constant temperature and pressure. The equation below represents this equilibrium.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

The graph below shows the initial concentration of each gas, the changes that occur as a result of adding $H_2(g)$ to the system, and the final concentrations when equilibrium is reestablished.



Refer to Figure 7 and answer the following Question:

What information on the graph indicates that the system was initially at equilibrium?

Answer

Acceptable responses include, but are not limited to:

- The initial concentration of each gas is constant.
- Concentrations stay the same.

Note: It is *not* sufficient to state that the rate of the forward reaction equals the rate of the reverse reaction *or* that the concentrations are equal.

16 Answer => 2

Given the reaction at equilibrium:

$$2A(g) + 3B(g) \leftrightarrow A_2B_3(g) + \text{heat}$$

Which change will not affect the equilibrium concentrations of $A(g)$, $B(g)$, and $A_2B_3(g)$?

1 adding more $A(g)$
2 adding a catalyst
3 increasing the temperature
4 increasing the pressure

17 Answer => 2

Given the chemical reaction: $Hg^{2+}(aq) + Cu(s) \leftrightarrow Hg(s) + Cu^{2+}(aq)$
When the reaction reaches equilibrium, the cell potential will be

1 -0.51 V
2 0.00 V
3 0.51 V
4 1.19 V

18 Answer => 1

Given the equation representing a solution equilibrium:

$$BaSO_4(s) \overset{H_2O}{\rightleftharpoons} Ba^{2+}(aq) + SO_4^{2-}(aq)$$

What occurs when $Na_2SO_4(s)$ is added to this system, increasing the concentration of $SO_4^{2-}(aq)$?

1 The equilibrium shifts to the left, and the concentration of $Ba^{2+}(aq)$ decreases.
2 The equilibrium shifts to the left, and the concentration of $Ba^{2+}(aq)$ increases.
3 The equilibrium shifts to the right, and the concentration of $Ba^{2+}(aq)$ decreases.
4 The equilibrium shifts to the right, and the concentration of $Ba^{2+}(aq)$ increases.

19 The equation for the saturated solution equilibrium of potassium nitrate (KNO_3) is shown below.

$$KNO_3(s) + \text{energy} \overset{H_2O}{\rightleftharpoons} K^+(aq) + NO_3^-(aq)$$

Compare the rate of dissolving KNO_3 with the rate of recrystallization of KNO_3 for the saturated solution.

Answer

Acceptable responses include, but are not limited to, this example:

- The rate of dissolving KNO_3 is equal to the rate of recrystallization of KNO_3 for the saturated solution.
- The rates are equal.

20 Answer <u>=> 4</u>

The addition of a catalyst to a chemical reaction provides an alternate pathway that

1 increases the potential energy of reactants
2 decreases the potential energy of reactants
3 increases the activation energy
4 decreases the activation energy

21 Answer <u>=> 4</u>

Which sample of HCl(aq) reacts at the fastest rate with a 1.0-gram sample of iron filings?

1 10. mL of 1 M HCl(aq) at 10.^{o}C
2 10. mL of 1 M HCl(aq) at 25^{o}C
3 10. mL of 3 M HCl(aq) at 10.^{o}C
4 10. mL of 3 M HCl(aq) at 25^{o}C

22 The balanced equation below represents the reaction between a 5.0-gram sample of zinc metal and a 0.5 M solution of hydrochloric acid. The reaction takes place in an open test tube at 298 K and 1 atm in a laboratory activity.

$Zn(s) + 2HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq) + energy$

State <u>one</u> change in reaction conditions, other than adding a catalyst, that will increase the rate of the reaction.

Answer

Any change that results in an increased number of collisions. Possible answers include:

- Increase the surface area of the zinc.
- Increase the temperature of the reaction.
- Use a more concentrated HCl(aq) solution.

23 **Refer to Figure 3 and answer the following Question:**

State the effect on the rates of both the forward and reverse reactions if no catalyst is used in the system.

Answer

Acceptable responses include, but are not limited to:

- Rate of forward reaction: decreases/slower
- Rate of reverse reaction: decreases/slower

Figure 8

Base your answer to the question on the information below and on your knowledge of chemistry.

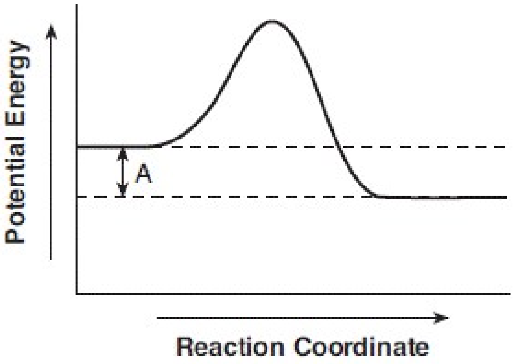
Millions of tons of ammonia are produced each year for use as fertilizer to increase food production. Most of the hydrogen needed to produce ammonia comes from methane gas reacting with steam. This reaction, which occurs in a container under controlled conditions, is shown below in unbalanced equation 1.

Equation 1: $CH_4(g) + H_2O(g) + \text{energy} \rightarrow CO(g) + H_2(g)$

The reaction that produces ammonia is represented by balanced equation 2, shown below. A catalyst can be used to increase the rate of the reaction.

Equation 2: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) + \text{energy}$

A potential energy diagram for equation 2 is shown below.



Refer to Figure 8 and answer the following Question:

Explain, in terms of collision theory, why an increase in temperature increases the rate of reaction between methane gas and steam.

Answer

Acceptable responses include, but are not limited to:

- An increase in temperature causes a greater number of effective collisions between methane and water molecules to occur.
- A greater number of collisions per second make the reaction rate faster.
- More molecules collide with sufficient energy.

25 Answer => 4

Given the equation representing a system at equilibrium:

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

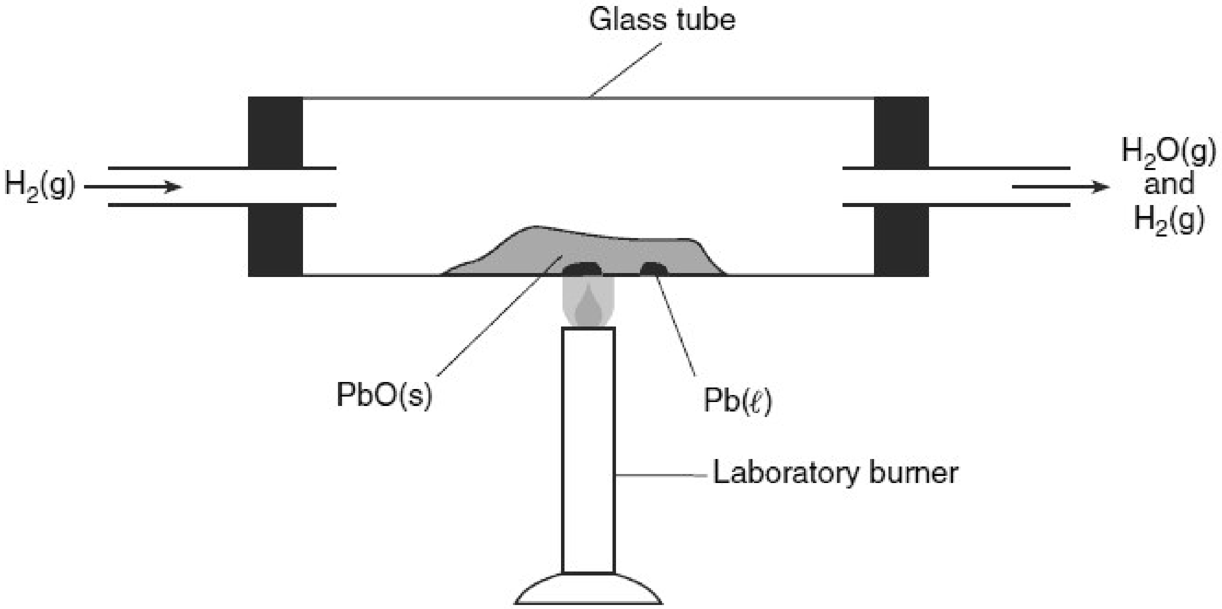
Which statement describes this system?

1 The concentration of $PCl_5(g)$ is increasing.
2 The concentration of $PCl_5(g)$ is decreasing.
3 The concentrations of $PCl_5(g)$ and $PCl_3(g)$ are equal.
4 The concentrations of $PCl_5(g)$ and $PCl_3(g)$ are constant.

Figure 9

Base your answer to the question on the information below and on your knowledge of chemistry.

In a laboratory apparatus, a sample of lead(II) oxide reacts with hydrogen gas at high temperature. The products of this reaction are liquid lead and water vapor. As the reaction proceeds, water vapor and excess hydrogen gas leave the glass tube. The diagram and balanced equation below represent this reaction.



$$PbO(s) + H_2(g) + \text{heat} \longrightarrow Pb(\ell) + H_2O(g)$$

Refer to Figure 9 and answer the following Question:

State *one* change in reaction conditions, other than adding a catalyst, that would cause the rate of this reaction to increase.

Answer

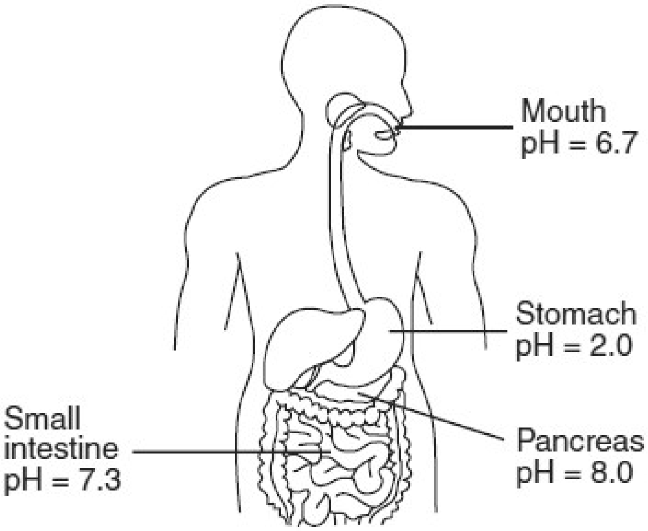
Acceptable responses include, but are not limited to:

- Increase the temperature.
- Increase the concentration of the hydrogen gas in the tube.
- Grind the metal oxide to increase its surface area.

27

Figure 10

The diagram below shows typical pH values found in four parts of the human digestive system. In the small intestine, the enzyme lipase acts as a catalyst, increasing the rate of fat digestion.



Refer to Figure 10 and answer the following Question:
State how the catalyst lipase increases the rate of the fat digestion.

Answer

Acceptable responses include, but are not limited to:

- The lipase provides an alternate reaction pathway that requires less energy.
- lower activation energy

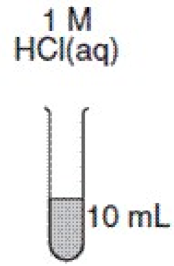
28 Answer => 4

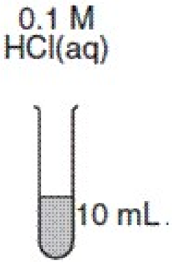
The solubility of KCl(s) in water depends on the

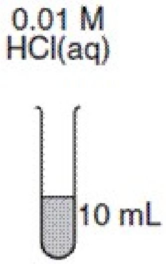
1 pressure on the solution
2 rate of stirring
3 size of the KCl sample
4 temperature of the water

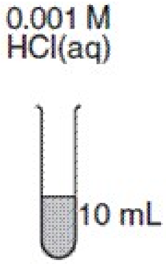
29 Answer => 1

Each of four test tubes contains a different concentration of HCl(aq) at 25°C. A 1-gram cube of Zn is added to each test tube. In which test tube is the reaction occurring at the fastest rate?

1 

2 

3 

4 

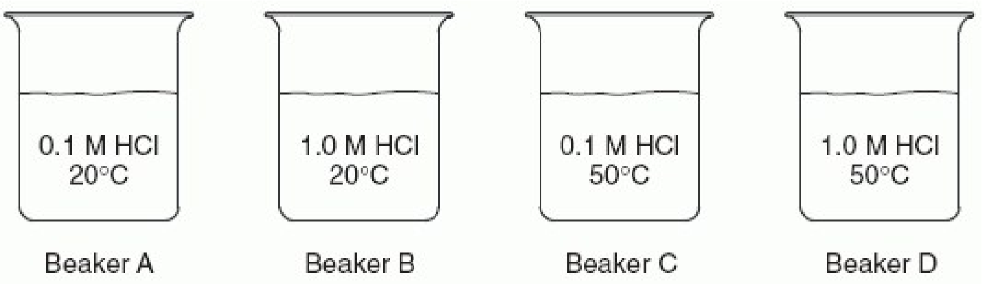
30 Answer => 4

A 5.0-gram sample of zinc and a 50.-milliliter sample of hydrochloric acid are used in a chemical reaction. Which combination of these samples has the fastest reaction rate?

1 a zinc strip and 1.0 M HCl(aq)
2 a zinc strip and 3.0 M HCl(aq)
3 zinc powder and 1.0 M HCl(aq)
4 zinc powder and 3.0 M HCl(aq)

31 Answer <u>=> 4</u>

In each of the four beakers shown below, a 2.0-centimeter strip of magnesium ribbon reacts with 100 milliliters of HCl(aq) under the conditions shown.



In which beaker will the reaction occur at the fastest rate?

1 Beaker *A*
2 Beaker *B*
3 Beaker *C*
4 Beaker *D*

32 Answer <u>=> 1</u>

Given the reaction:

$$\mathbf{CuSO_4(\mathit{s}) \leftrightarrow Cu_2{}^{+}(\mathit{aq}) + SO_4{}^{2-}(\mathit{aq})}$$

The $CuSO_4(s)$ dissolves more rapidly when it is powdered because the increased surface area due to powdering permits

1 increased solvent contact
2 increased solute solubility
3 the equilibrium to shift to the left
4 the equilibrium to shift to the right

33 Answer <u>=> 1</u>

At room temperature, which reaction would be expected to have the fastest reaction rate?

1 $Pb_2{}^{+}(aq) + S^{2-}(aq) \rightarrow PbS(s)$
2 $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
3 $N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$
4 $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

34 Answer <u>=> 4</u>

Which of the following gases would have the *slowest* rate of diffusion when all of the gases are held at the same temperature and pressure?

1 N_2
2 NO
3 O_2
4 CO_2

35 Answer => 1

Given the equation representing a system at equilibrium in a sealed, rigid container:

$2HI(g) \Leftrightarrow H_2(g) + I_2(g) + \text{energy}$

Increasing the temperature of the system causes the concentration of

1 HI to increase
2 H_2 to increase
3 HI to remain constant
4 H_2 to remain constant

36 Answer => 2

Given the equation representing a chemical reaction at equilibrium in a sealed, rigid container:

$$H_2(g) + I_2(g) + \text{energy} \rightleftharpoons 2HI(g)$$

When the concentration of $H_2(g)$ is increased by adding more hydrogen gas to the container at constant temperature, the equilibrium shifts

1 to the right, and the concentration of HI(g) decreases
2 to the right, and the concentration of HI(g) increases
3 to the left, and the concentration of HI(g) decreases
4 to the left, and the concentration of HI(g) increases

37 Answer => 2

Given the equation representing a reaction at equilibrium:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) + \text{heat}$$

Which change causes the equilibrium to shift to the right?

1 adding a catalyst
2 adding more $O_2(g)$
3 decreasing the pressure
4 increasing the temperature

38

Figure 11

Base your answer to the question on the information below.

Given the reaction at equilibrium:

$$2NO_2(g) \rightleftharpoons N_2O_4(g) + 55.3 \text{ kJ}$$

Refer to Figure 11 and answer the following Question:

Explain, in terms of Le Chatelier's principle, why the equilibrium shifts to the right to relieve the stress when the pressure on the system is increased at constant temperature.

Answer

Examples:

- Equilibrium shifts toward the fewer number of moles of gas
- The reaction shifts to the side that would result in a reduction of pressure.
- fewer moles of gas, less pressure

39 Answer => 2

Given the reaction at equilibrium: $2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g) + \text{heat}$

Which change will shift the equilibrium to the right?

1 increasing the temperature
2 increasing the pressure
3 decreasing the amount of $SO_2(g)$
4 decreasing the amount of $O_2(g)$

40 Answer => 1

Given the reaction at equilibrium: $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$

If the pressure is increased at a constant temperature, there will be an increase in the number of moles of

1 $NH_3(g)$, only
2 $N_2(g)$, only
3 $H_2(g)$, only
4 both $N_2(g)$ and $H_2(g)$

Solutions
Video #13

Name:_________________________ Class/Period:______________________

Assignment: Video 13. Solutions: Molarity and Colligative Properties; Bond and Molecular Polarity; Table G and F

Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 13/17 then answer the following questions.

1 In a laboratory investigation, an HCl(aq) solution with a pH value of 2 is used to determine the molarity of KOH(aq) solution. A 7.5-milliliter sample of the KOH(aq) is exactly neutralized by 15.0 milliliters of the 0.010 M HCl(aq). During this laboratory activity, appropriate safety equipment is used and safety equipment is used and safety procedures are followed.

Explain, in terms of aqueous ions, why 15.0 mL of a 1.0 M HCl(aq) solution is a better conductor of electricity than 15.0 mL of a 0.010 M HCl(aq) solution.

Answer

Possible correct answers include:

- The 1.0 M solution has a greater concentration of mobile ions than the 0.010 M solution.
- The 0.010 M solution has fewer mobile ions.
- The 1.0 M solution has more aqueous ions.

2

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

During a titration, 10.00 mL of acetic acid, $HC_2H_3O_2$(aq), is completely neutralized by adding 12.50 mL of 0.64 M sodium hydroxide, NaOH(aq).

Refer to Figure 1 and answer the following Question:

Explain why it is better to use data from multiple trials to determine the molarity of acetic acid, rather than data from a single trial.

Answer

Acceptable responses include, but are not limited to:

- Multiple trials may improve the precision of results.
- Each trial may involve errors either above or below the acceptable value. Therefore, an average value may be more accurate.
- Results can be shown to be reproducible.
- Multiple trials help cancel random errors.

3

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

A 2.50-liter aqueous solution contains 1.25 moles of dissolved sodium chloride. The dissolving of NaCl(s) in water is represented by the equation below.

$$\mathrm{NaCl(s)} \xrightarrow{\mathrm{H_2O}} \mathrm{Na^+(aq)} + \mathrm{Cl^-(aq)}$$

Refer to Figure 2 and answer the following Question:
Determine the molarity of this solution.

Answer

$$\text{molarity} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

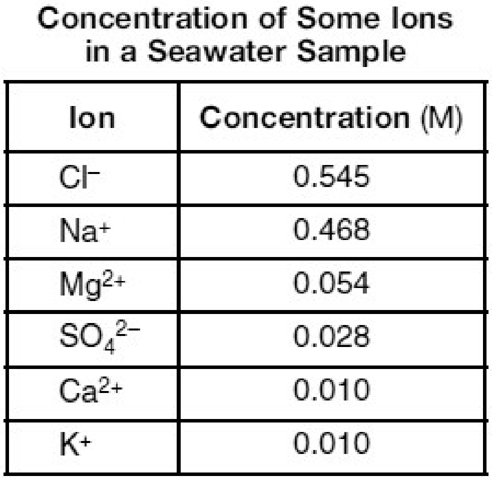
$$\text{molarity} = \frac{1.25 \text{ moles NaCl}}{2.50 \text{ L}} = 0.500 \text{ M}$$

4

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

A sample of seawater is analyzed. The table below gives the concentration of some ions in the sample.



Concentration of Some Ions in a Seawater Sample

Ion	Concentration (M)
Cl^-	0.545
Na^+	0.468
Mg^{2+}	0.054
SO_4^{2-}	0.028
Ca^{2+}	0.010
K^+	0.010

Refer to Figure 3 and answer the following Question:

Determine the number of moles of the SO_4^{2-} ion in a 1400.-liter sample of the seawater.

Answer

Use the formula for molarity on Reference Table *T*.

$$\text{molarity} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

$$0.028 \text{ M} = \frac{x \text{ moles of } SO_4^{2-} \text{ ions}}{1400. \text{ L}}$$

$$x = 1400. \text{ L} \times 0.028 \text{ moles/L}$$

$$x = 39 \text{ moles}$$

5

Figure 4

Base your answer to the question on the information below.

Ammonium chloride is dissolved in water to form a 0.10 M $NH_4Cl(aq)$ solution. This dissolving process is represented by the equation below.

$$NH_4Cl(s) + \text{heat} \xrightarrow{H_2O} NH_4^+(aq) + Cl^-(aq)$$

Refer to Figure 4 and answer the following Question:

Determine the number of moles of $NH_4Cl(s)$ used to produce 2.0 liters of this solution.

Answer

The formula for molarity is on Reference Table *T*.

$$\text{molarity} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

$$0.10\text{M} = \frac{x \text{ moles}}{2.0\text{L}}$$

Cross multiply:

$$2.0\text{L} \times 0.10\text{M} = x \text{ moles} = 0.20 \text{ moles } NH_4Cl(s)$$

6

Figure 5

Base your answer to the question on the information below.

A total of 1.4 moles of sodium nitrate is dissolved in enough water to make 2.0 liters of an aqueous solution. The gram-formula mass of sodium nitrate is 85 grams per mole.

Refer to Figure 5 and answer the following Question:

Determine the molarity of the solution.

Answer

$$\text{molarity} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

$$\text{molarity} = \frac{1.4 \text{ moles}}{2.0 \text{ liters}} = 0.70 \text{ M}$$

7 Water, H_2O, and hexane, C_6H_{14}, are commonly used as laboratory solvents because they have different physical properties and are able to dissolve different types of solutes. Some physical properties of water and hexane are listed on the table below.

Physical Properties of H_2O and C_6H_{14}

Solvent	Boiling Point (°C)	Melting Point (°C)	Vapor Pressure at 69°C (kPa)
H_2O	100.	0.	?
C_6H_{14}	69	−95	101.3

Explain, in terms of the molecular polarity, why hexane is nearly insoluble in water.

Answer

Acceptable responses include, but are not limited to:

- Hexane molecules are nonpolar, and water molecules are polar.
- Water and hexane have different molecular polarities.

Molecular polarity affects solubility in that polar molecules are best solvated by polar solvent molecules and nonpolar molecules are best solvated by nonpolar solvent molecules; i.e., "like dissolves like".

8 A sample of normal rainwater has a pH of 5.6 due to dissolved carbon dioxide gas from the atmosphere. Acid rain is formed when other gases, such as sulfur dioxide, dissolve in rainwater, which can result in lake water with a pH value of 4.6. The equation below represents the reaction of water with $SO_2(g)$.

$$H_2O(\ell) + SO_2(g) \rightarrow H_2SO_3(aq)$$

Based on Table G, describe what happens to the solubility of $SO_2(g)$ as the temperature increases from 10.$^{\text{O}}$C to 30.$^{\text{O}}$C at standard pressure.

Answer

Acceptable responses include, but are not limited to:

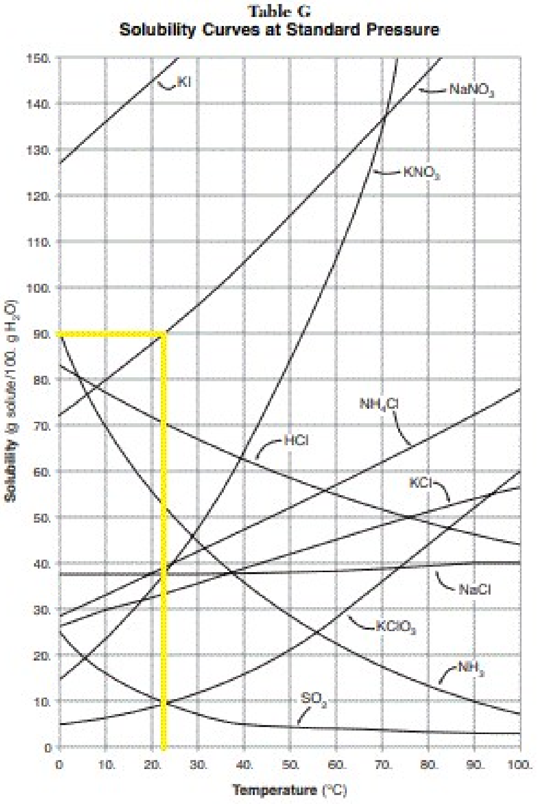
- As the water temperature increases, the solubility of sulfur dioxide decreases.
- The solubility of SO_2 decreases.
- The $SO_2(g)$ becomes less soluble.

9 At 23^{o}C, 85.0 grams of $NaNO_3$(s) are dissolved in 100. grams of H_2O(l).

Based on Table *G*, determine the additional mass of $NaNO_3$(s) that must be dissolved to saturate the solution at 23^{o}C.

Answer

Table G shows that at 23^{o}C, 90 grams of $NaNO_3$ are needed to dissolve in 100 g of H_2O to create a saturated solution. There are already 85 grams in the solution. Therefore, ***5*** more grams are needed to reach the saturation amount (90 - 85 = 5 g). Note: any value from 4 g to 6 g is acceptable.



10 At 23^{o}C, 85.0 grams of $NaNO_3$(s) are dissolved in 100. grams of H_2O(l).

State what happens to the boiling point and freezing point of the solution when the solution is diluted with an additional 100. grams of H_2O(l).

Answer

Boiling and freezing points of a solution are colligative properties. Colligative properties of solutions are properties that depend upon the concentration of solute molecules or ions, but not upon the identity of the solute. The more ions in solution the higher the boiling point and the lower the freezing point. Therefore, if a solution is diluted by adding more solvent (in this case water) then it will have just the opposite effect - ***the boiling point will decrease and the freezing point will increase.***

11

Figure 6

Base your answer to the question on the information below and on your knowledge of chemistry.

A saturated solution of sulfur dioxide is prepared by dissolving $SO_2(g)$ in 100. g of water at 10.°C and standard pressure.

Refer to Figure 6 and answer the following Question:

Based on Table *G*, state the general relationship between solubility and temperature of an aqueous SO_2 solution at standard pressure.

Answer

According to Table *G*, ***the solubility of SO2(g) decreases as temperature increases.*** This is true for all gases. In order for gases to dissolve into solution, the temperature must be low allowing, the gas particles to slow down enough to dissolve.

12 **Refer to Figure 6 and answer the following Question:**

Determine the mass of SO_2 in this solution.

Answer

According to Table *G*, a saturated solution of sulfur dioxide is prepared by dissolving approximately 15–18g of $SO_2(g)$ in 100.g of water at 10^{o}C and standard pressure.

Figure 7

Base your answer to the question on the information below and on your knowledge of chemistry.

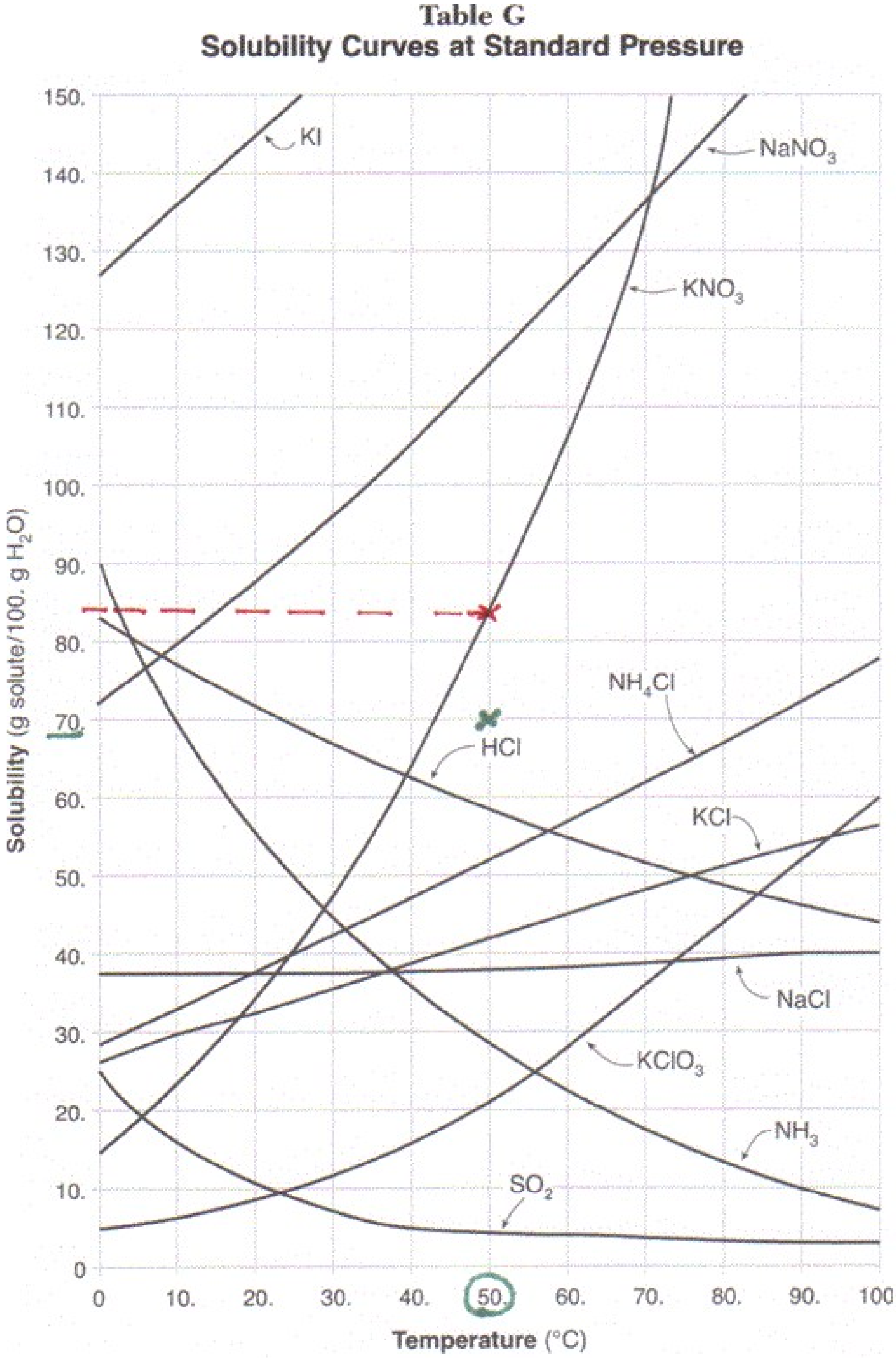
A solution is made by dissolving 70.0 grams of KNO_3(s) in 100. grams of water at 50.°C and standard pressure.

Refer to Figure 7 and answer the following Question:

Determine the number of additional grams of KNO_3 that must dissolve to make this solution saturated.

Answer

Any value from 12 g to 16 g, inclusive.

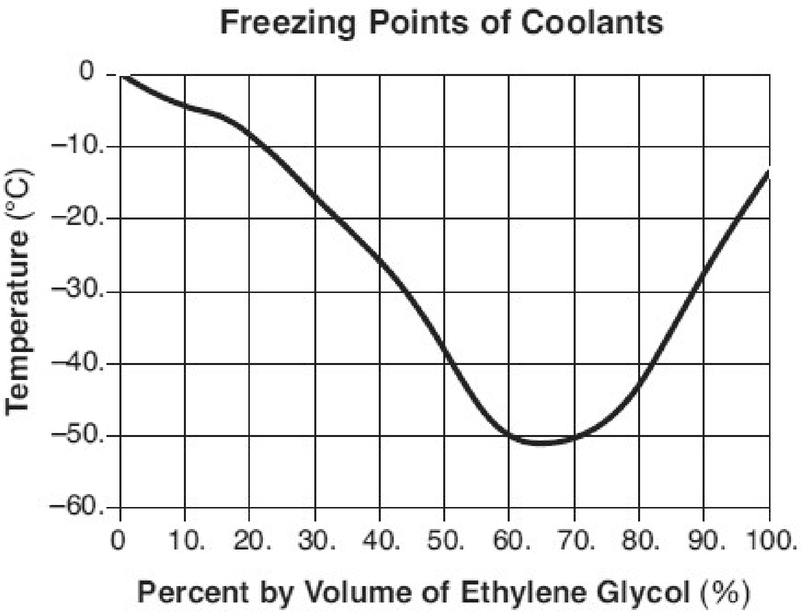


The green *X* shows the 70g of KNO_3(s) in the solution at 50.°C. The red *X* on the graph line indicates a saturated solution of KNO_3(s) at 50.°C . Follow the dashed line to the Y axis to see how much KNO_3(s) is needed to make a saturated solution. Subtract 70g from that amount to get the amount needed to add to get a saturated solution of KNO_3(s) at 50.°C. You should get a value between 12 g and 16 g.

Figure 8

Base your answer to the question on the information below and on your knowledge of chemistry.

> A solution of ethylene glycol and water can be used as the coolant in an engine-cooling system. The ethylene glycol concentration in a coolant solution is often given as percent by volume. For example, 100. mL of a coolant solution that is 40.% ethylene glycol by volume contains 40. mL of ethylene glycol diluted with enough water to produce a total volume of 100. mL. The graph below shows the freezing point of coolants that have different ethylene glycol concentrations.



Refer to Figure 8 and answer the following Question:

Explain, in terms of the molecular polarity, why ethylene glycol dissolves in water to form a solution.

Answer

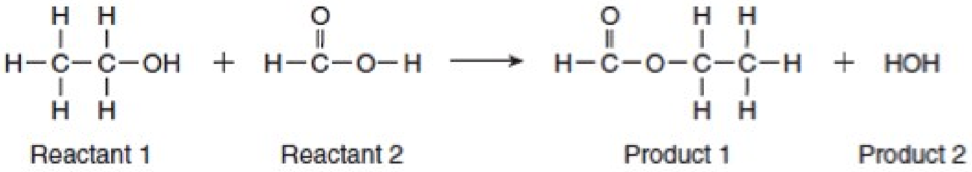
Acceptable response include, but are not limited to:

- Water molecules and ethylene glycol molecules are both polar.
- Water and the glycol have similar polarities.

Figure 9

Base your answer to the question on the information below and on your knowledge of chemistry.

The unique odors and flavors of many fruits are primarily due to small quantities of a certain class of organic compounds. The equation below represents the production of one of these compounds.



Refer to Figure 9 and answer the following Question:

Explain, in terms of molecular polarity, why reactant 2 is soluble in water.

Answer

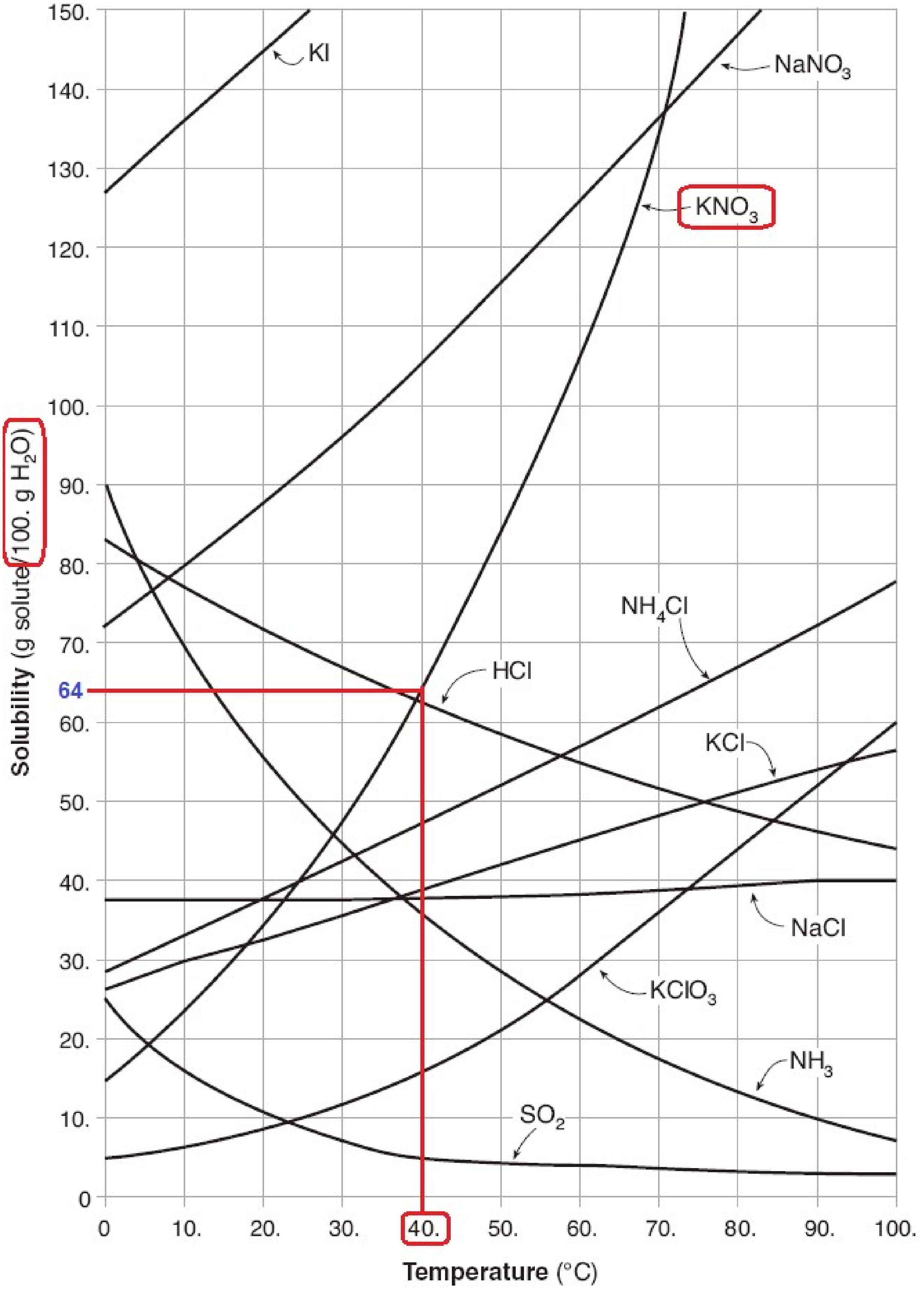
Acceptable responses include, but are not limited to:

- Both water and methanoic acid have polar molecules.
- Both molecules are polar.
- Polar dissolves polar.
- Reactant 2 molecules and the water molecules have similar polarities.

16 Determine the mass of KNO_3 that dissolves in 100. grams of water at 40.°C to produce a saturated solution.

Answer

Allow 1 credit for 64 g, or any value from 62 g to 66 g, inclusive.



17

Figure 10

Base your answer to this question on the information below.

> When a person perspires (sweats), the body loses many sodium ions and potassium ions. The evaporation of sweat cools the skin.
>
> After a strenuous workout, people often quench their thirst with sports drinks that contain NaCl and KCl. A single 250.-gram serving of one sports drink contains 0.055 gram of sodium ions.

Refer to Figure 10 and answer the following Question:

State why the salts in sports drinks are classified as electrolytes.

Answer

Acceptable responses include, but are not limited to:

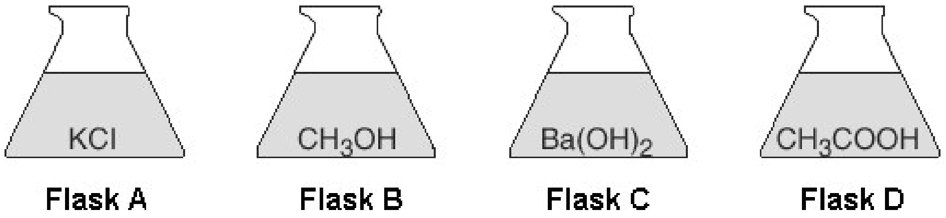
- Charged particles are free to move when salts dissolve in water.
- The ions in the salts dissociate and are free to move.
- The salts form aqueous solutions that can conduct electric current.

18 Answer => 3

Which solution has the highest boiling point at standard pressure?

1 0.10 M $KCl(aq)$
2 0.10 M $K_2SO_4(aq)$
3 0.10 M $K_3PO_4(aq)$
4 0.10 M $KNO_3(aq)$

19 Four flasks each contain 100 milliliters of aqueous solutions of equal concentrations at 25°C and 1 atm.



Which flask has the solution with the *lowest* freezing point? Explain your answer.

Answer

Flask *C* has the solution with the lowest freezing point.

Acceptable reasons include, but are not limited to, these examples:

- It has the greatest number of particles dissolved.
- It dissociates into the greatest number of particles.
- It has the highest van't Hoff factor (*i*).

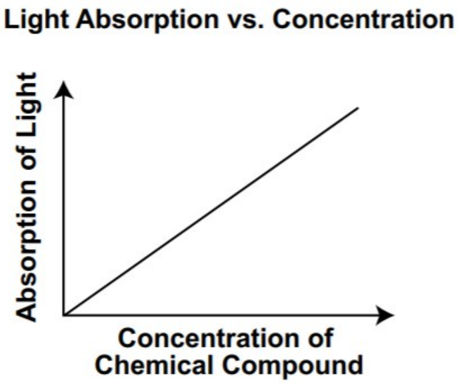
20 Answer => 1

Which solution containing 1 mole of solute dissolved in 1000 grams of water has the ***lowest*** freezing point?

1 $KOH(aq)$
2 $C_2H_{12}O_6(aq)$
3 $C_2H_5OH(aq)$
4 $C_{12}H_{22}O_{11}(aq)$

21 Answer => 3

A scientific technique can be used to determine the presence and concentration of a chemical compound in a sample. A light source is directed at samples of known concentrations and the amount of light each absorbs is measured. Based on the graph, which statement ***best*** describes the relationship between concentration and light absorption?



1 The light absorption of a sample is independent of the concentration of the chemical compound.
2 The concentration of the chemical compound in a sample remains steady as the light absorption increases.
3 An increase in the concentration of the chemical compound in a sample is accompanied by an increase in the light absorption.
4 A decrease in the light absorption of a sample is accompanied by an increase in the concentration of the chemical compound.

22 The electrical conductivity of three aqueous solutions was tested at room temperature. A 0.1 M HCl(aq) solution conducted, but a 6.0 M HCl(aq) solution was a better conductor. A 0.1 M $C_6H_{12}O_6$(aq) solution was also tested. During this laboratory activity, appropriate safety equipment was used and safety procedures were followed.
State, in terms of the concentration of ions, why the 6.0 M HCl(aq) is a better conductor of electricity than the 0.1 M HCl(aq).

Answer

Acceptable responses include, but are not limited to:

- There is a greater concentration of ions present in the 6.0 M HCl(aq) than in the 0.1 M HCl(aq).
- The 6.0 M HCl(aq) has a higher concentration of ions.

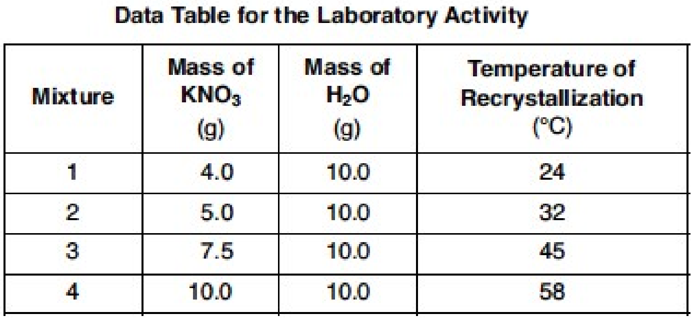
23

Figure 11

Base your answer to the question on the information below and on your knowledge of chemistry.

In a laboratory activity, each of four different masses of KNO_3(s) is placed in a separate test tube that contains 10.0 grams of H_2O at 25°C.

When each sample is first placed in the water, the temperature of the mixture decreases. The mixture in each test tube is then stirred while it is heated in a hot water bath until all of the KNO_3(s) is dissolved. The contents of each test tube are then cooled to the temperature at which KNO_3 crystals first reappear. The procedure is repeated until the recrystallization temperatures for each mixture are consistent, as shown in the table below.



Data Table for the Laboratory Activity

Mixture	Mass of KNO_3 (g)	Mass of H_2O (g)	Temperature of Recrystallization (°C)
1	4.0	10.0	24
2	5.0	10.0	32
3	7.5	10.0	45
4	10.0	10.0	58

Refer to Figure 11 and answer the following Question:
Determine the percent by mass concentration of KNO_3 in mixture 2 after heating.

Answer

The formula for percent composition by mass is found on ***Reference Table T***. The mass of KNO_3 in mixture 2 is 5.0g. The total mass of the mixture is the 10g of H_20 plus the 5g of KNO_3 which is a total of 15g.

$$\% \text{ comp. by mass} = \frac{\text{mass of part (5.0g } KNO_3\text{)}}{\text{mass of the whole mixture (15g)}} \times 100 = 33.3\%$$

24 A safe level of fluoride ions is added to many public drinking water supplies. Fluoride ions have been found to help prevent tooth decay. Another common source of fluoride ions is toothpaste. One of the fluoride compounds used in toothpaste is tin(II) fluoride.

A town located downstream from a chemical plant was concerned about fluoride ions from the plant leaking into its drinking water. According to the Environmental Protection Agency, the fluoride ion concentration in drinking water cannot exceed 4 ppm. The town hired a chemist to analyze its water. The chemist determined that a 175-gram sample of the town's water contains 0.000 250 gram of fluoride ions.

How many parts per million of fluoride ions are present in the analyzed sample?

Answer: ☐ ppm

Answer

1.43

25 An aqueous solution has 0.0070 gram of oxygen dissolved in 1000. grams of water. Calculate the dissolved oxygen concentration of this solution in parts per million.

Answer: ☐ ppm

Answer

7.0

26 Answer => 1

A 2400.-gram sample of an aqueous solution contains 0.012 gram of NH_3. What is the concentration of NH_3 in the solution, expressed as parts per million?

1 5.0 ppm
2 15 ppm
3 20. ppm
4 50. ppm

27 Answer => 2

A solution is prepared using 0.125 g of glucose, $C_6H_{12}O_6$, in enough water to make 250. g of total solution. The concentration of this solution, expressed in parts per million, is

1 5.00×10^1 ppm
2 5.00×10^2 ppm
3 5.00×10^3 ppm
4 5.00×10^4 ppm

28 Answer => 1

The table below gives information about four aqueous solutions at standard pressure.

Four Aqueous Solutions

Aqueous Solution	Concentration (M)	Solute
A	2.0	$BaCl_2$
B	2.0	$NaNO_3$
C	1.0	$C_6H_{12}O_6$
D	1.0	K_2SO_3

Which list of solutions is arranged in order from highest boiling point to lowest boiling point?

1 *A*, *B*, *D*, *C*
2 *A*, *C*, *B*, *D*
3 *C*, *D*, *B*, *A*
4 *D*, *B*, *C*, *A*

29 Answer => 2

Which expression could represent the concentration of a solution?

1 3.5 g
2 3.5 M
3 3.5 mL
4 3.5 mol

30 Answer => 4

The concentration of a solution can be expressed in

1 kelvins
2 milliliters
3 joules per kilogram
4 moles per liter

31 Answer => 3

Figure 12

Base your answer to this question on the information below.

The health of fish depends on the amount of oxygen dissolved in the water. A dissolved oxygen (DO) concentration between 6 parts per million and 8 parts per million is best for fish health. A DO concentration greater than 1 part per million is necessary for fish survival.

Fish health is also affected by water temperature and concentrations of dissolved ammonia, hydrogen sulfide, chloride compounds, and nitrate compounds. Most freshwater fish thrive in water with a pH between 6.5 and 8.5.

A student's fish tank contains fish, green plants, and 3800 grams of fish-tank water with 2.7×10^{-2} gram of dissolved oxygen. Phenolphthalein tests colorless and bromthymol blue tests blue in samples of the fish-tank water.

Refer to Figure 12 and answer the following Question:

When the fish-tank water has a pH of 8.0, the hydronium ion concentration is 1.0×10^{-8} mole per liter. What is the hydronium ion concentration when the water has a pH of 7.0?

1 7 moles per liter
2 1 mole per liter
3 10^{-7} mol/L
4 10^{-1} mol/L

32 Answer => 3

The bond between which two atoms is most polar?

1 C-O
2 F-F
3 H-O
4 N-H

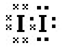
33 Answer => 1

The *least* polar bond is found in a molecule of

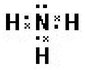
1 HI
2 HF
3 HCl
4 HBr

34 Answer => 3

Which molecule contains a polar covalent bond?

1 

2 

3 

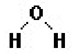
4 

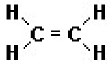
35 Answer => 2

Which structural formula represents a linear nonpolar molecule containing two polar bonds?

1 $N \equiv N$

2 $H-C \equiv C-H$

3 

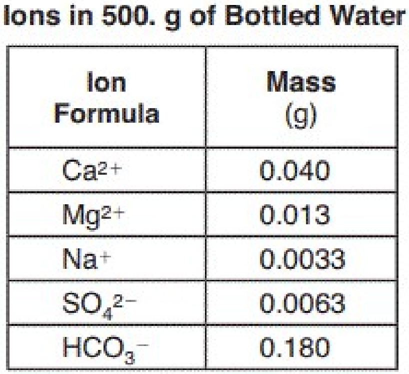
4 

36 Answer => 4

The bond between hydrogen and oxygen in a water molecule is classified as

1 ionic and nonpolar
2 ionic and polar
3 covalent and nonpolar
4 covalent and polar

37 A bottled water label lists the ions dissolved in the water. The table below lists the mass of some ions dissolved in a 500.-gram sample of the bottled water.



Ions in 500. g of Bottled Water

Ion Formula	Mass (g)
Ca^{2+}	0.040
Mg^{2+}	0.013
Na^{+}	0.0033
SO_4^{2-}	0.0063
HCO_3^{-}	0.180

Based on Table *F*, write the formula of the ion in the bottled water table that would form the least soluble compound when combined with the sulfate ion.

Answer

Solubility is a chemical property referring to the ability for a given substance, the solute, to dissolve in a solvent. According to Table F, the Ca^{2+} ion would form the least soluble compound when combined with the sulfate ion. Table F shows the most ions are soluble when combined with sulfate, with the exception of Ca^{2+}, Sr^{2+}, Ba^{2+}, or Pb^{2+}.

38 Answer => 1

A 1-gram sample of a compound is added to 100 grams of $H_2O(\ell)$ and the resulting mixture is then thoroughly stirred. Some of the compound is then separated from the mixture by filtration. Based on Table *F*, the compound could be

1 AgCl
2 $CaCl_2$
3 NaCl
4 $NiCl_2$

39

Figure 13

Base your answer on the article below, the *Reference Tables for Chemistry,* and your knowledge of chemistry.

> In the 1920s, paint used to inscribe the numbers on watch dials was composed of a luminescent (glow-in-the-dark) mixture. The powdered-paint base was a mixture of radium salts and zinc sulfide. As the paint was mixed, the powdered base became airborne and drifted throughout the workroom causing the contents of the workroom, including the painters' clothes and bodies, to glow in the dark.
>
> The paint is luminescent because radiation from the radium salts strikes a scintillator. A scintillator is a material that emits visible light in response to ionizing radiation. In watchdial paint, zinc sulfide acts as the scintillator.
>
> Radium present in the radium salts decomposes spontaneously, emitting alpha particles. These particles can cause damage to the body when they enter human tissue. Alpha particles are especially harmful to the blood, liver, lungs, and spleen because they can alter genetic information in the cells. Radium can be deposited in the bones because it substitutes for calcium.

Refer to Figure 13 and answer the following Question:

Based on Reference Table *F*, describe the solubility of zinc sulfide in water.

Answer

Acceptable responses include, but are not limited to, these examples:

- Zinc sulfide is not soluble in water.
- insoluble

40 Answer => 2

According to Reference Table *F*, which of the following compounds will form a saturated solution that is most dilute?

1 ammonium chloride
2 calcium carbonate
3 potassium iodide
4 sodium nitrate

Gases
Video #14

Name:__________________________ Class/Period:_______________________

Assignment: Video 14. Gases: Combined Gas Law and Kinetic Molecular Theory

Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 14/17 then answer the following questions.

1 Answer => 4

At STP, which 2.0-gram sample of matter uniformly fills a 340-milliliter closed container?

1 $Br_2(\ell)$
2 $Fe(NO_3)_2(s)$
3 KCl(aq)
4 Xe(g)

2 Answer => 4

A 1.0-gram sample of which element will uniformly fill a closed 2.0-liter container at STP?

1 antimony
2 sulfur
3 tellurium
4 xenon

3 Answer => 4

The arrangement of particles is most ordered in a sample of

1 NaCl(aq)
2 NaCl(ℓ)
3 NaCl(g)
4 NaCl(s)

4 Answer => 1

Which statement best describes the shape and volume of an aluminum cylinder at STP?

1 It has a definite shape and a definite volume.
2 It has a definite shape and no definite volume.
3 It has no definite shape and a definite volume.
4 It has no definite shape and no definite volume.

5 Answer => 4

Two basic properties of the gas phase are

1 a definite shape and a definite volume
2 a definite shape but no definite volume
3 no definite shape but a definite volume
4 no definite shape and no definite volume

6 Answer => 1

The pressure on 200. milliliters of a gas is decreased at constant temperature from 900. torr to 800. torr The new volume of the gas, in milliliters, is equal to

1 $200.\times\left(\frac{900.}{800.}\right)$

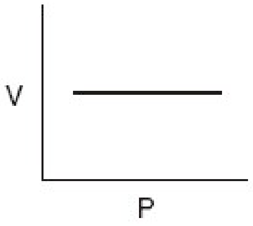
2 $200.\times\left(\frac{800.}{900.}\right)$

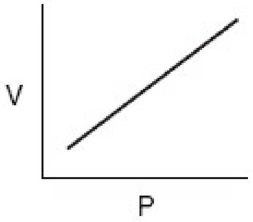
3 $800.\times\left(\frac{200.}{900.}\right)$

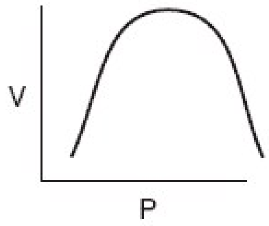
4 $800.\times\left(\frac{900.}{200.}\right)$

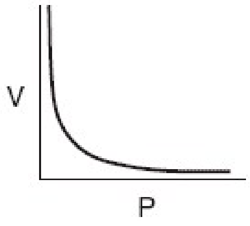
7 Answer => 4

Which graph best represents the pressure-volume relationship for an ideal gas at constant temperature?

1 

2 

3 

4 

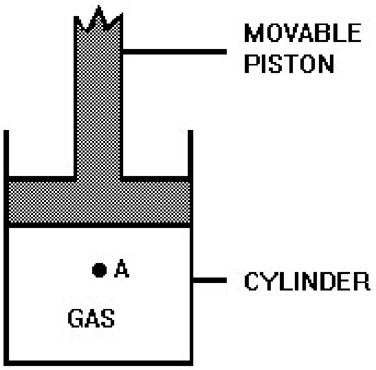
8 Answer => 4

A volume of 50.0 milliliters of an ideal gas at STP increases to 100 milliliters. If the pressure remains constant, the new temperature must be

1 0 K
2 100 K
3 273 K
4 546 K

9 Answer => 3

The diagram represents a gas sample confined in a cylinder fitted with a movable piston.



As the piston moves towards Point *A* at constant temperature, which mathematical relationship between pressure (*P*) and volume (*V*) remains constant?

1 $P + V$
2 $P - V$
3 $P \times V$
4 P / V

10 Answer => 2

If the pressure on a 3.0 liter sample of a gas is doubled at constant temperature, the new volume would be

1 0.75 L
2 1.5 L
3 6.0 L
4 9.0 L

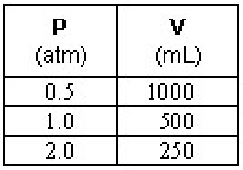
11 Answer => 1

When the pressure exerted on a confined gas at constant temperature is doubled, the volume of the gas is

1 halved
2 doubled
3 tripled
4 quartered

12 Answer => 2

The table shows the changes in the volume of a gas as the pressure changes at a constant temperature.



P (atm)	V (mL)
0.5	1000
1.0	500
2.0	250

Which equation best expresses the relationship between pressure and volume for the gas?

1 $P/V = 500$ atm×ml
2 $PV = 500$ atm×ml
3 $V/P = 500$ atm×ml
4 $PV = 1/500$ atm×ml

13 Water, H_2O, and hexane, C_6H_{14}, are commonly used as laboratory solvents because they have different physical properties and are able to dissolve different types of solutes. Some physical properties of water and hexane are listed on the table below.

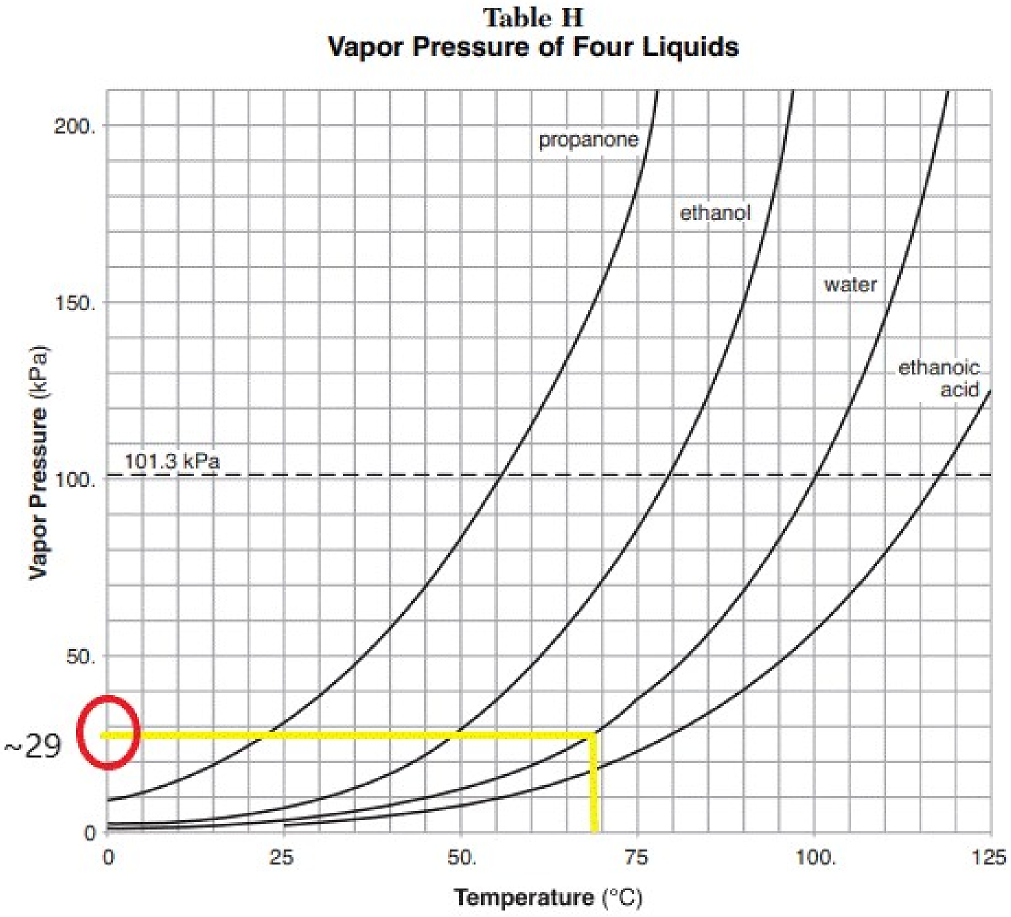
Physical Properties of H_2O and C_6H_{14}

Solvent	Boiling Point (°C)	Melting Point (°C)	Vapor Pressure at 69°C (kPa)
H_2O	100.	0.	?
C_6H_{14}	69	–95	101.3

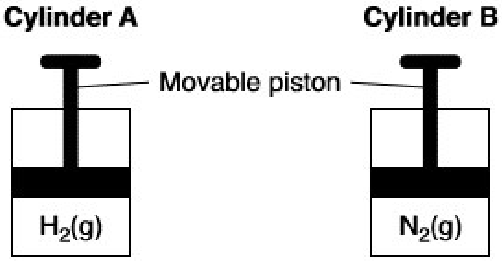
Determine the vapor pressure of water at 69°C.

Answer

Any value from ***28 kPa to 30. kPa***, inclusive.



14 Cylinder A and cylinder B are sealed, rigid cylinders with movable pistons. Each cylinder contains 500. milliliters of a gas sample at 101.3 kPa and 298 K. Cylinder A contains $H_2(g)$ and cylinder B contains $N_2(g)$. The diagrams below represent these two cylinders.



State the change in temperature and a change in pressure that will cause the gas in cylinder A to behave more like an ideal gas.

Answer

Acceptable responses include, but are not limited to:

Temperature: increase

Pressure: decrease

or

Temperature: above 25°C

Pressure: below 1.00 atm

or

Temperature: any temperature above 298 K

Pressure: any pressure below 101.3 kPa

15 The enclosed cabin of a submarine has a volume of 2.4×10^5 liters, a temperature of 312 K, and a pressure of 116 kPa. As people in the cabin breathe, carbon dioxide gas, $CO_2(g)$, can build up to unsafe levels. Air in the cabin becomes unsafe to breathe when the mass of $CO_2(g)$ in this cabin exceeds 2156 grams.

Convert the original air pressure in the cabin of the submarine to atmospheres.

Answer

Using Table A, there are 101.3 kPa in 1 atm. Therefore, a setup for converting units of kPa to atmospheres is as follows:

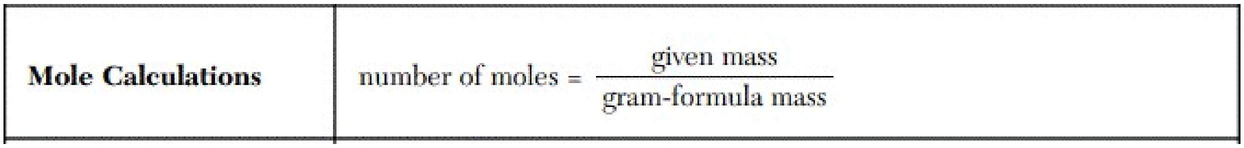
116 kPa x (1 atm/101.3 kPa) = ***1.15 atm***

16 The enclosed cabin of a submarine has a volume of 2.4 x 10^5 liters, a temperature of 312 K, and a pressure of 116 kPa. As people in the cabin breathe, carbon dioxide gas, $CO_2(g)$, can build up to unsafe levels. Air in the cabin becomes unsafe to breathe when the mass of $CO_2(g)$ in this cabin exceeds 2156 grams.

Determine the number of moles of $CO_2(g)$ in the submarine cabin at which the air becomes unsafe to breathe. The gram-formula mass of CO_2 is 44.0 g/mol.

Answer

Use the following formula from Table T:



Mole Calculations	$\text{number of moles} = \dfrac{\text{given mass}}{\text{gram-formula mass}}$

Moles = (2156g) / (44g/mol) = ***49 moles***

17 The enclosed cabin of a submarine has a volume of 2.4 x 10^5 liters, a temperature of 312 K, and a pressure of 116 kPa. As people in the cabin breathe, carbon dioxide gas, $CO_2(g)$, can build up to unsafe levels. Air in the cabin becomes unsafe to breathe when the mass of $CO_2(g)$ in this cabin exceeds 2156 grams.

Show a numerical setup for calculating the pressure in the submarine cabin if the cabin temperature changes to 293 K.

Answer

Acceptable responses include, but are not limited to:

$$\frac{(116\,\text{kPa})(2.4 \times 10^5\,\text{L})}{312\ \text{K}} = \frac{P_2(2.4 \times 10^5\,\text{L})}{293\ \text{K}}$$

$$\frac{116\,\text{kPa}}{312\ \text{K}} = \frac{x}{293\ \text{K}}$$

$$\frac{(116)(293)}{312}$$

18 The enclosed cabin of a submarine has a volume of 2.4 x 10^5 liters, a temperature of 312 K, and a pressure of 116 kPa. As people in the cabin breathe, carbon dioxide gas, $CO_2(g)$, can build up to unsafe levels. Air in the cabin becomes unsafe to breathe when the mass of $CO_2(g)$ in this cabin exceeds 2156 grams.

State what happens to the average kinetic energy of the gas molecules if the cabin temperature *decreases*.

Answer

Acceptable responses include, but are not limited to:

- The average kinetic energy of the gas molecules in the cabin would decrease.
- The average KE would be lower.

19 Answer <u>=> 3</u>

At which temperature and pressure will a sample of neon gas behave most like an ideal gas?

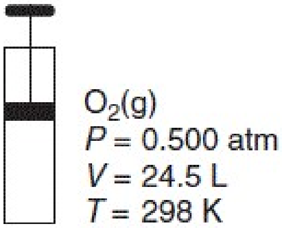
1 300. K and 2.0 atm
2 300. K and 4.0 atm
3 500. K and 2.0 atm
4 500. K and 4.0 atm

20

Figure 1

Base your answer to question on the information below and on your knowledge of chemistry.

The diagram below represents a cylinder with a moveable piston containing 16.0 g of O_2(g). At 298 K and 0.500 atm, the O_2(g) has a volume of 24.5 liters.



Refer to Figure 1 and answer the following Question:

State the changes in *both* pressure and temperature of the gas in the cylinder that would increase the frequency of collisions between the O_2(g) molecules.

Answer

Acceptable responses include, but are not limited to:

- Change in pressure: increases
  Change in temperature: higher
- Change in pressure: any pressure greater than 0.5 atm
  Change in temperature: any temperature above 298 K

21

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

Ammonia, $NH_3(g)$, can be used as a substitute for fossil fuels in some internal combustion engines. The reaction between ammonia and oxygen in an engine is represented by the unbalanced equation below.

$NH_3(g) + O_2(g) \rightarrow N_2(g) + H_2O(g) + \text{energy}$

Refer to Figure 2 and answer the following Question:

Determine the new pressure of a 6.40-L sample of oxygen gas at 300. K and 100. kPa after the gas is compressed to 2.40 L at 900. K.

Answer

Use the combined gas law from Reference Table *T*.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{100.\ \text{kPa} \times 6.40\ \text{L}}{300.\ \text{K}} = \frac{x\ \text{kPa} \times 2.40\ \text{L}}{900.\ \text{K}}$$

$$100.\ \text{kPa} \times 6.40\ \text{L} \times 900.\ \text{K} = 300.\ \text{K} \times x\ \text{kPa} \times 2.40\ \text{L}$$

$$\frac{100.\ \text{kPa} \times 6.40\ \text{L} \times 900.\ \text{K}}{300.\ \text{K} \times 2.40\ \text{L}} = \frac{300.\ \text{K} \times x\ \text{kPa} \times 2.40\ \text{L}}{300.\ \text{K} \times 2.40\ \text{L}}$$

$$x = 800.\ \text{kPa}$$

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

In industry, ethanol is primarily produced by two different reactions. One process involves the reaction of glucose in the presence of an enzyme that acts as a catalyst. The equation below represents this reaction.

Equation 1:

$$\underset{\text{glucose}}{C_6H_{12}O_6} \xrightarrow{\text{enzyme}} 2\,\underset{\text{ethanol}}{CH_3CH_2OH} + 2CO_2$$

In another reaction, ethanol is produced from ethene and water. The equation below represents this reaction in which H_2SO4 is a catalyst.

Equation 2:

$$CH_2CH_2 + H_2O \xrightarrow{H_2SO_4} CH_3CH_2OH$$

Industrial ethanol can be oxidized using a catalyst to produce ethanal. The equation representing this oxidation is shown below.

Equation 3:

$$CH_3CH_2OH \xrightarrow{\text{catalyst}} CH_3CHO + H_2$$

Refer to Figure 3 and answer the following Question:

Explain, in terms of intermolecular forces, why ethanol has a much higher boiling point than ethene, at standard pressure.

Answer

Acceptable responses include, but are not limited to:

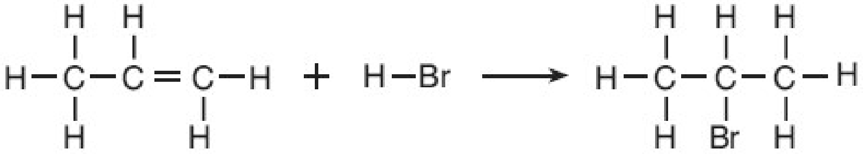
- The alcohol functional group, –OH, allows for hydrogen bonding between ethanol molecules, so ethanol has a higher boiling point than ethene.
- The boiling point of ethene is lower because its intermolecular forces are weaker than the intermolecular forces in the alcohol.
- IMF for ethanol is stronger.

23

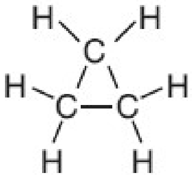
Figure 4

Base your answers to the question on the information below and on your knowledge of chemistry.

The equation below represents a reaction between propene and hydrogen bromide.



Cyclopropane, an isomer of propene, has a boiling point of –33ºC at standard pressure and is represented by the formula below.



Refer to Figure 4 and answer the following Question:

Convert the boiling point of cyclopropane at standard pressure to kelvins.

Answer

boiling point of cyclopropane = –33°C
Kelvins = °C + 273
Kelvins = –33 + 273 = 240

24

Figure 5

Base your answer to the question on the information below and on your knowledge of chemistry.

A sample of helium gas is placed in a rigid cylinder that has a movable piston. The volume of the gas is varied by moving the piston, while the temperature is held constant at 273 K. The volumes and corresponding pressures for three trials are measured and recorded in the data table below. For each of these trials, the product of pressure and volume is also calculated and recorded. For a fourth trial, only the volume is recorded.

Pressure and Volume Data for a Sample of Helium Gas at 273 K

Trial Number	Pressure (atm)	Volume (L)	P × V (L•atm)
1	1.000	0.412	0.412
2	0.750	0.549	0.412
3	0.600	0.687	0.412
4	?	1.373	?

Refer to Figure 5 and answer the following Question:

Determine the pressure of the helium gas in trial 4.

Answer

Allow credit for 0.300 atm. Significant figures do *not* need to be shown.

25 **Refer to Figure 5 and answer the following Question:**
State evidence found in the data table that allows the product of pressure and volume for the fourth trial to be predicted.

Answer

Acceptable responses include, but are not limited to:

- Pressure times volume for the first three trials is constant at 0.412.
- As the volume is increased, the pressure decreases proportionally.
- There is no change for P × V.
- $P_1V_1 = P_2V_2 = P_3V_3$
- PV = constant

26

Figure 6

Base your answer to this question on the information below.

A solution is made by completely dissolving 90. grams of $KNO_3(s)$ in 100. grams of water in a beaker. The temperature of this solution is 65°C.

Refer to Figure 6 and answer the following Question:
Describe the effect on the solubility of $KNO_3(s)$ in this solution when the pressure on the solution increases.

Answer

Acceptable responses include, but are not limited to:

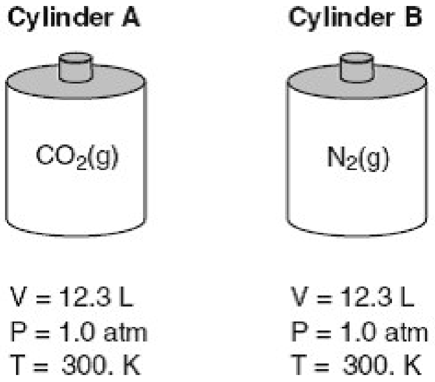
- The solubility of $KNO_3(s)$ is not affected by an increase in pressure.
- When the pressure on the solution increases, the solubility of KNO_3 remains the same.

27

Figure 7

Base your answer to the question on the information and diagrams below.

Cylinder *A* contains 22.0 grams of $CO_2(g)$ and cylinder *B* contains $N_2(g)$. The volumes, pressures, and temperatures of the two gases are indicated under each cylinder.



Refer to Figure 7 and answer the following Question:

Explain why the number of molecules of N_2(g) in cylinder *B* is the same as the number of molecules of CO_2(g) in cylinder *A*.

Answer

Acceptable responses include, but are not limited to:

- Equal volumes of two gases at the same temperature and pressure contain equal number of particles.
- both gases – same conditions

28 Base your answer to the question on the properties of propanone.

Explain, in terms of molecular energy, why the vapor pressure of propanone increases when its temperature increases.

Answer

Acceptable responses include, but are not limited to:

- As the temperature increases, more molecules have enough energy to escape the liquid phase.
- As the temperature increases, more molecules have the energy to become gases.

29

Figure 8

Base your answer to the question on the information below.

When cola, a type of soda pop, is manufactured, CO_2 (g) is dissolved in it.

Refer to Figure 8 and answer the following Question:

A capped bottle of cola contains CO_2 (g) under high pressure. When the cap is removed, how does pressure affect the solubility of the dissolved CO_2 (g)?

Answer

Acceptable responses include, but are not limited to, this example:

- Solubility of CO_2 (g) decreases with a decrease in pressure.

Note: A good answer should include a reference to solubility and pressure.

30 Answer => 4

According to the kinetic molecular theory, which statement describes the particles in a sample of an ideal gas?

1 The particles are constantly moving in circular paths.
2 The particles collide, decreasing the total energy of the system.
3 The particles have attractive forces between them.
4 The particles are considered to have negligible volume.

31 Answer => 2

The kinetic molecular theory states that all particles of an ideal gas are

1 colliding without transferring energy
2 in random, constant, straight-line motion
3 arranged in a regular geometric pattern
4 separated by small distances relative to their size

32 Answer => 3

According to the kinetic molecular theory, which statement describes an ideal gas?

1 The gas particles are diatomic.
2 Energy is created when the gas particles collide.
3 There are no attractive forces between the gas particles.
4 The distance between the gas particles is small, compared to their size.

33 Answer => 4

According to kinetic molecular theory, collisions between gas particles in a sample of an ideal gas

1 increase the energy content of the gas sample
2 produce strong attractive forces between the gas particles
3 result in a net loss of energy by the gas sample
4 transfer energy between the gas particles

34 Answer => 4

According to the kinetic molecular theory, the particles of an ideal gas

1 have no potential energy
2 have strong intermolecular forces
3 are arranged in a regular, repeated geometric pattern
4 are separated by great distances, compared to their size

35 Answer => 3

A sample of a gas is contained in a closed rigid cylinder. According to kinetic molecular theory, what occurs when the gas inside the cylinder is heated?

1 The number of gas molecules increases.
2 The number of collisions between gas molecules per unit time decreases.
3 The average velocity of the gas molecules increases.
4 The volume of the gas decreases.

Acids & Bases
Video #15

Name:__________________________ Class/Period:_______________________

Assignment: Video 15. Acids and Bases: Indicators, Titration, and Hydronium Concentration
Teacher: Dr. Salhoobi

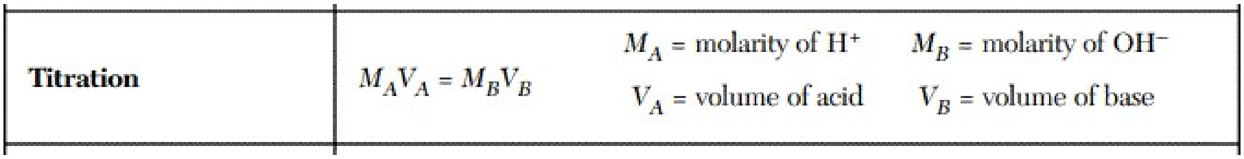
Instructions: Follow your teacher's directions to watch video # 15/17 then answer the following questions.

1 A NaOH(aq) solution with a pH value of 13 is used to determine the molarity of a HCl(aq) solution. A 10.0-mL sample of the HCl(aq) is exactly neutralized by 16.0 mL of 0.100 M NaOH(aq). During this laboratory activity, appropriate safety equipment was used and safety procedures were followed.

Determine the molarity of the HCl(aq) sample, using the titration data.

Answer

Using the following equation from Table T :



Titration	$M_AV_A = M_BV_B$	M_A = molarity of H^+ V_A = volume of acid	M_B = molarity of OH^- V_B = volume of base

Substitute in the given information as follows:

M_A (10.0) = (0.100)(16.0)

M_A = 0.16 M or 0.160 M

2 In a laboratory investigation, an HCl(aq) solution with a pH value of 2 is used to determine the molarity of KOH(aq) solution. A 7.5-milliliter sample of the KOH(aq) is exactly neutralized by 15.0 milliliters of the 0.010 M HCl(aq). During this laboratory activity, appropriate safety equipment is used and safety equipment is used and safety procedures are followed.

Show a numerical setup for calculating the molarity of the KOH solution.

Answer

According to Titration equation listed n Table T, the given information should be substituted into the following equation:

$M_AV_A = M_BV_B$

Possible correct numerical setups include:

$$\frac{(0.010\ \text{M})(15.0\ \text{mL})}{7.5\ \text{mL}}$$

$$(0.010\ \text{M})(15.0\ \text{mL}) = M_B\ (7.5\ \text{mL})$$

$$\frac{(0.01)(15)}{7.5}$$

3 In a laboratory activity, a student titrates a 20.0-milliliter sample of HCl(aq) using 0.025 M NaOH(aq). In one of the titration trials, 17.6 milliliters of the base solution exactly neutralizes the acid sample.

Identify the positive ion in the sample of HCl(aq).

Answer

Possible answers include:

- hydronium ion
- hydronium
- hydrogen ion
- hydrogen
- proton
- H_3O^+
- H^+
- $H_3O^+(aq)$
- $H^+(aq)$

4 In a laboratory activity, a student titrates a 20.0-milliliter sample of HCl(aq) using 0.025 M NaOH(aq). In one of the titration trials, 17.6 milliliters of the base solution exactly neutralizes the acid sample.

Show a numerical setup for calculating the concentration of the hydrochloric acid using the titration data.

Answer

Using the titration equation on Table T, $M_AV_A = M_BV_B$

Possible answers include:

M_A(20.0 mL) = (0.025 M)(17.6 mL)

(0.025 x 17.6)/ 20

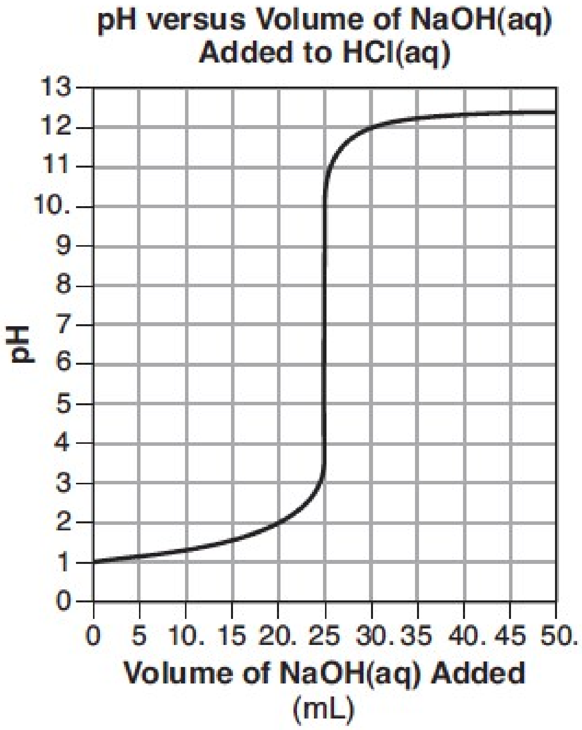
5

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

A student is to determine the concentration of an NaOH(aq) solution by performing two different titrations. In a first titration, the student titrates 25.0 mL of 0.100 M H_2SO_4(aq)with NaOH(aq) of unknown concentration.

In a second titration, the student titrates 25.0 mL of 0.100 M HCl(aq) with a sample of the NaOH(aq). During this second titration, the volume of the NaOH(aq) added and the corresponding pH value of the reaction mixture is measured. The graph below represents the relationship between pH and the volume of the NaOH(aq) added for this second titration.



Refer to Figure 1 and answer the following Question:

Complete the equation below for the neutralization that occurs in the first titration by writing a formula of the missing product.

$2NaOH(aq) + H_2SO_4(aq) \rightarrow 2H_2O(\ell) +$ _________ (aq)

Answer

A neutralization reaction is when an acid and a base react to form water and a salt.

$2NaOH(aq)+H_2SO_4(aq)\rightarrow 2H_2O(\ell)+\underline{\mathbf{2NaSO_4}}$ (aq)

base acid water ***SALT***

Salt is missing. In this case, it is a salt comprised of Na+ and SO_4^{2-} ions, making it Na_2SO_4, sodium sulfate. The coefficient 2 out in front is necessary to completely balance the equation.

6

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

A NaOH(aq) solution and an acid-base indicator are used to determine the molarity of an HCl(aq) solution. A 25.0-milliliter sample of the HCl(aq) is exactly neutralized by 15.0 milliliters of 0.20 M NaOH(aq).

Refer to Figure 2 and answer the following Question:

Identify the laboratory process described in this passage.

Answer

Acceptable responses include, but are not limited to:

- titration
- volumetric analysis

7 Determine the volume of 2.00 M HCl(aq) solution required to completely neutralize 20.0 milliliters of 1.00 M NaOH(aq) solution.

Answer

This is an acid-base titration. Use the formula on Reference Table *T*.

For the acid: $M_A = 2.00$ M, $V_A = x$

For the base: $M_B = 1.00$ M, $V_B = 20.0$ mL

$$M_A V_A = M_B V_B$$

$$2.00\ \mathrm{M} \times x\ \mathrm{mL} = 1.00\ \mathrm{M} \times 20.0\ \mathrm{mL}$$

$$x\ \mathrm{mL} = \frac{1.00\ \mathrm{M} \times 20.0\ \mathrm{mL}}{2.00\ \mathrm{M}}$$

$$x = 10.0\ \mathrm{mL}$$

8

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

During a laboratory activity, a student places 25.0 mL of HCl(aq) of unknown concentration into a flask. The student adds four drops of phenolphthalein to the solution in the flask. The solution is titrated with 0.150 M KOH(aq) until the solution appears faint pink. The volume of KOH(aq) added is 18.5 mL.

Refer to Figure 3 and answer the following Question:

Determine the concentration of the HCl(aq) solution, using the titration data.

Answer

$$M_A V_A = M_B V_B$$

$$M_A(25.0\ \text{mL}) = (0.150\ \text{M})(18.5\ \text{mL})$$

$$M_A = \frac{(0.150\ \text{M})(18.5\ \text{mL})}{25.0\ \text{mL}} = 0.111\ \text{M}$$

Acceptable responses include, but are not limited to:

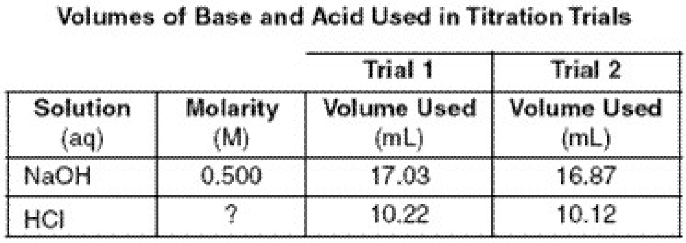
- 0.111 M
- 0.11 M
- 0.1 M

9

Figure 4

Base your answer to the question on the information below.

In preparing to titrate an acid with a base, a student puts on goggles and an apron. The student uses burets to dispense and measure the acid and the base in the titration. In each of two trials, a 0.500 M NaOH(aq) solution is added to a flask containing a volume of HCl(aq) solution of unknown concentration. Phenolphthalein is the indicator used in the titration. The calculated volumes used for the two trials are recorded in the table below.



Volumes of Base and Acid Used in Titration Trials

		Trial 1	Trial 2
Solution (aq)	Molarity (M)	Volume Used (mL)	Volume Used (mL)
NaOH	0.500	17.03	16.87
HCl	?	10.22	10.12

Refer to Figure 4 and answer the following Question:

Identify *one* additional safety precaution the student should have taken before performing the titration.

Answer

Acceptable responses include, but are not limited to:

- wearing gloves
- no open-toed shoes

10

Figure 5

Base your answer to the question on the information below.

In a titration experiment, a student uses a 1.4 M HBr(aq) solution and the indicator phenolphthalein to determine the concentration of a KOH(aq) solution. The data for trial 1 is recorded in the table below

Trial 1

Buret Readings	HBr(aq)	KOH(aq)
Initial volume (mL)	7.50	11.00
Final volume (mL)	22.90	33.10
Volume used (mL)	15.40	22.10

Refer to Figure 5 and answer the following Question:

Why is it better to use several trials of a titration rather than one trial to determine the molarity of a solution of an unknown concentration?

Answer

Acceptable responses include, but are not limited to, these examples:

- Multiple trials improve precision of results.
- to see if results are repeatable
- more trials, less error

11 Base your answer on the information below.

A student titrates 60.0 mL of $HNO_3(aq)$ with 0.30 M NaOH(*aq*). Phenolphthalein is used as the indicator. After adding 42.2 mL of NaOH(*aq*), a color change remains for 25 seconds, and the student stops the titration.

What color change does phenolphthalein undergo during this titration?

Answer

Acceptable responses include, but are not limited to, these examples:

- colorless to pink
- no color to red

12

Figure 6

Base your answer to the question on the information below.

A titration setup was used to determine the unknown molar concentration of a solution of NaOH. A 1.2 M HCl solution was used as the titration standard. The following data were collected.

	Trial 1	Trial 2	Trial 3	Trial 4
Amount of HCl Standard Used	10.0 mL	10.0 mL	10.0 mL	10.0 mL
Initial NaOH Buret Reading	0.0 mL	12.2 mL	23.2 mL	35.2 mL
Final NaOH Buret Reading	12.2 mL	23.2 mL	35.2 mL	47.7 mL

Refer to Figure 6 and answer the following Question:

According to Reference Table *M*, what indicator would be most appropriate in determining the end point of this titration? Give one reason for choosing this indicator.

Answer

Indicator: **phenolphthalein** or **bromthymol blue** or **litmus**

Acceptable reasons include, but are not limited to, these examples:

- Strong acid and strong base reach an end point at pH = 7.
- Phenolphthalein goes from colorless to pink after pH = 7.
- Bromthymol blue (or litmus) reaches an intermediate color around pH = 7.

13

Figure 7

Base your answer to question on the information below.

In a titration, 20.0 milliliters of 0.15 M HCl(aq) is exactly neutralized by 18.0 milliliters of KOH(aq).

Refer to Figure 7 and answer the following Question:

Compare the number of moles of H^+(aq) ions to the number of moles of OH^-(aq) ions in the titration mixture when the HCl(aq) is exactly neutralized by the KOH(aq).

Answer

Acceptable responses include, but are not limited to:

- The number of moles of H^+(aq) ions equals the number of moles of OH^- (aq) ions.
- The number of hydrogen ions is the same as the number of hydroxide ions.

14 **Refer to Figure 3 and answer the following Question:**

Complete the equation below for the neutralization reaction that occurs during the titration.

$KOH(aq) + HCl(aq) \rightarrow$ ______________

Answer

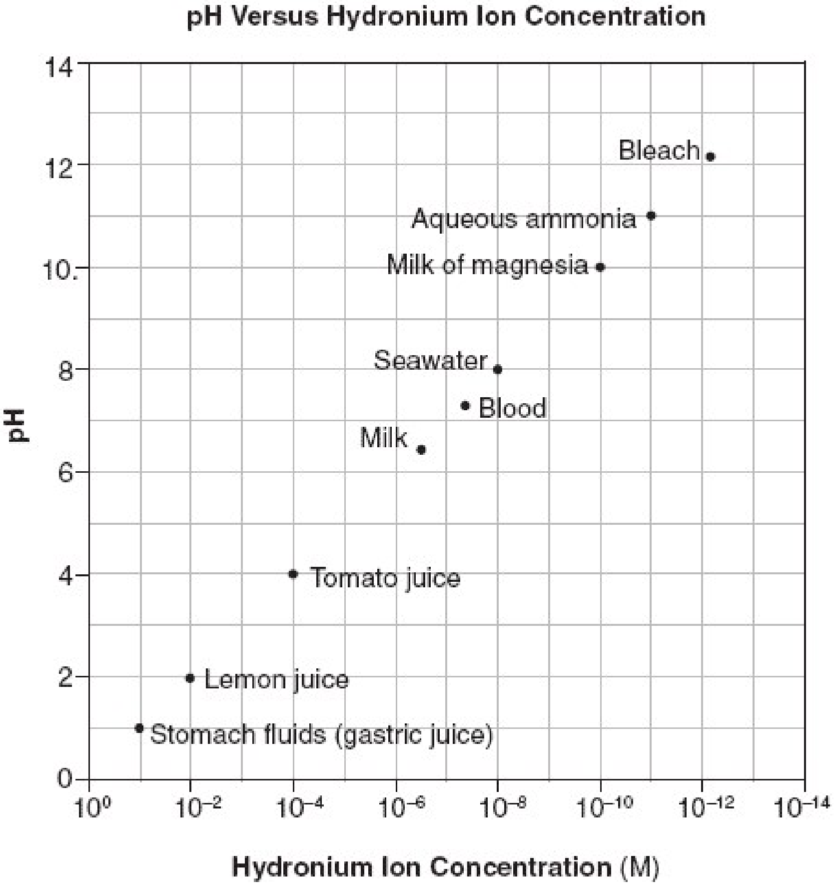
Acceptable responses include, but are not limited to:

- $KCl(aq) + H_2O(\ell)$
- $K^+ + Cl^- + OH^2(\ell)$
- HOH + ClK

15

Figure 8

Base your answer to the question on the graph below. The graph shows the relationship between pH value and hydronium ion concentration for common aqueous solutions and mixtures.



Refer to Figure 8 and answer the following Question:

According to this graph, which mixture is approximately 100 times more acidic than milk of magnesia?

Answer: ☐

Answer

seawater

16 Answer <u>=> 3</u>

What is the hydronium concentration of a solution that has a hydroxide ion concentration of 1×10^{-3} mole per liter at 25°C?

1 1×10^{-3} mole per liter
2 1×10^{-7} mole per liter
3 1×10^{-11} mole per liter
4 1×10^{-14} mole per liter

17 A sample of normal rainwater has a pH of 5.6 due to dissolved carbon dioxide gas from the atmosphere. Acid rain is formed when other gases, such as sulfur dioxide, dissolve in rainwater, which can result in lake water with a pH value of 4.6. The equation below represents the reaction of water with $SO_2(g)$.

$$H_2O(\ell) + SO_2(g) \rightarrow H_2SO_3(aq)$$

State the color of methyl orange in a sample of normal rainwater.

Answer

According to Table M, methyl orange is ***yellow*** in a sample of rainwater with a pH of 5.6.

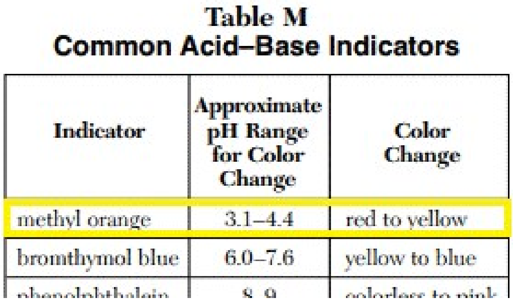


Table M
Common Acid–Base Indicators

Indicator	Approximate pH Range for Color Change	Color Change
methyl orange	3.1–4.4	red to yellow
bromthymol blue	6.0–7.6	yellow to blue
phenolphthalein	8–9	colorless to pink

18 In a laboratory investigation, an HCl(aq) solution with a pH value of 2 is used to determine the molarity of KOH(aq) solution. A 7.5-milliliter sample of the KOH(aq) is exactly neutralized by 15.0 milliliters of the 0.010 M HCl(aq). During this laboratory activity, appropriate safety equipment is used and safety equipment is used and safety procedures are followed.
State the color of the indicator bromcresol green if it is added to a sample of the KOH(aq) solution.

Answer

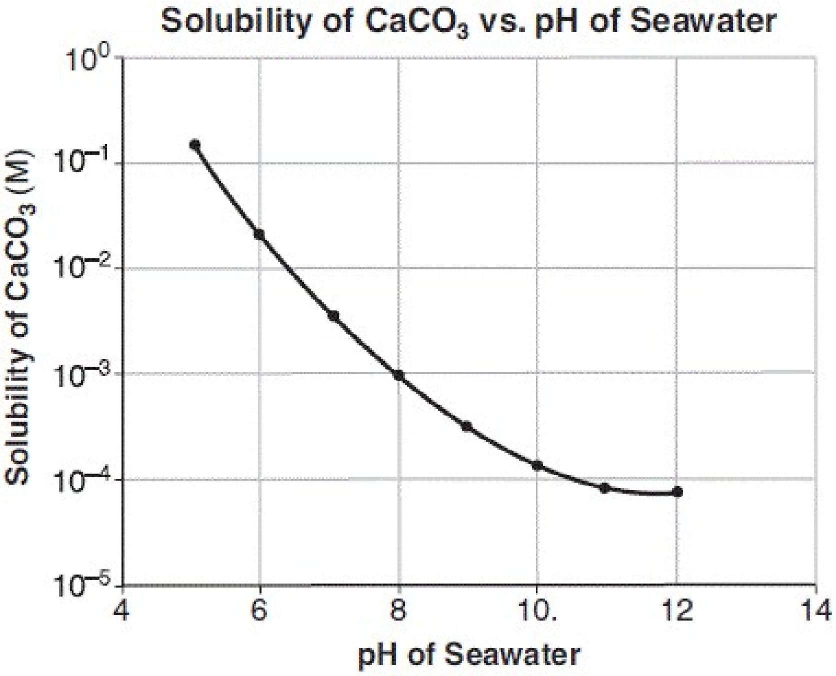
KOH(aq) is a base and therefore it's pH will be above 7. According to Table M, when tested with the indicator bromcresol green, the solution will turn ***blue***.

19

Figure 9

Base your answer to the question on the information below and on your knowledge of chemistry.

Carbon dioxide is slightly soluble in seawater. As carbon dioxide levels in the atmosphere increase, more CO_2 dissolves in seawater, making the seawater more acidic because carbonic acid, $H_2CO_3(aq)$, is formed. Seawater also contains aqueous calcium carbonate, $CaCO_3(aq)$, which is used by some marine organisms to make their hard exoskeletons. As the acidity of the sea water changes, the solubility of $CaCO_3$ also changes, as shown in the graph below.



Refer to Figure 9 and answer the following Question:

State the color of bromcresol green in a sample of seawater in which the $CaCO_3$ solubility is 10^{-2} M.

Answer

Refer to Table M - Common Acid-Base Indicators

- blue

20

Figure 10

Base your answer to the question on the information below and on your knowledge of chemistry.

Vinegar is a commercial form of acetic acid, $HC_2H_3O_2(aq)$. One sample of vinegar has a pH value of 2.4.

Refer to Figure 10 and answer the following Question:

State the color of bromthymol blue indicator in a sample of the commercial vinegar.

Answer

Reference Table *M* lists common Acid-Base Indicators. Vinegar has a pH value of 2.4. Bromthymol blue does not turn blue until the pH is above 6.0 So commercial vinegar solutions would remain yellow.

21

Figure 11

Base your answer to the question on the information below and on your knowledge of chemistry.

A company produces a colorless vinegar that is 5.0% $HC_2H_3O_2$ in water. Using thymol blue as an indicator, a student titrates a 15.0-milliliter sample of the vinegar with 43.1 milliliters of a 0.30 M NaOH(aq) solution until the acid is neutralized.

Refer to Figure 11 and answer the following Question:

Based on *Reference Table M*, what is the color of the indicator in the vinegar solution before any base is added?

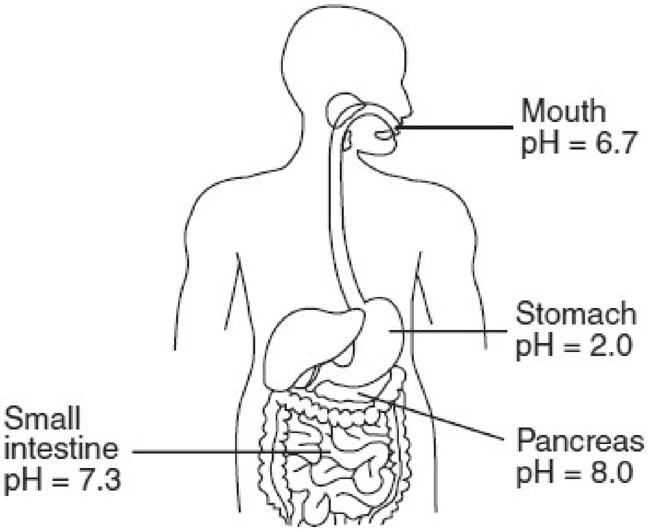
Answer

- Yellow
- Thymol blue is yellow in a solution with a pH that is acidic. Ethanoic acid, $HC_2H_3O_2$ is an acid as indicated on *Reference Table K.*

22

Figure 12

The diagram below shows typical pH values found in four parts of the human digestive system. In the small intestine, the enzyme lipase acts as a catalyst, increasing the rate of fat digestion.



Refer to Figure 12 and answer the following Question:

What is the color of thymol blue at the pH of the small intestine?

Answer

The pH of the small intestine is 7.3. Reference Table *M* shows that the indicator thymol blue is yellow at that pH.

23 Identify *two* indicators from Reference Table *M* that are yellow in solutions with a pH of 5.5.

Answer

Acceptable responses include, but are not limited to:

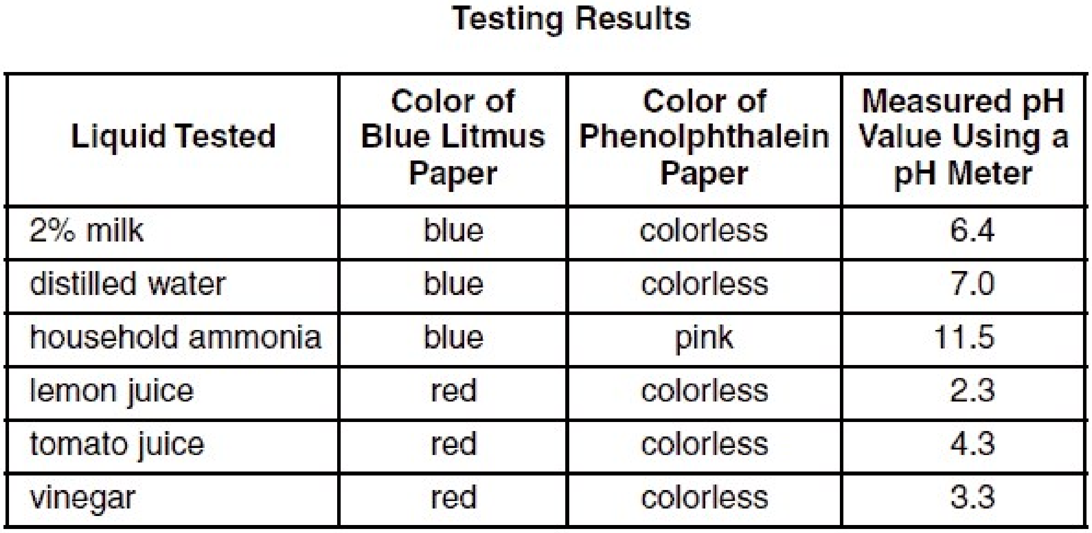
- methyl orange
- bromthymol blue
- thymol blue

24

Figure 13

Base your answer to this question on the information below.

A student used blue litmus paper and phenolphthalein paper as indicators to test the pH of distilled water and five aqueous household solutions. Then the student used a pH meter to measure the pH of the distilled water and each solution. The results of the student's work are recorded in the table below.



Testing Results

Liquid Tested	Color of Blue Litmus Paper	Color of Phenolphthalein Paper	Measured pH Value Using a pH Meter
2% milk	blue	colorless	6.4
distilled water	blue	colorless	7.0
household ammonia	blue	pink	11.5
lemon juice	red	colorless	2.3
tomato juice	red	colorless	4.3
vinegar	red	colorless	3.3

Refer to Figure 13 and answer the following Question:

Explain, in terms of the pH range for color change on Reference Table *M*, why litmus is ***not*** appropriate to differentiate the acidity levels of tomato juice and vinegar.

Answer

Acceptable responses include, but are not limited to:

- Because litmus changes color in a pH range of 4.5 to 8.3, litmus cannot be used to differentiate between a pH of 3.3 and 4.3.
- Litmus is red for all pH values below 4.5.

25

Figure 14

Base your answer to this question on the information below.

> A student, wearing chemical safety goggles and a lab apron, is to perform a laboratory test to determine the pH value of two different solutions. The student is given one bottle containing a solution with a pH of 2.0 and another bottle containing a solution with a pH of 5.0. The student is also given six dropping bottles, each containing a different indicator listed in Reference Table *M*.

Refer to Figure 14 and answer the following Question:

Identify an indicator in Reference Table *M* that would differentiate the two solutions.

Answer

Acceptable responses include, but are not limited to:

- methyl orange

26

Figure 15

Base your answer to the question on the information below.

> Some carbonated beverages are made by forcing carbon dioxide gas into a beverage solution. When a bottle of one kind of carbonated beverage is first opened, the beverage has a pH value of 3.

Refer to Figure 15 and answer the following Question:

Using Table *M*, identify *one* indicator that is yellow in a solution that has the same pH value as this beverage.

Answer

Acceptable responses include, but are not limited to:

- bromthymol blue
- bromcresol green
- thymol blue

27 Answer => 4

Which compounds are classified as Arrhenius acids?

1 HCl and NaOH
2 HNO_3 and NaCl
3 NH_3 and H_2CO_3
4 HBr and H_2SO_4

28 Answer => 1

The compound HNO_3 can be described as an

1 Arrhenius acid and an electrolyte
2 Arrhenius acid and a nonelectrolyte
3 Arrhenius base and an electrolyte
4 Arrhenius base and a nonelectrolyte

29 Answer => 2

Which 0.1 M solution contains an electrolyte?

1 $C_6H_{12}O_6$(*aq*)
2 CH_3 COOH(*aq*)
3 CH_3 OH(*aq*)
4 CH_3OCH_3 (*aq*)

30 Answer => 2

Figure 16

Base your answer to the question on the passage below.

> Acid rain lowers the pH in ponds and lakes and over time can cause the death of some aquatic life. Acid rain is caused in large part by the burning of fossil fuels in power plants and by gasoline-powered vehicles. The acids commonly associated with acid rain are sulfurous acid, sulfuric acid, and nitric acid.
>
> In general, fish can tolerate a pH range between 5 and 9. However, even small changes in pH can significantly affect the solubility and toxicity of common pollutants. Increased concentrations of these pollutants can adversely affect the behavior and normal life processes of fish and cause deformity, lower egg production, and less egg hatching.

Refer to Figure 16 and answer the following Question:

Which *negative* polyatomic ion is present in an aqueous nitric acid solution?

1 $N_2O_3^-$
2 NO_3^-
3 NO_2^-
4 NO^-

Redox Reactions
Video #16

Name:__________________________ Class/Period:_______________________

Assignment: Video 16. Redox Reactions. Teacher: Dr. Salhoobi

Instructions: Follow your teacher's directions to watch video # 16/17 then answer the following questions.

1 Answer => 4

Which metal is most easily oxidized?

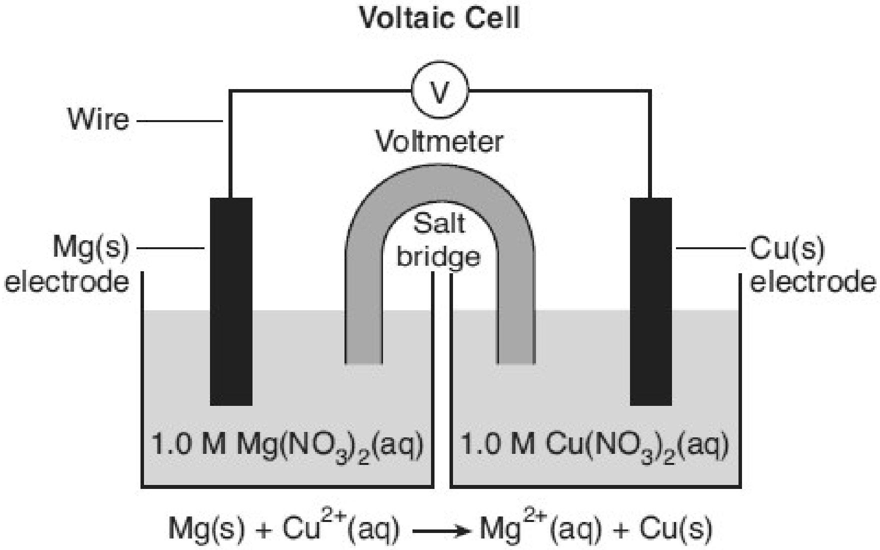
1 Ag
2 Co
3 Cu
4 Mg

2

Figure 1

Base your answer to the question on the information below and on your knowledge of chemistry.

The diagram and balanced ionic equation below represent two half cells connected to produce an operating voltaic cell in a laboratory investigation. The half-cells are connected by a salt bridge.



Refer to Figure 1 and answer the following Question:

Explain, in terms of atoms and ions, why the mass of the Mg(s) electrode decreases as the cell operates.

Answer

Acceptable responses include, but are not limited to:

- Magnesium atoms lose electrons and become magnesium ions in the solution.
- Some of the Mg atoms oxidize to Mg^{2+} ions, decreasing the electrode mass.
- Atoms become aqueous Mg^{2+} ions.

Figure 2

Base your answer to the question on the information below and on your knowledge of chemistry.

Stamping an identification number into the steel frame of a bicycle compresses the crystal structure of the metal. If the number is filed off, there are scientific ways to reveal the number.

One method is to apply aqueous copper(II) chloride to the number area. The Cu^{2+} ions react with some iron atoms in the steel frame, producing copper atoms that show the pattern of the number. The ionic equation below represents this reaction.

$$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$$

Another method is to apply hydrochloric acid to the number area. The acid reacts with the iron, producing bubbles of hydrogen gas. The bubbles form faster where the metal was compressed, so the number becomes visible. The equation below represents this reaction.

$$2HCl(aq) + Fe(s) \rightarrow FeCl_2(aq) + H_2(g)$$

Refer to Figure 2 and answer the following Question:

Explain why the Fe atoms in the bicycle frame react with the Cu^{2+} ions.

Answer

Acceptable responses include, but are not limited to:

- Fe oxidizes in the presence of Cu^{2+} ions.
- Iron is a more active metal than copper.
- Cu^{2+} ions act as an oxidizing agent.
- Fe is above Cu on *Reference Table J.*

4

Figure 3

Base your answer to the question on the information below and on your knowledge of chemistry.

A student develops the list shown below that includes laboratory equipment and materials for constructing a voltaic cell.

Laboratory Equipment and Materials

- a strip of zinc
- a strip of copper
- a 250-mL beaker containing 150 mL of 0.1 M zinc nitrate
- a 250-mL beaker containing 150 mL of 0.1 M copper(II) nitrate
- wires
- a voltmeter
- a switch
- a salt bridge

Refer to Figure 3 and answer the following Question:
Compare the activities of the two metals used by the student for constructing the voltaic cell.

Answer

Acceptable responses include, but are not limited to:

- Zn is more active than Cu.
- Zinc oxidizes more easily than copper.
- Zn is a better reducing agent.
- Cu is located below Zn on Table *J*.

5

Figure 4

Base your answer to the question on the information below and on your knowledge of chemistry.

Some properties of the element sodium are listed below.

- is a soft, silver-colored metal
- melts at a temperature of 371 K
- oxidizes easily in the presence of air
- forms compounds with nonmetallic elements in nature
- forms sodium chloride in the presence of chlorine gas

Refer to Figure 4 and answer the following Question:
Identify *one* chemical property of sodium from this list.

Answer

Acceptable responses include, but are not limited to:

- The Na oxidizes easily in the presence of air.
- Sodium reacts with chlorine to form NaCl.
- Sodium forms compounds.

6

Figure 5

Base your answer to the question on the information below and on your knowledge of chemistry.

A student made a copper bracelet by hammering a small copper bar into the desired shape. The bracelet has a mass of 30.1 grams and was at a temperature of 21°C in the classroom. After the student wore the bracelet, the bracelet reached a temperature of 33°C. Later, the student removed the bracelet and placed it on a desk at home, where it cooled from 33°C to 19°C. The specific heat capacity of copper is 0.385 J/g•K.

Refer to Figure 5 and answer the following Question:

Explain, in terms of chemical activity, why copper is a better choice than iron to make the bracelet.

Answer

Acceptable responses include, but are not limited to:

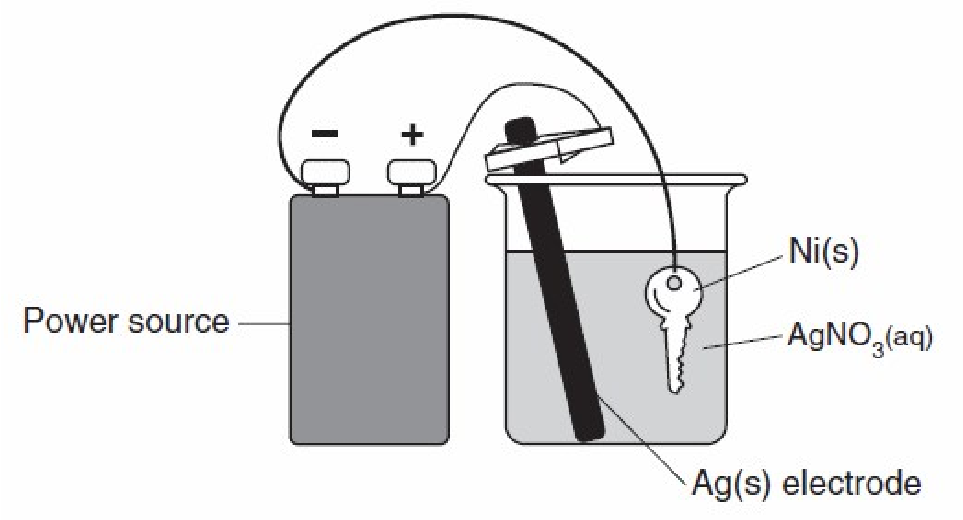
- Copper is less chemically active than iron, so copper is less likely to react with substances in the air or on the skin.
- Iron is more active.
- Fe oxidizes more easily.

7

Figure 6

Base your answer to the question on the information below.

The diagram below represents an operating electrolytic cell used to plate silver onto a nickel key. As the cell operates, oxidation occurs at the silver electrode and the mass of the silver electrode decreases.



Refer to Figure 6 and answer the following Question:

Explain, in terms of Ag atoms and Ag^+(aq) ions, why the mass of the silver electrode *decreases* as the cell operates.

Answer

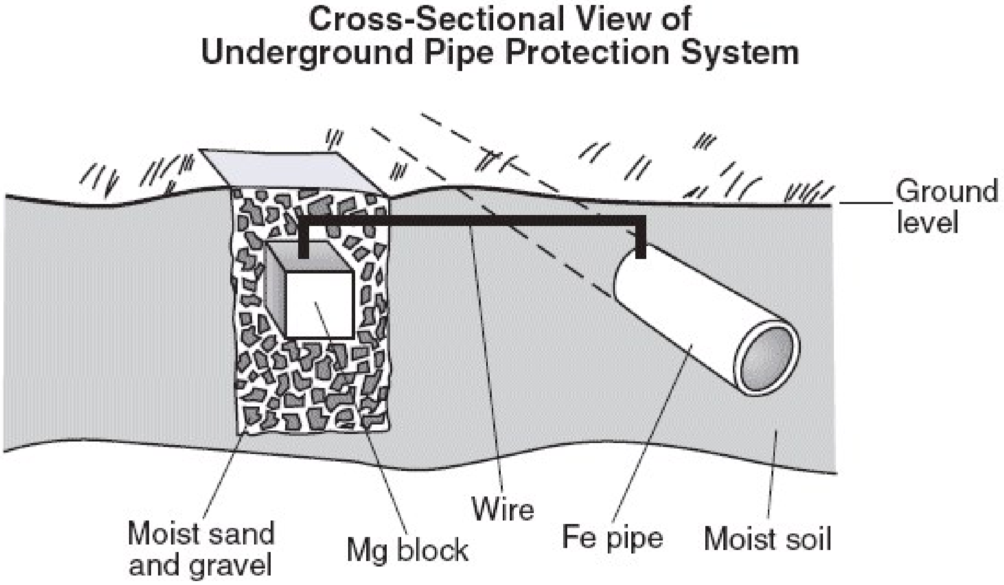
Acceptable responses include, but are not limited to:

- Silver atoms lose electrons and become silver ions in the solution.
- Some of the Ag atoms become Ag^+ ions.
- Silver atoms are oxidized to silver ions.

Figure 7

Base your answer to the question on the information below.

> Underground iron pipes in contact with moist soil are likely to corrode. This corrosion can be prevented by applying the principles of electrochemistry. Connecting an iron pipe to a magnesium block with a wire creates an electrochemical cell. The magnesium block acts as the anode and the iron pipe acts as the cathode. A diagram of this system is shown below.



Refer to Figure 7 and answer the following Question:

Explain, in terms of reactivity, why magnesium is preferred over zinc to protect underground iron pipes. Your response must include *both* magnesium and zinc.

Answer

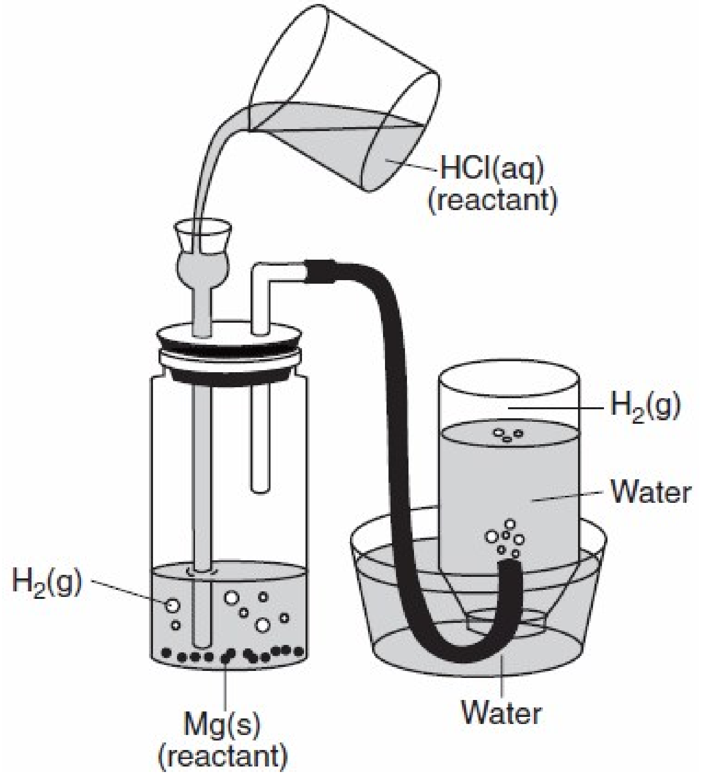
Acceptable responses include, but are not limited to:

- Magnesium atoms lose electrons more easily than zinc atoms.
- Mg oxidizes more readily than Zn.
- Mg is more active than Zn.

Figure 8

Base your answer to the question on the information below.

A student places a 2.50-gram sample of magnesium metal in a bottle and fits the bottle with a 2-hole stopper as shown in the diagram. Hydrochloric acid is added to the bottle, causing a reaction. As the reaction proceeds, hydrogen gas travels through the tubing to an inverted bottle filled with water, displacing some of the water in the bottle.



Refer to Figure 8 and answer the following Question:
Based on Reference Table *J*, explain why Ag(s) will *not* react with HCl(aq) to generate $H_2(g)$.

Answer

Acceptable responses include, but are not limited to:

- Ag is below H_2 in the activity series.
- Ag is more difficult to oxidize.

10

Figure 9

Base your answer to question on the information.

> The outer structure of the Statue of Liberty is made of copper metal. The framework is made of iron. Over time, a thin green layer (patina) forms on the copper surface.

Refer to Figure 9 and answer the following Question:

Where the iron framework came in contact with the copper surface, a reaction occurred in which iron was oxidized. Using information from Reference Table *J*, explain why the iron was oxidized.

Answer

Acceptable responses include, but are not limited to, these examples:

- Iron is a more active metal.
- Fe above Cu
- Iron metal loses electrons more easily than copper metal.
- copper less active

11 Answer => 3

Which equation represents an oxidation-reduction reaction?

1 $H^+ + OH^- \rightarrow H_2O$

2 ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$

3 $Zn + Sn^{4+} \rightarrow Zn^{2+} + Sn^{2+}$

4 $3AgNO_3 + Li_3PO_4 \rightarrow Ag_3PO_4 + 3LiNO_3$

12 Answer => 3

Which balanced equation represents an oxidation-reduction reaction?

1 $Ba(NO_3)_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaNO_3$

2 $H_3PO_4 + 3KOH \rightarrow K_3PO_4 + 3H_2O$

3 $Fe(s) + S(s) \rightarrow FeS(s)$

4 $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

13 Answer => 1

Which balanced equation represents a redox reaction?

1 $PCl_5 \rightarrow PCl_3 + Cl_2$

2 $KOH + HCl \rightarrow KCl + H_2O$

3 $LiBr \rightarrow Li^+ + Br^-$

4 $Ca^{2+} + SO_4^{2-} \rightarrow CaSO_4$

14 Answer => 4

Which balanced equation represents a redox reaction?

1 $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$
2 $H_2CO_3(aq) \rightarrow H_2O(\ell) + CO_2(g)$
3 $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(\ell)$
4 $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

15 Answer => 1

Which equation represents an oxidation-reduction reaction?

1 $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
2 $H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$
3 $MgCrO_4 + BaCl_2 \rightarrow MgCl_2 + BaCrO_4$
4 $Zn(NO_3)_2 + Na_2CO_3 \rightarrow 2NaNO_3 + ZnCO_3$

16 Answer => 3

Given the balanced equation representing the reaction occurring in a voltaic cell:

$Zn(s) + Pb^{2+}(aq) \rightarrow Zn^{2+}(aq) + Pb(s)$

In the completed external circuit, the electrons flow from

1 $Pb(s)$ to $Zn(s)$
2 $Pb^{2+}(aq)$ to $Zn^{2+}(aq)$
3 $Zn(s)$ to $Pb(s)$
4 $Zn^{2+}(aq)$ to $Pb^{2+}(aq)$

17 Answer => 2

Which balanced equation represents a redox reaction?

1 $CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$
2 $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$
3 $AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$
4 $H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(\ell)$

18 Answer => 3

Given the balanced ionic equation representing a reaction:

$2Al^{3+}(aq) + 3Mg(s) \rightarrow 3Mg^{2+}(aq) + 2Al(s)$

In this reaction, electrons are transferred from

1 Al to Mg^{2+}
2 Al^{3+} to Mg
3 Mg to Al^{3+}
4 Mg^{2+} to Al

19 Answer => 2

Which balanced equation represents an oxidation-reduction reaction?

1 $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$
2 $C + H_2O \rightarrow CO + H_2$
3 $CaCO_3 \rightarrow CaO + CO_2$
4 $Mg(OH)_2 + 2HNO_3 \rightarrow Mg(NO_3)_2 + 2H_2O$

20 Answer => 1

In which reaction are electrons transferred from one reactant to another reactant?

1 $2Ca(s) + O_2(g) \rightarrow 2CaO(s)$
2 $AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$
3 $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(\ell)$
4 $H_3O^+(aq) + OH^-(aq) \rightarrow 2H_2O(\ell)$

21 Answer => 3

Refer to Figure 9 and answer the following Question:

When copper oxidized to form this patina layer, the copper atoms became copper(II) ions (Cu^{2+}). Which of the following is a balanced half-reaction for this oxidation of copper?

1 $Cu^{2+} \rightarrow Cu + 2e^-$
2 $Cu + 2e^- \rightarrow Cu^{2+}$
3 $Cu \rightarrow Cu^{2+} + 2e^-$
4 $Cu + 2e^- \rightarrow Cu^{2-}$

22 Answer => 2

Given the balanced equation representing a redox reaction:

$2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$

Which statement is true about this reaction?

1 Each Al loses $2e^-$ and each Cu^{2+} gains $3e^-$.
2 Each Al loses $3e^-$ and each Cu^{2+} gains $2e^-$.
3 Each Al^{3+} gains $2e^-$ and each Cu loses $3e^-$.
4 Each Al^{3+} gains $3e^-$ and each Cu loses $2e^-$.

23 Answer => 2

Which reaction is an example of an oxidation-reduction reaction?

1 $AgNO_3 + KI \rightarrow AgI + KNO_3$
2 $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$
3 $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$
4 $Ba(OH)_2 + 2HCl \rightarrow BaCl_2 + 2H_2O$

24 Answer => 2

In a redox reaction, how does the total number of electrons lost by the oxidized substance compare to the total number of electrons gained by the reduced substance?

1 The number lost is always greater than the number gained.
2 The number lost is always equal to the number gained.
3 The number lost is sometimes equal to the number gained.
4 The number lost is sometimes less than the number gained.

25 Answer => 2

Given the balanced equation: $3Fe^{3+}(aq) + Al(s) \rightarrow 3Fe^{2+}(aq) + Al^{3+}(aq)$
What is the total number of moles of electrons lost by 2 moles of Al(*s*)?

1 1 mole
2 6 moles
3 3 moles
4 9 moles

26 Answer => 2

The oxidation number of a reducing agent can change from

1 -1 to -3
2 -2 to -1
3 3 to -1
4 4 to -3

27 Answer => 1

Given the reaction:

$$Mg(s) + 2H^{+}(aq) + 2Cl^{-}(aq) \rightarrow Mg^{2+}(aq) + 2Cl^{-}(aq) + H_2(g)$$

Which species undergoes oxidation?

1 Mg(*s*)
2 $H^{+}(aq)$
3 $Cl^{-}(aq)$
4 $H_2(g)$

28 Answer => 3

In the reaction $Cu + 2Ag^{+} \rightarrow Cu^{2+} + 2Ag$, the oxidizing agent is

1 Cu
2 Cu^{2+}
3 Ag^{+}
4 Ag

29 Answer => 1

Given the lead-acid battery reaction:

$$Pb + PbO_2 + 2H_2SO_4 \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftarrows}} 2PbSO_4 + 2H_2O$$

Which species is oxidized during battery discharge?

1 Pb
2 PbO_2
3 SO_4^{2-}
4 H_2O

30 Answer => 2

Given the *unbalanced* equation:

$\_\_NO_3^- + 4H^+ + \_\_Pb \rightarrow \_\_Pb^{2+} + \_\_NO_2 + 2H_2O$

What is the coefficient of NO_2 when the equation is correctly balanced?

1 1
2 2
3 3
4 4

Electrochemistry
Video #17

Name:___________________________ Class/Period:_______________________

Assignment: Video 17. Electrochemical Cells: Voltaic vs. Electrolytic. Teacher: Dr. Salhoobi

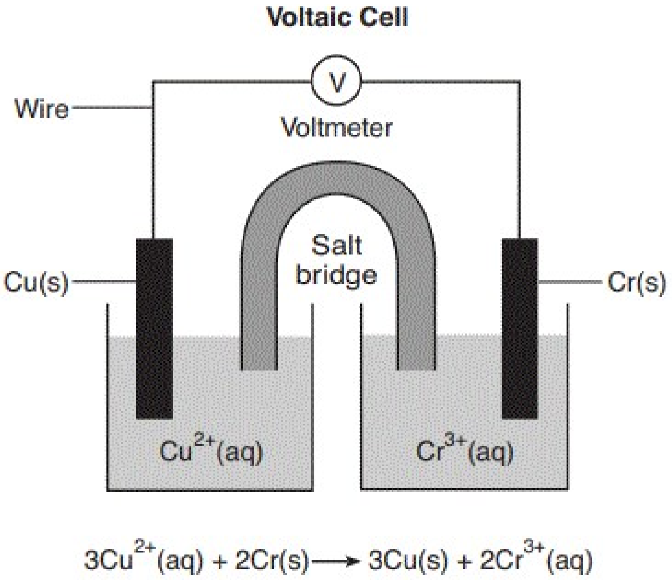
Instructions: Follow your teacher's directions to watch video # 17/17 then answer the following questions.

1 Answer => 1

Which form of energy is converted to electrical energy in a voltaic cell?

1 chemical
2 mechanical
3 nuclear
4 thermal

2 The diagram and ionic equation below represent an operating voltaic cell.



$$3Cu^{2+}(aq) + 2Cr(s) \rightarrow 3Cu(s) + 2Cr^{3+}(aq)$$

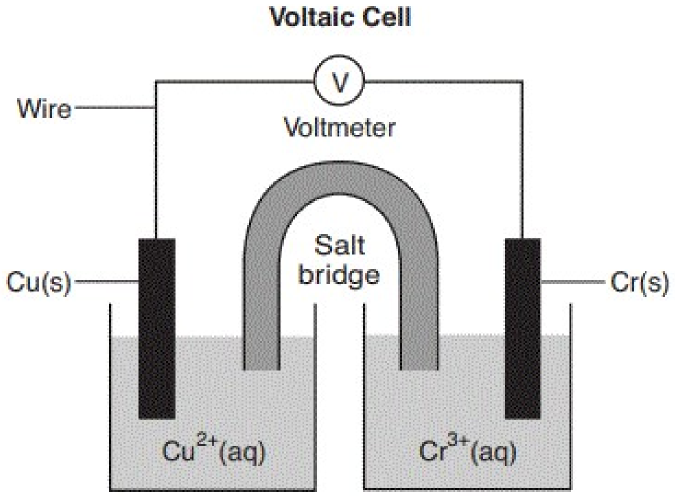
Write a balanced equation for the half-reaction that occurs in the copper half-cell when the cell operates.

Answer

Copper is being reduced as it is gaining electrons. Therefore, acceptable responses include, but are not limited to:

- $Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$
- $Cu^{2+} + 2e^{-} \rightarrow Cu$
- $3Cu^{2+} + 6e^{-} \rightarrow 3Cu$

3 The diagram and ionic equation below represent an operating voltaic cell.



$$3Cu^{2+}(aq) + 2Cr(s) \longrightarrow 3Cu(s) + 2Cr^{3+}(aq)$$

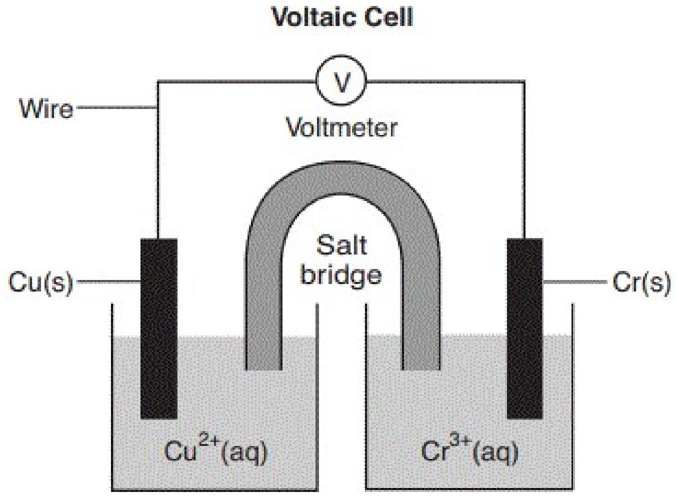
State the purpose of the salt bridge in completing the circuit in this cell.

Answer

Acceptable responses include, but are not limited to:

- The salt bridge allows the migration of ions between the half-cells.
- The salt bridge prevents polarization of the half-cells.
- Electrical neutrality of the solutions is maintained.

4 The diagram and ionic equation below represent an operating voltaic cell.



Voltaic Cell

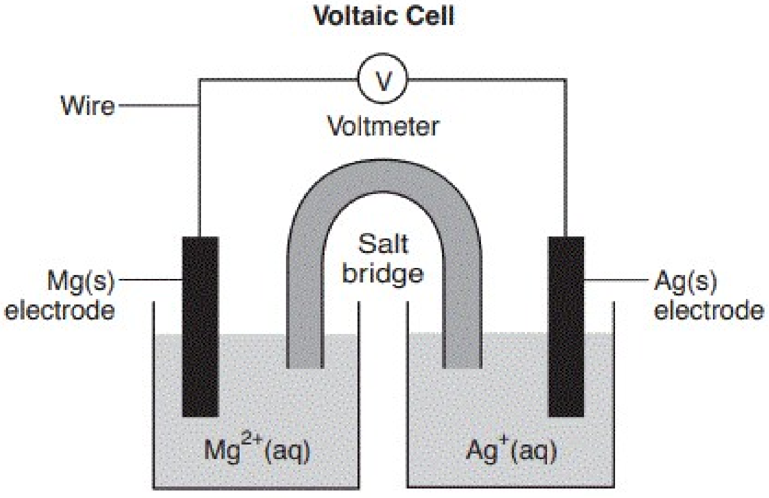
$$3Cu^{2+}(aq) + 2Cr(s) \longrightarrow 3Cu(s) + 2Cr^{3+}(aq)$$

Identify the subatomic particles that flow through the wires as the cell operates.

Answer

A oxidation-reduction reaction is occurring in an operating voltaic cell. This means that ***electrons*** are flowing through the wires as the cell operates as one substance loses electrons at the anode and another substance is gaining the electrons at the cathode.

5 An operating voltaic cell has magnesium and silver electrodes. The cell and the ionic equation representing the reaction that occurs in the cell are shown below.



$$Mg(s) + 2Ag^{+}(aq) \longrightarrow Mg^{2+}(aq) + 2Ag(s)$$

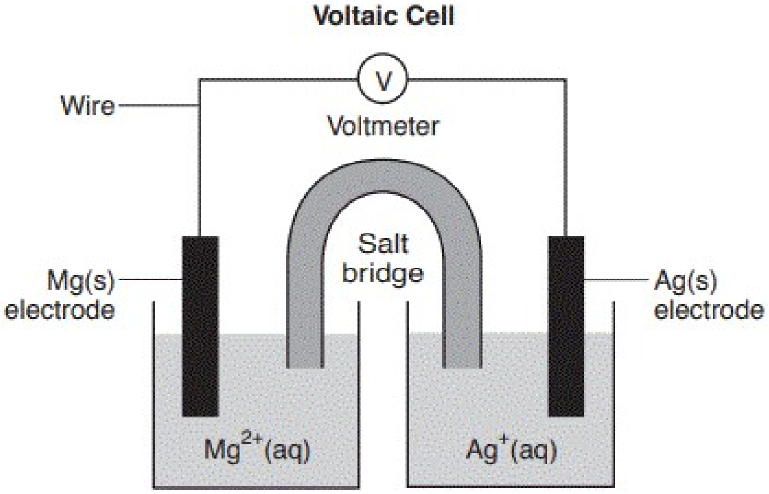
Explain, in terms of electrical energy, how electrolysis reactions differ from voltaic cell reactions.

Answer

Possible answers include:

- Electrical energy is required for electrolytic reactions, while voltaic cell reactions produce electricity.
- Voltaic cells produce electrical energy, and electrolytic cells use electrical energy.
- Electrolysis reactions require an external source of electricity.

6 An operating voltaic cell has magnesium and silver electrodes. The cell and the ionic equation representing the reaction that occurs in the cell are shown below.



$$Mg(s) + 2Ag^{+}(aq) \longrightarrow Mg^{2+}(aq) + 2Ag(s)$$

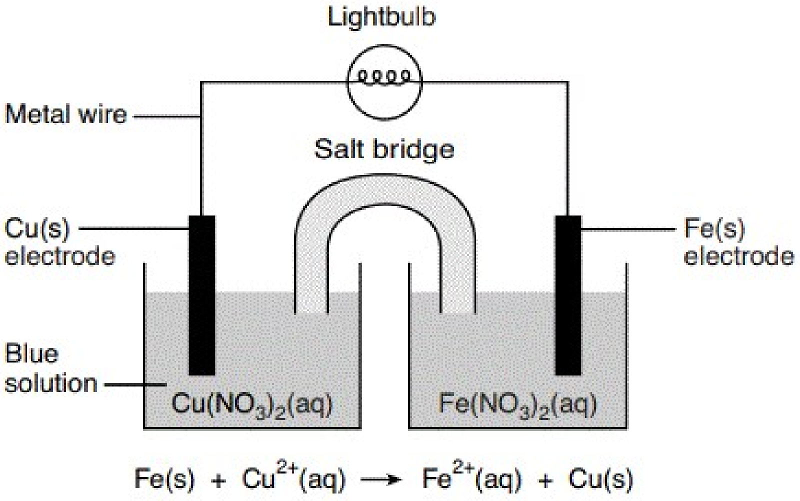
Write a balanced equation for the half-reaction that occurs at the magnesium electrode in this cell.

Answer

Oxidation occurs at the magnesium electrode as there is a loss of electrons when Mg atoms form Mg^{2+} ions. The balanced equation for the oxidation of magnesium is

$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^{-}$

7 A student constructs an electrochemical cell. A diagram of the operating cell and the unbalanced ionic equation representing the reaction occurring in the cell are shown below. The blue color of the solution in the copper half-cell indicates the presence of Cu^{2+} ions. The student observes that the blue color becomes less intense as the cell operates.



Identify the type of electrochemical cell represented by the diagram.

Answer

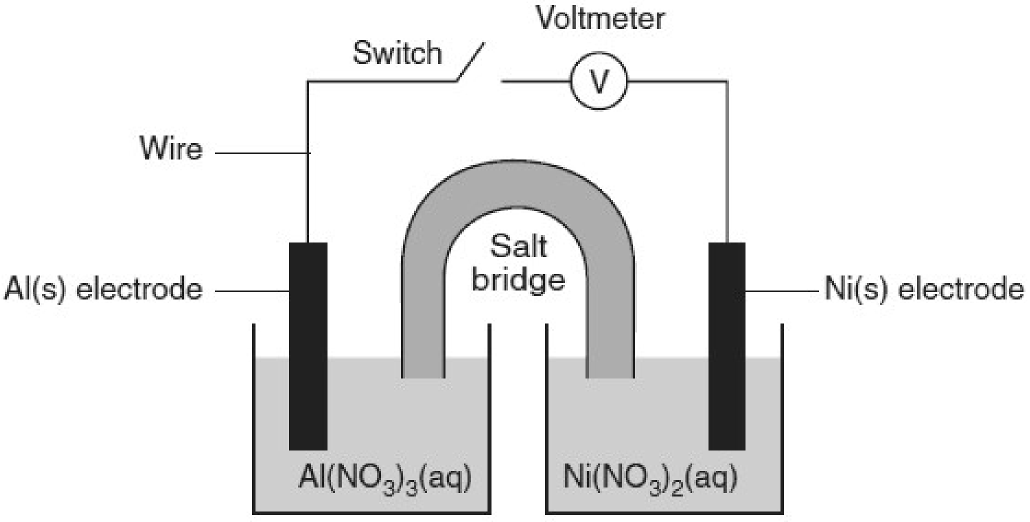
Possible answers include:

- voltaic cell
- voltaic
- Galvanic

Figure 1

Base your answer to the question on the information below.

A student constructs an electrochemical cell during a laboratory investigation. When the switch is closed, electrons flow through the external circuit. The diagram and equation below represent this cell and the reaction that occurs.



$$2Al(s) + 3Ni^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Ni(s)$$

Refer to Figure 1 and answer the following Question:
State, in terms of energy, why this cell is a voltaic cell.

Answer

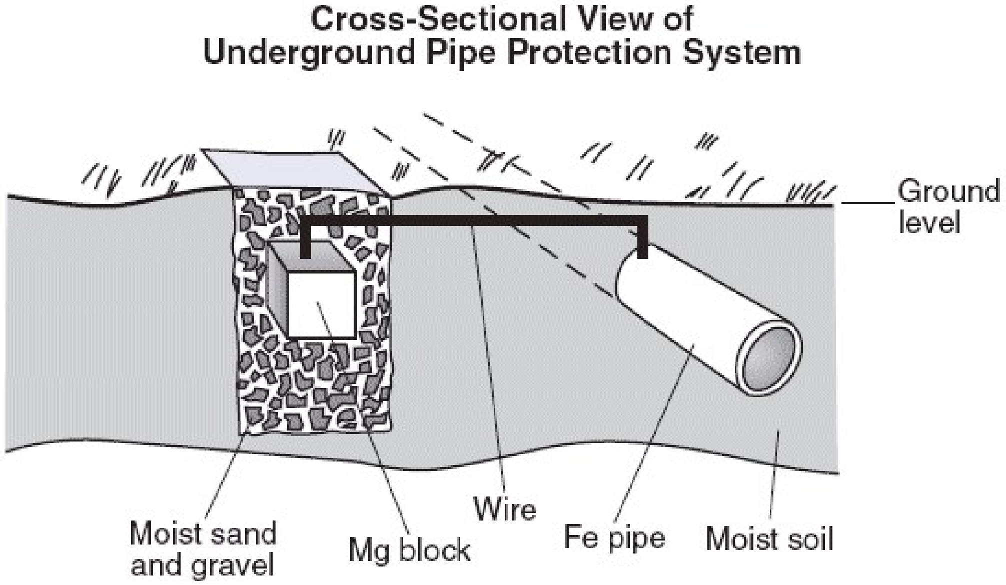
Acceptable responses include, but are not limited to:

- A spontaneous reaction converts chemical energy to electrical energy.
- A battery is not required to provide energy for the cell to operate.

Figure 2

Base your answer to the question on the information below.

Underground iron pipes in contact with moist soil are likely to corrode. This corrosion can be prevented by applying the principles of electrochemistry. Connecting an iron pipe to a magnesium block with a wire creates an electrochemical cell. The magnesium block acts as the anode and the iron pipe acts as the cathode. A diagram of this system is shown below.



Refer to Figure 2 and answer the following Question:

State the direction of the flow of electrons between the electrodes in this cell.

Answer

Acceptable responses include, but are not limited to:

- Electrons flow from the magnesium block to the iron pipe.
- Electrons flow from the Mg to the Fe through the wire.
- Electrons flow from the anode to the cathode in a voltaic cell.
- from the block to the pipe

10

Figure 3

Base your answer to the question on the information below.

> Aluminum is one of the most abundant metals in Earth's crust. The aluminum compound found in bauxite ore is Al_2O_3. Over one hundred years ago, it was difficult and expensive to isolate aluminum from bauxite ore. In 1886, a brother and sister team, Charles and Julia Hall, found that molten (melted) cryolite, Na_3AlF_6, would dissolve bauxite ore. Electrolysis of the resulting mixture caused the aluminum ions in the Al_2O_3 to be reduced to molten aluminum metal. This less expensive process is known as the Hall process.

Refer to Figure 3 and answer the following Question:
Explain, in terms of electrical energy, how the operation of a voltaic cell differs from the operation of an electrolytic cell used in the Hall process. Include *both* the voltaic cell and the electrolytic cell in your answer.

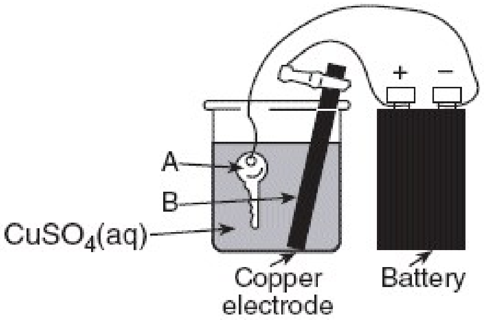
Answer

Examples:

- A voltaic cell produces electrical energy and an electrolytic cell used in the Hall process requires electrical energy.
- Electrolysis uses electrical energy. Voltaic cells produce electrical energy.

11 Answer => 2

The diagram below shows a key being plated with copper in an electrolytic cell.



Given the reduction reaction for this cell: $Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$
This reduction occurs at

1 *A*, which is the anode
2 *A*, which is the cathode
3 *B*, which is the anode
4 *B*, which is the cathode

12 Answer => 1

When comparing voltaic cells to electrolytic cells, oxidation occurs at the

1 anode in both types of cells
2 cathode in both types of cells
3 anode in voltaic cells, only
4 cathode in voltaic cells, only

13 Answer => 1

Which statement describes the reactions in an electrochemical cell?

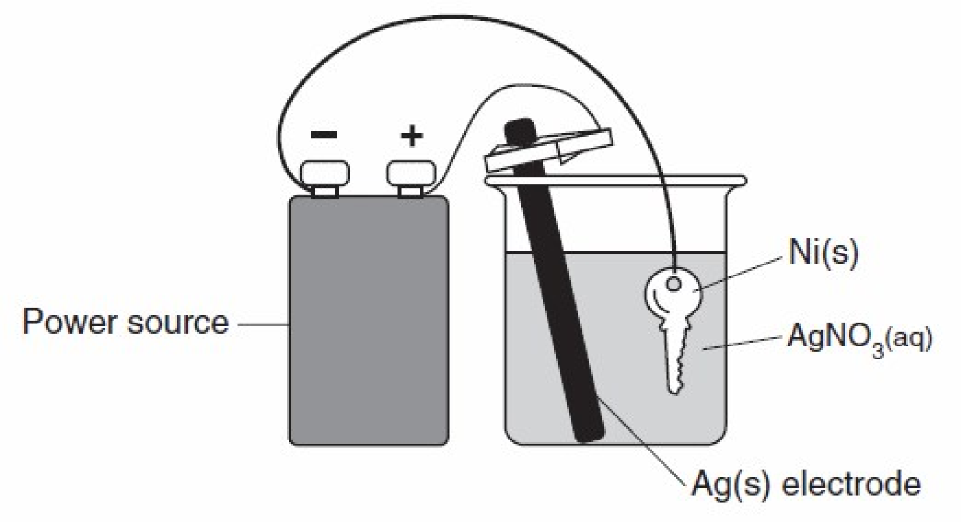
1 Oxidation occurs at the anode, and reduction occurs at the cathode.
2 Oxidation occurs at the cathode, and reduction occurs at the anode.
3 Oxidation and reduction both occur at the cathode.
4 Oxidation and reduction both occur at the anode.

14

Figure 4

Base your answer to the question on the information below.

The diagram below represents an operating electrolytic cell used to plate silver onto a nickel key. As the cell operates, oxidation occurs at the silver electrode and the mass of the silver electrode decreases.



Refer to Figure 4 and answer the following Question:
Identify the cathode in the cell.

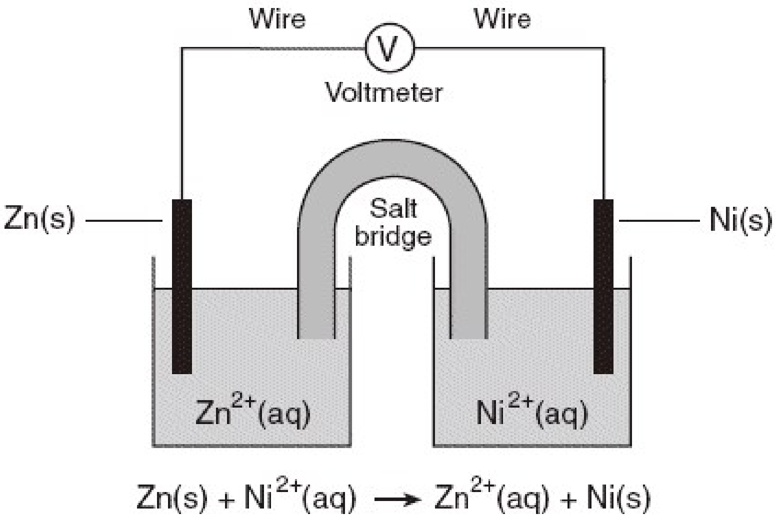
Answer

Acceptable responses include, but are not limited to:

- Ni(s) key
- key
- nickel

15 Answer => 4

The diagram below represents an operating electrochemical cell and the balanced ionic equation for the reaction occurring in the cell.



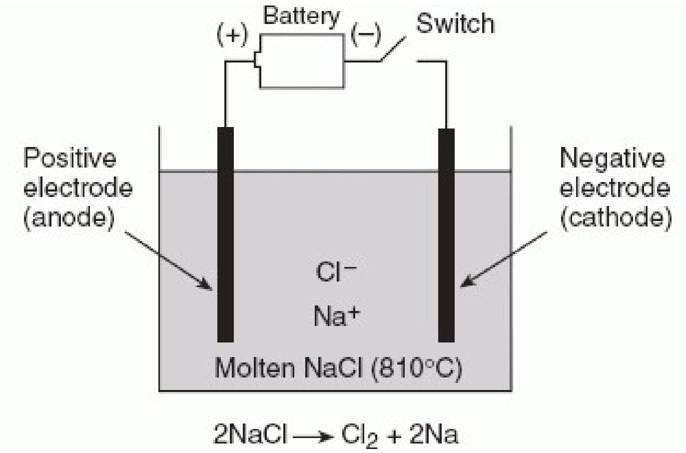
Which statement identifies the part of the cell that conducts electrons and describes the direction of electron flow as the cell operates?

1 Electrons flow through the salt bridge from the Ni(s) to the Zn(s).
2 Electrons flow through the salt bridge from the Zn(s) to the Ni(s).
3 Electrons flow through the wire from the Ni(s) to the Zn(s).
4 Electrons flow through the wire from the Zn(s) to the Ni(s).

16 Answer => 2

Figure 5

Base your answer to the question on the diagram and balanced equation, which represent the electrolysis of molten NaCl.

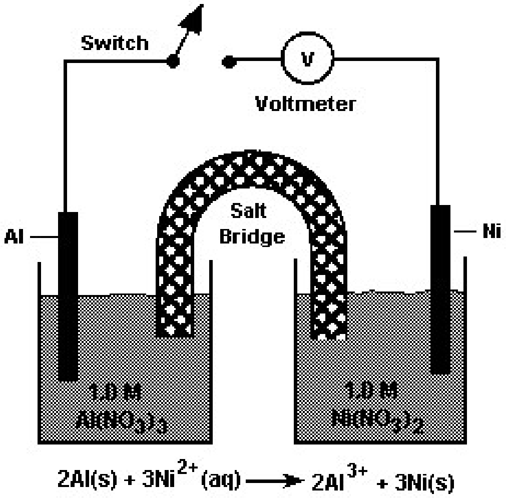


Refer to Figure 5 and answer the following Question:
When the switch is closed, which electrode will attract the sodium ions?

1 the anode
2 the cathode
3 both the anode and the cathode

17 Answer => 1

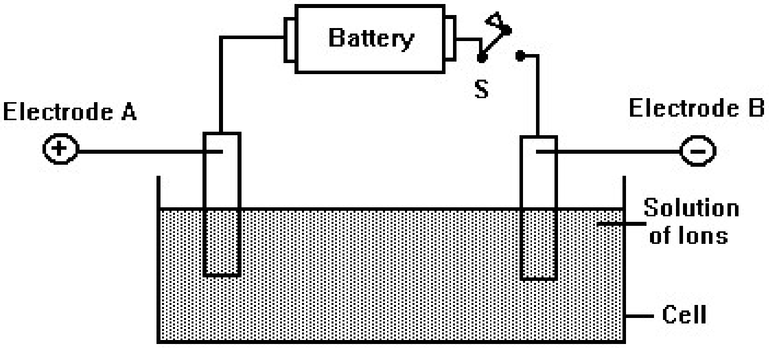
The diagram represents a chemical cell at 298 K.



When the switch is closed, electrons flow from

1 Al(*s*) to Ni(*s*)
2 Ni(*s*) to Al(*s*)
3 $Al^{3+}(aq)$ to $Ni^{2+}(aq)$
4 $Ni^{2+}(aq)$ to $Al^{3+}(aq)$

18 Answer => 3



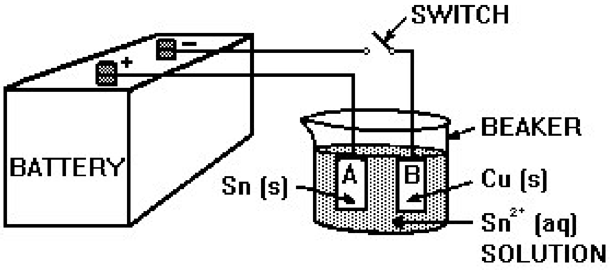
When switch *S* is closed, positive ions will undergo

1 oxidation at electrode *B*
2 oxidation at electrode *A*
3 reduction at electrode *B*
4 reduction at electrode *A*

19 Answer => 1

Figure 6

The diagram shows an electrolytic cell in which the electrodes are tin and copper.

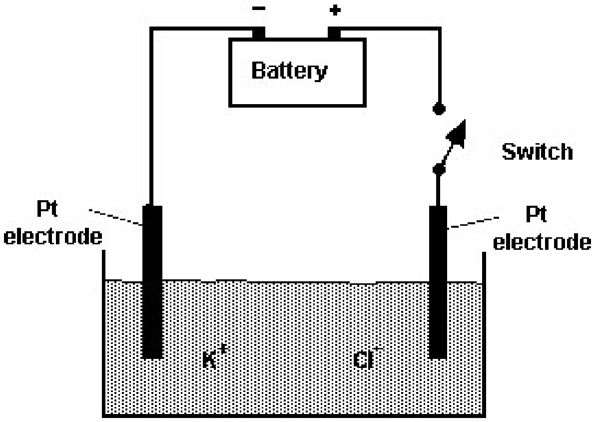


Refer to Figure 6 and answer the following Question:
In this electrolytic cell, electrode *A* is designated as the

1 anode and is positive
2 anode and is negative
3 cathode and is positive
4 cathode and is negative

20 Answer => 4

The diagram slows the electrolysis of fused KCl.

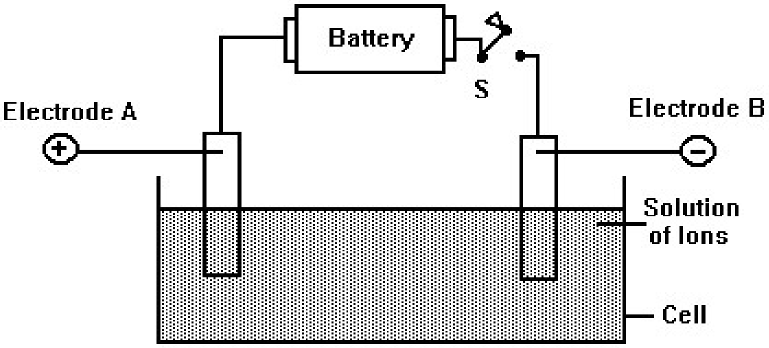


What occurs when the switch is closed?

1 Positive ions migrate toward the anode, where they lose electrons.
2 Positive ions migrate toward the anode, where they gain electrons.
3 Positive ions migrate toward the cathode, where they lose electrons.
4 Positive ions migrate toward the cathode, where they gain electrons.

21 Answer => 1

Which type of cell does the diagram represent?

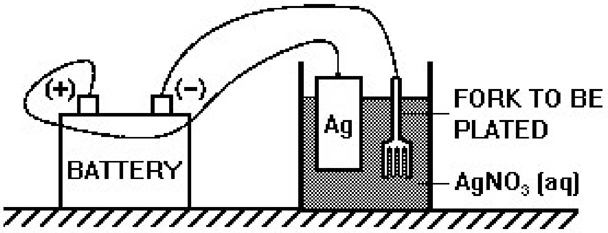


1 electrolytic, with the anode at *A*
2 electrolytic, with the cathode at *A*
3 voltaic , with the anode at *A*
4 voltaic , with the cathode at *A*

22 Answer => 2

Figure 7

The diagram represents the electroplating of a metal fork with Ag(*s*).



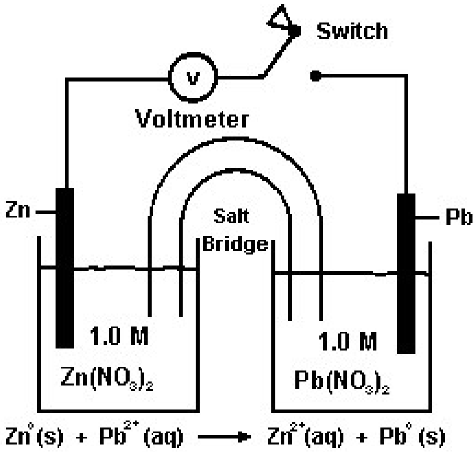
Refer to Figure 7 and answer the following Question:
Which part of the electroplating is represented by the fork?

1 the anode, which is the negative electrode
2 the cathode, which is the negative electrode
3 the anode, which is the positive electrode
4 the cathode, which is the positive electrode

23 Answer => 3

Figure 8

The diagram shows a voltaic cell. The reaction occurs at 1 atmosphere and 298 K.



Refer to Figure 8 and answer the following Question:
When the switch is closed, what occurs?

1 Pb is oxidized and electrons flow to the Zn electrode.
2 Pb is reduced and electrons flow to the Zn electrode.
3 Zn is oxidized and electrons flow to the Pb electrode.
4 Zn is reduced and electrons flow to the Pb electrode.

24 Answer => 3

In an electrolytic cell, to which electrode will a positive ion migrate and undergo reduction?

1 the anode, which is negatively charged
2 the anode, which is positively charged
3 the cathode, which is negatively charged
4 the cathode, which is positively charged

25 Answer => 1

In an electrolytic cell, oxidation takes place at the

1 anode, which is positive
2 anode, which is negative
3 cathode, which is positive
4 cathode, which is negative

26 Refer to Figure 5 and answer the following Question:
What is the purpose of the battery in this electrolytic cell?

Answer

Acceptable responses include, but are not limited to:

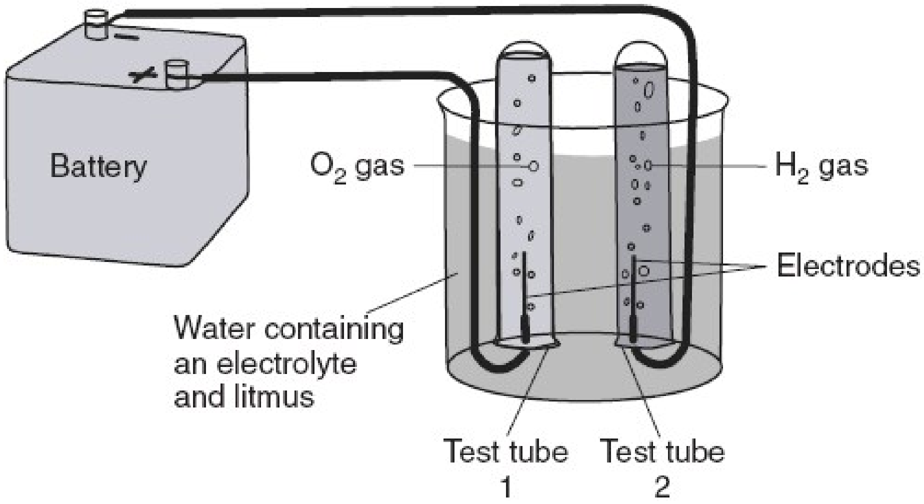
- Electrolytic cells require energy.
- The battery forces the nonspontaneous reaction to occur.

27

Figure 9

Base your answer to this question on the information below.

The diagram below shows a system in which water is being decomposed into oxygen gas and hydrogen gas. Litmus is used as an indicator in the water. The litmus turns red in test tube 1 and blue in test tube 2.



The oxidation and reduction occurring in the test tubes are represented by the balanced equations below.

Test tube 1: $2H_2O(\ell) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

Test tube 2: $4H_2O(\ell) + 4e^- \rightarrow 2H_2(g) + 4OH^-(aq)$

Refer to Figure 9 and answer the following Question:

Identify the information in the diagram that indicates this system is an electrolytic cell.

Answer

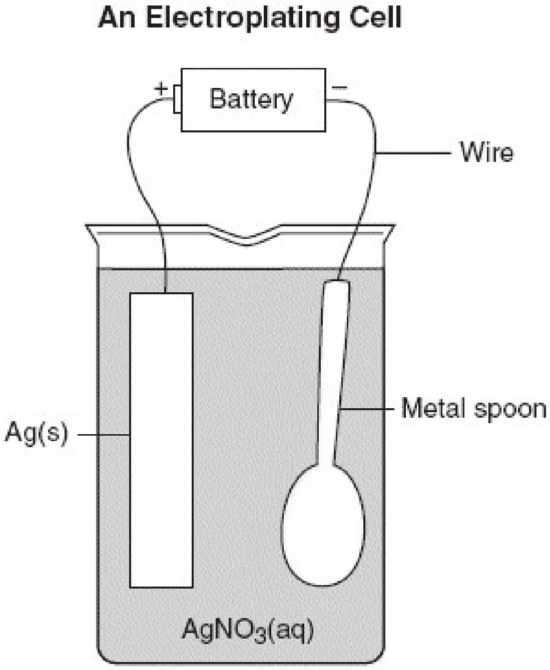
Acceptable responses include, but are not limited to:

- A battery is part of the cell and is providing energy that causes the reaction.
- Electricity is used to operate the cell.

Figure 10

Base your answer to this question on the information below.

> Electroplating is an electrolytic process used to coat metal objects with a more expensive and less reactive metal. The diagram below shows an electroplating cell that includes a battery connected to a silver bar and a metal spoon. The bar and spoon are submerged in $AgNO_3(aq)$.



Refer to Figure 10 and answer the following Question:
Explain why $AgNO_3$ is a better choice than AgCl for use in this electrolytic process.

Answer

Acceptable responses include, but are not limited to:

- Silver nitrate produces more ions than silver chloride in water.
- $AgNO_3$ readily dissolves in H_2O; AgCl dissolves only slightly in H_2O.

29

Figure 11

Base your answer to the question on the information below and on your knowledge of chemistry.

A student develops the list shown below that includes laboratory equipment and materials for constructing a voltaic cell.

Laboratory Equipment and Materials

- a strip of zinc
- a strip of copper
- a 250-mL beaker containing 150 mL of 0.1 M zinc nitrate
- a 250-mL beaker containing 150 mL of 0.1 M copper(II) nitrate
- wires
- a voltmeter
- a switch
- a salt bridge

Refer to Figure 11 and answer the following Question:
Identify *one* item of laboratory equipment required to build an electrolytic cell that is *not* included in the list.

Answer

Acceptable responses include, but are not limited to:

- battery
- external power source
- source of electricity

30

Figure 12

Base your answer to the question on the information below and on your knowledge of chemistry.

Fossil fuels produce air pollution and may eventually be depleted. Scientists are researching ways to use hydrogen as an alternate fuel. A device called an artificial leaf was invented to produce hydrogen and oxygen using sunlight and water. The artificial leaf is an electrochemical cell. Equations 1 and 2 below represent the reactions taking place in the leaf. Equation 3 represents a reaction of hydrogen when used as fuel.

Equation 1: $2H_2O + \text{energy from sunlight} \rightarrow O_2 + 4H^+ + 4e^-$

Equation 2: $4H^+ + 4e^- \rightarrow 2H_2$

Equation 3: $2H_2(g) + O_2(g) \rightarrow 2H_2O(g) + \text{energy}$

Refer to Figure 12 and answer the following Question:
Explain, in terms of energy, why the artificial leaf is an electrolytic cell.

Answer

Acceptable responses include, but are not limited to:

- Sunlight is used as an external power source for the cell.
- Sunlight is required to cause a nonspontaneous chemical change.
- Energy is required.

Regents Exam
2020

The State Education Department / The University of the State of New York

Regents Examination in Physical Setting/Chemistry – January 2020

Scoring Key: Parts A and B-1 (Multiple-Choice Questions)

Examination	Date	Question Number	Scoring Key	Question Type	Credit	Weight
Physical Setting/Chemistry	January '20	**1**	**4**	MC	1	1
Physical Setting/Chemistry	January '20	**2**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**3**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**4**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**5**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**6**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**7**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**8**	**4**	MC	1	1
Physical Setting/Chemistry	January '20	**9**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**10**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**11**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**12**	**4**	MC	1	1
Physical Setting/Chemistry	January '20	**13**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**14**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**15**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**16**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**17**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**18**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**19**	**4**	MC	1	1
Physical Setting/Chemistry	January '20	**20**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**21**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**22**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**23**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**24**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**25**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**26**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**27**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**28**	**4**	MC	1	1
Physical Setting/Chemistry	January '20	**29**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**30**	**4**	MC	1	1
Physical Setting/Chemistry	January '20	**31**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**32**	**4**	MC	1	1
Physical Setting/Chemistry	January '20	**33**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**34**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**35**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**36**	**4**	MC	1	1
Physical Setting/Chemistry	January '20	**37**	**4**	MC	1	1
Physical Setting/Chemistry	January '20	**38**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**39**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**40**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**41**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**42**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**43**	**3**	MC	1	1
Physical Setting/Chemistry	January '20	**44**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**45**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**46**	**2**	MC	1	1
Physical Setting/Chemistry	January '20	**47**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**48**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**49**	**1**	MC	1	1
Physical Setting/Chemistry	January '20	**50**	**3**	MC	1	1

Scoring Key: Parts B-2 and C (Constructed-Response Questions)

Examination	Date	Question Number	Scoring Key	Question Type	Credit	Weight
Physical Setting/Chemistry	January '20	**51**	-	CR	1	1
Physical Setting/Chemistry	January '20	**52**	-	CR	1	1
Physical Setting/Chemistry	January '20	**53**	-	CR	1	1
Physical Setting/Chemistry	January '20	**54**	-	CR	1	1
Physical Setting/Chemistry	January '20	**55**	-	CR	1	1
Physical Setting/Chemistry	January '20	**56**	-	CR	1	1
Physical Setting/Chemistry	January '20	**57**	-	CR	1	1
Physical Setting/Chemistry	January '20	**58**	-	CR	1	1
Physical Setting/Chemistry	January '20	**59**	-	CR	1	1
Physical Setting/Chemistry	January '20	**60**	-	CR	1	1
Physical Setting/Chemistry	January '20	**61**	-	CR	1	1
Physical Setting/Chemistry	January '20	**62**	-	CR	1	1
Physical Setting/Chemistry	January '20	**63**	-	CR	1	1
Physical Setting/Chemistry	January '20	**64**	-	CR	1	1
Physical Setting/Chemistry	January '20	**65**	-	CR	1	1
Physical Setting/Chemistry	January '20	**66**	-	CR	1	1
Physical Setting/Chemistry	January '20	**67**	-	CR	1	1
Physical Setting/Chemistry	January '20	**68**	-	CR	1	1
Physical Setting/Chemistry	January '20	**69**	-	CR	1	1
Physical Setting/Chemistry	January '20	**70**	-	CR	1	1
Physical Setting/Chemistry	January '20	**71**	-	CR	1	1
Physical Setting/Chemistry	January '20	**72**	-	CR	1	1
Physical Setting/Chemistry	January '20	**73**	-	CR	1	1
Physical Setting/Chemistry	January '20	**74**	-	CR	1	1
Physical Setting/Chemistry	January '20	**75**	-	CR	1	1
Physical Setting/Chemistry	January '20	**76**	-	CR	1	1
Physical Setting/Chemistry	January '20	**77**	-	CR	1	1
Physical Setting/Chemistry	January '20	**78**	-	CR	1	1
Physical Setting/Chemistry	January '20	**79**	-	CR	1	1
Physical Setting/Chemistry	January '20	**80**	-	CR	1	1
Physical Setting/Chemistry	January '20	**81**	-	CR	1	1
Physical Setting/Chemistry	January '20	**82**	-	CR	1	1
Physical Setting/Chemistry	January '20	**83**	-	CR	1	1
Physical Setting/Chemistry	January '20	**84**	-	CR	1	1
Physical Setting/Chemistry	January '20	**85**	-	CR	1	1

Key
MC = Multiple-choice question CR = Constructed-response question

The chart for determining students' final examination scores for the **January 2020 Regents Examination in Physical Setting/Chemistry** will be posted on the Department’s web site at http://www.p12.nysed.gov/assessment/ on the day of the examination. Conversion charts provided for the previous administrations of the Physical Setting/Chemistry examination must NOT be used to determine students’ final scores for this administration.

FOR TEACHERS ONLY

The University of the State of New York
REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING/CHEMISTRY

Friday, January 24, 2020 — 9:15 a.m. to 12:15 p.m., only

RATING GUIDE

Directions to the Teacher:

Refer to the directions on page 2 before rating student papers.

Updated information regarding the rating of this examination may be posted on the New York State Education Department's web site during the rating period. Check this web site at: http://www.p12.nysed.gov/assessment/ and select the link "Scoring Information" for any recently posted information regarding this examination. This site should be checked before the rating process for this examination begins and several times throughout the Regents Examination period.

Directions to the Teacher

Follow the procedures below for scoring student answer papers for the Regents Examination in Physical Setting/Chemistry. Additional information about scoring is provided in the publication *Information Booklet for Scoring Regents Examinations in the Sciences.*

At least two science teachers must participate in the scoring of the Part B–2 and Part C open-ended questions on a student's paper. Each of these teachers should be responsible for scoring a selected number of the open-ended questions on each answer paper. No one teacher is to score more than approximately one-half of the open-ended questions on a student's answer paper. Teachers may not score their own students' answer papers.

Students' responses must be scored strictly according to the Rating Guide. For open-ended questions, credit may be allowed for responses other than those given in the rating guide if the response is a scientifically accurate answer to the question and demonstrates adequate knowledge, as indicated by the examples in the rating guide. Do not attempt to correct the student's work by making insertions or changes of any kind. On the student's separate answer sheet, for each question, record the number of credits earned and the teacher's assigned rater/scorer letter.

Fractional credit is *not* allowed. Only whole-number credit may be given for a response. If the student gives more than one answer to a question, only the first answer should be rated. Units need not be given when the wording of the questions allows such omissions.

For hand scoring, raters should enter the scores earned in the appropriate boxes printed on the separate answer sheet. Next, the rater should add these scores and enter the total in the box labeled "Total Raw Score." Then the student's raw score should be converted to a scale score by using the conversion chart that will be posted on the Department's web site at: http://www.p12.nysed.gov/assessment/ on Friday, January 24, 2020. The student's scale score should be entered in the box labeled "Scale Score" on the student's answer sheet. The scale score is the student's final examination score.

Schools are not permitted to rescore any of the open-ended questions on this exam after each question has been rated once, regardless of the final exam score. Schools are required to ensure that the raw scores have been added correctly and that the resulting scale score has been determined accurately.

Because scale scores corresponding to raw scores in the conversion chart may change from one administration to another, it is crucial that, for each administration, the conversion chart provided for that administration be used to determine the student's final score.

Part B–2

Allow a total of 15 credits for this part. The student must answer all questions in this part.

51 [1] Allow 1 credit for 16 protons and 17 neutrons.

52 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

(31.972 u)(0.9499) + (32.971 u)(0.0075) + (33.968 u)(0.0425) + (35.967 u)(0.0001)

$$\frac{31.972(94.99) + 32.971(0.75) + 33.968(4.25) + (35.967)(0.01)}{100}$$

4.25%(33.968) + .75%(32.971) + 94.99%(31.972) + .01%(35.967)

Note: Do *not* allow credit for a numerical setup using mass numbers rather than isotopic masses.

53 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The energy of an electron in the third shell is higher than the energy of an electron in the first shell.

The third shell electron has higher energy.

The electron in the first shell has less.

Note: The student response must address energy of electrons, not just shells.

54 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The NaCl is soluble in water, and the rock particles are insoluble.

The mixture can be separated by filtration.

55 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The particles of the rock are much larger than the openings in the filter paper.

The rock particles are too big to pass through the paper.

56 [1] Allow 1 credit for 4 *or* four.

57 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

$$\frac{(240.0\text{ g} - 224.2\text{ g})}{16.4\text{ g}} \times 100$$

$$\frac{(100)(15.8)}{16.4}$$

$$\frac{16.4 - 0.6}{16.4} \times 100$$

$$\frac{15.8}{16.4} = \frac{x}{100}$$

Note: Do *not* allow credit if the fraction is not multiplied by 100.

58 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The gas in cylinder *A* has a smaller mass than the mass of the gas in cylinder *B*.

The nitrogen gas has more mass.

The $H_2(g)$ in cylinder *A* has less mass.

59 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

Temperature: increase
Pressure: decrease

Temperature: above 25°C
Pressure: below 1.00 atm
Temperature: any temperature above 298 K
Pressure: any pressure below 101.3 kPa

60 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

Moving the piston farther into the cylinder would increase the number of collisions per unit area between the nitrogen molecules and the inside walls of the cylinder, creating greater pressure.

There would be more collisions, causing a higher pressure.

61 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

$$\frac{(101.3 \text{ kPa})(500. \text{ mL})}{298 \text{ K}} = \frac{(101.3 \text{ kPa})(V_2)}{273 \text{ K}}$$

$$\frac{(500 \text{ mL})(273 \text{ K})}{298 \text{ K}}$$

$$\frac{(500)(273)}{298}$$

62 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

There is a greater concentration of ions present in the 6.0 M HCl(aq) than in the 0.1 M HCl(aq).

The 6.0 M HCl(aq) has a higher concentration of ions.

Note: Do *not* allow credit for "more ions" because it is not in terms of concentrations of ions.

63 [1] Allow 1 credit for C or carbon.

64 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

$^{30}_{14}\text{Si}$

^{30}Si

silicon-30

Si-30

65 [1] Allow 1 credit for 28.56 d. Significant figures do *not* need to be shown.

Part C

Allow a total of 20 credits for this part. The student must answer all questions in this part.

66 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The Ar in the sample did not react, and the nitrogen did.

Magnesium reacted with the nitrogen gas, and the argon gas did not react.

Nitrogen is more reactive.

67 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The density of nitrogen gas is less than the density of argon gas.

Argon is more dense.

Nitrogen gas has a density of 0.001145 g/cm^3, which is less than the density of argon.

68 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

Their atoms have the same number of valence electrons.

These elements have similar chemical properties because their atoms have valence electron shells with a complete octet.

Their outermost shells have 8 e^-.

They have a full outermost shell of electrons.

69 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

As the atomic number of these elements increases, their boiling points increase.

Boiling point goes up as atomic number gets larger.

70 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

10

ten

tenfold

10 times

71 [1] Allow 1 credit for yellow.

72 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

As the water temperature increases, the solubility of sulfur dioxide decreases.

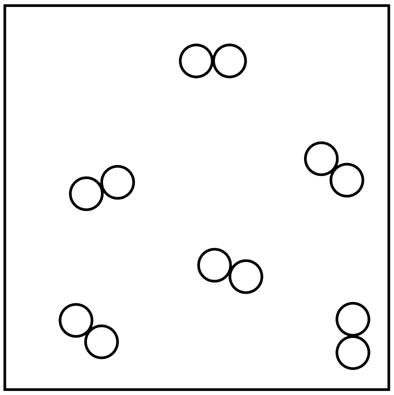
The solubility of SO_2 decreases.

The $SO_2(g)$ becomes less soluble.

73 [1] Allow 1 credit for CH *or* HC.

74 [1] Allow 1 credit for a diagram with *at least six* diatomic molecules drawn to represent the gas phase of the sample.

Example of a 1-credit response:



75 [1] Allow 1 credit for

$\underline{\quad 2 \quad}\ C_2H_2(g) + \underline{\quad 5 \quad}\ O_2(g) \rightarrow \underline{\quad 4 \quad}\ CO_2(g) + \underline{\quad 2 \quad}\ H_2O(g) + \text{heat}$

76 [1] Allow 1 credit for 650 g *or* any value from 650 g to 651 g, inclusive.

77 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

Each molecule has a triple carbon-to-carbon bond, C≡C.

The two C atoms share 6 electrons.

Each molecule has a triple bond.

Alkynes have a C≡C.

78 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The thermal energy is greater for the 1000 g sample of water.

The smaller sample has less thermal energy.

79 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The potential energy increases.

P.E. goes up.

80 [1] Allow 1 credit for any value from 28 kPa to 30. kPa, inclusive.

81 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

Hexane molecules are nonpolar, and water molecules are polar.

Water and hexane have different molecular polarities.

82 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The hexane and the 2,2-dimethylhexane have the same molecular formula but have different structural formulas.

Both molecules have the same number of C atoms and the same number of H atoms but have a different arrangement of atoms.

Both compounds are C_6H_{14}, but have different structures.

83 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

From −2 to 0

From 2− to 0

From negative two to zero

Note: Do *not* allow credit for 2 without a minus sign (−).

84 [1] Allow 1 credit. Acceptable responses include, but are *not* limited to:

The number of electrons lost by oxygen is equal to the number of electrons gained by hydrogen.

The same number of electrons is lost and gained.

equal

same

85 [1] Allow 1 credit for 0.0008 mol *or* 8×10^{-4} mol. Significant figures do *not* need to be shown.

Regents Examination in Physical Setting/Chemistry

January 2020

Chart for Converting Total Test Raw Scores to Final Examination Scores (Scale Scores)

The *Chart for Determining the Final Examination Score for the January 2020 Regents Examination in Physical Setting/Chemistry* will be posted on the Department's web site at: http://www.p12.nysed.gov/assessment/ on Friday, January 24, 2020. Conversion charts provided for previous administrations of the Regents Examination in Physical Setting/Chemistry must NOT be used to determine students' final scores for this administration.

Online Submission of Teacher Evaluations of the Test to the Department

Suggestions and feedback from teachers provide an important contribution to the test development process. The Department provides an online evaluation form for State assessments. It contains spaces for teachers to respond to several specific questions and to make suggestions. Instructions for completing the evaluation form are as follows:

1. Go to http://www.forms2.nysed.gov/emsc/osa/exameval/reexameval.cfm.
2. Select the test title.
3. Complete the required demographic fields.
4. Complete each evaluation question and provide comments in the space provided.
5. Click the SUBMIT button at the bottom of the page to submit the completed form.

Map to Core Curriculum

January 2020 Physical Setting/Chemistry			
Question Numbers			
Key Ideas/Performance Indicators	Part A	Part B	Part C
Standard 1			
Math Key Idea 1		52, 56, 57, 61	
Math Key Idea 2		41, 48	70, 79
Math Key Idea 3		35, 36, 37, 40, 47, 51, 64, 65	73, 75, 76, 83, 85
Science Inquiry Key Idea 1		34, 45, 46, 50, 51, 53, 54, 55, 58, 59, 60, 62, 63, 64	66, 67, 68, 69, 77, 81, 82, 84
Science Inquiry Key Idea 2			
Science Inquiry Key Idea 3		31, 36, 37, 39, 42, 43, 46, 48, 49, 50, 63	66, 67, 73, 77, 80, 82, 83
Engineering Design Key Idea 1			
Standard 2			
Key Idea 1		54	
Key Idea 2			
Key Idea 3			
Standard 6			
Key Idea 1			
Key Idea 2		35	74
Key Idea 3			70
Key Idea 4			
Key Idea 5			72, 80
Standard 7			
Key Idea 1			
Key Idea 2			
Standard 4 Process Skills			
Key Idea 3		32, 33, 38, 39, 42, 45, 46, 47, 49, 51, 52, 59,61	69, 71, 72, 73, 74, 75, 76, 85
Key Idea 4		44, 50, 64, 65	78, 79
Key idea 5		40, 62	
Standard 4			
Key Idea 3	1, 2, 3, 4, 5, 6, 11, 12, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 29	31, 32, 33, 35, 36, 37, 38, 39, 41, 42, 43, 45, 46, 47, 48, 49, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63	66, 67, 68, 69,70, 71, 72, 73, 74, 75, 76, 77, 82, 83, 84, 85
Key Idea 4	13, 27, 30	44, 50, 64, 65	78, 79
Key Idea 5	7, 8, 9, 10, 14, 28	34, 40	80, 81
Reference Tables			
2011 Edition	4, 5, 6, 9, 10, 13, 18, 20, 24, 27, 29	32, 33, 35, 36, 40, 43, 46, 47, 48, 50, 51, 53, 57, 58, 59, 61, 64, 65	66, 67, 68, 69, 71, 72, 76, 77, 80, 82, 83

Regents Exam
2004

FOR TEACHERS ONLY

The University of the State of New York
REGENTS HIGH SCHOOL EXAMINATION

PS–CH

PHYSICAL SETTING/CHEMISTRY

Wednesday, June 23, 2004 — 9:15 a.m. to 12:15 p.m., only

SCORING KEY AND RATING GUIDE

Directions to the Teacher:

Refer to the directions on page 3 before rating student papers.

Updated information regarding the rating of this examination may be posted on the New York State Education Department's web site during the rating period. Visit the site http://www.emsc.nysed.gov/osa/ and select the link "Latest Information" for any recently posted information regarding this examination. This site should be checked before the rating process for this examination begins and at least one more time before the final scores for the examination are recorded.

Part A and Part B–1
Allow 1 credit for each correct response.

Part A						Part B–1			
1	4	12	4	23	1	34	1	43	2
2	3	13	3	24	4	35	3	44	1
3	1	14	1	25	1	36	2	45	4
4	3	15	2	26	1	37	4	46	4
5	2	16	3	27	2	38	1	47	4
6	3	17	4	28	2	39	1	48	2
7	2	18	4	29	1	40	2	49	2
8	2	19	3	30	2	41	2	50	1
9	4	20	3	31	1	42	3		
10	3	21	1	32	1				
11	3	22	3	33	3				

Directions to the Teacher

Follow the procedures below for scoring student answer papers for the Physical Setting/Chemistry examination. Additional information about scoring is provided in the publication *Information Booklet for Administering and Scoring Regents Examinations in the Sciences*.

Use only *red* ink or *red* pencil in rating Regents papers. Do *not* correct the student's work by making insertions or changes of any kind.

On the detachable answer sheet for Part A and Part B–1, indicate by means of a check-mark each incorrect or omitted answer. In the box provided at the end of each part, record the number of questions the student answered correctly for that part.

At least two science teachers must participate in the scoring of each student's responses to the Part B–2 and Part C open-ended questions. Each of these teachers should be responsible for scoring a selected number of the open-ended questions on each answer paper. No one teacher is to score all the open-ended questions on a student's answer paper.

Students' responses must be scored strictly according to the Scoring Key and Rating Guide. For open-ended questions, credit may be allowed for responses other than those given in the rating guide if the response is a scientifically accurate answer to the question and demonstrates adequate knowledge as indicated by the examples in the rating guide. Complete sentences are *not* required. Phrases, diagrams, and symbols may be used. In the student's answer booklet, record the number of credits earned for each answer in the box printed to the right of the answer lines or spaces for that question.

Fractional credit is *not* allowed. Only whole-number credit may be given to a response. Units need not be given when the wording of the questions allows such omissions.

Raters should enter the scores earned for Part A, Part B–1, Part B–2, and Part C on the appropriate lines in the box printed on the answer booklet and then should add these four scores and enter the total in the box labeled "Total Written Test Score." Then, the student's raw score should be converted to a scaled score by using the conversion chart that will be posted on the Department's web site http://www.emsc.nysed.gov/osa/ on Wednesday, June 23, 2004. The student's scaled score should be entered in the labeled box on the student's answer booklet. The scaled score is the student's final examination score.

All student answer papers that receive a scaled score of 60 through 64 **must** be scored a second time. For the second scoring, a different committee of teachers may score the student's paper or the original committee may score the paper, except that no teacher may score the same open-ended questions that he/she scored in the first rating of the paper. The school principal is responsible for assuring that the student's final examination score is based on a fair, accurate, and reliable scoring of the student's answer paper.

Because scaled scores corresponding to raw scores in the conversion chart may change from one examination to another, it is crucial that for each administration, the conversion chart provided in the scoring key for that administration be used to determine the student's final score. The chart in this scoring key is usable only for this administration of the examination.

Part B–2

Allow a total of 14 credits for this part. The student must answer all questions in this part.

51 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

decomposition

analysis

redox

endothermic

electrolysis

52 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

4 H and 2 O on both sides

4 H = 4 H and 2 O = 2 O

same number of each element on both sides

53 [1] Allow 1 credit for **4**.

54 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

$Ag^+ + e^- \rightarrow Ag$

$2\ Ag^+ + 2e^- \rightarrow 2\ Ag$

55 [1] Allow 1 credit for ____ $Cu(s)$ + **__2__** $AgNO_3(aq) \rightarrow$ ____ $Cu(NO_3)_2(aq)$ + **__2__** $Ag(s)$.

Allow credit even if the coefficient "1" is written in front of $Cu(s)$ and $Cu(NO_3)_2(aq)$.

56 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

colorless to pink

no color to red

57 [1] Allow 1 credit for a correct numerical setup. Acceptable responses include, but are not limited to, these examples:

$$\frac{(0.30\text{ M})(42.2\text{ mL})}{60.0\text{ mL}}$$

$(x)(60) = (.3)(42.2)$

58 [1] Allow 1 credit for **2**.

59 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

Each isotope has a different number of neutrons.

different number of neutrons

Ne-22 has two more neutrons than Ne-20 and one more neutron than Ne-21.

60 [1] Allow 1 credit for a correct numerical setup. Acceptable responses include, but are not limited to, these examples:

$(0.909)(19.99) + (0.003)(20.99) + (0.088)(21.99)$

$(90.9\%)(19.99) + (0.3\%)(20.99) + (8.8\%)(21.99)$

$$\frac{(90.9)(19.99) + (0.3)(20.99) + (8.8)(21.99)}{100}$$

61 [1] Allow 1 credit for **20**.

62 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

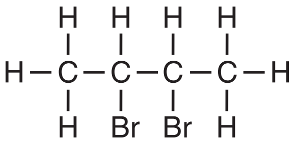
They have the same number of valence electrons.

form 1^+ ions

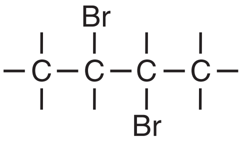
are located in same group

both alkali metals

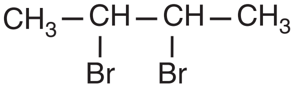
63 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:



$$\begin{array}{ccccccccccc} & & \text{H} & & \text{H} & & \text{H} & & \text{H} & & \\ & & | & & | & & | & & | & & \\ \text{H} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{H} \\ & & | & & | & & | & & | & & \\ & & \text{H} & & \text{Br} & & \text{Br} & & \text{H} & & \end{array}$$



$$\begin{array}{ccccccccc} & & & \text{Br} & & & & & \\ & | & & | & & | & & | & \\ - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \\ & | & & | & & | & & | & \\ & & & & & \text{Br} & & & \end{array}$$



$$\begin{array}{ccccccc} \text{CH}_3 & - & \text{CH} & - & \text{CH} & - & \text{CH}_3 \\ & & | & & | & & \\ & & \text{Br} & & \text{Br} & & \end{array}$$

$CH_3CHBrCHBrCH_3$

64 [1] Allow 1 credit for $\mathbf{{}^{0}_{+1}e}$ or $\mathbf{{}^{0}_{+1}\beta}$ or $\boldsymbol{\beta^{+}}$ or **positron**.

Part C

Allow a total of 21 credits for this part. The student must answer all questions in this part.

65 [1] Allow 1 credit for a correct numerical setup. Acceptable responses include, but are not limited to, these examples:

$$8.40\ \text{g} \times \frac{1\ \text{mole}}{58.3\ \text{g}} =$$

$$\frac{8.4}{58.3}$$

66 [1] Allow 1 credit for **0.025**.

67 [1] Allow 1 credit for **$NaHCO_3$**.

68 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

Naphthalene has weak intermolecular forces.

They are weak.

69 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

Naphthalene is nonpolar; water is polar.

Nonpolar won't dissolve in polar.

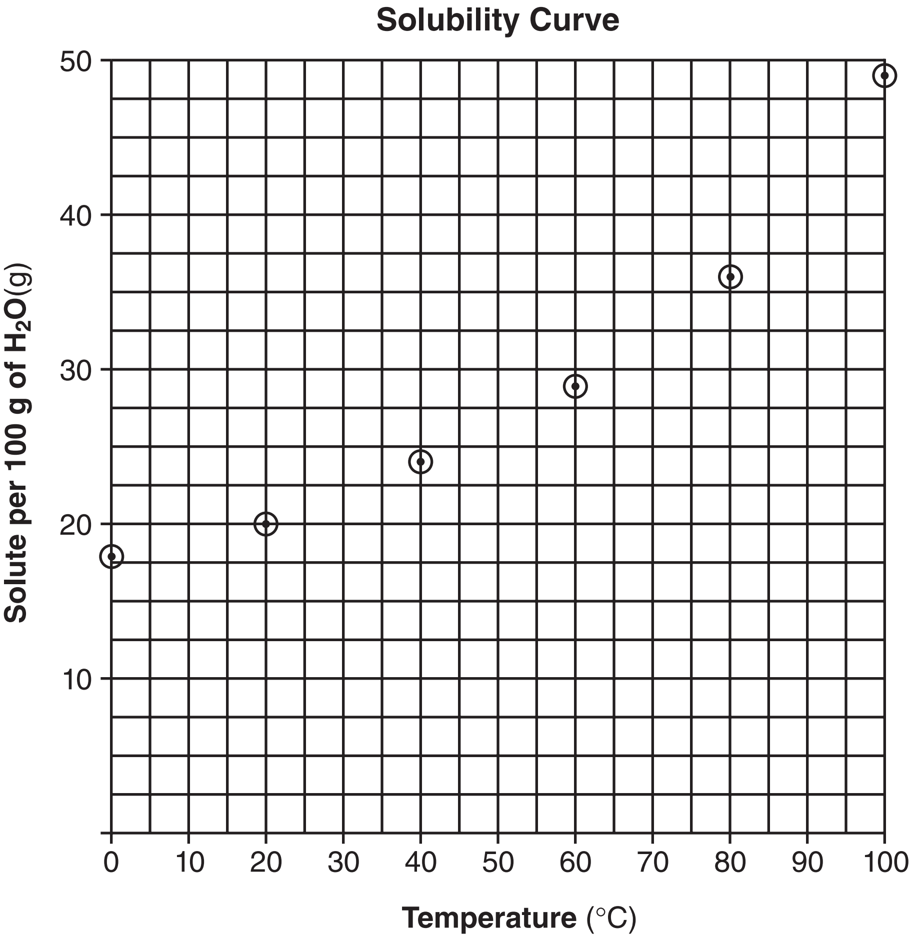
Like dissolves like.

70 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

$C_{10}H_8$

H_8C_{10}

71 and 72 An example of a correct response is shown below.



71 [1] Allow 1 credit for marking an appropriate scale. An appropriate scale is one that allows a trend to be seen.

72 [1] Allow 1 credit for plotting all the points correctly (±0.3 grid space). Plotted points do *not* need to be circled or connected.

73 [1] Allow 1 credit for **9**.

74 [1] Allow 1 credit for a response in the range of 6–8.

75 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

Particles move slower.

The molecules will slow down as the temperature decreases.

The average kinetic energy of the particles decreases.

decreases

76 [1] Allow 1 credit for a correct numerical setup. Acceptable responses include, but are not limited to, these examples:

$$\frac{(100.8\text{ kPa})(52.5\text{ L})}{(295\text{ K})} = \frac{(45.6\text{ kPa})(X)}{(252\text{ K})}$$

$$52.5 \times \frac{252}{295} \times \frac{100.8}{45.6}$$

77 [1] Allow 1 credit for **–21**.

78 [1] Allow 1 credit for **.45** or **0.45**. Significant figures do *not* need to be shown.

79 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

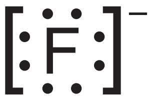
Removing CO_2 disrupts equilibrium and thus the system must shift to create more CO_2 from the H_2CO_3 in order to restore equilibrium.

Equilibrium shifts to the right.

H_2CO_3 decreases to remove the stress of changing the CO_2.

80 [1] Allow 1 credit for **+4** or **4**.

81 [1] Allow 1 credit for a correct response. Brackets do *not* need to be shown. Acceptable responses include, but are not limited to, this example:



82 [1] Allow 1 credit for **SnF_2**.

83 [1] Allow 1 credit for **1.43**. Significant figures do *not* need to be shown.

84 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

The water has a fluoride level of 1.43 ppm, which is below the maximum contaminant level for fluoride, so it is safe to drink.

F^- below 4 ppm, safe, below max level

Safe: 1.43 ppm < 4 ppm

or

Allow 1 credit for a response consistent with the student's answer to question 83.

85 [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

Perform tests under ventilation (fume) hood.

Avoid spills.

no open-toed shoes

The *Chart for Determining the Final Examination Score for the June 2004 Regents Examination in Physical Setting/Chemistry* will be posted on the Department's web site http://www.emsc.nysed.gov/osa/ on Wednesday, June 23, 2004. Conversion charts provided for previous administrations of the Regents Examination in Physical Setting/Chemistry must NOT be used to determine students' final scores for this administration.

Map to Core Curriculum

June 2004 Physical Setting/ Chemistry			
Question Numbers			
Key Ideas	Part A	Part B	Part C
Standard 1			
Math Key Idea 1		58	71,72,77,78
Math Key Idea 2			
Math Key Idea 3			
Sci. Inq. Key Idea 1		52,62	
Sci. Inq. Key Idea 2			85
Sci. Inq. Key Idea 3		41,49,61	67,74,80,82
Eng. Des. Key Idea 1			
Standard 2			
Key Idea 1		41,49	
Key Idea 2			
Standard 6			
Key Idea 1			
Key Idea 2			
Key Idea 3			
Key Idea 4			
Key Idea 5			
Standard 7			
Key Idea 1			84
Key Idea 2			
Standard 4 Process Skills			
Key Idea 3		34,35,36,37,38, 42,43,44,45,46, 47,48,50,51,53, 54,55,56,57,59, 60,63	65,66,69,70,73, 74,75,76,79,83
Key Idea 4		40,49,64	
Key Idea 5		39,41	68,81
Standard 4			
Key Idea 3	1,2,3,4,5,6,7,8, 14,16,18,19,20, 21,22,23,24,25, 26,27,28,29,30, 31,33	34,35,36,37,38, 42,43,44,45,46, 47,48,50,51,52, 53,54,55,56,57, 58,59,60,61,62, 63	65,66,67,69,70, 71,72,73,74,75, 76,78,79,80,82, 83,84,85
Key Idea 4	15	40,49,64	77
Key Idea 5	9,10,11,12,13, 17,32	34,39,41	68,81
Reference Tables			
2002 Edition	2,4,5,8,10,11, 13,23,24,25,26, 31	34,35,37,39,41, 48,49,50,54,56, 57	67,74,76,77,78, 80,81,82,83

Regents Exam
1998

FOR TEACHERS ONLY

C

The University of the State of New York
REGENTS HIGH SCHOOL EXAMINATION

CHEMISTRY

Tuesday, June 23, 1998—9:15 a.m. to 12:15 p.m., only

SCORING KEY

Part I

Refer to the table on the answer sheet for the number of credits to be given on Part I.

Part I (65 credits)

1	1	2	X	4
2	X	2	3	4
3	1	2	X	4
4	1	2	3	X
5	1	2	3	X
6	1	2	X	4
7	1	X	3	4
8	1	X	3	4
9	X	2	3	4
10	1	2	X	4
11	1	2	3	X
12	1	2	3	X
13	1	X	3	4
14	1	2	X	4
15	X	2	3	4
16	1	2	X	4
17	1	X	3	4
18	1	2	3	X
19	1	X	3	4
20	1	2	3	X
21	1	2	3	X
22	X	2	3	4
23	1	X	3	4
24	X	2	3	4
25	1	2	X	4
26	1	2	3	X
27	1	2	X	4
28	1	2	3	X
29	1	X	3	4
30	1	2	X	4
31	X	2	3	4
32	1	2	X	4
33	1	X	3	4
34	1	2	3	X
35	1	X	3	4
36	X	2	3	4
37	1	2	3	X
38	1	2	3	X
39	X	2	3	4
40	1	2	X	4
41	1	2	X	4
42	1	X	3	4
43	1	2	3	X
44	1	2	X	4
45	X	2	3	4
46	X	2	3	4
47	1	X	3	4
48	1	2	X	4
49	1	X	3	4
50	1	2	3	X
51	1	2	X	4
52	X	2	3	4
53	1	2	X	4
54	X	2	3	
55	1	2	X	
56	1	X	3	

Directions to the teacher:

Use only *red* ink or *red* pencil in rating Regents examination papers. Do *not* correct the student's work by making insertions or changes of any kind.

Scan each answer sheet to make certain that the student has marked only one answer for each question. If a student has marked two or more answers with an X in ink, draw a red line through the row of numbers for that question to indicate that no credit is to be allowed for that question when the answer sheet is scored.

To facilitate scoring, the scoring key has been printed in the same format as the answer sheet. The scoring key may be made into a scoring stencil by punching out the correct answers. Be sure that the stencil is aligned with the answer sheet so that the holes correspond to the correct answers. To aid in proper alignment, punch out the first and last item numbers in each part and place the stencil on the answer sheet so that these item numbers appear through the appropriate holes.

Part II

Allow a total of 35 credits, one credit for each question, for only seven of the twelve groups in this part. If more than seven groups are answered, only the first seven answered should be considered.

Group 1
Matter and Energy

57	1	X	3	4
58	1	X	3	4
59	1	2	3	X
60	1	2	X	4
61	X	2	3	4

Group 2
Atomic Structure

62	1	X	3	4
63	1	2	X	4
64	1	X	3	4
65	1	2	3	X
66	1	2	X	4

Group 3
Bonding

67	1	2	X	4
68	1	2	X	4
69	1	X	3	4
70	X	2	3	4
71	1	2	3	X

Group 4
Periodic Table

72	X	2	3	4
73	1	2	X	4
74	X	2	3	4
75	1	X	3	4
76	1	2	3	X

Group 5
Mathematics of Chemistry

77	X	2	3	4
78	1	2	3	X
79	X	2	3	4
80	1	X	3	4
81	X	2	3	4

Group 6
Kinetics and Equilibrium

82	1	2	3	X
83	1	X	3	4
84	1	2	X	4
85	1	2	X	4
86	1	2	3	X

Group 7
Acids and Bases

87	1	2	X	4
88	X	2	3	4
89	1	2	3	X
90	1	X	3	4
91	1	2	3	X

Group 8
Redox and Electrochemistry

92	X	2	3	4
93	X	2	3	4
94	1	2	3	X
95	X	2	3	4
96	1	X	3	4

Group 9
Organic Chemistry

97	1	2	3	X
98	1	X	3	4
99	1	2	X	4
100	X	2	3	4
101	X	2	3	4

Group 10
Applications of Chemical Principles

102	1	2	3	X
103	1	X	3	4
104	1	2	X	4
105	1	X	3	4
106	X	2	3	4

Group 11
Nuclear Chemistry

107	1	X	3	4
108	X	2	3	4
109	1	X	3	4
110	1	2	3	X
111	1	X	3	4

Group 12
Laboratory Activities

112	1	2	3	X
113	1	X	3	4
114	1	2	X	4
115	1	X	3	4
116	X	2	3	4