PHYSICAL AND CHEMICAL PROPERTIES AND CHANGES

PHYSICAL PROPERTY

1. observed with senses
2. determined without changing matter

CHEMICAL PROPERTY

1. indicates how a substance reacts with something else
2. matter will be changed into a new substance after the reaction

Identify the following as a chemical (C) or physical property (P):

P 1. blue color
P 2. density
C 3. flammability (burns)
P 4. solubility (dissolves)
C 5. reacts with acid
P 6. brittleness
P 7. sour taste
P 8. melting point
C 9. reacts with water
P 10. hardness
P 11. boiling point
P 12. luster
P 13. odor
C 14. reacts with air

PHYSICAL CHANGE

1. a change in size, shape, or state
2. no new substance is formed

CHEMICAL CHANGE

1. a change in the physical and chemical properties
2. a new substance is formed

Identify the following as physical *(P)* or chemical *(C)* changes.

P 1. NaCl (Table Salt) dissolves in water.
C 2. Ag (Silver) tarnishes.
P 3. An apple is cut.
P 4. Heat changes H_2O to steam.
C 5. Baking soda reacts to vinger.
C 6. Fe (Iron) rusts.
P 7. Alcohol evaporates .
P 8. Ice melts.
C 9. Milk sours.
P 10. Sugar dissolves in water.
C 11. Wood rots.
C 12. Pancakes cook.
P 13. Grass grows.
P 14. A tire is inflated.
C 15. Food is digested.
P 16. Paper towel absorbs water.

Physical and Chemical Changes

Part A

Can you recognize the chemical and physical changes that happen all around us? If you change the way something looks, but haven't made a new substance, a **physical change** (P) has occurred. If the substance has been changed into another substance, a **chemical change** (C) has occurred.

1.	P	An ice cube is placed in the sun. Later there is a puddle of water. Later still the puddle is gone.
2.	C	Two chemical are mixed together and a gas is produce.
3.	C	A bicycle changes color as it rusts.
4.	P	A solid is crushed to a powder.
5.	C	Two substances are mixed and light is produced.
6.	P + C	A piece of ice melts and reacts with sodium.
7.	P	Mixing salt and pepper.
8.	P	Chocolate syrup is dissolved in milk.
9.	C	A marshmallow is toasted over a campfire.
10.	P	A marshmallow is cut in half.

Part B

Read each scenario. Decide whether a physical or chemical change has occurred and give evidence for your decision. The first one has been done for you to use as an example.

	Scenario	**Physical or Chemical Change?**	**Evidence…**
1.	Umm! A student removes a loaf of bread hot from the oven. The student cuts a slice off the loaf and spreads butter on it.	Physical	No change in substances. No unexpected color change, temperature change or gas given off.
2.	Your friend decides to toast a piece of bread, but leaves it in the toaster too long. The bread is black and the kitchen if full of smoke.	CHEMICAL	New black color and solid, gas is produced. (The black is actually pure carbon)
3.	You forgot to dry the bread knife when you washed it and reddish brown spots appeared on it.	CHEMICAL	New color and if left long enough you will see that the new color is also a new solid.

4.	You blow dry your wet hair.	PHYSICAL	Water evaoporates only.
5.	In baking biscuits and other quick breads, the baking powder reacts to release carbon dioxide bubbles. The carbon dioxide bubbles cause the dough to rise.	CHEMICAL	A new gas is produced which makes the biscuits rise.
6.	You take out your best silver spoons and notice that they are very dull and have some black spots.	CHEMICAL	New color and if left long enough you will see that the new color is also a new solid.
7.	A straight piece of wire is coiled to form a spring.	PHYSICAL	Only a change of shape, no new substance is made.
8.	Food color is dropped into water to give it color.	PHYSICAL	Only a change in size from powder to particles to small to see.
9.	Chewing food to break it down into smaller particles represents a _____ change, but the changing of starch into sugars by enzymes in the digestive system represents a _____change.	PHYSICAL CHEMICAL	First the teeth just make a change in size, and then the enzymes make a chemical change producing new molecules. Our temperature goes up while we digest from the energy released.
10.	In a fireworks show, the fireworks explode giving off heat and light.	CHEMICAL	Substances giving off heat and light, themselves, is always chemical. What we see in the sky are new colors and light.

Part C: True (T) or False (F)

1.	**F**	Changing the size and shapes of pieces of wood would be a chemical change.
2.	**F**	In a physical change, the makeup of matter is changed.
3.	**T**	Evaporation occurs when liquid water changes into a gas.
4.	**T**	Evaporation is a physical change.
5.	**F**	Burning wood is a physical change.
6.	**F**	Combining hydrogen and oxygen to make water is a physical change.
7.	**T**	Breaking up concrete is a physical change.
8.	**F**	Sand being washed out to sea from the beach is a chemical change.
9.	**F**	When ice cream melts, a chemical change occurs.
10.	**F**	Acid rain damaging a marble statue is a physical change.

Significant Figures, Scientific Notation, and Rounding

1) Determine the number of significant figures in the following values:

Value	# of sig. figures	Value	# of sig. figures
140.74	5	4	1
0.0041	2	3.70×10^{14}	3
31.00	4	1.05×10^{12}	3
1300	2	7.0400×10^{3}	5
847.040	6	2495	4

2) Round the following values to 3 significant figures.

$3.76411 \rightarrow 3.76$	$0.0411984 \rightarrow 0.0412$
$3.76811 \rightarrow 3.77$	$150.6142 \rightarrow 151$
$3.76511 \rightarrow 3.77$	$0.013877 \rightarrow 0.0139$
$11.048176 \rightarrow 11.0$	$4.88223 \times 10^{9} \rightarrow 4.88 \times 10^{9}$
$8.75510 \rightarrow 8.76$	$2.0097 \times 10^{-12} \rightarrow 2.01 \times 10^{-12}$

3) Perform the following calculations and round the final answer to the correct number of significant figures.

Calculation	Rounded Answer	Calculation	Rounded Answer
18.7644 - 3.472 + 0.4101	= 15.703	0.87 + 4.061 + 10.4	= 15.3
17.441÷ 3	= 6	16 x 841.1 ÷ 16.300	= 830
14.044 + 8.11 + 3.4	= 25.6	21.01 x 2.0	= 42
3.41 – 0.086652	= 3.32	18.4 +12.99 +13.772 + 9.704	= 54.9

4. Convert the following into scientific notation or standard notation

Standard notation	Scientific notation
47,000	4.7×10^{4}
0.0008	8×10^{-4}
675,000,000	6.75×10^{8}
157,000,000,000,000,000,000,000	1.57×10^{23}
0.0000003407	3.407×10^{-7}
0.0766	7.66×10^{-2}
780,000	7.8×10^{5}
0.000475	4.75×10^{-4}
0.006	6×10^{-3}
900,000,000	9×10^{8}

Metric System:

Perform the following metric conversions. Show your conversion factors. Use correct number of significant figures. If you need more room, do calculations on separate page(s).

0.50 m = 5.0×10^2 mm	2.00 km = 2.00×10^3 m	0.4000 L = 4.000×10^2 mL or 400.0 mL
1.00 g = 1.00×10^{-3} kg or .00100 kg	01.00 cm = 0.0100 m or 1.00×10^{-2} m	8.00 mm = 0.800 cm or 8.00×10^{-1} cm
22.4 L = 2.24×10^4 mL or 22400 mL	5.00 g = 5.00×10^{-3} kg or .00500 kg	4.245 L = 4245 mL or 4.245×10^3 mL
345 g = 0.345 kg or 3.45×10^{-1} kg	10.0 nm = 1.00×10^{-8} m or .0000000100 m	3.22 Gg = 3.22×10^6 kg or 3220000 kg
3.001 cg = 30.01 mg or 3.001×10^1 mg	1.2 m = 1.2×10^6 µm or 1200000 µm	455 nm = 4.55×10^{-7} m or .000000455 m

English-Metric Conversions **(show your work)**

10.0 cm = 3.94 in	15.0 lb = 6.80 kg
1.00 yd = 91.4 cm	16.9 fl. oz = 0.500 L (0.0338 fl oz.= 1 mL)
1.00 qt = 0.946 L	6.00 in = 15.2 cm
0.800 kg = 28.2 oz (16 oz = 1 lb)	1.83 kg = 4.04 lb
25.00 mL = 0.0264 qt (1qt = .946L)	1.40 L = 1.40×10^3 = cm^3 note: 1 mL = $1 cm^3$

Temperature Conversions

Perform the following temperature conversions (show your calculation)

75°C = __348___ K
-15°C = ___258___ K
0.00 K = __-273.15_ °C = __-459.67__ °F
25°C (room temperature) = ____298___ K
98.6 °F (body temperature) = ___37.0___ °C
25°C = ___77____ °F
-40.0 °C = __-40.0___ °F
412 K = __282____ °F

Name Answer Key **Date** 9/9/15

Chp 2-1: Specific Heat Worksheet

$$(m)(\Delta T)(C_{sp})=Q$$

1. Specific heat is the amount of energy that it takes to raise the temperature of 1 gram of a substance by 1 degree kelvin

2. Absolute zero is the temperature at which all molecular motion ceases

3. Endothermic process is a change in matter in which energy is absorbed

4. Exothermic process is a change in matter in which energy is released

5. What is the specific heat of a substance that absorbs 2500 joules of heat when a sample of 100 g of the substance increases in temperature from 10 °C to 70°C?

   $Q = m\ C\ \Delta T \quad C = Q/\ m\ \Delta T = 2500\ J/\ 100\ g \cdot 60°C = 0.417\ J/g\ °C$

6. If 200 grams of water is to be heated from 24.0°C to 100.0°C to make a cup of tea, how much heat must be added? The specific heat of water is 4.18 J/g·C

   $Q = m\ C\ \Delta T = 200\ g \cdot 4.18\ J/g\ °C \cdot 76\ °C = 63{,}536\ J$

7. How many grams of water would require 2200 joules of heat to raise its temperature from 34°C to 100°C? The specific heat of water is 4.18 J/g·C

   $Q = m\ C\ \Delta T \quad m = Q/\ C\ \Delta T = 2200\ J/\ 4.18\ J/g\ °C \cdot 66°C = 7.97\ g$

8. A block of aluminum weighing 140 g is cooled from 98.4°C to 62.2°C with the release of 1080 joules of heat. From this data, calculate the specific heat of aluminum.

   $Q = m\ C\ \Delta T \quad C = Q/\ m\ \Delta T = 1080\ J/\ 140\ g \cdot 36.2°C = 0.213\ J/g\ °C$

9. 100.0 mL of 4.0°C water is heated until its temperature is 37°C. If the specific heat of water is 4.18 J/g°C, calculate the amount of heat energy needed to cause this rise in temperature.

   (1 mL H_2O = 1 g H_2O)

   $Q = m\ C\ \Delta T = 100\ g \cdot 4.18\ J/g\ °C \cdot 33\ °C = 13{,}794\ J$

10. A total of 54.0 joules of heat are absorbed as 58.3 g of lead is heated from 12.0°C to 42.0°C. From these data, what is the specific heat of lead?

$Q = m\ C\ \Delta T \quad C = Q/\ m\ \Delta T = 54\ J/\ 58.3\ g \cdot 30\ °C = 0.031\ J/g\ °C$

11. The specific heat of wood is 2.03 J/g·°C. How much heat is needed to convert 550 g of wood at -15.0°C to 10.0°C?

$Q = m\ C\ \Delta T = 550\ g \cdot 2.03\ J/g\ °C \cdot 25\ °C = 27{,}912.5\ J$

12. What is the total amount of heat needed to change 2.25 kg of silver at 0.0°C to 200.0°C? The specific heat of silver is 0.129 J/g·°C (2.25 kg = 2250 g)

$Q = m\ C\ \Delta T = 2250\ g \cdot 0.129\ J/g\ °C \cdot 200\ °C = 58{,}050\ J$

13. Granite has a specific heat of 800 J/g·°C. What mass of granite is needed to store 150,000 J of heat if the temperature of the granite is to be increased by 15.5°C?

$Q = m\ C\ \Delta T \quad m = Q/\ C\ \Delta T = 150{,}000\ J/\ 800\ J/g\ °C \cdot 15.5°C = 1.86 \times 10^9\ g$

14. A 55 kg block of metal has an original temperature of 15.0°C and 0.45 J/g·°C. What will be the final temperature of this metal if 450 J of heat energy are added?

$Q = m\ C\ \Delta T \quad \Delta T = Q\ /\ m\ C$ where $\Delta T = T_f - T_i$ so $T_f - T_i = Q/\ m\ C$ and $T_f = Q/\ m\ C + T_i$

$T_f = Q/\ m\ C + T_i = (450\ J/\ 55{,}000\ g \cdot 0.45\ J/g\ °C) + 15.0°C = 15.018\ °C$

15. Object A specific heat is 2.45 J/g·°C and object B specific heat is 0.82 J/g·°C. Which object will heat up faster if they have the same mass and equal amount of heat is applied? Explain why.

Object B has a lower specific heat and requires less heat to raise 1 gram by 1 degree Celsius, therefore, it will heat up faster.

Electron Configurations - Solutions

Note: The electron configurations in this worksheet assume that lanthanum (La) is the first element in the 4f block and that actinium (Ac) is the first element in the 5f block. If your periodic table doesn't agree with this, your answers for elements near the f-orbitals may be slightly different.

1) sodium $1s^2 2s^2 2p^6 3s^1$

2) iron $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

3) bromine $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

4) barium $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2$

5) neptunium $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6 7s^2 5f^5$

6) cobalt $[Ar]\ 4s^2 3d^7$ OR $\rightarrow 5d^1 4f^{14} 5d^9 6p^6 7s^2 6d^1 5f^4$

7) silver $[Kr]\ 5s^2 4d^9$

8) tellurium $[Kr]\ 5s^2 4d^{10} 5p^4$

9) radium $[Rn]\ 7s^2$

10) lawrencium $[Rn]\ 7s^2 5f^{14} 6d^1$ OR $[Rn]\ 7s^2 6d^1 5f^{14}$

11) $1s^2 2s^2 2p^6 3s^2 3p^4$ sulfur

12) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$ rubidium

13) $[Kr]\ 5s^2 4d^{10} 5p^3$ antimony

14) $[Xe]\ 6s^2 4f^{14} 5d^6$ osmium OR $[Xe]\ 6s^2 5d^1 4f^{14} 5d^5$

15) $[Rn]\ 7s^2 5f^{11}$ einsteinium OR $[Rn]\ 7s^2 6d^1 5f^{10}$

16) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^{10} 4p^5$ not valid (take a look at "4d")

17) $1s^2 2s^2 2p^6 3s^3 3d^5$ not valid (3p comes after 3s)

18) $[Ra]\ 7s^2 5f^8$ not valid (radium isn't a noble gas)

19) $[Kr]\ 5s^2 4d^{10} 5p^5$ valid

20) [Xe] not valid (an element can't be its own electron configuration)

Chemistry Worksheet: Atomic Structure and Isotopes Answers

Give the chemical symbol for the following isotopes, including the atomic number and mass number. List the number of protons and neutrons for each.

Reference: p. 88 – 94 (chapter 3) in your chemistry book (Click on the link to go directly to the web version of chapter 3.)

mass number = number of protons + number of neutrons

Example: hydrogen – 2

answer: $^{2}_{1}H$ 1 proton 1 neutron

1. hydrogen – 3 (3 is the mass number)

$^{3}_{1}H$ 1 proton 2 neutrons

2. sulfur – 36

$^{36}_{16}S$ 16 protons 24 neutrons

3. chlorine - 37

$^{37}_{17}Cl$ 17 protons 20 neutrons

4. uranium – 235

$^{235}_{92}U$ 92 protons 143 neutrons

Complete the table below:

element name	*atomic number*	*mass number*	*number of neutrons*	*number of electrons (neutral atom)*	*element symbol*
5. boron	**5**	10	5	**5**	**B**
6. sulfur	16	**32**	16	**16**	**S**
7. scandium	**21**	**45**	24	21	**Sc**
8. einsteinium	**99**	254	**155**	**99**	Es
9. boron	5	**11**	6	**5**	**B**
10. oxygen	**8**	**18**	10	**8**	O
11. einsteinium	99	252	**153**	**99**	**Es**

More Questions on the Back -------->

12. Numbers **5.** and **9.** (on the front of this page) are atoms of the same element. The same is true for numbers **8.** and **11.** Explain the relationship that these atoms have and why it is possible for an element to have atoms that are not all identical.

Boron – 10 and Boron – 11 are isotopes. They are the same element because they both have 5 protons. Atoms with the same number of protons are atoms of the same element.

13. Write the name and symbol for the elements that are described below:

a. 78 protons in the nucleus of each atom. **Platinum, Pt**

b. 42 electrons in each uncharged atom. **molybdenum, Mo**

c. 18 electrons in each +2 cation. **calcium, Ca**

d. 10 electrons in each -1 anion. **fluorine, F**

Identify the isotope in each of the following. Give the appropriate symbol and name. Use the mass number in the name of the isotope as was done in 1 - 4.

e. 52 neutrons in each nucleus and a mass number of 92.

zirconium – 92 $^{92}_{40}Zr$

f. A mass number of 112 and 48 electrons in each uncharged atom.

cadmium – 112 $^{112}_{48}Cd$

g. A mass number of 75 and 36 electrons in each -3 anion.

arsenic – 75 $^{75}_{33}As$

h. A mass number of 262 and 159 neutrons in the nucleus.

lawrencium - 262 $^{262}_{103}Lr$

i. A mass number of 103 and 41 electrons in each +3 cation.

ruthenium - 103 $^{103}_{44}Ru$

j. A mass number of 79 and 36 electrons in each -1 anion.

bromine – 79 $^{79}_{35}Br$

Worksheet: Periodic Table Trends Name Key

For each of the following, circle the correct element.

Li	Si	S	metal
N	P	As	smallest ionization energy
K	Ca	Sc	largest atomic mass
S	Cl	Ar	member of the halogen family
Al	Si	P	greatest electron affinity
Ga	Al	Si	largest atomic radius
V	Nb	Ta	largest atomic number
Te	I	Xe	member of noble gases
Si	Ge	Sn	4 energy levels
Li	Be	B	member of alkali metals
As	Se	Br	6 valence electrons
H	Li	Na	nonmetal
Hg	Tl	Pb	member of transition metals
Na	Mg	Al	electron distribution ending in s^2p^1
Pb	Bi	Po	metalloid
B	C	N	gas at room temperature
Ca	Sc	Ti	electron distribution ending in s^2d^2

Naming Ionic Compounds Practice Worksheet - Solutions

Name the following ionic compounds:

1)	NH_4Cl	**ammonium chloride**
2)	$Fe(NO_3)_3$	**iron (III) nitrate**
3)	$TiBr_3$	**titanium (III) bromide**
4)	Cu_3P	**copper (I) phosphide**
5)	$SnSe_2$	**tin (IV) selenide**
6)	GaAs	**gallium arsenide**
7)	$Pb(SO_4)_2$	**lead (IV) sulfate**
8)	$Be(HCO_3)_2$	**beryllium bicarbonate**
9)	$Mn_2(SO_3)_3$	**manganese (III) sulfite**
10)	$Al(CN)_3$	**aluminum cyanide**

Write the formulas for the following compounds:

11)	chromium (VI) phosphate	**$Cr(PO_4)_2$**
12)	vanadium (IV) carbonate	**$V(CO_3)_2$**
13)	tin (II) nitrite	**$Sn(NO_2)_2$**
14)	cobalt (III) oxide	**Co_2O_3**
15)	titanium (II) acetate	**$Ti(C_2H_3O_2)_2$**
16)	vanadium (V) sulfide	**V_2S_5**
17)	chromium (III) hydroxide	**$Cr(OH)_3$**
18)	lithium iodide	**LiI**
19)	lead (II) nitride	**Pb_3N_2**
20	silver bromide	**AgBr**

Naming Covalent Compounds Solutions

Write the formulas for the following covalent compounds:

1) antimony tribromide **$SbBr_3$**

2) hexaboron silicide **B_6Si**

3) chlorine dioxide **ClO_2**

4) hydrogen iodide **HI**

5) iodine pentafluoride **IF_5**

6) dinitrogen trioxide **N_2O_3**

7) ammonia **NH_3**

8) phosphorus triiodide **PI_3**

Write the names for the following covalent compounds:

9) P_4S_5 **tetraphosphorus pentasulfide**

10) O_2 **oxygen**

11) SeF_6 **selenium hexafluoride**

12) Si_2Br_6 **disilicon hexabromide**

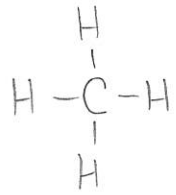
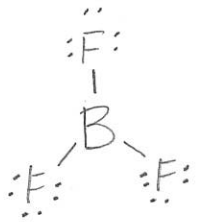
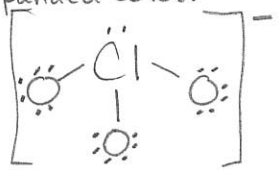
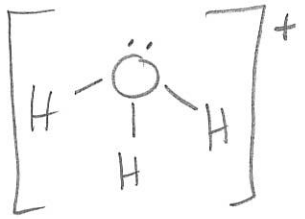
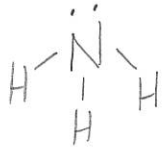
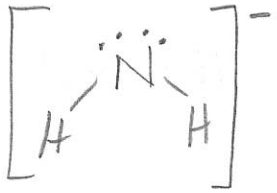
13) SCl_4 **sulfur tetrachloride**

14) CH_4 **methane**

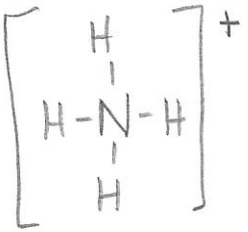
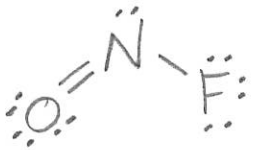
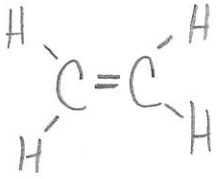
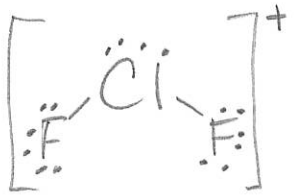
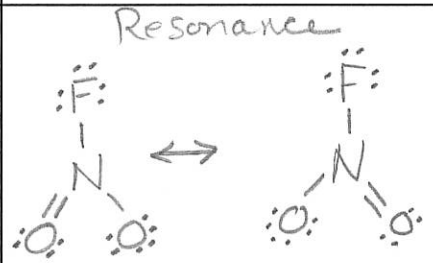
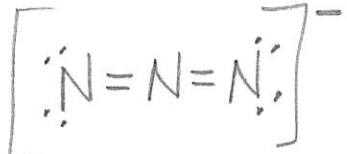
15) B_2Si **diboron silicide**

16) NF_3 **nitrogen trifluoride**

Lewis Structure - Answers

Formula	Lewis Structure	Molecular Geometry	Formula	Lewis Structure	Molecular Geometry
1. CH_4 8 ve		tetrahedral	**5. H_2O** 2(1)+6=8		bent
2. BF_3 * B does not form an octet 3+3(7)=24		trigonal planar	**6. ClO_3^-** **Cl = Chlorine** 7+3(6)+1 =26	* Note: The more accurate structure involves an expanded octet. 	trigonal pyramidal
3. HCN 1+4+5=10		linear	**7. H_3O^+** 1(3)+6-1=8		trigonal pyramidal
4. NH_3 5+3(1)=8		trigonal pyramidal	**8. NH_2^-** 5+1(2)+1=8		bent

Lewis Structure - Answers

Formula	Lewis Structure	Molecular Geometry	Formula	Lewis Structure	Molecular Geometry
9. NH_4^+ $5+4-1=8$		tetrahedral	**13. NOF** $5+6+7=18$		bent
10. C_2H_4 $2(4)+4=12$		Geometry about each Carbon atom is trigonal planar.	**14. ClF_2^+** **Cl = Chlorine** $7+2(7)-1=20$		bent
11. C_2H_2 $2(4)+2=10$		linear	**15. FNO_2** $7+5+2(6)=24$		trigonal planar
12. N_3^- $3(5)+1=16$		linear	**16. XeF_5^+**		

Molar Conversion Worksheet

Answer Key

1. What is the mass of 1 mole of Barium acetate, $Ba(C_2H_3O_2)_2$?
   There are: 1 Ba; 4 C; 6 H; 4 O
   1x(137.3) + 4x(12.0) + 6x(1.0) + 4x(16.0) = 255.3 g/mol
   1 mole x 255.3 g/mol = 255.3 g
2. What is the molar mass (g/mol) of cyclohexanol, $C_6H_{11}OH$?
   There are: 6 C; 12 H; 1 O
   6x(12.0) + 12x(1.0) + 1x(16.0) = 100 g/mol

3. How many moles are in 2.35 g of H_2O?
   H_2O: 2x(1.0) + 1x(16.0) = 18 g/mol
   $2.35\text{ g} \times \frac{1\text{ mole}}{18\text{ g}} = 0.13\text{ moles}$
4. If we have 0.072 moles of $FeCl_3$ then how many grams would it weigh?
   $FeCl_3$: 1x(55.8) + 3x(35.5) = 162.3 g/mol
   $0.072\text{ mole} \times \frac{162.3\text{ g}}{1\text{ mole}} = 11.7\text{ g}$
5. If there are $9.6\text{x}10^{15}$ particles of sugar in a solution then how many moles of sugar are there?
   $9.6\text{x}10^{15}\text{ particles} \times \frac{1\text{ mole}}{6.02\text{x}10^{23}\text{ particles}} = 1.59\text{x}10^{-8}\text{ moles}$

6. When there are 0.0314 moles of candy canes how many candy canes are there?
   $0.0314\text{ moles} \times \frac{6.02\text{x}10^{23}\text{ candy canes}}{1\text{ mole}} = 1.89\text{x}1022\text{ candy canes}$

7. What volume (L) is 0.00353 moles of He gas at 0°C and 1.0 atm?
   $0.00353\text{ moles} \times \frac{22.4\text{ L}}{1\text{ mole}} = 0.079\text{ L}$

8. A gas at STP is 4.38 L, how many moles are there?
   $4.38\text{ L} \times \frac{1\text{ mole}}{22.4\text{ L}} = 0.196\text{ moles}$

9. How heavy (g) will $6.14\text{x}10^{25}$ atoms of gold be?
   $6.14\text{x}10^{25}\text{ atoms} \times \frac{1\text{ mole}}{6.02\text{x}10^{23}\text{ atoms}} \times \frac{107.9\text{ g}}{1\text{ mole}} = 11005\text{ g}$

10. How many atoms are there in 10.2 L of Ar gas at STP?
    $10.2\text{ L} \times \frac{1\text{ mole}}{22.4\text{ L}} \times \frac{6.02\text{x}10^{23}\text{ atoms}}{1\text{ mole}} = 2.74\text{x}10^{23}\text{ atoms}$

Percent Composition Worksheet - Solutions

Find the percent compositions of all of the elements in the following compounds:

1) $CuBr_2$

Cu: 28.4%

Br: 71.6%

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2) NaOH

Na: 57.5%

O: 40.0%

H: 2.5%

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3) $(NH_4)_2S$

N: 41.1%

H: 11.8%

S: 47.1%

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4) N_2S_2

N: 30.4%

S: 69.6%

Empirical and Molecular Formula Worksheet ANSWER KEY

Write the empirical formula for the following compounds.

1) C_6H_6 **CH**

6) C_8H_{18} **C_4H_9**

7) WO_2 **WO_2**

8) $C_2H_6O_2$ **CH_3O**

9) $X_{39}Y_{13}$ **X_3Y**

6) A compound with an empirical formula of C_2OH_4 and a molar mass of 88 grams per mole. What is the molecular formula of this compound? **$C_4O_2H_8$**

7) A compound with an empirical formula of C_4H_4O and a molar mass of 136 grams per mole. What is the molecular formula of this compound? **$C_8H_8O_2$**

8) A compound with an empirical formula of CFBrO and a molar mass of 253.8 grams per mole. What is the molecular formula of this compound? **$C_2F_2Br_2O_2$**

9) A compound with an empirical formula of C_2H_8N and a molar mass of 46 grams per mole. What is the molecular formula of this compound? **C_2H_8N**

10) A well-known reagent in analytical chemistry, dimethylglyoxime, has the empirical formula C_2H_4NO. If its molar mass is 116.1 g/mol, what is the molecular formula of the compound? **$C_4H_8N_2O_2$**

12. A certain blue solid contains 36.84% N and 63.16% O. What is the empirical formula of this compound? **The ratios are $N_{1.00}O_{1.50}$. Since 1.50 is not close to a whole number, we multiply *both* subscripts by 2. The empirical formula is thus N_2O_3. (The name is dinitrogen trioxide.)**

13. A sample of indium chloride weighing 0.5000 g is found to contain 0.2404 g of chlorine. What is the empirical formula of the indium compound? **$InCl_3$**

14. An unknown compound was found to have a percent composition as follows: 47.0 % potassium, 14.5 % carbon, and 38.5 % oxygen. What is its empirical formula? If the true molar mass of the compound is 166.22 g/mol, what is its molecular formula? **$K_2C_2O_4$**

15. Rubbing alcohol was found to contain 60.0 % carbon, 13.4 % hydrogen, and the remaining mass was due to oxygen. What is the empirical formula of rubbing alcohol? **C_3H_8O**

A Voyage through Equations ANSWER KEY

Section 1: Identify the type of reaction

1) $Na_3PO_4 + 3\ KOH \rightarrow 3\ NaOH + K_3PO_4$ **DOUBLE DISPLACEMENT**

2) $MgCl_2 + Li_2CO_3 \rightarrow MgCO_3 + 2\ LiCl$ **DOUBLE DISPLACEMENT**

3) $C_6H_{12} + 9\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ **COMBUSTION**

4) $Pb + FeSO_4 \rightarrow PbSO_4 + Fe$ **SINGLE DISPLACEMENT**

5) $CaCO_3 \rightarrow CaO + CO_2$ **DECOMPOSITION**

6) $P_4 + 3\ O_2 \rightarrow 2\ P_2O_3$ **SYNTHESIS**

7) $2\ RbNO_3 + BeF_2 \rightarrow Be(NO_3)_2 + 2\ RbF$ **DOUBLE DISPLACEMENT**

8) $2\ AgNO_3 + Cu \rightarrow Cu(NO_3)_2 + 2\ Ag$ **SINGLE DISPLACEMENT**

9) $C_3H_6O + 4\ O_2 \rightarrow 3\ CO_2 + 3\ H_2O$ **COMBUSTION**

10) $2\ C_5H_5 + Fe \rightarrow Fe(C_5H_5)_2$ **SYNTHESIS**

11) $SeCl_6 + O_2 \rightarrow SeO_2 + 3Cl_2$ **SINGLE DISPLACEMENT**

12) $2\ MgI_2 + Mn(SO_3)_2 \rightarrow 2\ MgSO_3 + MnI_4$ **DOUBLE DISPLACEMENT**

13) $O_3 \rightarrow O^{\cdot} + O_2$ **DECOMPOSITION**

14) $2\ NO_2 \rightarrow 2\ O_2 + N_2$ **DECOMPOSITION**

Section 2: Practicing equation balancing

1) $\underline{2}\ C_6H_6 + \underline{15}\ O_2 \rightarrow \underline{6}\ H_2O + \underline{12}\ CO_2$

2) $\underline{4}\ NaI + \underline{1}\ Pb(SO_4)_2 \rightarrow \underline{1}\ PbI_4 + \underline{2}\ Na_2SO_4$

3) $\underline{2}\ NH_3 + \underline{2}\ O_2 \rightarrow \underline{1}\ NO + \underline{3}\ H_2O$

4) $\underline{2}\ Fe(OH)_3 \rightarrow \underline{1}\ Fe_2O_3 + \underline{3}\ H_2O$

5) $\underline{2}\ HNO_3 + \underline{1}\ Mg(OH)_2 \rightarrow \underline{2}\ H_2O + \underline{1}\ Mg(NO_3)_2$

6) $\underline{1}\ H_3PO_4 + \underline{3}\ NaBr \rightarrow \underline{3}\ HBr + \underline{1}\ Na_3PO_4$

7) $\underline{3}\ C + \underline{4}\ H_2 \rightarrow \underline{1}\ C_3H_8$

8) $\underline{2}\ CaO + \underline{1}\ MnI_4 \rightarrow \underline{1}\ MnO_2 + \underline{2}\ CaI_2$

9) $\underline{1}\ Fe_2O_3 + \underline{3}\ H_2O \rightarrow \underline{2}\ Fe(OH)_3$

10) $\underline{1}\ C_2H_2 + \underline{2}\ H_2 \rightarrow \underline{1}\ C_2H_6$

11) $\underline{2}\ VF_5 + \underline{10}\ HI \rightarrow \underline{1}\ V_2I_{10} + \underline{10}\ HF$

12) $\underline{1}\ OsO_4 + \underline{2}\ PtCl_4 \rightarrow \underline{2}\ PtO_2 + \underline{1}\ OsCl_8$

13) $\underline{1}\ CF_4 + \underline{2}\ Br_2 \rightarrow \underline{1}\ CBr_4 + \underline{2}\ F_2$

14) $\underline{2}\ Hg_2I_2 + \underline{1}\ O_2 \rightarrow \underline{2}\ Hg_2O + \underline{2}\ I_2$

15) $\underline{1}\ Y(NO_3)_2 + \underline{1}\ GaPO_4 \rightarrow \underline{1}\ YPO_4 + \underline{1}\ Ga(NO_3)_2$

Section 3: Predicting the products of chemical reactions

1) $\underline{2}\ Ag + \underline{1}\ CuSO_4 \rightarrow \underline{1}\ Ag_2SO_4 + \underline{1}\ Cu$ Type: Single Displacement

2) $\underline{2}\ NaI + \underline{1}\ CaCl_2 \rightarrow \underline{2}\ NaCl + \underline{1}\ CaI_2$ Type: Double Displacement

3) $\underline{1}\ O_2 + \underline{1}\ H_2 \rightarrow \underline{2}\ H_2O$ Type: Synthesis

4) $\underline{2}\ HNO_3 + \underline{1}\ Mn(OH)_2 \rightarrow \underline{2}\ H_2O + \underline{1}\ Mn(NO_3)_2$ Type: Acid-Base

5) $\underline{2}\ AgNO_2 + \underline{1}\ BaSO_4 \rightarrow \underline{1}\ Ag_2SO_4 + \underline{1}\ Ba(NO_2)_2$ Type: Double Displacement

6) $\underline{2}\ HCN + \underline{1}\ CuSO_4 \rightarrow \underline{1}\ H_2SO_4 + \underline{1}\ Cu(CN)_2$ Type: Double Displacement

7) $\underline{1}\ H_2O + \underline{1}\ AgI \rightarrow \underline{1}\ HI + \underline{1}\ AgOH$ Type: Double Displacement

8) $\underline{3}\ HNO_3 + \underline{1}\ Fe(OH)_3 \rightarrow \underline{3}\ H_2O + \underline{1}\ Fe(NO_3)_3$ Type: Acid-Base

9) $\underline{4}\ LiBr + \underline{1}\ Co(SO_3)_2 \rightarrow \underline{2}\ Li_2SO_3 + \underline{1}\ CoBr_4$ Type: Double Displacement

10) $\underline{1}\ LiNO_3 + \underline{1}\ Ag \rightarrow \underline{1}\ AgNO_3 + \underline{1}\ Li$ Type: Single Displacement

11) $\underline{1}\ N_2 + \underline{2}\ O_2 \rightarrow \underline{2}\ NO_2$ Type: Synthesis

12) $\underline{1}\ H_2CO_3 \rightarrow \underline{1}\ CO_2 + \underline{1}\ H_2O$ Type: Decomposition

13) $\underline{1}\ AlCl_3 + \underline{3}\ Cs \rightarrow \underline{3}\ CsCl + \underline{1}\ Al$ Type: Single Displacement

14) $\underline{1}\ Al(NO_3)_3 + \underline{1}\ Ga \rightarrow \underline{1}\ Ga(NO_3)_3 + \underline{1}\ Al$ Type: Single Displacement

15) $\underline{1}\ H_2SO_4 + \underline{2}\ NH_4OH \rightarrow \underline{2}\ H_2O + \underline{1}\ (NH_4)_2SO_4$ Type: Acid-Base

16) $\underline{1}\ CH_3COOH + \underline{1}\ O_2 \rightarrow \underline{1}\ CO_2 + \underline{2}\ H_2O$ Type: Combustion

17) $\underline{1}\ C_4H_8 + \underline{6}\ O_2 \rightarrow \underline{4}\ CO_2 + \underline{4}\ H_2O$ Type: Combustion

18) $\underline{2}\ KCl + \underline{1}\ Mg(OH)_2 \rightarrow \underline{2}\ KOH + \underline{1}\ MgCl_2$ Type: Double Displacement

19) $\underline{1}\ Zn + \underline{1}\ Au(NO_2)_2 \rightarrow \underline{1}\ Zn(NO_2)_2 + \underline{1}\ Au$ Type: Single Displacement

20) $\underline{2}\ KOH + \underline{1}\ H_2SO_4 \rightarrow \underline{1}\ K_2SO_4 + \underline{2}\ H_2O$ Type: Acid-Base

21) $\underline{1}\ BaS + \underline{1}\ PtCl_2 \rightarrow \underline{1}\ BaCl_2 + \underline{1}\ PtS$ Type: Double Displacement

22) $\underline{2}\ Na_2O \rightarrow \underline{4}\ Na + \underline{1}\ O_2$ Type: Decomposition