**MULTIPLE CHOICE (NO CALCULATOR ALLOWED)**

1. Which of the following processes requires a chemical change?

    (A) Separating a sample of saltwater into water and salt

    (B) Separating a sample of water into hydrogen and oxygen

    (C) Separating a sample of air into nitrogen, oxygen, and other gases

    (D) Separating a sample of green ink into a blue component and a yellow component

2. Which of the following statements is consistent with Thomson's and Millikan's work with cathode rays and electrons?

    (A) Cathode rays from helium atoms are heavier than cathode rays from hydrogen atoms.

    (B) Cathode rays are attracted toward a negatively charged electric plate.

    (C) The mass of an electron is about 2000 times lighter than the mass of a hydrogen atom.

    (D) The plum pudding model of the atom consists of a uniform sphere of negative charge in which the protons are embedded, like raisins in a pudding.

3. How many protons, neutrons, and electrons are present in the following ion? $^{56}Fe^{3+}$

	Protons	Neutrons	Electrons
(A)	26	30	23
(B)	26	26	29
(C)	26	30	29
(D)	26	56	23

4. Which of the following calculations is set up correctly to determine the volume (in mL) of aluminum (density = 2.7 g/mL) of a pure sample of Al that contains 2.0 x 10^{24} atoms?

    (A) $\dfrac{(2.0\times10^{24})(26.98)(2.7)}{(6.02\times10^{23})}$

    (C) $\dfrac{(2.0\times10^{24})(2.7)}{(6.02\times10^{23})(26.98)}$

    (B) $\dfrac{(2.0\times10^{24})}{(6.02\times10^{23})(26.98)(2.7)}$

    (D) $\dfrac{(2.0\times10^{24})(26.98)}{(6.02\times10^{23})(2.7)}$
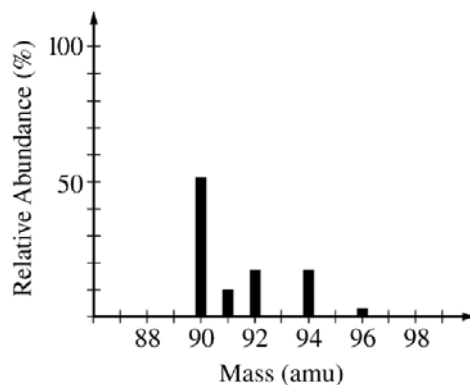
5. The mass spectrum of element X is presented in the diagram above. Based on the spectrum, which of the following can be concluded about element X?

(A) X is a transition metal, and each peak represents an oxidation state of the metal.

(B) X contains five electron sublevels.

(C) The atomic mass of X is 90.

(D) The atomic mass of X is between 90 and 92.

Compound	Empirical Formula	Mass of Carbon	Mass of Hydrogen
X	CH	3.0 g	0.25 g
Y	?	6.0 g	1.0 g

6. Based on the information shown in the table above, the empirical formula for Compound Y is

(A) C_2H

(B) CH_2

(C) CH_3

(D) CH_4

7. The element boron has two naturally occurring isotopes: ^{10}B and ^{11}B.
   Which of the following represents the most probable data for the relative abundances of these two isotopes?

	Abundance of boron-10	Abundance of boron-11
(A)	20%	80%
(B)	40%	60%
(C)	50%	50%
(D)	80%	20%

8. What is the empirical formula of an oxide of chromium that is 48 percent oxygen by mass?

   (A) CrO

   (B) CrO_2

   (C) CrO_3

   (D) Cr_2O_3

mass of crucible and lid	36.0 g
mass of crucible, lid, and metal	41.0 g
mass of crucible, lid, and metal oxide product	43.0 g

9. A metallic element is heated in air until the metal reacts completely with oxygen. Given the information in the table above, the most probable formula for the metal oxide product is

   (A) MgO

   (B) CaO

   (C) K_2O

   (D) SnO_2

10. According to the information in the table at right, a 1.00 g sample of which of the following contains the greatest mass of oxygen?

   (A) Na_2O

   (B) MgO

   (C) K_2O

   (D) CaO

Compound	Molar Mass (grams)
Na_2O	62.0
MgO	40.3
K_2O	94.2
CaO	56.1

11. The empirical formula of a compound is XF_4. This compound contains 1.6 grams of X atoms for every 3.8 grams of fluorine atoms. The atomic mass of element X is most likely to be

   (A) 16 amu

   (B) 32 amu

   (C) 64 amu

   (D) 128 amu

12. A sample of a compound that contains only the elements C, H, and N is completely burned in O_2 to produce 44.0 g of CO_2, 45.0 g of H_2O, and some NO_2. A possible empirical formula of the compound is

(A) CH_2N

(B) CH_5N

(C) C_2H_5N

(D) $C_3H_3N_2$

13. A sample of solid potassium chlorate ($KClO_3$, FW = 122.6) was placed in a test tube and heated strongly in the presence of a catalyst until it completely decomposed. The products of the decomposition reaction are potassium chloride and oxygen gas (which escaped from the test tube). If the mass of $KClO_3$ used in the experiment was 12.26 g, how many grams of oxygen gas were produced in this experiment?

(A) 2.4 g

(B) 3.2 g

(C) 4.8 g

(D) 6.4 g

$$PCl_5 \ + \ 4\,H_2O \ \rightarrow \ 5\,HCl \ + \ H_3PO_4$$
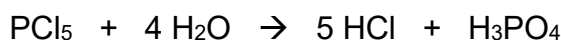
14. In the reaction represented above, how many molecules of PCl_5 are required to react completely with 18 grams of water?

(A) 1.5×10^{23}

(B) 3.0×10^{23}

(C) 6.0×10^{23}

(D) 2.4×10^{24}

15. Equal masses of $K(s)$ and $Cl_2(g)$ are combined together and allowed to react, producing $KCl(s)$. The reaction proceeds until either one or both of the reactants have been completely consumed. At that point, what remains in the reaction vessel?

(A) KCl only

(B) KCl and K only

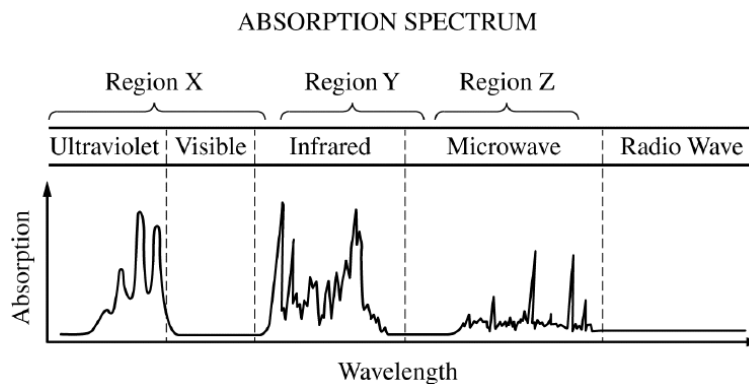(C) KCl and Cl_2 only

(D) KCl, K, and Cl_2

16. What is the limiting reactant and the theoretical yield of ammonia when 3.0 g of H_2 reacts with 7.0 g of N_2 ?

	Limiting Reactant	Theoretical Yield of NH_3
(A)	hydrogen	8.5 g
(B)	hydrogen	10. g
(C)	nitrogen	8.5 g
(D)	nitrogen	10. g

17. In a paper chromatography experiment, a sample of a pigment is separated into two components, A and B, as shown in the figure at right. The solvent (water) is polar, and the surface of the paper is coated with a material that is moderately nonpolar. What can be concluded about A and B based on the experimental results?

Filter Paper
Component A
Component B
Pigment Sample
Water
$t = 0$
$t = 15$ min
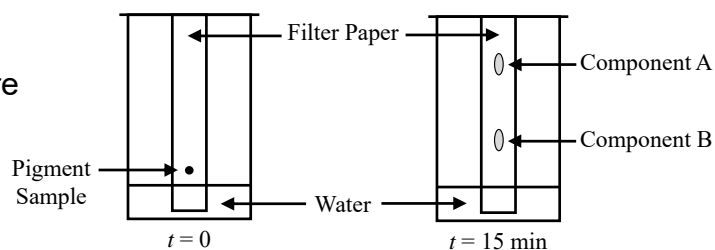
(A) A has a larger molar mass than B does.

(B) B has a larger molar mass than A does.

(C) A is more polar than B.

(D) B is more polar than A.

ABSORPTION SPECTRUM

Region X   Region Y   Region Z

Ultraviolet Visible   Infrared   Microwave   Radio Wave

Absorption

Wavelength

18. The diagram above represents the absorption spectrum for a pure molecular substance. Which of the following correctly indicates the type of transition observed for the substance in each of the regions of the absorption spectrum?

	Region X	Region Y	Region Z
(A)	Molecular vibration	Molecular rotation	Electronic transition
(B)	Electronic transition	Molecular rotation	Molecular vibration
(C)	Molecular rotation	Molecular vibration	Electronic transition
(D)	Electronic transition	Molecular vibration	Molecular rotation

CHAPTERS 1–3 PRACTICE TEST   Name_____

FREE RESPONSE (CALCULATOR IS ALLOWED)

1. Fill in the table with the missing information. Each nuclear symbol should contain the mass number and the charge.

Nuclear Symbol	Charge	Protons	Neutrons	Electrons
$^{115}In^{3+}$				
$^{32}P^{3-}$				
		35	45	36
		56	81	54

2. For each name, write the correct formula. Indicate if the substance is ionic or covalent.

Chemical Formula	Name	Ionic (I) or Covalent (C)?
	cobalt(II) carbonate	
	barium chlorate	
	dinitrogen trioxide	
	ammonium phosphate	
	sulfur tetrafluoride	

3. For each formula, write the correct name. Indicate if the substance is ionic or covalent.

| Chemical Formula	Name	Ionic (I) or Covalent (C)?
Cl_2O_7		
$Mg(NO_3)_2$		
K_2S		
PBr_5		
$Cu(C_2H_3O_2)_2$		

4. A chemist needs to determine the empirical formula of an unknown compound. This compound contains the elements C, H, N, and O.

A sample of the unknown compound with a mass of 3.8625 g was burned in excess oxygen. The reaction produced 6.8618 g of $CO_2(g)$ and 1.7557 g of $H_2O(g)$.

(a) Determine the mass, in grams, of carbon in the 3.8625 g sample of the compound.

(b) Determine the mass, in grams, of hydrogen in the 3.8625 g sample of the compound.

(c) When the compound is analyzed for nitrogen content only, the mass percent of nitrogen is found to be 14.14 percent. Determine the mass, in grams, of nitrogen in the 3.8625 g sample of the compound.

(d) Determine the mass, in grams, of oxygen in the 3.8625 g sample of the compound.

(e) Determine the empirical formula of the compound.

(f) In another experiment, it was determined that a 8.65-g sample of this compound contained 1.75×10^{22} molecules. Calculate the molar mass of this compound.

(g) Determine the molecular formula of this compound. Justify your answer.

$$2\ C_5H_{12}O\ +\ 15\ O_2\ \rightarrow\ 10\ CO_2\ +\ 12\ H_2O$$
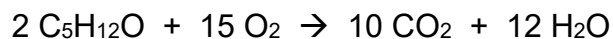
5. Liquid pentanol undergoes complete combustion in the presence of oxygen gas according to the equation above. In a certain experiment, 7.35 mL of pentanol (density = 0.814 g mL^{-1}) is added to 16.0 L of oxygen gas at 150°C. (density of O_2 @ 150°C = 0.922 g L^{-1}).

(a) Calculate the following quantities.

   (i) moles of pentanol

   (ii) moles of oxygen gas

(b) Identify the limiting reactant in this experiment. Justify your answer.

(c) Calculate the theoretical yield of carbon dioxide (in grams) that could be produced from this experiment.

(d) If the mass of carbon dioxide recovered from this experiment is 11.0 g, calculate the percent yield from this experiment.

6. In a laboratory experiment, a student obtained a sample of barium hydroxide hydrate. The number of water molecules in the hydrate formula was unknown. The formula for this compound can be written as $Ba(OH)_2 \cdot xH_2O$, where x indicates the number of moles of water per mole of $Ba(OH)_2$.

A sample of this hydrate was heated strongly in a crucible, in order to drive off the water of hydration. The anhydrous $Ba(OH)_2$ salt was then treated with excess sodium sulfate solution. This resulted in the formation of a white precipitate, barium sulfate. The precipitate was filtered from the solution, dried and weighed. The data table below indicates measurements recorded in this experiment.

Mass of clean, dry crucible	61.857 g
Mass of crucible + $Ba(OH)_2 \cdot xH_2O$ (before heating)	66.081 g
Mass of white precipitate, $BaSO_4$	3.126 g

(a) Calculate the mass of the hydrate sample $Ba(OH)_2 \cdot xH_2O$ (before heating).

(b) Write a balanced chemical equation for the reaction between barium hydroxide and sodium sulfate.

(c) The mass of the white precipitate was 3.126 g. Calculate the number of moles of this precipitate.

(d) Calculate the mass of the anhydrous salt, $Ba(OH)_2$.

(e) Calculate the mass of water that was lost in the heating process.

(f) Calculate the value of x for the sample of $Ba(OH)_2 \cdot xH_2O$.