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SECTION I

MULTIPLE CHOICE: Choose the option that best completes the statement or answers the question. Each question is worth 2.0 points unless indicated otherwise.

1. A healthy dog has a temperature ranging from 37.2°C to 39.2°C. Is a dog with a temperature of 103.5 °F within the normal range?

- a. No, because 39.7 °C is above the normal range.
 b. Yes, because 39.7 °C is within the normal range.
 c. No, because 25.5 °C is much less than the normal range.
 d. No, because 75.3 °C is much greater than the normal range.

$$T = (103.5^\circ\text{F} - 32^\circ\text{F}) \frac{5}{9} \text{C}$$

$$= 39.7^\circ\text{C}$$

2. A tentative explanation used to explain observed facts or laws is called

- a. an empirical fact.
 b. a hypothesis.
 c. the scientific method.
 d. a theory.
 e. a scientific law.

3. The two types of pure substances are

- a. compounds and solutions.
 b. elements and mixtures.
 c. mixtures and solutions.
 d. solutions and elements.
 e. compounds and elements.

4. Which is an example of a physical change?

- a. Bleach turns hair yellow.
 b. Sugar, when heated, becomes brown.
 c. Water, when heated, forms steam.
 d. Milk turns sour over time.
 e. Apples, when exposed to air, turn brown over time.

5. Which is an example of an extensive property of matter?

- a. color
 b. density
 c. mass
 d. melting point
 e. flash point

6. What is the number needed to complete the following: 1 g = ___ kg?

- a. 10^3
 b. 2.0×10^{-9}
 c. 10^{-3}
 d. 0.1
 e. 10^{12}

$$1\text{g} = 10^{-3}\text{kg}$$

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7. Give the correct answer for the following problem with the correct number of significant figures.

$$\frac{13.726 + 0.027}{8.221}$$

$$\frac{13.753}{8.221} = 1.673$$

- a. 1.7
 b. 1.67
 c. 1.673
 d. 1.703
 e. 1.699
8. Which of the following numbers has exactly **three** significant figures as written?
 a. 300
 b. 12.0
 c. 4021
 d. 0.12
 e. 0.005
9. An industrial container was filled with 210.8 liters of a solvent. How many gallons of solvent does this container contain?
 a. 179.1 gal
 b. 798.0 gal
 c. 55.00 gal
 d. 55.69 gal
 e. 59.15 gal
10. A sample of an alloy (density = 9.62 g/cm³) was submerged in a graduated cylinder containing water. The water level in the cylinder rose from 166.5 cm³ to 182.0 cm³. How many grams did the sample weigh?
 a. 0.621 g
 b. 175 g
 c. 18.9 g
 d. 17.8 g
 e. 149 g
11. In which family of elements does Fr belong?
 a. alkali metals
 b. alkaline earth metals
 c. halogens
 d. noble gases
 e. transition metals
12. Which of these elements have the most chemical properties that are similar to sulfur?
 a. calcium
 b. oxygen
 c. phosphorus
 d. bromine
 e. nitrogen

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13. Which compound exists as a diatomic molecule in the free state?

- a. helium
 b. fluorine
 c. neon
 d. argon
 e. xenon

14. Which of these pairs of elements would be most likely to form an ionic compound?

- a. P and Br *binary*
 b. Cu and K *no*
 c. C and O *binary*
 d. O and Zn *cat - anion*
 e. Al and Rb *no*

15. Write the most likely formula for the ionic compound formed from magnesium and phosphorus.

- a. MgP_2
 b. Mg_3P
 c. Mg_2P
 d. Mg_3P_2
 e. MgP_3
- Mg²⁺ P⁻³*
Mg₃P₂

16. How many protons, neutrons, and electrons are in the ion, $^{57}Fe^{3+}$?

- a. 27 protons, 30 neutrons, and 30 electrons
 b. 26 protons, 31 neutrons, and 23 electrons
 c. 29 protons, 28 neutrons, and 26 electrons
 d. 26 protons, 31 neutrons, and 29 electrons
 e. 25 protons, 32 neutrons, and 22 electrons

26
Fe
57 - 26 =
26 prot
31 neut
23 el

17. What is the name for the compound $NaCl_3$?

- a. sodium chlorate
 b. sodium chlorite
 c. sodium perchloride
 d. sodium trichloride
 e. There is no such compound.

18. The atomic mass of C is 12.011 g/mol. How many moles of C are there in a 3.50 g sample of carbon?

- a. 0.291 moles
 b. 0.374 moles
 c. 1.00 moles
 d. 3.43 moles
 e. 3.50 moles

3.50gC (1 mol C / 12.011gC) = 0.291

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19. How many moles of carbon atoms are combined with 11.2 moles of hydrogen atoms in a sample of the compound, C_3H_8 ?

- a. 3.00
 b. 5.60
 c. 4.20
 d. 6.02×10^{23}
 e. 29.9

$$11.2 \text{ mol H} \left(\frac{3 \text{ mol C}}{8 \text{ mol H}} \right) = 4.2 \text{ mol C}$$

20. Which one of the following is definitely not an empirical formula?

- a. NH_3
 b. N_2H_4
 c. $Al(NO_3)_3$
 d. H_3PO_4
 e. H_2O

21. Given the chemical equation, $2AsI_3 \rightarrow 2As + 3I_2$, how many grams of I_2 are produced in the reaction, if 4.200 g As are obtained from AsI_3 ?

Answer: 21.34 g I_2

$$4.200 \text{ g As} \left(\frac{1 \text{ mol As}}{74.92 \text{ g As}} \right) \left(\frac{3 \text{ mol } I_2}{2 \text{ mol As}} \right) \left(\frac{253.8 \text{ g } I_2}{1 \text{ mol } I_2} \right) = 21.34$$

22. Given the chemical equation, $Cl_2 + F_2 \rightarrow 2ClF$, how many moles of ClF are produced in the reaction, if 2.50 moles Cl_2 are made to react with 1.75 moles F_2 ?

Answer: 3.50 mol ClF

$$2.50 \text{ mol } Cl_2 \left(\frac{1 \text{ mol } F_2}{1 \text{ mol } Cl_2} \right) = 1.50 \text{ mol } Cl_2$$

L.R. F_2

$$1.75 \text{ mol } F_2 \left(\frac{2 \text{ mol ClF}}{1 \text{ mol } F_2} \right) = 3.50 \text{ mol ClF}$$

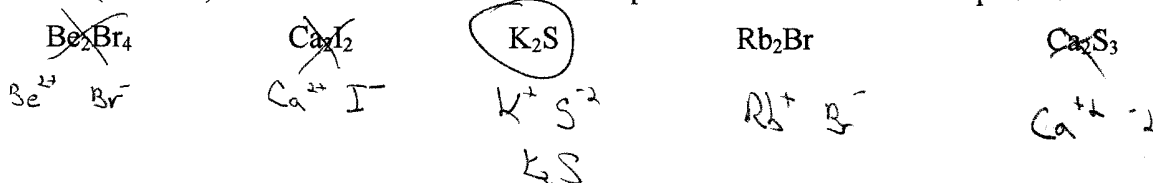
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SECTION II**Complete each of the following.****Show all work. No Credit will be given for answer only.**

1. (6 Points) What is the name of each of the following:

W	Tungsten
As	Arsenic
Br ⁻	bromide ion
CO ₃ ²⁻	carbonate ion
OH ⁻	hydroxide ion
Be ²⁺	Beryllium ion

2. (3 Points) Circle the correct formula that represents a known ionic compound?



3. (8 Points) Identify each of the following as molecules or ionic, give its name and number of atoms.

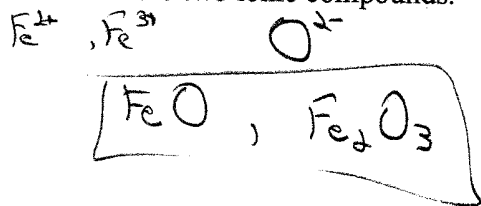
	Identification	Name and number of atoms
P ₄ O ₆	molecule	tetraphosphorous hexoxide 10
CaSO ₃	ionic	calcium sulfite 5
S ₂ Cl ₂	molecule	disulfur dichloride 4
Fe(OH) ₂	ionic	iron (II) hydroxide 5

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4. (8 Points) Write chemical formulas for the following.

	Chemical Formula
iron (III) oxide iodide $Fe^{3+} I^{-}$	FeI_3
chromium (III) sulfate hexahydrate $Cr^{+3} SO_4^{-2} 6 H_2O$	$Cr_2(SO_4)_3 \cdot 6 H_2O$
boron trichloride	BCl_3
xenon tetrafluoride	XeF_4

5. (3 Points) Iron metal can form two compounds with oxygen. Write the chemical formula for the two ionic compounds.



6. (8 Points) Complete the blanks and show the work.

- a. When the equation is balanced, $PCl_3(l) + 3H_2O(l) \rightarrow H_3PO_3(aq) + 3HCl(aq)$, the coefficient of H_2O is 3.
- b. When the equation is balanced, $SF_4 + 3H_2O \rightarrow H_2SO_3 + 4HF$, the coefficient of HF is 4.
- c. When the equation is balanced, $CF_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$, the coefficient of HCl is 4.

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7. (6 Points) Calculate the percentage composition by mass for each element in $\text{NH}_4\text{H}_2\text{PO}_4$.

Step 1: Calculate the molar mass of the ionic compound

N	1	14.01	14.01
H	6	1.008	6.048
P	1	30.97	30.97
O	4	16.00	64.00
			115.028 g/mol

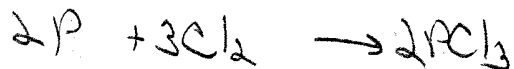
Step 2: Calculate the percent composition of each element

$$\begin{array}{l}
 \text{N} \quad \frac{14.01}{115.028} \times 100 = 12.18\% \\
 \text{H} \quad \frac{6.048}{115.028} \times 100 = 5.25\% \\
 \text{P} \quad \frac{30.97}{115.028} \times 100 = 26.92\% \\
 \text{O} \quad \frac{64.00}{115.028} \times 100 = 55.64\% \\
 \hline
 \quad \quad \quad 100\%
 \end{array}$$

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8. (7 Points) A chemist set up a synthesis of phosphorous trichloride by mixing ^{33.0}12.0 g of phosphorous with ~~35.0~~ g chlorine gas and obtained experimentally ~~41.7~~ 10.0 g of solid phosphorous trichloride. Calculate the percent yield of this compounds. 10.0

Step 1: Write the balanced chemical reaction.



Step 2: Calculate the theoretical production of phosphorous trichloride (Hint: Limiting Reactant).

$$33.0 \text{ g P} \left(\frac{1 \text{ mol P}}{30.97 \text{ g P}} \right) \left(\frac{3 \text{ mol Cl}_2}{2 \text{ mol P}} \right) \left(\frac{70.9 \text{ g Cl}_2}{1 \text{ mol Cl}_2} \right) = 120.15 \text{ g Cl}_2$$

L.R. Cl₂

$$12.0 \text{ g Cl}_2 \left(\frac{1 \text{ mol Cl}_2}{70.9 \text{ g Cl}_2} \right) \left(\frac{2 \text{ mol PCl}_3}{3 \text{ mol Cl}_2} \right) \left(\frac{137.32 \text{ g PCl}_3}{1 \text{ mol PCl}_3} \right) = 15.4344 \text{ g PCl}_3$$

Step 3: Calculate the Percent Yield.

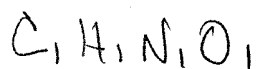
$$\% \text{ yield} = \frac{10.0 \text{ g}}{15.434 \text{ g}} \times 100 = \boxed{64.84\%}$$

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9. (7 Points) A sample of a compound of C, H, N, and O, was found to have a percentage composition of 27.91% C, 3.41% H, and 32.56% N. Its formula mass is 129 g/mol. Calculate the empirical formula and molecular formula.

Step 1: Calculate the Empirical Formula

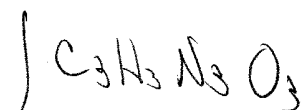
		mass 100g	moles	ratio
C	27.91%	27.91g	12.01	2.32389
H	3.41%	3.41g	1.008	2.1516
N	32.56%	32.56g	14.01	2.3240
O	37.184%	37.184g	16.00	2.3243



$$\begin{array}{r}
 M_w = \\
 \begin{array}{l}
 C \quad 1 \quad 12.01 \\
 H \quad 1 \quad 1.008 \\
 N \quad 1 \quad 14.01 \\
 O \quad 1 \quad 16.00 \\
 \hline
 43.108 \text{ g/mol}
 \end{array}
 \end{array}$$

Step 2: Calculate the Molecular Formula

$$n = \frac{129.5 \text{ g/mol}}{43.108 \text{ g/mol}} = 3$$



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SECTION III: BONUS POINTS

Complete each of the following.

Show all work. No Credit will be given for answer only.

1. (2 Points) How many molecules of air exist in a standard USA room? The volume of a standard USA room is 1,200 ft³, the molar mass of dry air is 28.97 g/mol and the density of dry air is 0.0012 g/cm³. (Hint: 1 ft = 30.48 cm)

$$1,200 \text{ ft}^3 \left(\frac{30.48 \text{ cm}}{1 \text{ ft}} \right)^3 \left(\frac{0.0012 \text{ g}}{1 \text{ cm}^3} \right) \left(\frac{1 \text{ mol}}{28.97 \text{ g}} \right) \left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \right) = 8.476 \times 10^{26} \text{ molecules of Air}$$

2. (2 Points) Define specific gravity

$$SG = \frac{\text{sample density}}{\text{water density}} \quad \text{@ specific gravity}$$

3. (2 Points) Give me an example of a chemical change in daily life and explain the chemical reason.

rust corrosion

electrolysis

4. (2 Points) How many atoms are there in one formula unit of (NH₄)₄Fe(CN)₆?

$$\text{N} \quad 4 \times 6 = 24$$

$$\text{H} \quad 4 \times 4 = 16$$

$$\text{Fe} \quad 1$$

$$\text{C} \quad 6$$

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Periodic Table of the Elements

1A												2A												8A											
1	H 1.008											4	Be											2	He 4.003										
3	Li 6.939											12	Mg											10	Ne 20.18										
11	Na 22.99											20	Ca											17	Cl 35.45										
19	K 39.10											21	Sc											35	Br 79.90										
37	Rb 85.47											38	Sr											54	Xe 131.3										
55	Cs 132.9											39	Y											86	Rn [222]										
87	Fr [223]											56	Ba											88	Ra [226]										
		3B										4B		5B		6B		7B		8B		1B		2B		3A		4A		5A		6A		7A	
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
		Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
		44.96	47.90	50.94	52.00	54.94	55.85	58.93	58.71	63.55	65.37	69.72	72.59	74.92	78.96	79.90	83.80	85.47	87.62	88.91	91.22	92.91	95.94	98.91	101.1	102.9	106.4	107.9	112.4	114.8	118.7	121.8	127.	126.9	131.3
		La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Th	Pa	U	
		138.9	178.5	180.9	183.9	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	(210)	(210)	(222)	140.1	140.9	144.2	(145)	150.4	152.0	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175	231	238.0		
		Lanthanum series																Actinium series																	

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USEFUL INFORMATION

$$\% \text{Yield} = \frac{\text{actual}}{\text{theoretical}} * 100$$

$$T_C = (T_F - 32^\circ F) * \frac{5^\circ C}{9^\circ F}$$

$$N = \frac{\text{sample}_{\text{mass}}}{\text{atom}_{\text{mass}}}$$

$$\text{Mass}\%_{\text{element}} = \frac{\text{mass}_{\text{element}}}{\text{mass}_{\text{total-sample}}} * 100\%$$

$$M = m_{\text{atom}} N_A$$

$$N = n N_A$$

$$\frac{\text{molar_mass_of_compound}}{\text{molar_mass_of_empirical_formula_unit}} = \text{interger}$$

$$m = nM$$

Measurement	English Units	SI Units	Power of Ten	Normal Notation	Word	Metric Prefix	Abbrev
Length	inch	1 in. = 2.54 cm	10 ¹²	1,000,000,000,000	trillion	Tera	T
	yard	1 yd = 0.9144 m	10 ⁹	1,000,000,000	billion	Giga	G
	mile	1 mile = 1.609 km	10 ⁶	1,000,000	million	Mega	M
Mass	pounds	1 lb = 453.6 g	10 ³	1,000	thousand	kilo	k
	ounces (mass)	1 oz = 28.35 g	10 ⁰	1	one	-	-
Volume	gallon	1 gal = 3.785 L	10 ⁻²	0.01	hundredth	centi	C
	quart	1 qt = 946.4 mL	10 ⁻³	0.001	thousandth	milli	m
	ounce (fluid)	1 Oz = 29.6 mL	10 ⁻⁶	0.000001	millionth	micro	μ ("mu")
			10 ⁻⁹	0.000000001	billionth	nano	n

