

Chemical Principles 115
Department of Chemistry
Rutgers, The State University of New Jersey- Camden

EXAM 1 A

Name: _____
 Last Key First Initial

Date: _____

RU Number: _____

Name: _____

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. Convert 79.0°F to °C.

- a. 79.0 °C
 b. 26.1 °C
 c. 352 °C
 d. 45 °C
 e. 111 °C

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

$$= (79.0 - 32) \left(\frac{5^\circ C}{9^\circ F} \right) = 26.1^\circ C$$

2. Which of the following gives the best description of what the scientific method is?

- a. It is unifying principle that explains a body of facts and relations.
 b. It is the process of making observations and then designing ways to evaluate or explain those observations.
 c. It is a guidebook for laboratory techniques that is followed by all chemists.
 d. It is the process of carefully following the steps of a lab procedure.
 e. It is the guidelines that are followed during laboratory measurements.

3. The two types of pure substances are

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

4. Which is an example of a physical change?

- a. The milk in the box left on the table becomes sour after a few days.
 b. The bit of scrap metal dissolves when placed in the container of acid.
 c. The gas is cooled until it finally becomes a liquid.
 d. A piece of paper burns in air with a smoky flame.
 e. Bubbles are seen on the egg shell after some vinegar is poured on it.

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

- a. temperature
 b. volume
 c. length
 d. weight
 e. ~~melting point~~ number of moles

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

- a. 10⁶
 b. 10⁻⁹
 c. 10⁻³
 d. 0.1
 e. None of the above

1g = 10⁶ micrograms

Name: _____

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

$$(1.5 \times 10^{-4} \times 61.3) + 2.01$$

$$0.009195 + 2.01$$

2 sig

$$= 2.02$$

- a. 2.0192
 b. 2.0
 c. 2.019
 d. 2.02
 e. 2.019195
8. Which of the following numbers has exactly **four** significant figures as written?
 a. 3150
 b. 0.921
 c. 4020
 d. 0.0068
 e. 170.0
9. An industrial container was filled with 210.8 liters of a solvent. How many gallons of solvent does this container contain?
 a. 55.00 gal
 b. 55.69 gal
 c. 59.15 gal
 d. 179.1 gal
 e. 798.0 gal
- 210.8 L $\left(\frac{1 \text{ gal}}{3.785 \text{ L}} \right) = 55.69$
10. A sample of zinc metal (density = 7.14 g/cm^3) was submerged in a graduated cylinder containing water. The water level in the cylinder rose from 162.5 cm^3 to 186.0 cm^3 . How many grams did the sample weigh?
 a. 168 g
 b. 22.7 g
 c. 26.1 g
 d. 8.8 g
 e. 3.29 g
- $186.0 \text{ cm}^3 - 162.5 \text{ cm}^3 = 23.5 \text{ cm}^3$
 $d = \frac{m}{V} \Rightarrow m = d \cdot V = 7.14 \frac{\text{g}}{\text{cm}^3} (23.5 \text{ cm}^3)$
 $167.79 \text{ g} = 168$
11. In which family of elements does Ra 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 magnesium?
 a. calcium
 b. sodium
 c. aluminum
 d. iron
 e. cesium

Name: _____

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

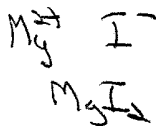
- a. helium
 b. neon
 c. argon
 d. iodine
 e. xenon

14. Which of these pairs of elements would be most likely to form a binary compound?

- a. P and Br
~~b. Cu and K~~
~~c. K and O~~
~~d. O and Zn~~
~~e. Al and Rb~~

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

- a. MgI
 b. Mg₂I
 c. MgI₂
 d. MgI₃
 e. Mg₃I

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

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

$$\begin{array}{l} \text{Fe} \quad p: (26) \\ 57 - 26 = (31) \text{ neutrons} \\ 26 - 3 = (23) \text{ electrons} \end{array}$$

17. What is the name for the compound NaCl₃?

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

18. The atomic mass of Mg is 24.305 g/mol. How many moles of Mg are there in a 3.50 g sample of magnesium?

- a. 0.0182 moles
 b. 0.144 moles
 c. 0.218 moles
 d. 0.226 moles
 e. 1.31×10^{23} moles

$$3.50 \text{ g Mg} \left(\frac{1 \text{ mol Mg}}{24.305 \text{ g}} \right) = 0.144 \text{ mol}$$

Name: _____

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. 4.20
 c. 5.60
 d. 6.02×10^{23}
 e. 29.9

$$C_3H_8$$

$$1 \text{ mol } C_3H_8 = 8 \text{ mol H}$$

$$3 \text{ mol C} = 8 \text{ mol H}$$

$$11.2 \text{ mol H} \left(\frac{3 \text{ mol C}}{8 \text{ mol H}} \right) = 4.20$$

20. A compound has an empirical formula of CH_2O . An independent analysis gave a value of 150.13 g for its molar mass. What is the molecular formula of the compound?

- a. $C_5H_{10}O_5$
 b. $C_6H_{12}O_6$
 c. $C_{11}H_{22}O_{11}$
 d. $C_6H_6O_6$
 e. $C_9H_{10}O_2$

$$n = \frac{\text{molar mass}}{\text{empirical mass}}$$

$$CH_2O = 30.026$$

$$\frac{150.13 \text{ g/mol}}{30.026 \text{ g/mol}} = 5$$

$$C_5H_{10}O_5$$

21. Given the chemical equation, $2AsI_3 \rightarrow 2As + 3I_2$, how many grams of I_2 are produced in the reaction, if 3.200 g As are obtained from AsI_3 ?

Answer: 16.26 g I_2

$$3.2000 \text{ g As} \left(\frac{1 \text{ mol As}}{74.92 \text{ g}} \right) \left(\frac{3 \text{ mol } I_2}{2 \text{ mol As}} \right) \left(\frac{253.8 \text{ g}}{1 \text{ mol } I_2} \right) =$$

22. Given the chemical equation, $Cl_2 + F_2 \rightarrow 2ClF$, how many moles of ClF are produced in the reaction, if 1.50 moles Cl_2 are made to react with 1.75 moles F_2 ?

Answer: 3 mol ClF

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

L.R. Cl_2

$$1.50 \text{ mol } Cl_2 \left(\frac{2 \text{ mol } ClF}{1 \text{ mol } Cl_2} \right) =$$

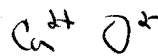
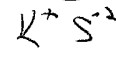
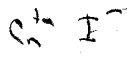
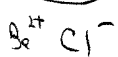
Name: _____

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:

Sn	Tin
Pb	Lead
I ⁻	Iodide ion
NO ₃ ⁻	nitrate ion
H ₃ O ⁺	hydronium ion
Al ³⁺	aluminum 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, and give its name and number of atoms.

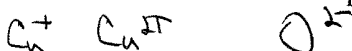
	Identification	Name and Number of Atoms
S ₂ Cl ₁₂	molecule	disulfur dodechloride / 14
C ₄ H ₁₀	molecule	butane 14
MgSO ₄	ionic	magnesium sulfate 6
Fe(OH) ₂	ionic	iron (II) hydroxide 5

Name: _____

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

	Chemical Formula
Dialuminum hexachloride	Al_2Cl_6
Chromium (II) sulfide $Cr^{2+} S^{2-}$	CrS
calcium chloride dihydrate $Ca^{2+} Cl^-$	$CaCl_2 \cdot 2H_2O$
xenon tetrafluoride	XeF_4

5. (3 Points) Copper 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, $2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$, the coefficient for CO_2 is 3.

b. When the equation is balanced, $TiCl_4(g) + 2Mg(l) \rightarrow 2MgCl_2(l) + Ti(s)$, the coefficient for $TiCl_4$ is 1.

c. When the equation is balanced, $V_2O_5(s) + 5Ca(l) \rightarrow 2V(l) + 5CaO(s)$, the coefficient for CaO is, 5.

d. When the equation is balanced, $2NaCl(s) + H_2SO_4(aq) \rightarrow 2HCl(g) + Na_2SO_4(s)$, the coefficient for HCl is, 2.

Name: _____

7. (6 Points) Calculate the percentage composition by mass for each element in $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$

Step 1: Calculate the molar mass of the ionic compound

		5/2		5/2
Ca	1	40.08		40.08
C	4	12.01		48.04
H	6	1.008		6.048
O	4	16.00		64.00
				158.168

158.168 g/mol

Step 2: Calculate the Percent Composition of each Element

$$\text{Ca} : \frac{40.08}{158.168} \times 100 = \boxed{25.34\%}$$

$$\text{C} : \frac{48.04}{158.168} \times 100 = \boxed{30.37\%}$$

$$\text{H} : \frac{6.048}{158.168} \times 100 = \boxed{3.82\%}$$

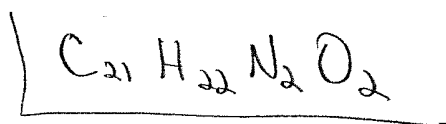
$$\text{O} : \frac{64.00}{158.168} \times 100 = \boxed{40.46\%}$$

Name: _____

8. (7 Points) Strychnine, a deadly poison, has a formula mass of 334 g/mol and a percentage composition of 75.42% C, 6.63% H, 8.38% N and the balanced oxygen. Calculate the empirical formula and molecular formula of strychnine.

Step 1: Calculate the Empirical Formula

	%	100g	Mw g/mol	moles	ratio		
C	75.42	75.42g	12.01	6.27977	10.5	$\frac{105}{10}$	$\frac{21}{2}$
H	6.63	6.63g	1.008	6.5774	11		
N	8.38	8.38g	14.01	0.59814	1		
O	9.57	9.57g	16.00	<u>0.59812</u>	1		
				5.9812			



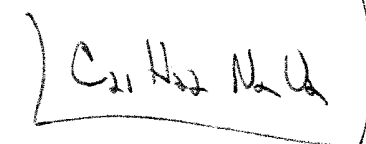
Mw:

C	21	12.01	252.21
H	22	1.008	22.176
N	2	14.01	28.02
O	2	16.00	32

$$\boxed{334.406 \text{ g/mol}}$$

Step 2: Calculate the Molecular Formula

$$\text{Integer} = \frac{334 \text{ g/mol}}{334.406 \text{ g/mol}} \approx 1$$



Name: _____

9. (7 Points) A chemist set up a synthesis of phosphorous trichloride by mixing 12.0 g of phosphorous with 35.0 g chlorine gas and obtained experimentally 41.7 g of solid phosphorous trichloride. Calculate the percent yield of this compounds.

Step 1: Write the balanced chemical reaction.



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

$$12.0 \text{ g P} \left(\frac{1 \text{ mol P}}{30.97 \text{ g P}} \right) \left(\frac{3 \text{ mol Cl}_2}{2 \text{ mol P}} \right) \left(\frac{70.9 \text{ g Cl}_2}{1 \text{ mol Cl}_2} \right) = 41.207 \text{ g Cl}_2 \text{ bigger}$$

L.R. Cl_2

$$35.0 \text{ g } Cl_2 \left(\frac{1 \text{ mol } Cl_2}{70.9 \text{ g } Cl_2} \right) \left(\frac{2 \text{ mol } PCl_3}{3 \text{ mol } Cl_2} \right) \left(\frac{137.32 \text{ g } PCl_3}{1 \text{ mol } PCl_3} \right) = 45.19 \text{ g } PCl_3$$

Step 3: Calculate the Percent Yield.

$$\% \text{ Yield} = \frac{41.7 \text{ g}}{45.19 \text{ g}} \times 100 = 92.28\%$$

Name: _____

SECTION III: BONUS POINTS**Complete each of the following.****Show all work. No Credit will be given for answer only.**

1. (2 Points) Give me an example of a chemical change in daily life and Explain the chemical reason.

Metal corrosion

channel reactor by reason of electrochemical oxidation

2. (2 Points) Define specific gravity

$$SG = \frac{\text{sample density}}{\text{water density}} \quad @ \text{ same temperature}$$

3. (2 Points) How many atoms are there in one formula unit of $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$?

Ni	1
S	1
O	4+7=11
H	14
27	

4. (2 Points) How many molecules of air exist in a standard USA room? The volume of a standard USA room is $1,200 \text{ ft}^3$, the molar mass of dry air is 28.97 g/mol and the density of dry air is 0.0012 g/cm^3 . (Hint: $1 \text{ ft} = 30.48 \text{ cm}$)

$$1 \text{ mol Air} = 6.022 \times 10^{23} \text{ molecules Air}$$

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

Name: _____

Periodic Table of the Elements

1A 1 H 1.008	2A 4 Be 9.012											3A 5 B 10.81	4A 6 C 12.01	5A 7 N 14.01	6A 8 O 16.00	7A 9 F 18.99	8A 2 He 4.003										
3 Li 6.939	11 Na 22.99	12 Mg 24.31	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.55	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80							
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [99]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.	53 I 126.9	54 Xe 131.3				86 Rn [222]						
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At [210]				89 Ac (227)							
87 Fr [223]	88 Ra [226]	89 Ac (227)	104	105	106																						
Lanthanum series																											
Actinium series																											
58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175	90 Th 231	91 Pa 231	92 U 238.0	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (256)	103 Lr (257)

Name: _____

USEFUL INFORMATION

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

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

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

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

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

$$N = n N_A$$

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

$$m = nM$$

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

