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

EXAM 1 A

Name: Key
Last 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

$T_C = (T_F - 32°F)\frac{5°C}{9°F}$

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

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.) 10^6
   b. 10^{-9}
   c. 10^{-3}
   d. 0.1
   e. None of the above

µg microgram 10^6

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

$$210.8\ L \left(\frac{1\ gal}{3.785\ L}\right) = 55.69$$

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

$186.0\ cm^3 - 162.5\ cm^3 = 23.5\ cm^3$

$d = \frac{m}{V} \Rightarrow m = (V)(7.14\ g/cm^3)(23.5\ cm^3)$

167.79 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

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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. Mg_2I
    c. MgI_2
    d. MgI_3
    e. Mg_3I

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

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 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

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

C_3H_8

$1\ mol\ C_3H_8 = 8\ mol\ H$

$3\ mol\ C = 8\ mol\ H$

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

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. $C_{11}H_2O$
d. $C_6H_6O_8$
e. $C_9H_{10}O_2$

$CH_2O = 30.026$

$n = \frac{\text{molar mass}}{\text{empirical mass}} = \frac{150.13\ g/mol}{30.026\ g/mol} = 5$

$C_5H_{10}O_5$

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

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

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

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

L.R. Cl_2

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

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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:

Sn	Tin
Pb	Lead
I^-	Iodide ion
NO_3^-	nitrate ion
H_3O^+	hydronium ion
Al^{3+}	aluminum ion

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

$BeCl_2$ CaI_2 K_2S $RbBr$ Ca_2O_3

Be^{2+} Cl^- Ca^{2+} I^- K^+ S^{-2} Ca^{2+} O^{2-}

$BeCl_2$ CaI_2

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_2Cl_{12}	molecule	disulfur dodecachloride / 14
C_4H_{10}	molecule	butane 14
$MgSO_4$	ionic	magnesium sulfite 6
$Fe(OH)_2$	ionic	iron (II) hydroxide 5

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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.

Cu^+ Cu^{2+} O^{2-}

① Cu_2O

② CuO

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___.

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7. (6 Points) Calculate the percentage composition by mass for each element in $Ca(C_2H_3O_2)_2$

Step 1: Calculate the molar mass of the ionic compound

		s/l	s/l
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 s/l

Step 2: Calculate the Percent Composition of each Element

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

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

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

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

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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	0.59812	1	

smallest

$C_{21} H_{22} N_2 O_2$

M_w:

C	21	12.01	252.21
H	22	1.008	22.176
N	2	14.01	28.02
O	2	16.00	32
			334.406 g/mol

Step 2: Calculate the Molecular Formula

integer : $\frac{334 \text{ g/mol}}{334.406 \text{ g/mol}} \approx 1$

$C_{21} H_{22} N_2 O_2$

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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 phosphorus trichloride. Calculate the percent yield of this compounds.

Step 1: Write the balanced chemical reaction.

$2P + 3Cl_2 \rightarrow 2PCl_3$

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

$12.0\,g\,P \left(\frac{1\,mol\,P}{30.97\,g\,P}\right)\left(\frac{3\,mol\,Cl_2}{2\,mol\,P}\right)\left(\frac{70.9\,g\,Cl_2}{1\,mol\,Cl_2}\right) = 41.107\,g\,Cl_2$ bigger

L.R. Cl_2

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

Step 3: Calculate the Percent Yield.

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

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

Metal corrosion
chemical reaction by means of electrochemical oxidation

2. (2 Points) Define specific gravity

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

3. (2 Points) How many atoms are there in one formula unit of $NiSO_4 \cdot 7H_2O$?

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 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 ft = 30.48 cm)

1 mol Air = 6.022×10^{23} molecules Air

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

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Periodic Table of the Elements

1A	2A	3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	8A
1 H 1.008																	2 He 4.003
3 Li 6.939	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 18.99	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.96	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
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 127.6	53 I 126.9	54 Xe 131.3
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]	86 Rn [222]
87 Fr [223]	88 Ra [226]	89 Ac (227)	104	105	106												

Lanthanum 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
Actinium series	90 Th	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)

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USEFUL INFORMATION

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

$$T_C = (T_F - 32°F) * \frac{5°C}{9°F} \qquad N = \frac{sample_{mass}}{atom_{mass}} \qquad Mass\%_{element} = \frac{mass_{element}}{mass_{total-sample}} * 100\%$$

$$M = m_{atom} N_A$$

$$N = nN_A \qquad \frac{molar\_mass\_of\_compound}{molar\_mass\_of\_empirical\_formula\_unit} = \text{interger}$$

$$m = nM$$

Measurement	English Units	SI Units
Length	inch	1 in. = 2.54 cm
	yard	1 yd = 0.9144 m
	mile	1 mile = 1.609 km
Mass	pounds	1 lb = 453.6 g
	ounces (mass)	1 oz = 28.35 g
Volume	gallon	1 gal = 3.785 L
	quart	1 qt = 946.4 mL
	ounce (fluid)	1 0z = 29.6 mL

Power of Ten	Normal Notation	Word	Metric Prefix	Abbrev
10^{12}	1,000,000,000,000	trillion	Tera	T
10^{9}	1,000,000,000	billion	Giga	G
10^{6}	1,000,000	million	Mega	M
10^{3}	1,000	thousand	kilo	k
10^{0}	1	one	-	-
10^{-2}	0.01	hundredth	centi	C
10^{-3}	0.001	thousandth	milli	m
10^{-6}	0.000001	millionth	micro	μ ("mu")
10^{-9}	0.000000001	billionth	nano	n