Unit 7 Test
Honors Chemistry

Name _____
Block _____

Must Show Calculations! No Work, No Credit!

Molar Mass & Percent Composition

1.) Calculate the molar mass and percent composition of **calcium hypochlorite**.

$Ca(ClO)_2$ **(10 points)**

Ca	1	x	40.0	=	40
Cl	2	x	35.5	=	71
O	2	x	16.0	=	32

143 g/mol $Ca(ClO)_2$ **(10 points)**

Ca	40	÷	143	x	100	=	27.97% Ca
Cl	71	÷	143	x	100	=	49.65% Cl
O	32	÷	143	x	100	=	22.38% O

(8 points)

2.) Calculate the molar mass and percent composition of **iron III cyanide**. $Fe(CN)_3$ (10 points)

Fe	1	x	55.8	=	56
C	3	x	12.0	=	36
N	3	x	14.0	=	42

Calcium Hypochlorite = 134 g/mol $Ca(ClO)_2$

Fe	56	÷	134	x	100	=	41.79% Fe
C	36	÷	134	x	100	=	26.87% C
N	42	÷	134	x	100	=	31.34% N

(8 points)

2.) Calculate the molar mass and percent composition of **ammonium nitrate**. NH_4NO_3 (10 points)

N	2	x	14	=	28
H	4	x	1	=	4
O	3	x	16	=	48

Ammonium nitrate = 80 g/mol NH_4NO_3

N	28	÷	80	x	100	=	**35.00% N**
H	4	÷	80	x	100	=	**5.00% H**
O	48	÷	80	x	100	=	**60.00% O**

(8 points)

Empirical Formulas

.) Calculate the molar mass and percent composition of **gold III sulfate**. $Au_2(SO_4)_3$ **(10 points)**

Au	2	x	197	=	394
S	3	x	32	=	96
O	12	x	16	=	192

Aluminum sulfate = 682 g/mol $Al_2(SO_4)_3$

Au	394	÷	682	x	100	=	57.77% Au **(8 points)**
S	96	÷	682	x	100	=	14.08% S
O	192	÷	682	x	100	=	28.15% O

2.) Calculate the molar mass and percent composition of **beryllium phosphate.** $Be_3(PO_4)_2$ **(10 points)**

Be	3	x	9	=	27
P	2	x	31	=	62
O	8	x	16	=	128

Beryllium phosphate = 217 g/mol $Be_3(PO_4)_2$

Be	27	÷	217	x	100	=	12.44% Be **(8 points)**
P	62	÷	217	x	100	=	28.57% P
O	128	÷	217	x	100	=	58.99% O

Calculate the molar mass and percent composition of **lead IV carbonate**. $Pb(CO_3)_2$ **(10 points)**

Pb	1	x	207	=	207
C	2	x	12	=	24
O	6	x	16	=	96

Beryllium nitrate = 133 g/mol CH_3CH_2OH

Be	9	÷	133	x	100	=	6.77% Be **(8 points)**
N	28	÷	133	x	100	=	21.05% N
O	96	÷	133	x	100	=	72.18% O

.) Oxybenzone, an ingredient in sunscreens, contains 73.67% C, 5.30% H, and 21.03% O. Find its empirical formula. **(17 points)**

C	73.67 grams	1 mol / 12.0 grams	=	6.139	mol /	1.314=	4.67	x3 =	14
H	5.30 grams	1 mol / 1.0 grams	=	5.30	mol /	1.314=	4	x3 =	12
O	21.03 grams	1 mol / 16.0 grams	=	1.314	mol /	1.314=	1	x3 =	3

Formula is: $C_{14}H_{12}O_3$

2.) Salicylic acid helps unclog pores to resolve acne. It contains 60.87% C, 4.38% H, and 34.75% O. Calculate its empirical formula. **(17 points)**

C	60.87 grams	1 mol / 12.0 grams	=	5.073	mol /	2.172=	2.33	x3 = 7
H	4.38 grams	1 mol / 1.0 grams	=	4.380	mol /	2.172=	2	x3 = 6
O	34.75 grams	1 mol / 16.0 grams	=	2.172	mol /	2.172=	1	x3 = 3

Formula is: $C_7H_6O_3$

Find the empirical formula for a flavoring derived from orchids, which contains 63.15% C, 5.30 % H, and 31.55% O. **(15 points)**

C	63.15 grams	÷ 12 g/mol	=	5.263	mol /	1.972 =	2.67	x 3 = 8
H	5.30 grams	÷ 1 g/mol	=	5.300	mol /	1.972 =	2.69	x 3 = 8
O	31.55 grams	÷ 16 g/mol	=	1.972	mol /	1.972 =	1	x 3 = 3

Formula is: $C_8H_8O_3$

Nitroglycerine helps widen the blood vessels so more blood gets to the heart muscle. It contains 15.87% C, 2.16% H, 18.15% N, and 63.41% O. Find its empirical formula.

C	15.87 grams	1 mol / 12.0 grams	=	1.323	mol /	1.296 =	1	x 3 = 3
H	2.16 grams	1 mol / 1.0 grams	=	2.16	mol /	1.296 =	1.67	x 3 = 5
N	18.15 grams	1 mol / 14.0 grams	=	1.296	mol /	1.296 =	1	x 3 = 3
O	63.41 grams	1 mol / 16.0 grams	=	3.963	mol /	1.296 =	3	x 3 = 9

Formula is: $C_3H_5N_3O_9$

Theobromine, a bitter alkaloid flavoring in chocolate, is composed of 40.04% Ca, 12.00%C, and 48% O by mass. Calculate the empirical formula.

C	46.67 grams	1 mol / 12.0 grams	=	3.889	mol /	1.110 =	3.5	x 2 = 7
H	4.48 grams	1 mol / 1.0 grams	=	4.480	mol /	1.110 =	4	x 2 = 8
N	31.10 grams	1 mol / 14.0 grams	=	2.221	mol /	1.110 =	2	x 2 = 4
O	17.76 grams	1 mol / 16.0 grams	=	1.110	mol /	1.110 =	1	x 2 = 2

Formula is: $C_7H_8N_4O_2$

One form of asbestos, chrysolite, has the composition 26.31% Mg, 20.27% Si, 1.45% H, and the remainder is oxygen. Determine the empirical formula of chrysolite.

Mg	26.31 grams	1 mol / 24.3 grams	=	1.083	mol /	0.724=	1.5	x2 = 3
Si	20.27 grams	1 mol / 28.0 grams	=	0.724	mol /	0.724=	1	x2 = 2
H	1.45 grams	1 mol / 1 .0 grams	=	1.450	mol /	0.724=	2	x2 = 4
O	51.97 grams	1 mol / 16.0grams	=	3.248	mol/	0.724=	4.5	x2 = 9

Formula is: $Mg_3Si_2H_4O_9$

1.) Forsterite, a gemstone most commonly found in igneous rocks, contains 34.55% Mg, 19.96% Si, and 45.49% O. Find its empirical formula. **(11 points)**

Mg	34.55 grams	÷ 24.3 g/mol	=	1.422	mol /	0.713=	2
Si	19.96 grams	÷ 28 g/mol	=	0.713	mol /	0.713=	1
O	45.49 grams	÷ 16 g/mol	=	2.843	mol/	0.713=	4
						Formula is =	Mg_2SiO_4

An emerald green gemstone contains 13.18% Be, 26.31% Al, 13.69% Si, and 46.81% O. Calculate its empirical formula. **(14 points)**

Be	13.18 grams	1 mol / 9.0 grams	=	1.464	mol /	0.489=	3
Al	26.31 grams	1 mol / 27.0 grams	=	0.974	mol /	0.489=	2
Si	13.69 grams	1 mol / 28.0 grams	=	0.489	mol /	0.489=	1
O	46.81 grams	1 mol / 16.0grams	=	2.926	mol/	0.489=	6

Formula is: $Be_3Al_3SiO_6$

Find the empirical formula for Camphor, a chemical with a strong, sweet woody odor, which contains 78.90% C, 10.59% H, and 10.51% O. **(15 points)**

C	78.90 grams	÷ 12 g/mol	=	6.575	mol /	0.659 =	9.98	= 10
H	10.59 grams	÷ 1 g/mol	=	10.59	mol /	0.659 =	16.07	= 16
O	10.51 grams	÷ 16 g/mol	=	0.659	mol /	0.659 =	1	= 1

Formula is: $C_{10}H_{16}O$

Find the empirical formula for an alcohol commonly used in cooking recipes, which contains 52.15% C, 13.04% H, and 34.78% O. **(12 points)**

C	52.15 grams	1 mol / 12.0 grams	=	4.346	mol /	2.174=	2.
H	13.04 grams	1 mol / 1.0 grams	=	13.040	mol /	2.174 =	6

O	34.78 grams	1 mol					
		16.0 grams	=	2.174	mol /	2.174=	1

Formula is: C_2H_6O

The percent composition of zircon is 49.76% Zr, 15.32% Si, and the remainder oxygen. Determine the empirical formula of zircon.

Zr	49.76 grams	1 mol					
		91.2 grams	=	0.546	mol /	0.546=	1
Si	15.32 grams	1 mol					
		28.0 grams	=	0.547	mol /	0.546=	1
O	34.92 grams	1 mol					
		16.0 grams	=	2.183	mol /	0.546=	4

Formula is: $ZrSiO_4$

Find the empirical formula of a chemical, used to remove finger nail polish, which contains 62.04% C, 10.41% H, and the remainder is oxygen.

C	52.15 grams	1 mol					
		12.0 grams	=	4.346	mol /	2.174=	2.
H	13.04 grams	1 mol					
		1.0 grams	=	13.040	mol /	2.174 =	6
O	34.78 grams	1 mol					
		16.0 grams	=	2.174	mol /	2.174=	1

Formula is: C_2H_6O

Molecular Formulas

1.) Phenolphthalein, an acid base indicator, has an empirical formula of $C_{10}H_7O_2$ and a molar mass of 318.32 g/mol. Calculate its molecular formula. **(3 pts)**

$C_{10}H_7O_2 = 10(12) + 7(1) + 2(16) = 159$ g/mol

318.32 g/mol ÷ 159 g/mol = 2 → $C_{20}H_{14}O_4$

Haptens are small molecules that elicit an immune response only when attached to a large carrier such as a protein. One of the haptens has an empirical formula of $C_3H_4NO_2$ and a molecular mass of 344.28 g/mol. Find its molecular formula.

$C_3H_4NO_2$ = 3(12) + 4(1) + 1(14) + 2(16) = 86 g/mol

344.28 g/mol ÷ 86 g/mol = 4 → **$C_{12}H_{16}N_4O_8$**

2.) An ingredient, used by the food industry to produce fruity flavors, has an empirical formula of C_2H_4O and a molar mass of 132 g/mol Calculate the molecular formula of this compound. **(3 pts)**

$C_2H_4O_1$ = 2(12) + 4(1) + 1(16) = 44 g/mol

132 g/mol ÷ 44 g/mol = 3 → **$C_6H_{12}O_3$**

1.) An organic acid, produced in muscle cells, has an empirical formula of CH_2O and a molar mass of 90.08 g/mol. Find its molecular formula. **(3 pts)**

$C_1H_2O_1$ = 1(12) + 2(1) + 1(16) = 30 g/mol

90.08 g/mol ÷ 30 g/mol = 3 → **$C_3H_6O_3$**

2.) An α-amino acid, used in the biosynthesis of proteins, has an empirical formula of C_3H_7NO and a molar mass of 146.19 g/mol. Find its molecular formula. **(3 pts)**

$C_3H_7N_1O_1$ = 3(12) + 7(1) + 1(14) + 1(16) = 73 g/mol

146.19 g/mol ÷ 73 g/mol = 2 → **$C_6H_{14}N_2O_2$**

A common ligand in coordination chemistry has the empirical formula C3H10N2 and a molecular mass of 74 g/mol. Find its molecular formula.

$C_3H_{10}N_2$ = 3(12) + 10(1) + 2(14) = 74 g/mol

74 g/mol ÷ 74 g/mol = 1 → **$C_3H_{10}N_2$**

2.) p-Phenylenediamine, used as a component of engineering polymers and composites like kevlar, has an empirical formula of C3H4N and a molar mass of 108 g/mol. Find its molecular formula.

C_3H_4N = 3(12) + 4(1) + 1(14) = 54 g/mol

108 g/mol ÷ 54 g/mol = 2 → **$C_6H_8N_2$**

Chemical Reactions:

1) **_1_ $Zn_{(s)}$ + _1_ $CuSO_{4\,(aq)}$ → _1_ $ZnSO_{4\,(aq)}$ + _1_ $Cu_{(s)}$** — **Type: _Single Replacement_**
2) **_2_ $KClO_{3\,(s)}$ → _2_ $KCl_{(s)}$ + _3_ $O_{2\,(g)}$** — **Type: _Decomposition_**
3) **_2_ $CH_3OH_{(l)}$ _3_ $O_{2\,(g)}$ → _2_ $CO_{2\,(g)}$ + _4_ $H_2O_{(g)}$** — **Type: _Combustion_**
4) **_1_ $SO_{3\,(g)}$ + _1_ $H_2O_{(l)}$ → _1_ $H_2SO_{4\,(aq)}$** — **Type: _Synthesis_**

5) _1_ $Ba(NO_3)_{2\ (aq)}$ + _1_ $Na_2SO_{4\ (aq)}$ → _1_ $BaSO_{4\ (s)}$ + _2_ $NaNO_{3\ (aq)}$ Type: _Double Replacement_
6) _1_ $H_3PO_{4\ (aq)}$ + _3_ $LiOH_{(aq)}$ → _1_ $Li_3PO_{4\ (aq)}$ + _3_ $H_2O_{(l)}$ Type: _Neutralization_

7) _2_ AgCl (s) → _2_ Ag (s) + _1_ Cl_2 (g) Type: _Decomposition_
8) _2_ KCl (aq) + _1_ MgO (aq) → _1_ K_2O (aq) + _1_ $MgCl_2$ (aq) Type: _Double Replacement_
9) _3_ $Ca(OH)_2$ + _2_ H_3PO_4 →_1_ $Ca_3(PO_4)_2$ + _6_ H_2O Type: _Neutralization_
10) 1 C_6H_{12} (l) + 9 O_2 (g) → 6 CO_2 (g) + 6 H_2O (g) Type: Combustion
11) 2 $Au(NO_3)_3$ + 3 Zn → 2 Au + 3 $Zn(NO_3)_2$ Type: Single Replacement
12) 1 P_4 (s) + 6 Cl_2 (g) → 4 PCl_3 (l) Type: Synthesis

13) 2 NaOH + 1 H2CO3 □ 1 Na2CO3 + 2 H2O Type: Neutralization
14) 2 NH3 (l) + 3 I2 (g) □ 1 N2I6 (s) + 3 H2 (g) Type: Single Replacement
15) 6 NaCl + 1 Ba3(PO4)2 □ 2 Na3PO4 + 3 BaCl2 Type: Double Replacement
16) 2 PbSO4 (s) □ 2 PbSO3 (s) + 1 O2 (g) Type: Decomposition
17) 2 C5H12O (l) + 15 O2 (g) □ 10 CO2 (g) + 12 H2O (g) Type: Combustion
18) jkl

1.) 2 K (s) + 1 Cl_2 (g) → 2 KCl (s) Type: Synthesis
2.) 1 N_2O_5 (g) + 1 H_2O (l) → 2 HNO_3 (aq) Type: Synthesis
3.) 1 P_4 (s) + 6 Cl_2 (g) → 4 PCl_3 (l) Type: Synthesis
4.) 1 S_8 (s) + 8 O_2(g) → 8 SO_2(g) Type: Synthesis
5.) 1 CaO (s) + 1 H_2O (l) → 1 $Ca(OH)_2$ (s) Type: Synthesis
6.) 2 Zn (s) + 1 O_2 (s) → 2 ZnO (s) Type: Synthesis

7.) 2 $AlCl_3$(s) → 2 Al(s) + 3 Cl_2 (g) Type: Decomposition
8.) 2 $KClO_3$ (s) → 2 KCl (s) + 3 O_2 (g) Type: Decomposition
9.) 2 HgO (s) → 2 Hg (l) + 1 O_2 (g) Type: Decomposition
10.) 2 $PbSO_4$ (s) → 2 $PbSO_3$ (s) + 1 O_2 (g) Type: Decomposition
11.) $CaCO_3$ (s) → CaO (s) + CO_2 (g) Type: Decomposition
12.) H_2CO_3 (aq) → CO_2 (g) + H_2O (l) Type: Decomposition

13.) 3 Fe (s) + 4 H_2O (l) → 1 Fe_3O_4 (s) + 4 H_2 (g) Type: SR
14.) 1 Mg(s) + 1 $CuSO_4$(aq) → 1 $MgSO_4$(aq) + 1 Cu(s) Type: SR
15.) 2 $Au(NO_3)_3$ (aq) + 3 Zn (s) → 2 Au (s) + 3 $Zn(NO_3)_2$ (aq) Type: SR
16.) 2 NH_3 (l) + 3 I_2 (g) → 1 N_2I_6 (s) + 3 H_2 (g) Type: SR
17.) 1 Fe (s) + 1 $CuNO_3$ (aq) → 1 Cu (s) + 1 $FeNO_3$ (aq) Type: SR
18.) 1 Cl_2 (g) + 2 NaBr (aq) → 2 NaCl (aq) + 1 Br_2 (l) Type: SR

19.) 3 $CaBr_2$ (aq) + 2 K_3PO_4 (aq) → 6 KBr (aq) + 1 $Ca_3(PO_4)_2$ (aq) Type: DR
20.) 2 $Al(NO_3)_3$ (aq) + 3 Na_2SO_4 (aq) → 6 $NaNO_3$ + 1 $Al_2(SO_4)_3$ Type: DR
21.) 2 KCl (aq) + 1 MgO (aq) → 1 K_2O (aq) + 1 $MgCl_2$ (aq) Type: DR
22.) 6 NaCl (aq) + 1 $Ba_3(PO_4)_2$ (aq) → 2 Na_3PO_4 (aq) + 3 $BaCl_2$ (aq) Type: DR
23.) 1 FeS + 2 HCl → 1 $FeCl_2$ + 1 H_2S Type: DR
24.) 2 NaCl + 1 H_2SO_4 → 1 Na_2SO_4 + 2 HCl Type: DR

25.) 1 H_2SO_4 (aq) + 2 NaOH (aq) → 1 Na_2SO_4 (aq) + 2 H_2O (l) Type: Neutralization
26.) 1 HCl (aq) + 1 AgOH (aq) → 1 AgCl (s) + 1 H_2O (l) Type: Neutralization
27.) 3 $Ca(OH)_2$ (aq) + 2 H_3PO_4 (aq) → 1 $Ca_3(PO_4)_2$ (aq) + 6 H_2O (l) Type: Neutralization
28.) 2 KOH (aq) + 1 H_2CO_3 (aq) → 1 K_2CO_3 (aq) + 2 H_2O (l) Type: Neutralization
29.) 1 $Mg(OH)_2$ + 1 H_2SO_4 → 1 $MgSO_4$ + 2 H_2O Type: Neutralization
30.) 2 HNO_3 + 1 $Pb(OH)_2$ → 1 $Pb(NO_3)_2$ + 2 H_2O Type: Neutralization

31.) $1\ C_5H_{12}\ (l) + 8\ O_2\ (g) \rightarrow 5\ CO_2\ (g) + 6\ H_2O\ (g)$ Type: Combustion

32.) $2\ C_2H_2\ (l) + 5\ O_2\ (g) \rightarrow 4\ CO_2\ (g) + 2\ H_2O\ (g)$ Type: Combustion

33.) $1\ C_2H_5OH(l) + 3\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 3\ H_2O\ (g)$ Type: Combustion

34.) $1\ C_4H_8\ (l) + 6\ O_2\ (g) \rightarrow 4\ CO_2\ (g) + 4\ H_2O\ (g)$ Type: Combustion

35.) $1\ C_7H_6O\ (l) + 8\ O_2\ (g) \rightarrow 7\ CO_2\ (g) + 3\ H_2O\ (g)$ Type: Combustion

36.) $1\ C_3H_6O(l) + 4\ O_2\ (g) \rightarrow 3\ CO_2\ (g) + 3\ H_2O\ (g)$ Type: Combustion

Predict the Products and Write a Balanced Equation: (15 formulas; 4 balancing)

1) **Calcium reacts in the presence of oxygen gas:** $2\ Ca + O_2 \rightarrow 2\ CaO$
2) **Solid zinc metal is added to hydrochloric acid:** $1\ Zn + 2\ HCl \rightarrow 1\ ZnCl_2 + 1\ H_2$
3) **Sulfuric acid is titrated with potassium hydroxide:** $1\ H_2SO_4 + 2\ KOH \rightarrow 1\ K_2SO_4 + 2\ H_2O$
4) **Octane burns in the presence of oxygen:** $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

Activity Series