

Name: \_\_\_\_\_

Key

### Unit 6 review Packet: The mole

A 1) What is the total mass of iron in 1.0 mole of  $Fe_2O_3$ ?  $2(55.8) = 111.6 \text{ g/mol} = 112 \text{ g}$

A) 112 g      B) 56 g      C) 160 g      D) 72 g

A 2) Which mass contains  $6.0 \times 10^{23}$  atoms?  $\Rightarrow 1 \text{ mol}$

A) 28 g of silicon  $\Rightarrow 1 \text{ mol}$       C)  $\frac{3.0}{4.0}$  3.0 g of helium = 0.75 mol He  
~~B) 6.0 g of carbon  $\Rightarrow 0.5 \text{ mol C}$~~       D) 16 g of sulfur = 0.5 mol S

C 3) What is the total number of atoms contained in 2.00 moles of nickel?

A) 58.9      B) 118      C)  $1.20 \times 10^{24}$       D)  $6.02 \times 10^{23}$

$2.00 \text{ mol Ni} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol Ni}} = 1.20 \times 10^{24}$

C 4) What is the total number of molecules of hydrogen in 0.25 mole of hydrogen?

A)  $6.0 \times 10^{23}$       B)  $4.5 \times 10^{23}$       C)  $1.5 \times 10^{23}$       D)  $3.0 \times 10^{23}$

$0.25 \text{ mol H}_2 \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol H}_2} = 1.5 \times 10^{23} \text{ molecule}$

D 5) The total number of molecules in 34.0 grams of  $NH_3$  is equal to

A)  $2.00 \times 22.4$       B)  $1.00 \times 22.4$       C)  $1.00 \times 6.02 \times 10^{23}$       D)  $2.00 \times 6.02 \times 10^{23}$

$34.0 \text{ g NH}_3 \times \frac{1 \text{ mol NH}_3}{17.0 \text{ g NH}_3} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol NH}_3} = 1.20 \times 10^{24}$

A 6) What is the total number of moles of atoms represented by one mole of  $(CH_3)_2NH$ ?

A) 10      B) 9      C) 8      D) 5

$2 \text{ C} + 6 \text{ H} + 1 \text{ N} + 1 \text{ H} = 10$

C 7) A sample of nitrogen containing  $3.0 \times 10^{23}$  molecules has the same number of molecules as a sample containing

A) 1.0 mole of  $H_2$       B) 2.0 moles of He      C) 0.50 mole of Ne      D) 0.25 mole of  $O_2$

$3.0 \times 10^{23} \text{ molecules N}_2 \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} = 0.498 \approx 0.5 \text{ mol}$

B 8) What is the total mass of  $3.01 \times 10^{23}$  atoms of helium gas?

A) 8.00 g      B) 2.00 g      C) 4.00 g      D) 3.50 g

$3.01 \times 10^{23} \text{ atoms} \times \frac{1 \text{ mol He}}{6.02 \times 10^{23} \text{ atoms He}} \times \frac{4.0 \text{ g He}}{1 \text{ mol He}} = 2.00 \text{ g}$

A 9) Which gas sample contains a total of  $3.0 \times 10^{23}$  molecules?

A) 14 g of  $N_2$       B) 71 g of  $Cl_2 \Rightarrow 1 \text{ mol of } Cl_2$       C) 2.0 g of  $H_2 \Rightarrow$  this is 1 mol of  $H_2$       D) 38 g of  $F_2 \Rightarrow$  this is 1 mol of  $F_2$

$1 \text{ mol of } N_2 = 28.0 \text{ g}, \text{ so } 14 \text{ g is half of } 28 \text{ g (} 0.50 \text{ mol } N_2)$

C 10) What is the mass in grams of 1.00 mole of  $O_2$  gas?  $2(16.0) = 32.0$  g  
 A) 22.4                      B) 11.2                      C) 32.0                      D) 16.0

B 11) What is the percent by mass of sulfur in sulfur dioxide?  $SO_2 \Rightarrow 32.1 \text{ amu} + 2(16.0 \text{ amu}) =$   
 A) 32                      B) 50.                      C) 33                      D) 67

A 12) The percent by mass of nitrogen in  $Mg(CN)_2$  is equal to  
 $\% S = \frac{32.1 \text{ amu}}{64.1 \text{ amu}} \times 100 =$   
A)  $\frac{28}{76} \times 100$                        $\frac{2(14.0) \text{ g/mol}}{76.3 \text{ g/mol}} \times 100 =$  C)  $\frac{14}{50} \times 100$   
 B)  $\frac{28}{50} \times 100$                       D)  $\frac{14}{76} \times 100$

B 13) What is the percent by mass of water in the hydrate  $Na_2CO_3 \cdot 10H_2O$  (formula mass = 286)?  
 A) 214.5%                       $\frac{10(18.0 \text{ amu})}{286} \times 100 =$  C) 26.1%  
B) 62.9%                      D) 6.89%

D 14) How many moles of water are contained in 0.250 mole of  $CuSO_4 \cdot 5H_2O$ ?  $0.250(5) = 1.25$  mol  
 A) 62.5                      B) 4.50                      C) 40.0                      D) 1.25

B 15) The diagram below shows the data collected during the heating of a 5.0 gram sample of a hydrated salt.

Mass of Salt (grams)	Heating Time (minutes)
5.0	0.0
4.1	5.0
3.1	10.
3.0	15.
3.0	30.
3.0	60.

$$\% H_2O = \frac{5.0 - 3.0}{5.0} \times 100 = \frac{2.0}{5.0} \times 100 = 40\%$$

What is the percent water in the original sample?

A) 82.0%                      B) 40.0%                      C) 60.0%                      D) 30.0%

D 16) An 8.24-gram sample of a hydrated salt is heated until it has a constant mass of 6.20 grams. What was the percent by mass of water contained in the original sample?

A) 14.1%                      C) 32.9%  
 B) 75.2%                      D) 24.8%

$$\% H_2O = \frac{8.24g - 6.20g}{8.24g} \times 100 = \frac{2.04g}{8.24g} \times 100 = 24.76\%$$

A 17) Which of the following statements explains why mass is lost when a student heats a sample of  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$  crystals?

- (A) Water is given off as a gas. C) Chlorine is given off as a gas.  
 B) The crystals fuse (melt). D) The crystals sublime.

C 18) What is the empirical formula of the compound whose molecular formula is  $\text{P}_4\text{O}_{10}$ ?

- A)  $\text{PO}_2$  C)  $\text{P}_2\text{O}_5$   $\frac{2}{2}$   
 B)  $\text{P}_8\text{O}_{20}$  D)  $\text{PO}$   $\frac{\text{P}_2\text{O}_5}{2}$

C 19) The molecular mass of a compound of carbon and hydrogen is 42. What is the empirical formula of the compound? *answer needs to be a multiple of 42 g/mol*

- A)  $\text{CH}_3$  B)  $\text{CH}_4$  C)  $\text{CH}_2$  D)  $\text{CH}$   
*15 g/mol      16 g/mol      14 g/mol      13 g/mol*

A 20) A compound has the empirical formula  $\text{NO}_2$ . Its molecular formula could be

- (A)  $\text{NO}_2$  ~~B)  $\text{N}_2\text{O}$~~  ~~C)  $\text{N}_4\text{O}_2$~~  ~~D)  $\text{N}_4\text{O}_4$~~

D 21) A hydrocarbon has the empirical formula  $\text{CH}_3$ . The most probable molecular formula for this compound is

- A)  $\text{C}_4\text{H}_6$  B)  $\text{CH}_4$  C)  $\text{C}_3\text{H}_8$  D)  $\text{C}_2\text{H}_6$   
*multiple of a 1:3 ratio*

A 22) A compound with an empirical formula of  $\text{CH}_2$  has a molecular mass of 70. What is the molecular formula? *14.0 g/mol*

- (A)  $\text{C}_5\text{H}_{10}$  B)  $\text{C}_2\text{H}_4$  C)  $\text{CH}_2$  D)  $\text{C}_4\text{H}_8$   
 $\frac{70.0 \text{ g/mol}}{14.0 \text{ g/mol}} = 5$   *$\text{C}_5\text{H}_{10}$*

B 23) A compound is 86% carbon and 14% hydrogen by mass. What is the empirical formula for this compound?

- A)  $\text{CH}$  B)  $\text{CH}_2$  C)  $\text{CH}_3$  D)  $\text{CH}_4$   
 $\frac{86 \text{ g C}}{1} \times \frac{1 \text{ mol}}{12.0 \text{ g C}} = 7.17 \text{ mol C}$   $\frac{14.0 \text{ g H}}{1} \times \frac{1 \text{ mol}}{1.0 \text{ g H}} = 14.0 \text{ mol H}$   
 $\frac{7.17}{7.17} \text{ C}$   $\frac{14.0}{7.17} \text{ H} \approx 2 \text{ H}$

C 24) What is the total mass of oxygen, in grams, in 1.00 mole of  $\text{Al}_2(\text{CrO}_4)_3$ ?

- A) 64.0 g C) 192 g  $12(16.0 \text{ g/mol}) = 192.0 \text{ g/mol}$   
 B) 112 g D) 48.0 g

C 25) The gram molecular mass of  $\text{CO}_2$  is the same as the gram molecular mass of

- A)  $\text{C}_2\text{H}_6$  B)  $\text{SO}_2$  C)  $\text{C}_3\text{H}_8$  D)  $\text{CO}$   
 $24.0 + 6.0 = 30.0 \text{ g/mol}$   $32.1 + 32.0 = 64.1 \text{ g/mol}$   $36.0 + 18.0 = 54.0 \text{ g/mol}$   $12.0 + 16.0 = 28.0 \text{ g/mol}$

D 26) Which substance has the greatest molecular mass?

- A)  $\text{CF}_4$  B)  $\text{H}_2\text{O}_2$  C)  $\text{NO}$  D)  $\text{I}_2$   
 $12.0 + 4(19.0) = 12.0 \text{ g/mol}$   $2.0 + 32.0 = 34.0 \text{ g/mol}$   $14.0 + 16.0 = 30.0 \text{ g/mol}$   $2(126.9 \text{ g/mol}) = 253.8 \text{ g/mol}$

A<sub>27</sub>) Which represents the *greatest* mass of chlorine?

A) 1 mole of chlorine 71.0 g

B) 1 atom of chlorine

C) 1 gram of chlorine

D) 1 molecule of chlorine

*Very small mass*

*small mass*

B<sub>28</sub>) What is the total number of moles contained in 115 grams of C<sub>2</sub>H<sub>5</sub>OH?

A) 1.50

B) 2.50

C) 3.00

D) 1.00

*24.0 + 6.0 + 16.0*

A<sub>29</sub>) What is the total number of moles of oxygen atoms present in 1 mole of Mg(ClO<sub>3</sub>)<sub>2</sub>? *3 x 2 = 6*

A) 6

B) 2

C) 3

D) 5

D<sub>30</sub>) What is the mass, in grams, of 1.00 mole of CaSO<sub>4</sub> · 2H<sub>2</sub>O?

A) 154 g

B) 118 g

C) 136 g

D) 172 g

$$\begin{aligned} & 1 \text{ Ca} + 1 \text{ S} + 4 \text{ O} + 2 \text{ H}_2\text{O} \\ & 1(40.1) + 1(32.1) + 4(16.0) + 2(18.0) \\ & = 172.2 \text{ g/mol} \end{aligned}$$

28)

$$\frac{115 \text{ g C}_2\text{H}_5\text{OH}}{1} \times \frac{1 \text{ mol C}_2\text{H}_5\text{OH}}{46.0 \text{ g C}_2\text{H}_5\text{OH}} = 2.50 \text{ mol C}_2\text{H}_5\text{OH}$$

Unit 6 Exam Review

Key

Part A: Calculating Formula/Molar Mass and Percent Composition

1. Given the following compound,  $(\text{NH}_4)_2 \text{SO}_4$

a) Calculate the formula mass of this compound



$$2(14.0) + 8(1.0 \text{ amu}) + 1(32.1 \text{ amu}) + 4(16.0 \text{ amu}) = \boxed{132.1 \text{ amu}}$$

b) What is the percent composition of nitrogen in this compound?

$$\% \text{ N} = \frac{28.0 \text{ amu}}{132.1 \text{ amu}} \times 100 = 21.2\%$$

2. Given the following compound,  $\text{Na}_3\text{N}$

a) Calculate the formula mass of this compound



$$3(23.0) + 1(14.0) = 83.0 \text{ amu}$$

b) What is the percent composition of sodium in this compound?

$$\% \text{ Na} = \frac{69.0 \text{ amu}}{83.0 \text{ amu}} \times 100 = 83.1\%$$

3. Given the following compound,  $\text{Al}_2(\text{Cr}_2\text{O}_7)_3$

a) Calculate the formula mass of this compound



$$2(27.0 \text{ amu}) + 6(52.0 \text{ amu}) + 21(16.0 \text{ amu}) = 702.0 \text{ amu}$$

b) What is the percent composition of oxygen in this compound?

$$\% \text{ O} = \frac{336.0 \text{ amu}}{702.0 \text{ amu}} \times 100 = 47.86\%$$

4. An 85.4 gram sample of  $\text{BaI}_2 \cdot \text{XH}_2\text{O}$  was heated to a constant mass of 65.6 grams. Based on this information, what is the percent composition of water in this hydrate?

$$85.4 \text{ g} - 65.6 \text{ g} = 19.8 \text{ g H}_2\text{O}$$

$$\% \text{ H}_2\text{O} = \frac{19.8 \text{ g H}_2\text{O}}{85.4 \text{ g}} \times 100 = 23.2\%$$

$$85.4 \text{ g}$$

mass  $\rightleftharpoons$  moles  $\rightleftharpoons$  molecules/  
atoms

### Part B: Conversions

4. How many moles of Mg is  $1.25 \times 10^{23}$  atoms of magnesium?

$$1.25 \times 10^{23} \text{ atoms Mg} \times \frac{1 \text{ mol Mg}}{6.022 \times 10^{23} \text{ atoms Mg}} = 0.208 \text{ mol Mg}$$

5. How many grams are in 3.26 moles of  $\text{LiC}_2\text{H}_3\text{O}_2$ ?

$$3.26 \text{ mol LiC}_2\text{H}_3\text{O}_2 \times \frac{65.9 \text{ g}}{1 \text{ mol C}_2\text{H}_3\text{O}_2} = 214.834 \rightarrow 215 \text{ g LiC}_2\text{H}_3\text{O}_2$$

6. How many grams is  $2.80 \times 10^{24}$  atoms of silicon?

$$2.80 \times 10^{24} \text{ atoms Si} \times \frac{1 \text{ mol Si}}{6.022 \times 10^{23} \text{ atoms Si}} \times \frac{28.1 \text{ g Si}}{1 \text{ mol Si}} = 131 \text{ g Si}$$

7. How many moles are in 66.5 g  $\text{NiCO}_3$ ?

$$66.5 \text{ g NiCO}_3 \times \frac{1 \text{ mol NiCO}_3}{118.7 \text{ g NiCO}_3} = 0.560 \text{ mol NiCO}_3$$

8. How many moles is  $2.17 \times 10^{23}$  molecules of  $\text{Br}_2$ ?

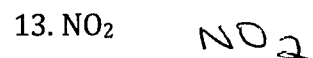
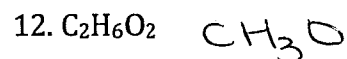
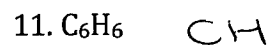
$$2.17 \times 10^{23} \text{ molecules} \times \frac{1 \text{ mol Br}_2}{6.022 \times 10^{23} \text{ molecules}} = 0.360 \text{ mol Br}_2$$

9. How many molecules are in 88.3 g  $\text{SO}_2$ ?

$$88.3 \text{ g SO}_2 \times \frac{1 \text{ mol SO}_2}{64.1 \text{ g SO}_2} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol SO}_2} = 8.29 \times 10^{23} \text{ molecules SO}_2$$

### Part C: Molecular and Empirical Formulas

Write the empirical formulas for the following compounds:



14. The percentage composition of acetic acid is found to be 39.9% C, 6.7% H, and 53.4% O.

Determine the empirical formula of acetic acid.

$$39.9 \text{ g C} \times \frac{1 \text{ mol C}}{12.0 \text{ g C}} = 3.33 \text{ mol C}$$

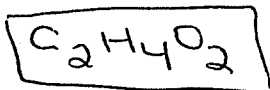
$$6.7 \text{ g H} \times \frac{1 \text{ mol H}}{1.0 \text{ g H}} = 6.7 \text{ mol H}$$

$$53.4 \text{ g O} \times \frac{1 \text{ mol O}}{16.0 \text{ g O}} = 3.34 \text{ mol O}$$

$$\text{C}_{\frac{3.33}{3.33}} \text{H}_{\frac{6.7}{3.33}} \text{O}_{\frac{3.34}{3.33}} = \boxed{\text{CH}_2\text{O}}$$

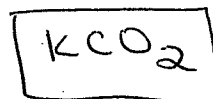
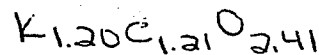
15. The molar mass for question #14 was determined by experiment to be 60.0 g/mol. What is the molecular formula?

$$\begin{array}{l} \text{CH}_2\text{O} \qquad 60.0 \text{ g/mol} \\ 12 + 2 + 16 = \\ 30.0 \text{ g/mol} \end{array} \qquad \frac{60.0 \text{ g/mol}}{30.0 \text{ g/mol}} = 2$$



16. An unknown compound was found to have a percent composition as follows: 47.0 % potassium, 14.5 % carbon, and 38.5 % oxygen. What is its empirical formula?

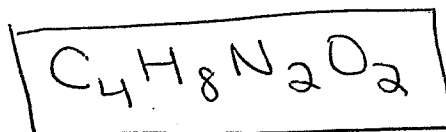
$$\begin{array}{l} 47.0 \text{ g K} \times \frac{1 \text{ mol K}}{39.1 \text{ g K}} = 1.20 \text{ mol K} \\ 38.5 \text{ g O} \times \frac{1 \text{ mol O}}{16.0 \text{ g O}} = 2.41 \text{ mol O} \\ 14.5 \text{ g C} \times \frac{1 \text{ mol C}}{12.0 \text{ g C}} = 1.21 \text{ mol C} \end{array}$$



17. A well-known reagent in analytical chemistry, dimethylglyoxime, has the empirical formula  $\text{C}_2\text{H}_4\text{NO}$ . If its molar mass is 116.1 g/mol, what is the molecular formula of the compound?

$$\begin{array}{l} \text{C}_2\text{H}_4\text{NO} \qquad 116.1 \text{ g/mol} \\ 24.0 + 4.0 + 14.0 + 16.0 = \\ 58.0 \text{ g/mol} \end{array}$$

$$\frac{116.1 \text{ g/mol}}{58.0 \text{ g/mol}} = 2$$



**\*\*You must SHOW WORK to receive full credit!\*\***

18) How many moles are there in 93g of  $C_4H_{10}$ ?

$$\frac{93 \text{ g } C_4H_{10}}{1} \times \frac{1 \text{ mol } C_4H_{10}}{58.0 \text{ g } C_4H_{10}} = 1.6 \text{ mol } C_4H_{10}$$

19) How many moles are there in 1.15g of  $MnO_2$ ?

$$\frac{1.15 \text{ g } MnO_2}{1} \times \frac{1 \text{ mol } MnO_2}{86.9 \text{ g } MnO_2} = 0.0132 \text{ mol } MnO_2$$

20) What is the mass, in grams, of 1.25 moles of  $Ca(OH)_2$ ?

$$\frac{1.25 \text{ mol } Ca(OH)_2}{1} \times \frac{74.1 \text{ g } Ca(OH)_2}{1 \text{ mol } Ca(OH)_2} = 92.6 \text{ g } Ca(OH)_2$$

21) What is the mass, in grams, of 0.035 moles of  $AlBr_3$ ?

$$\frac{0.035 \text{ mol } AlBr_3}{1} \times \frac{266.7 \text{ g } AlBr_3}{1 \text{ mol } AlBr_3} = 9.3 \text{ g } AlBr_3$$

22) How many moles are there in 5.82g of  $MgCO_3$ ?

$$\frac{5.82 \text{ g } MgCO_3}{1} \times \frac{1 \text{ mol } MgCO_3}{84.3 \text{ g } MgCO_3} = 0.0690 \text{ mol } MgCO_3$$

23) What is the mass, in grams, of 0.65 moles of  $Ba(NO_3)_2$ ?

$$\frac{0.65 \text{ mol } Ba(NO_3)_2}{1} \times \frac{261.3 \text{ g } Ba(NO_3)_2}{1 \text{ mol } Ba(NO_3)_2} = 1.7 \times 10^2 \text{ g } Ba(NO_3)_2$$

24) What is the percent composition by mass of calcium, chlorine, and oxygen in  $Ca(ClO_3)_2$ ?

$$1 \text{ Ca} + 2 \text{ Cl} + 6 \text{ O}$$

$$1(40.1) + 2(35.5) + 6(16.0) = 207.1 \text{ amu}$$

Ca:  $\frac{40.1}{207.1} \times 100 = 19.4\%$       Cl:  $\frac{71.0}{207.1} \times 100 = 34.3\%$       O:  $\frac{96.0}{207.1} \times 100 = 46.4\%$



25) What is the percent composition by mass of carbon in  $C_6H_{12}O_6$ ?

$$6C + 12H + 6O$$

$$6(12.0) + 12(1.0) + 6(16.0) = 180.0 \text{ amu} \quad \% C = \frac{72.0 \text{ amu}}{180.0 \text{ amu}} \times 100 = \boxed{40.0\%}$$

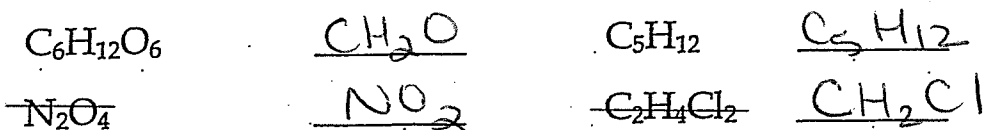
26) What is the percent by mass of water in  $CuCO_3 \cdot 5H_2O$ ?

$$63.5 + 12.0 + 3(16.0) + 5(18.0) = 213.5 \text{ amu}$$

$$1Cu + 1C + 3O + 5H_2O$$

$$\% H_2O = \frac{90.0 \text{ amu}}{213.5 \text{ amu}} \times 100 = 42.2\%$$

27) What is the empirical formula of:



28) A compound has an empirical formula of  $CH_2$  and a molecular mass of 70.0 g/mol. What is the molecular formula?

$$\frac{70.0 \text{ g/mol}}{14.0 \text{ g/mol}} = 5 \quad \boxed{C_5H_{10}}$$

29) A compound has an empirical formula of  $P_2O_5$  and a molecular mass of 284 g/mol. What is the molecular formula?

$$\frac{284 \text{ g/mol}}{142.0 \text{ g/mol}} = 2 \quad \boxed{P_4O_{10}}$$

30) Given the percent composition by mass, find the empirical formula. 46.74% Si, and 53.26% O

$$\frac{46.74 \text{ g Si}}{1} \times \frac{1 \text{ mol Si}}{28.1 \text{ g Si}} = \frac{1.663 \text{ mol Si}}{1.663} = 1$$

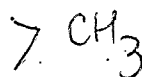
$$\frac{53.26 \text{ g O}}{1} \times \frac{1 \text{ mol O}}{16.0 \text{ g O}} = \frac{3.329 \text{ mol O}}{1.663} = 2 \quad \boxed{SiO_2}$$

31) Given the percent composition by mass and the molecular mass, find the molecular formula. 2 steps

80.% C, and 20.% H      molecular mass = 30.0 g/mol

$$\frac{80. \text{ g C}}{1} \times \frac{1 \text{ mol C}}{12.0 \text{ g C}} = \frac{6.67 \text{ mol C}}{6.67} = 1$$

$$\frac{20. \text{ g H}}{1} \times \frac{1 \text{ mol H}}{1.0 \text{ g H}} = \frac{20. \text{ mol H}}{6.67} \approx 3$$



$$\rightarrow 15.0 \text{ g/mol}$$

$$\frac{30.0 \text{ g/mol}}{15.0 \text{ g/mol}} = 2$$

