Name _____ Date _____ Class _____

CHAPTER 8 REVIEW ACTIVITY

Text Reference: Section 8-2

Formula Mass

Find the formula mass of each of the following compounds, given its formula and the atomic mass of each element in the compound. Write the letter of the correct answer in the blank provided.

u = ATOMIC MASS UNITS

1. Na_2S (Na = 23.0 u; S = 32.1 u)
- **a.** 55.1 u
- **b.** 64.2 u
- **c.** 78.1 u
- **d.** 87.1 u

46
+32.1

1. C

2. $Ba(NO_3)_2$ (Ba = 137.3 u; N = 14.0 u; O = 16.0 u)
- **a.** 261.3 u
- **b.** 294.6 u
- **c.** 303.3 u
- **d.** 321.6 u

137.3
28.0
+96.0

2. A

3. $(NH_4)_3P$ (N = 14.0 u; H = 1.0 u; P = 31.0 u)
- **a.** 56.0 u
- **b.** 85.0 u
- **c.** 87.0 u
- **d.** 93.0 u

42.0
12.0
+31.0

3. B

4. CH_3Cl (C = 12.0 u; H = 1.0 u; Cl = 35.5 u)
- **a.** 48.5 u
- **b.** 50.5 u
- **c.** 51.5 u
- **d.** 54.5 u

12.0
3.0
+35.5

4. B

5. SiF_4 (Si = 28.1 u; F = 19.0 u)
- **a.** 47.1 u
- **b.** 63.4 u
- **c.** 92.1 u
- **d.** 104.1 u

28.1
+76.0

5. D

6. Cu_2SO_4 (Cu = 63.5 u; S = 32.1 u; O = 16.0 u)
- **a.** 223.1 u
- **b.** 233.1 u
- **c.** 234.4 u
- **d.** 249.1 u

127.0
32.1
+64.0

6. A

7. $NaHCO_3$ (Na = 23.0 u; H = 1.0 u; C = 12.0 u; O = 16.0 u)
- **a.** 52.0 u
- **b.** 76.0 u
- **c.** 84.0 u
- **d.** 88.0 u

23.0
1.0
12.0
+48.0

7. C

8. H_2SO_3 (H = 1.0 u; S = 32.1 u; O = 16.0 u)
- **a.** 50.1 u
- **b.** 82.1 u
- **c.** 85.1 u
- **d.** 87.1 u

2.0
32.1
+48.0

8. B

1) Determine each element's mass (# of Atoms x MASS)

2) Add up masses to get formula mass

3) Calculate % Composition

Percentage Composition Worksheet

Give the % composition of all elements in these compounds. ***Show all work!***

EXAMPLE

1) ammonium sulfite $(NH_4)_2SO_3$

FORMULA MASS 116

% N 24% $(28/116)100 =$

% H 7% $(8/116)100 =$

% S 28% $(32/116)100 =$

% O 41% $(48/116)100 =$

2 N Atoms = 2(14) = 28
8 H Atoms = 8(1) = 8
1 S Atoms = 1(32) = 32
3 O Atoms = 3(16) = 48
+
116

# of Atoms (mass of 1 atom)

---

2) aluminum acetate $Al(C_2H_3O_2)_3$

FORMULA MASS 204

% Al 13.2 $(27/204)100 =$

% C 35.3 $(72/204)100 =$

% H 4.4 $(9/204)100 =$

% O 47.1 $(96/204)100 =$

Al → 27
C → 72
H → 9
O → + 96
204

---

3) sodium bromide NaBr

FORMULA MASS 103

% Na 22.3 $(23/103)100 =$

% Br 77.7 $(80/103)100 =$

Na → 23
Br → + 80
103

---

4) copper (II) hydroxide $Cu(OH)_2$

FORMULA MASS 98

% Cu 65.3 $(64/98)100 =$

% O 32.7 $(32/98)100 =$

% H 2.0 $(2/98)100 =$

Cu → 64
O → 32
H → + 2
98

---

5) magnesium carbonate $MgCO_3$

FORMULA MASS 84

% Mg 28.6 $(24/84)100 =$

% C 14.3 $(12/84)100 =$

% O 57.1 $(48/84)100 =$

Mg → 24
C → 12
O → + 48
84

---

6) iron (II) phosphate

$Fe_3(PO_4)_2$

Formula Mass 358

% Fe 46.9 $(168/358)100 =$

% P 17.3 $(62/358)100 =$

% O 35.8 $(128/358)100 =$

Fe → 168
P → 62
O → +128
358

---

7) beryllium nitride

Be_3N_2

Formula Mass 55

% Be 49 $(27/55)100 =$

% N 50.9 $(28/55)100 =$

Be → 27
N → +28
55

---

8) potassium cyanide

KCN

Formula Mass 65

% K 60 $(39/65)100 =$

% C 18.5 $(12/65)100 =$

% N 21.5 $(14/65)100 =$

K → 39
C → 12
N → +14
65

---

9) manganese (III) nitrate

$Mn(NO_3)_3$

Formula Mass 241

% Mn 22.8 $(55/241)100 =$

% N 17.4 $(42/241)100 =$

% O 59.8 $(144/241)100 =$

Mn → 55
N → 42
O → 144
+
241

---

10) lithium phosphide

Li_3P

Formula Mass 52

% Li 40.4 $(21/52)100 =$

% P 59.6 $(31/52)100 =$

Li → 21
P → +31
52

---

11) nickel (III) sulfate

$Ni_2(SO_4)_3$

Formula Mass 406

% Ni 29.1 $(118/406)100 =$

% S 23.6 $(96/406)100 =$

% O 47.3 $(192/406)100 =$

Ni → 118
S → 96
O → +192
406

Molecular Formulas

Wohlgemut

1. Which pair of formulas correctly represents a molecular formula and its corresponding empirical formula?
   1) C_2H_6 and CH_3
   2) C_3H_4 and CH_2
   3) C_4H_6 and CH
   4) C_5H_8 and C_2H_2

2. A compound has a molar mass of 90. grams per mole and the empirical formula CH_2O. What is the molecular formula of this compound?
   1) CH_2O
   2) $C_2H_4O_2$
   3) $C_3H_6O_3$
   4) $C_4H_8O_4$

   $\frac{90}{30} = 3$

   $C_3H_6O_3$

3. A substance has an empirical formula of CH_2 and a molar mass of 56 grams per mole. The molecular formula for this compound is
   1) CH_2
   2) C_4H_6
   3) C_4H_8
   4) C_8H_4

   $\frac{56}{14} = 4$ C_4H_8

4. The empirical formula of a compound is CH_3. The molecular formula of this compound could be
   1) CH_4
   2) C_2H_4
   3) C_2H_6
   4) C_3H_6

   1:3

5. What is the molecular formula of a compound that has a molecular mass of 92 and an empirical formula of NO_2?
   1) NO_2
   2) N_2O_4
   3) N_3O_6
   4) N_4O_8

   $\frac{92}{46} = 2$

   N_2O_4

6. Vitamin C has an empirical formula of $C_3H_4O_3$ and a molecular mass of 176. What is the molecular formula of vitamin C?
   1) $C_3H_4O_3$
   2) $C_6H_8O_6$
   3) $C_9H_{12}O_9$
   4) $C_{10}H_8O_3$

   $\frac{176}{88} = 2$

   $C_6H_8O_6$

7. What is the molecular formula of a compound with the empirical formula P_2O_5 and a gram-molecular mass of 284 grams?
   1) P_2O_5
   2) P_5O_2
   3) $P_{10}O_4$
   4) P_4O_{10}

   $\frac{284}{142} = 2$ P_4O_{10}

   $62 + 80 = 142$

Molecular Formula Worksheet

Write the molecular formulas of the following compounds:

1) A compound with an empirical formula of C_2OH_4 and a molar mass of 88 grams per mole.

$C_2OH_4 = \underbrace{24+16+4}_{44}$ $\quad \frac{88}{44} = 2$

$\boxed{C_4O_2H_8}$

2) A compound with an empirical formula of C_4H_4O and a molar mass of 136 grams per mole.

$C_4H_4O = \underbrace{48+4+16}_{68}$ $\quad \frac{136}{68} = 2$

$\boxed{C_8H_8O_2}$

3) A compound with an empirical formula of CFBrO and a molar mass of 254.7 grams per mole.

$CFBrO = 12+19+80+16$ $\quad \frac{254.7}{127} = 2$

$\boxed{C_2F_2Br_2O_2}$

4) A compound with an empirical formula of C_2H_8N and a molar mass of 46 grams per mole.

$C_2H_8N = \underbrace{24+8+14}_{46}$ $\quad \frac{46}{46} = 1$

$\boxed{C_2H_8N}$

Name:

Mole Conversion Practice

1. What is the total number of molecules in a 0.5-mole sample of He gas?

A) 6×10^{23} B) 2×10^{23}
C) 3×10^{23} D) 4×10^{23}

2. What is the total number of atoms contained in a 1.00-mole sample of helium?

1 mole = 6.02×10^{23}

A) 1.00 atom B) 2.00 atoms
C) 1.20×10^{24} atoms D) 6.02×10^{23} atoms

3. What is the total mass of iron in 1.0 mole of Fe_2O_3 ?

$2(56) = 112$

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

4. What is the mass in grams of 2.0 moles of NO_2?

$2 \text{ moles} = \frac{X\,g}{46\,g/mol}$

A) 92 B) 60. C) 46 D) 30.

5. Which sample contains a mole of atoms?

1 mole = Gram formula mass

A) 23 g Na B) 24 g C
C) 42 g Kr D) 78 g K

6. What is the total mass in grams of 0.75 mole of SO_2 ?

$0.75 \text{ moles} = \frac{X\,g}{64\,g}$

A) 16 g B) 24 g C) 32 g D) 48 g

7. At STP, which gas sample has a volume of 11.2 liters?

Liters → Volume of gas
22.4L = 1mole

A) 1.00 mole of CO_2
B) 0.750 mole of NH_3
C) 0.500 mole of CO_2
D) 0.250 mole of NH_3

8. The total number of moles represented by 20 grams of $CaCO_3$ is

$X \text{ moles} = \frac{20\,g}{100\,g}$

A) 1 B) 2 C) 0.1 D) 0.2

9. What mass of carbon dioxide occupies a volume of 22.4 liters at STP?

22.4 L = 1mole
1mole = Gram formula mass
$CO_2 = 12 + 32 = 44$

A) 22.0 g B) 44.0 g
C) 66.0 g D) 88.0 g

10. Which quantity is equivalent to 39 grams of LiF?

$X \text{ moles} = \frac{39\,g}{26}$ LiF = 7 + 19

A) 1.0 mole B) 2.0 moles
C) 0.50 mole D) 1.5 moles

Name: Answer Key

---

1. Base your answer to the following question on the information below.

Vitamin C, also known as ascorbic acid, is water soluble and cannot be produced by the human body. Each day, a person's diet should include a source of vitamin C, such as orange juice. Ascorbic acid has a molecular formula of $C_6H_8O_6$ and a gram-formula mass of 176 grams per mole.

Determine the number of moles of vitamin C in an orange that contains 0.071 gram of vitamin C.

$$X\ mol = \frac{0.071\ g}{176\ g}$$ **0.0004 mol**

2. Determine the mass of 5.20 moles of C_6H_{12} (gram-formula mass = 84.2 grams/mole)

$$5.2\ mol = \frac{X\ g}{84.2\ g/mol}$$ **437.84 g**

3. Base your answer to the following question on the following paragraph.

A portable propane-fueled lantern contains a mesh silk bag coated with metal hydroxides. The primary metal hydroxide is yttrium hydroxide. When the silk bag is installed, it is ignited and burned away, leaving the metal hydroxide coating. The coating forms metal oxides that glow brightly when heated to a high temperature.

During a test, a propane lantern is operated for three hours and consumes 5.0 moles of propane from the lantern's tank. The balanced equation below represents the combustion of propane.

Propane = C_3H_8

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O + energy$$

Calculate the total mass of propane consumed during the lantern test. Your response must include *both* a correct numerical setup and the calculated result.

$$5\ mol = \frac{X\ g}{44\ g/mol}$$ **220 g**

(36)+(8)= **44 g**

---

4. What is the mass of 4.76 moles of Na_3PO_4 (gram-formula mass = 164 grams/mole)?

$$4.76\ mol = \frac{X\ g}{164\ g/mol}$$ **780.64 g**

5. Base your answer to the following question on

What is the total number of moles present in a 52.0-gram sample of $NaN_3(s)$ (gram-formula mass = 65.0 gram/mole)?

$$X\ moles = \frac{52\ g}{65\ g/mol}$$ **0.80 mol**

---

6. Show a correct numerical setup for calculating the number of moles of CO_2 (gram-formula mass = 44 g/mol) present in 11 grams of CO_2.

$$X\ moles = \frac{11\ g}{44\ g/mol}$$ **.25 mol**

---

7. Base your answer to the following question on the information and equation below.

Antacids can be used to neutralize excess stomach acid. Brand Antacid contains the acid-neutralizing agent magnesium hydroxide, $Mg(OH)_2$. It reacts with HCl(aq) in the stomach, according to the following balanced equation:

$$2\ HCl(aq) + Mg(OH)_2(s) \rightarrow MgCl_2(aq) + 2\ H_2O(\ell)$$

Show a correct numerical setup for calculating the number of moles of $Mg(OH)_2$ (gram-formula mass = 58.3 grams/mole) in an 8.40-gram sample.

$$X\ mol = \frac{8.4\ g}{58.3\ g/mol}$$ 0.14 mol

8. Base your answer to the following question on Given the compound $C_4H_{10}O_8$,

a Calculate the molar mass of the compound. $4(12) + 10(1) + 8(16) =$ 186g

b Calculate the number of moles in 17.7 grams of the compound. $X\ mol = \frac{17.7\ g}{186\ g}$ 0.095 mol

c What is the empirical formula for this compound? $C_2H_5O_4$

9. In a laboratory experiment, a student determined the mass of the product, LiCl(s), to be 0.333 grams.

a Calculate the gram formula mass of LiCl(s). Round atomic masses from the Periodic Table to the nearest tenth. [Show all work. Indicate the correct answer in proper significant figures and include an appropriate unit.] $7 + 35 =$ 42g

6.9 + 35.5 = 42.4

b Calculate the number of moles of LiCl(s) produced. [Show all work. Indicate the correct answer in proper significant figures.] $X\ mol = \frac{.333\ g}{42\ g}$ 0.008 mol

10. In a laboratory experiment, a student determined the mass of the product, $KClO_3(s)$, to be 45.7 grams.

a. Calculate the gram formula mass of $KClO_3(s)$. Round atomic masses from the Periodic Table to the nearest tenth. [Show all work. Indicate the correct answer in proper significant figures and include an appropriate unit.] $39 + 35 + 3(16) =$ 122g

39.1 + 35.5 + 3(16.0) = 122.6

b. Calculate the number of moles of $KClO_3(s)$ produced. [Show all work. Indicate the correct answer in proper significant figures.]

$$X\ moles = \frac{45.7\ g}{122\ g/mol}$$

0.37 mol

MOLES OF ATOMS IN A COMPOUND

1 molecule of H_2O contains 1 atoms of hydrogen

1 molecule of H_2O contains 2 atoms of oxygen

Now count moles....

1 mole of H_2O contains 1 moles of hydrogen atoms

1 mole of H_2O contains 2 moles of oxygen atoms

The number of moles of atoms in a formula is proportional to the number of atoms in the formula.

1 mole of the compound → Number of atoms in the formula
2 moles of the compound → Number of atoms in the formula X 2

How many moles of oxygen atoms are in 1 mole of $CaSO_4$? 4 moles

How many moles of atoms are in 1 mole of $CaSO_4$?

6 moles of atoms (add-up all atoms in the formula)

GASES: Measured in Liters

1 mole = 22.4 L

(.5 mole = 11.2 L, 2 moles = 44.8 L)

1. Given the reaction $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ what is the maximum number of moles of H_2O that can be produced when 2.0 moles of NH_3 are completely reacted?

$$\frac{H_2O}{NH_3} = \frac{6 \text{ moles}}{4 \text{ moles}} = \frac{X}{2 \text{ moles}}$$

$4X = 12$

$X =$ 3 mol NH_3

2. Given the reaction $2KClO_3\,(s) \rightarrow 2KCl(s) + 3O_2(g)$, what is the total number of moles of $KClO_3$ needed to produce 6 moles of $O_2(g)$?

$$\frac{KClO_3}{O_2} = \frac{2 \text{ moles}}{3 \text{ moles}} = \frac{X}{6}$$

$3X = 12$

4 moles $KClO_3$

3. Using the following reaction $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, what amount of oxygen is needed to completely react with 1 mol CH_4?

$$\frac{O_2}{CH_4} = \frac{2}{1} = \frac{X}{1}$$

2 moles O_2

4. What is the total number of moles of O_2 required to produce 40 mol of NO given the reaction $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$.

$$\frac{O_2}{NO} = \frac{5}{4} = \frac{X}{40}$$

$200 = 4X$

50 moles O_2

5. Given the reaction $2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H2O(g)$, how many moles of $O_2(g)$ are needed to produce exactly 20 mol of $CO_2(g)$?

$$\frac{O_2}{CO_2} \rightarrow \frac{3}{2} = \frac{X}{20}$$

$2X = 60$

$X =$ 30 moles O_2

6. Given the reaction $4Na + O_2 \rightarrow 2Na_2O$, how many moles of oxygen are completely consumed in the production of 1.00 mol of Na_2O?

$$\frac{O_2}{Na_2O} \rightarrow \frac{1}{2} = \frac{X}{1}$$

$2X = 1$

.5 moles O_2

7. Consider the following equation: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
How many moles of oxygen are needed for the complete combustion of 3.0 mol of $CH_4(g)$?

$$\frac{O_2}{CH_4} \rightarrow \frac{2}{1} = \frac{X}{3}$$

$X = 6$

6 moles O_2

8. According to the reaction $2Al + 3H_2SO_4 \rightarrow 3H_2 + Al_2(SO_4)_3$, the total number of moles of H_2SO_4 needed to react completely with 5.0 mol of Al is ...

$$\frac{H_2SO_4}{Al} \rightarrow \frac{3}{2} \times \frac{X}{5}$$

$15 = 2X$

7.5 moles H_2SO_4

9. Given the equation $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, what is the total number of moles of NH_3 produced when 10 mol of H_2 reacts completely with N_2?

$$\frac{NH_3}{H_2} \rightarrow \frac{2}{3} \times \frac{X}{10}$$

$3X = 20$

6.7 moles NH_3

How many grams of NH_3 is this equal to? (convert your mole value to grams)

moles → mass (Table T)

$14 + 3 = 17$

$$6.7 \text{ moles} = \frac{X\ g}{17\ g/mol}$$

113.9 g

10. The process of photosynthesis can be represented by the following equation:

$6CO_2(g) + 6H_2O(l) + \text{energy} \rightarrow C_6H_{12}O_6(s) + 6O_2(g)$

If 4 mol of $C_6H_{12}O_6$ is produced by the process, how many moles of CO_2 were used?

$$\frac{C_6H_{12}O_6}{CO_2} \rightarrow \frac{1}{6} \times \frac{4}{X}$$

$X =$ **24 moles CO_2**

How many moles of H_2O were used?

(Set-up another proportion, now between $C_6H_{12}O_6$ & H_2O)

$$\frac{C_6H_{12}O_6}{H_2O} \rightarrow \frac{1}{6} \times \frac{4}{X}$$

24 moles H_2O

How many grams of H_2O is this equivalent to? (Convert the mole value to grams)

mole → mass (Table T)

$2 + 16 = 18$

$$24 \text{ moles} = \frac{X\ g}{18\ g/mol}$$

$432_g\ H_2O$

★ 11. Given the equation $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, how many grams of CO_2 will be produced when 6 mol of O_2 are reacted completely? (set-up a regular mole ratio and then convert the moles of CO_2 to grams)

C 1. Given the balanced equation representing a reaction:

$$Al_2(SO_4)_3 + 6NaOH \rightarrow 2Al(OH)_3 + 3Na_2SO_4$$

The mole ratio of $NaOH$ to $Al(OH)_3$ is $6:2 \rightarrow 3:1$

A) 1:1 B) 1:3 (C) 3:1) D) 3:7

D 2. Given the balanced equation representing a reaction:
$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

What is the total number of moles of $O_2(g)$ required for the complete combustion of 1.5 moles of $C_3H_8(g)$?

$$\frac{O_2}{C_3H_8} \rightarrow \frac{5}{1} \times \frac{X}{1.5}$$

$X = (5)(1.5)$

A) .30 mol B) 1.5 mol
C) 4.5 mol (D) 7.5 mol)

A 3. Given the balanced equation representing a reaction:
$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$
What is the mole ratio of $CO(g)$ to $CO_2(g)$ in this reaction?

$2:2 \rightarrow 1:1$

(A) 1:1) B) 1:2 C) 2:1 D) 3:2

B 4. Given the balanced equation:

$CaCO_3(s) + (2HCl(aq)) \rightarrow CaCl_2(aq) + H_2O(\ell) + (CO_2)(g)$

What is the total number of moles of CO_2 formed when 20. moles of HCl is completely consumed?

$$\frac{CO_2}{HCl} \rightarrow \frac{1}{2} \times \frac{X}{20}$$

$2X = 20$

$X = 10$

A) 5.0 mol (B) 10. mol)
C) 20. mol D) 40. mol

D 5. Given the reaction:

$PbCl_2(aq) + (Na_2CrO_4(aq)) \rightarrow PbCrO_4(s) + (2\ NaCl(aq))$

What is the total number of moles of $NaCl$ formed when 2 moles of Na_2CrO_4 react completely?

$$\frac{NaCl}{Na_2CrO_4} \rightarrow \frac{2}{1} \times \frac{X}{2}$$

$X = 4$

A) 1 mole B) 2 moles
C) 3 moles (D) 4 moles)

A 6. Given the equation:

$(2\ C_2H_2(g)) + (5\ O_2(g)) \rightarrow 4\ CO_2(g) + 2\ H_2O(g)$

How many moles of oxygen are required to react completely with 1.0 mole of C_2H_2?

$$\frac{O_2}{C_2H_2} \rightarrow \frac{5}{2} \times \frac{X}{1}$$

$2X = 5$

(A) 2.5) B) 2.0 C) 5.0 D) 10

D 7. Given the reaction:

$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$

What is the total number of moles of water needed to make 2.5 moles of $C_6H_{12}O_6$?

A) 2.5 B) 6.0 C) 12 D) 15

$\frac{H_2O}{C_6H_{12}O_6} \rightarrow \frac{6}{1} \times \frac{X}{2.5}$

$X = (6)(2.5)$

D 8. Given the reaction:

$2\,C_2H_6 + 7\,O_2 \rightarrow 4\,CO_2 + 6\,H_2O$

What is the total number of moles of CO_2 produced by the complete combustion of 5.0 moles of C_2H_6?

A) 1.0 mole B) 2.0 moles

C) 5.0 moles D) 10. moles

$\frac{CO_2}{C_2H_6} \rightarrow \frac{4}{2} \times \frac{X}{5}$

$2X = 20$

$X = 10$

D 9. Given the reaction:

$C_6H_{12}O_6(s) + 6\,O_2(g) \rightarrow 6\,CO_2(g) + 6\,H_2O(\ell)$

How many moles of $C_6H_{12}O_6(s)$ are needed to produce 24 moles of carbon dioxide?

A) 1.0 moles B) 12 moles

C) 24 moles D) 4.0 moles

$\frac{C_6H_{12}O_6}{CO_2} \rightarrow \frac{1}{6} \times \frac{X}{24}$

$\frac{6X}{6} = \frac{24}{6}$ $X=4$

B 10. Given the reaction:

$2\,C_2H_6 + 7\,O_2 \rightarrow 4\,CO_2 + 6\,H_2O$

What is the ratio of moles of CO_2 produced to moles of C_2H_6 consumed?

A) 1 to 1 B) 2 to 1

C) 3 to 2 D) 7 to 2

$4:2 \rightarrow 2:1$

B 11. Given the reaction:

$2\,C_2H_6 + 7\,O_2 \rightarrow 4\,CO_2 + 6\,H_2O$

What is the total number of moles of CO_2 produced when one mole of C_2H_6 is completely reacted?

A) 1 B) 2 C) 3 D) 4

$\frac{CO_2}{C_2H_6} \rightarrow \frac{4}{2} = \frac{X}{1}$

B 12. Given the balanced equation:

$2\,Na + S \rightarrow Na_2S$

What is the total number of moles of S that reacted when 4.0 moles of Na were completely consumed?

A) 1.0 mole B) 2.0 moles

C) 0.5 mole D) 4.0 moles

$\frac{S}{Na} \rightarrow \frac{1}{2} = \frac{X}{4}$

Name: **Gas Density Calculations**

---

1. At STP, 1.0 liter of helium contains the same total number of atoms as

   (A) 1.0 L of Ne B) 2.0 L of Kr
   C) 0.5 L of Rn D) 1.5 L of Ar

Same volume, Same # of particles (moles)

2. Which two samples of gas at STP contain the same total number of molecules?

   A) 1 L of $CO(g)$ and 0.5 L of $N_2(g)$
   B) 2 L of $CO(g)$ and 0.5 L of $NH_3(g)$
   C) 1 L of $H_2(g)$ and 2 L of $Cl_2(g)$
   (D) 2 L of $H_2(g)$ and 2 L of $Cl_2(g)$ → Same volumes

3. Which gaseous element has the greatest density at STP?

   A) N_2 28g B) O_2 32g (C) Cl_2 70g D) F_2 38g

$d = m/22.4L$

* Look for the greatest formula MASS.

4. If the density of a gas at STP is 2.50 grams per liter, what is the gram molecular mass of the gas?

   A) 2.50 B) 22.4 (C) 56.0 D) 89.6

$2.50 = \frac{X}{22.4}$

5. Which gas has a density of 1.52 grams per liter at STP?

   (A) H_2S 34g B) CH_4 16g C) NO 30g D) CO 28g

$1.52 = \frac{X}{22.4}$ $X = 34g$

6. At STP, what is the density of a gas that has a gram molecular mass of 32 grams?

   A) 0.70 g/L B) 2.0 g/L
   C) 3.2 g/L (D) 1.4 g/L

$X = \frac{32}{22.4}$

7. What is the molecular mass of a gas whose density is 1.4 grams per liter at STP?

   A) 16 B) 22 (C) 31 D) 38

$1.4 = \frac{X}{22.4}$

8. What is the density, in grams per liter, of N_2 gas at STP?

   A) 28.0 B) 14.0 (C) 1.25 D) 0.800

N_2 G.F.M. = 28g

$X = \frac{28}{22.4}$

Name:

Mole Stoichiometry
Practice questions

1. The molecular formula of a compound is represented by X_3Y_6. What is the empirical formula of this compound?
   (1) X_3Y
   (2) X_2Y
   (3) XY_2
   (4) XY_3

2. Which formula below is an empirical formula?
   (1) H_2O_2
   (2) NH_3
   (3) C_2H_6
   (4) Hg_2Cl_2

   Reduced

3. What is the molecular formula of a compound that has a molecular mass of 54 and the empirical formula C_2H_3?
   (1) C_2H_3
   (2) C_4H_6
   (3) C_6H_9
   (4) C_8H_{12}

   $\frac{52}{27} = 2$

4. The formula H_2O_2 is an example of
   (1) a molecular formula
   (2) an empirical formula
   (3) an ionic formula
   (4) an organic formula

5. What is the gram formula mass of $(NH_4)_3PO_4$?
   (1) 113 g
   (2) 121 g
   (3) 149 g
   (4) 404 g

   3(14)
   12(1)
   31
   +4(16)

6. What is the formula mass of $Al_2(SO_4)_3$?
   (1) 123
   (2) 150
   (3) 214
   (4) 342

   2(27)
   3(32)
   +12(16)

7. What is the total number of moles of sulfur atoms in 1 mole of $Fe_2(SO_4)_3$?
   (1) 1
   (2) 15
   (3) 3
   (4) 17

   * Atoms in a compound Look @ subscripts

8. What is the total number of moles of hydrogen atoms contained in 1 mole of $(NH_4)_2C_2O_4$?
   (1) 6
   (2) 2
   (3) 8
   (4) 4

9. Which represents the greatest mass of chlorine?
   (1) 1 mole of chlorine
   (2) 1 atom of chlorine
   (3) 1 gram of chlorine
   (4) 1 molecule of chlorine

   35g
   1g

10. Which sample contains a mole of atoms?
    (1) 23 g Na
    (2) 24 g C
    (3) 42 g Kr
    (4) 78 g K

    1 mole = gram form. mass

11. The number of moles of molecules in a 12.0-gram sample of Cl_2 is
    (1) $\frac{12.0}{35.5}$ mole
    (2) $\frac{12.0}{71.0}$ mole
    (3) 12.0 moles
    (4) 12.0×35.5 moles

    $x \text{ moles} = \frac{12g}{71g/mol}$

12. What is the total mass in grams of 0.75 mole of SO_2?
    (1) 16 g
    (2) 24 g
    (3) 32 g
    (4) 48 g

    $.75 \text{ mol} = \frac{X}{64g/mol}$

13. What is the mass in grams of 1.00 mole of O_2 gas?
    (1) 11.2
    (2) 16.0
    (3) 22.4
    (4) 32.0

14. A compound has a gram formula mass of 56 grams per mole. What is the molecular formula for this compound?
    (1) CH_2
    (2) C_2H_4
    (3) C_3H_6
    (4) C_4H_8

15. A compound has an empirical formula of CH_2 and a molecular mass of 56. What is its molecular formula?
    (1) CH_2
    (2) C_2H_4
    (3) C_3H_6
    (4) C_4H_8

    C_4H_8
    $\frac{56}{14} = 4$

16. A sample of an unknown gas at STP has a density of 1.25 grams per liter. What is the gram molecular mass of this gas?
    (1) 28.0 g
    (2) 44.0 g
    (3) 64.0 g
    (4) 80.0 g

    $1.25 = \frac{X}{22.4}$

17. What is the mass of 1 mole of a gas that has a density of 2.00 grams per liter at STP?
    (1) 11.2 g
    (2) 22.4 g
    (3) 33.6 g
    (4) 44.8 g

    $2 = \frac{X}{22.4}$

18. What is the percent composition by mass of nitrogen in NH_4NO_3 (gram-formula mass = 80.0 grams/mole)?
    (1) 17.5%
    (2) 35.0%
    (3) 52.5%
    (4) 60.0%

    $\frac{28}{80} \times 100 =$

19. What is the percent by mass of oxygen in propanal, CH_3CH_2CHO?
    (1) 10.0%
    (2) 27.6%
    (3) 38.1%
    (4) 62.1%

    $\frac{16}{58} \times 100 =$

20. A 10.0 gram sample of a hydrate was heated until all the water of hydration was driven off. The mass of anhydrous product remaining was 8.00 grams. What is the percent of water in the hydrate?
    (1) 12.5%
    (2) 20.0%
    (3) 25.0%
    (4) 80.0%

    2g H_2O

    $\frac{2}{10} \times 100 =$

21. Given the reaction:

    $$2\,C_2H_6 + 7\,O_2 \rightarrow 4\,CO_2 + 6\,H_2O$$

    What is the total number of moles of CO_2 produced when one mole of C_2H_6 is completely reacted?
    (1) 1
    (2) 2
    (3) 3
    (4) 4

    $\frac{CO_2}{C_2H_6} \rightarrow \frac{4}{2} = \frac{X}{1} \quad \frac{2X}{2} = \frac{4}{2}$

Mole Stoichiometry

22. Given the reaction:

$$CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(g)$$

How many moles of oxygen are needed for the complete combustion of 3.0 moles of $CH_4(g)$?

(1) 6.0 moles
(2) 2.0 moles
(3) 3.0 moles
(4) 4.0 moles

23. Given the equation:

$$Zn + 2\,HCl \rightarrow ZnCl_2 + H_2$$

How many moles of HCl would be required to produce a total of 2 moles of H_2?

(1) 0.5
(2) 2
(3) 3
(4) 4

$\frac{HCl}{H_2} \rightarrow \frac{2}{1} \times \frac{X}{2}$

$X = 4$

24. The table below shows the temperature, pressure, and volume of five samples.

Sample	Substance	Temperature (K)	Pressure (atm)	Volume (L)
A	He	273	1	22.4
B	O_2	273	1	22.4
C	Ne	273	2	22.4
D	N_2	546	2	44.8
E	Ar	546	2	44.8

(moles)

Which sample contains the same number of molecules as sample *A*?

(1) *E*
(2) *B*
(3) *C*
(4) *D*

25. Which quantity of N_2 gas has a volume of 11.2 liters at STP?

(1) 1.0 mole
(2) 2.0 moles
(3) 14.0 grams
(4) 28.0 grams

11.2L = .5 mol

$.5mol = \frac{X}{28}$

$X = 14g$

22. $\frac{O_2}{CH_4} \rightarrow \frac{2}{1} \times \frac{X}{3}$

$X = 6$

Stoichiometry
Multiple Choice Review

1. Which pair of formulas correctly represents a molecular formula and its corresponding empirical formula?

A) C_2H_2 and CH B) C_3H_4 and CH_2

C) C_4H_6 and CH D) C_5H_8 and C_2H_2

2. What is the empirical formula of a compound with the molecular formula $C_6H_{12}O_6$?

A) $C_4H_8O_4$ B) $C_3H_6O_3$

C) $C_2H_4O_2$ **D) CH_2O**

3. What is the total number of atoms contained in 1 mole of NH_3?

A) 1 mole B) 2 moles

C) 3 moles **D) 4 moles**

4. What is the molecular formula of a compound that has a molecular mass of 54 and the empirical formula C_2H_3?

A) C_2H_3 **B) C_4H_6**

C) C_6H_9 D) C_8H_{12}

5. A compound whose empirical formula is NO_2 could have a molecular mass of

A) 23 B) 39 **C) 92** D) 120

6. Which chemical formula is both an empirical formula and a molecular formula?

A) CH_4

B) C_2H_6

C) CH_3COOH

D) $CH_3CH_2COOCH_3$

7. The gram-formula mass of $(NH_4)_2CO_3$ is

A) 46.0 g B) 64.0 g

C) 78.0 g **D) 96.0 g**

8. What is the gram formula mass of $Ca(OH)_2$?

A) 29 g B) 34 g C) 57 g **D) 74 g**

9. Which sample contains a mole of atoms?

A) 23 g Na B) 24 g C

C) 42 g Kr D) 78 g K

10. The number of moles of molecules in a 12.0-gram sample of Cl_2 is

A) $\frac{12.0}{35.5}$ mole **B) $\frac{12.0}{71.0}$ mole**

C) 12.0 moles D) 12.0×35.5 moles

11. What is the mass in grams of 2.0 moles of NO_2?

A) 92 B) 60. C) 46 D) 30.

12. What is the total mass in grams of 0.75 mole of SO_2?

A) 16 g B) 24 g C) 32 g **D) 48 g**

13. What is the percent by mass of oxygen in propanal, CH_3CH_2CHO?

A) 10.0% **B) 27.6%**

C) 38.1% D) 62.1%

14. In which compound is the percent by mass of oxygen greatest?

A) BeO B) MgO

C) CaO D) SrO

15. A hydrate is a compound that includes water molecules within its crystal structure. During an experiment to determine the percent by mass of water in a hydrated crystal, a student found the mass of the hydrated crystal to be 4.10 grams. After heating to constant mass, the mass was 3.70 grams. What is the percent by mass of water in this crystal?

A) 90.% B) 11%

C) 9.8% D) 0.40%

16. The percent by mass of hydrogen in NH_3 is equal to

A) $\frac{17}{1} \times 100$ B) $\frac{17}{3} \times 100$

C) $\frac{1}{17} \times 100$ **D)** $\frac{3}{17} \times 100$

17. Given the reaction:

$N_2(g) + 3\ H_2(g) \leftrightarrow 2\ NH_3(g)$
What is the mole-to-mole ratio between nitrogen gas and hydrogen gas?

A) 1:2 **B) 1:3** C) 2:2 D) 2:3

18. Given the balanced equation:

$2\ C_4H_{10}(g) + 13\ O_2(g) \rightarrow 8\ CO_2(g) + 10\ H_2O(g)$
What is the total number of moles of $O_2(g)$ that must react completely with 5.00 moles of $C_4H_{10}(g)$?

A) 10.0 B) 20.0 C) 26.5 **D) 32.5**

19. Given the equation:

$2\ C_2H_2(g) + 5\ O_2(g) \rightarrow 4\ CO_2(g) + 2\ H_2O(g)$
How many moles of oxygen are required to react completely with 1.0 mole of C_2H_2?

A) 2.5 B) 2.0 C) 5.0 D) 10

20. At the same temperature and pressure, which sample contains the same number of moles of particles as 1 liter of $O_2(g)$?

A) 1 L Ne(g) B) 2 L $N_2(g)$

C) 0.5 L $SO_2(g)$ D) 1 L $H_2O(\ell)$

Stoichiometry
Constructed Response Practice

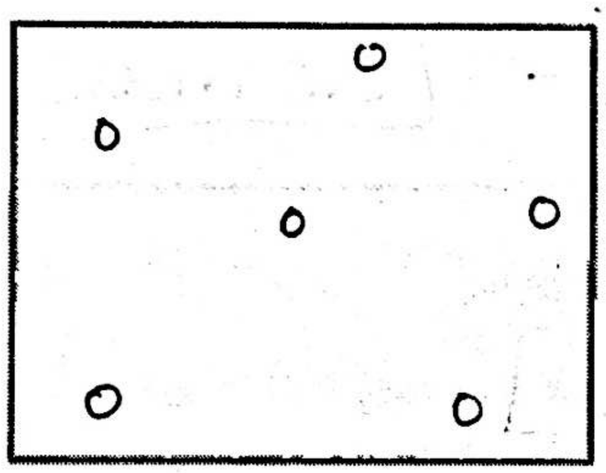
Base your answers to questions **1** through **3** on the following paragraph.

A portable propane-fueled lantern contains a mesh silk bag coated with metal hydroxides. The primary metal hydroxide is yttrium hydroxide. When the silk bag is installed, it is ignited and burned away, leaving the metal hydroxide coating. The coating forms metal oxides that glow brightly when heated to a high temperature.
During a test, a propane lantern is operated for three hours and consumes 5.0 moles of propane from the lantern's tank. The balanced equation below represents the combustion of propane.

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O + \text{energy}$

1. At standard pressure, the boiling point of propane is 231 K. In the box below, draw a particle diagram to represent the phase of the propane as it leaves the tank at 294 K. Your response must include *at least six* molecules.

Key
○ = propane molecule



Propane: $C_3H_8 = 3(12) + 8(1) = 44\ g/mol$

2. Calculate the total mass of propane consumed during the lantern test. Your response must include *both* a correct numerical setup and the calculated result.

$5\ \text{moles} = \frac{x}{44\ g/mol}$ **220g**

3. Determine the total number of moles of CO_2 produced during the lantern test.

$\frac{C_3H_8}{CO_2} \rightarrow \frac{1}{3} \times \frac{5}{x}$ **15 moles CO_2**

4. Base your answer to the following question on the information below.

The decomposition of sodium azide, $NaN_3(s)$, is used to inflate airbags. On impact, the $NaN_3(s)$ is ignited by an electrical spark, producing $N_2(g)$ and $Na(s)$. The $N_2(g)$ inflates the airbag.
What is the total number of moles present in a 52.0-gram sample of $NaN_3(s)$ (gram- formula mass = 65.0 gram/mole)?

$x\ \text{moles} = \frac{52\ g}{65\ g/mol}$ **.8 moles**

Base your answers to questions **5** and **6** on the information below.

Some dry chemicals can be used to put out forest fires. One of these chemicals is $NaHCO_3$. When $NaHCO_3(s)$ is heated, one of the products is $CO_2(g)$, as shown in the balanced equation below.

$$2NaHCO_3(s) + heat \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

5. Show a correct numerical setup for calculating the percent composition by mass of carbon in the product Na_2CO_3.

Na → 2(23) = 46
C → 1(12) = 12
O → 3(16) = 48
106

$\frac{12}{106} \times 100 =$

6. Determine the total number of moles of $CO_2(g)$ produced when 7.0 moles of $NaHCO_3(s)$ is completely reacted.

$\frac{CO_2}{NaHCO_3} \rightarrow \frac{1}{2} = \frac{X}{7}$ 3.5 moles

7. Write the empirical formula for the compound $C_6H_{12}O_6$.

CH_2O

8. Show a correct numerical setup for calculating the formula mass of glucose, $C_6H_{12}O_6$.

$6(12) + 12(1) + 6(16) =$

Base your answers to questions **9** and **10** on the information and equation below.

Antacids can be used to neutralize excess stomach acid. Brand A Antacid contains the acid-neutralizing agent magnesium hydroxide, $Mg(OH)_2$. It reacts with HCl(aq) in the stomach, according to the following balanced equation:

$$2\,HCl(aq) + Mg(OH)_2(s) \rightarrow MgCl_2(aq) + 2\,H_2O(\ell)$$

9. Show a correct numerical setup for calculating the number of moles of $Mg(OH)_2$ (gram-formula mass = 58.3 grams/mole) in an 8.40-gram sample.

$X = \frac{8.40\ g}{58.3\ g/mol}$ .14 mol

10. If a person produces 0.050 mole of excess HCl in the stomach, how many moles of $Mg(OH)_2$ are needed to neutralize this excess hydrochloric acid?

$\frac{HCl}{Mg(OH)_2} \rightarrow \frac{2}{1} \times \frac{.05}{X}$

$\frac{.05}{2} = \frac{2X}{2}$

.025 mol

Base your answers to questions **11** and **12** on the information below.

Gypsum is a mineral that is used in the construction industry to make drywall (sheetrock). The chemical formula for this hydrated compound is $CaSO_4 \cdot 2\ H_2O$. A hydrated compound contains water molecules within its crystalline structure. Gypsum contains 2 moles of water for each 1 mole of calcium sulfate.

11. What is the gram formula mass of $CaSO_4 \cdot 2\ H_2O$?

Ca = 40 H = 4(1) = 4
S = 32 O = 2(16) = 32
O = 4(16) = 64

172 g/mol

12. Show a correct numerical setup for calculating the percent composition by mass of water in this compound *and* record your answer.

water = 36
whole = 172

$\frac{36}{172} \times 100 = 20.9\%$

---

13. Given the compound $C_4H_{10}O_8$,

a Calculate the molar mass of the compound. 4(12) + 10(1) + 8(16) = 186 g/mol

b Calculate the number of moles in 17.7 grams of the compound. $x\text{moles} = \frac{17.7\ g}{186\ g/mol}$ .095 mol

c What is the empirical formula for this compound?

$C_2H_5O_4$