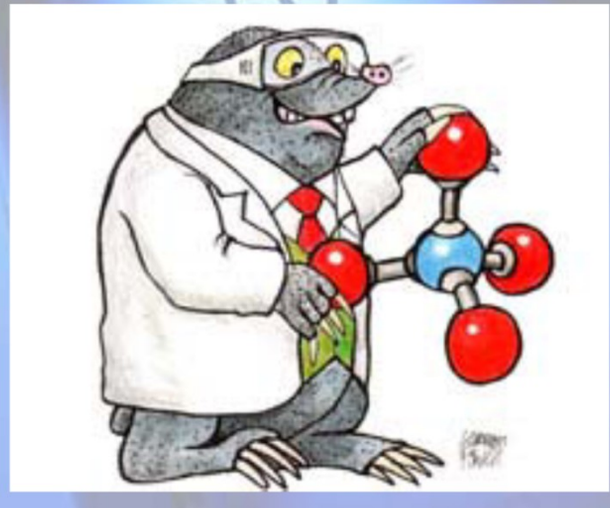
Chemistry

PRACTICE PACKET

Unit 5: Moles & Stoichiometry



GFM (Molar Mass) Calculations – SHOW ALL WORK!

Calculate the gram formula mass of the following chemicals:

1) Br_2 Br = 2 × 79.904 = 159.814g

2) $CsOH$ Cs = 1 × 132.905 = 132.905
O = 1 × 15.994 = 15.994
H = 1 × 1.00794 = 1.00794
149.91294g

3) $BaCl_2$ 208.236g

4) FeF_3 112.8402g

5) $AlCl_3$ 133.34054g

6) Al_2O_3 Al = 2 × 26.98154 = 53.9630g
O = 3 × 15.9994 = 47.9982
101.96125g

7) SO_3 80.0632g

8) HNO_3 63.01284g

9) $(NH_4)_2CO_3$ 96.08622g

10) $Mg_3(PO_4)_2$ 262.85772g

11) $Pb(CH_3COO)_2$ 325.28964g

Percent Composition

Compound	GFM	% comp	% comp	% comp
H_2SO_4 H S O	$2\times1.00794=2.01588$ $1\times32.065=32.065$ $4\times15.9994=63.9976$ whole → 98.07848	% H $=\frac{2.01588}{98.07848}\times100$ $=2.1\%$	% S $=\frac{32.06}{98.07848}\times100$ $=32.7\%$	% O $=\frac{63.9994}{98.07848}\times100$ $=65.3\%$
$CaCl_2$	110.986	% Ca 36.1%	% Cl 63.9%	% comp = $\frac{\text{mass of part}}{\text{mass of whole}}\times100$
H_2O	18.01528	% H 11.2%	% O 88.8%	
$CuCO_3$	123.553	% Cu 51.4%	% C 9.7%	% O 38.8%
NaCl	Na = 22.98977 Cl = 35.453	% Na 39.3	% Cl 60.7	
$Al_2(PO_4)_3$	Al = 2 × 26.98154 P = 3 × 30.97376 O = 12 × 15.9994	% Al 15.9	% P 27.4	% O 56.7
KOH	K = 39.0983 O = 15.9994 H = 1.00794	% K 69.7	% O 28.5	% H 1.8

Regents Chemistry **Crystal Hydrates (% Composition)**

1. Base your answer to the following question on A hydrate is a compound with water molecules incorporated into its crystal structure. In an experiment to find the percent by mass of water in a hydrated compound, the following data were recorded:

Mass of crucible + hydrated crystals before heating	7.50 grams
Mass of crucible	6.90 grams
Mass of crucible + anhydrous crystals after heating	7.20 grams

What is the percent by mass of water in the hydrate?

A) 72. % B) 50. % C) 96. % D) 8.0 %

2. The percent by mass of water in the hydrate $Na_2SO_4 \cdot 10H_2O$ is closest to

A) 18% B) 44% C) 76% D) 56%

3. What is the percent by mass of water present in 1.0 mole of $CaSO_4 \cdot 2H_2O$?

A) 79% B) 10.% C) 12% D) 21%

4. A student obtained the following data to determine the percent by mass of water in a hydrate.

Mass of empty crucible + cover	11.70 g
Mass of crucible + cover + hydrated salt before heating	14.90 g
Mass of crucible + cover + anhydrous salt after thorough heating	14.53 g

What is the approximate percent by mass of the water in the hydrated salt?

A) 12% B) 88% C) 98% D) 2.5%

5. A 4.4 gram sample of a hydrate was heated until the water of hydration was driven off. The anhydrous compound remaining had a mass of 3.3 grams. What is the percentage by mass of water in the hydrate?

A) 25% B) 33% C) 67% D) 75%

6. A 20. gram sample of a hydrate is heated until all the water of hydration is driven off. The mass of the anhydrous compound remaining is 15 grams. What is the percent by mass of water in the hydrate?

A) 75% B) 15% C) 25% D) 33%

7. Which species contains the greatest percent by mass of hydrogen?

A) H_3O^+ B) H_2O_2
C) H_2O D) OH^-

8. A 1.20-gram sample of a hydrated salt is heated to a constant mass of 0.80 gram. What was the percent by mass of water contained in the original sample?

A) 20. B) 33 C) 50. D) 67

9. A student determining the percent by mass of water in a hydrated crystal obtained the following data.
Mass of crystal before heating.....5.0 g
Mass of crystal after 1st heating.....4.0 g
Mass of crystal after 2nd heating.....4.0 g
What is the percent by mass of water in the hydrate?

A) 0.80% B) 0.20%
C) 80.% D) 20.%

10. The percent by mass of water in $BaCl_2 \cdot 2\ H_2O$ (formula mass = 243) is equal to

A) $\frac{18}{243} \times 100$ B) $\frac{243}{18} \times 100$
C) $\frac{243}{36} \times 100$ D) $\frac{36}{243} \times 100$

Crystal Hydrates (% Composition)

11. 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?

A) 25.0% B) 12.5%
C) 80.0% D) 20.0%

12. A 60. gram sample of $LiCl \cdot H_2O$ is heated in an open crucible until all of the water has been driven off. What is the total mass of LiCl remaining in the crucible?

A) 42 g B) 24 g C) 18 g D) 60 g

13. A student determining the percent by mass of water in a hydrated sample of salt obtained the following data:
Mass of hydrate 6.25 g
Mass of sample after 1st heating 5.12 g
Mass of sample after 2nd heating 5.12 g

The correct expression for obtaining the percent by mass of water in the sample is

A) $\frac{6.25\ g}{1.13\ g} \times 100$ B) $\frac{5.12\ g}{6.25\ g} \times 100$
C) $\frac{6.25\ g}{5.12\ g} \times 100$ D) $\frac{1.13\ g}{6.25\ g} \times 100$

14. 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) 75.2% B) 14.1%
C) 24.8% D) 32.9%

Base your answers to questions **15** and **16** on the table below shows the data collected during the heating of a 5.0 gram sample of a hydrated salt.

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

15. What is the percent of water in the original sample?

A) 82.% B) 40.%
C) 60.% D) 30.%

16. After 60. minutes, how many grams of water appear to remain in the salt?

A) 0.00 B) 2.0 C) 1.9 D) 0.90

Grams to Moles & Moles to Grams

Convert the following from grams to moles:

1) 15.0 g $C_6H_{12}O_6$

C 6x
H 12x
O 6x

GFM 180.157689/mol

mole = 15g / 180.157689/mol = .0832 mol

2) 25.0 g NaOH

GFM 39.99711

mole = 25 / 39.99711 = 0.625 mol

3) 54.0 g HCl

GFM 36.46094

mole = 54 / 36.46094 = 1.481 mol

4) 13.0 g H_2O

GFM 18.01528

mole = 13 / 18.01528 = 0.7216 mol

5) 23.0 g $Ca(NO_3)_2$

GFM 164.08989/mol

mole = 23 / 164.0898 = 0.14016752 mol

6) 1.00 g H_2SO_4

GFM

7) 0.105 g O_2

GFM 31.998

mole = .105 / 31.998 = 0.003 mol

Convert the following from moles to grams:

1) 0.500 moles LiF

GFM 25.9391

mass = 0.500 x 25.9391 = 12.96945 g

2) 0.1188 moles NaOH

GFM 31.99711

mass = 0.1188 x 31.99711 = 4.75 g

3) 4.00 moles KCl

GFM 74.5513

mass = 4 x 74.5513 = 298.2052 g

4) 10.0 moles H_2O_2

GFM 34.01468

mass = 10 x 34.01468 = 340.1468 g

5) 13.0 moles Na_2CO_3

GFM 100.98824

mass = 13 x 100.98824 = 1,377.8534 g

6) 28.0 moles H_2O

GFM 17.00734

mass = 28 x 17.00734 = 476.2055 2g

7) 0.800 moles NH_3

GFM 17.2449

mass = 0.8 x 17.2449 = 13.79592 g

Grams, Molecules, and Moles Worksheet

Need have

1) How many molecules are there in 32.0 grams of FeF_3?

$mol = \frac{32}{112.8422} = 0.2836\ mol$ molecules $= 0.2836 \times (6.02 \times 10^{23})$ (Avogadro's number)

$= 1.707 \times 10^{23}$

2) How many molecules are there in 250. grams of Na_2SO_4?

$mol = \frac{250}{124.076} = 2.0149\ mol$ molecules $= 2.0149 \times (6.02 \times 10^{23})$

$= 1.213 \times 10^{24}$

3) How many grams are there in 4.60×10^{24} atoms of silver?

$moles = \frac{4.60 \times 10^{24}}{6.02 \times 10^{23}} = 7.641\ mol$ mass = moles x gfm

$= 7.641 \times 107.868$

$= 824.24\ g$

4) How many grams are there in 4.70×10^{23} molecules of $AgNO_3$?

$moles = \frac{4.70 \times 10^{23}}{6.02 \times 10^{23}} = 0.781\ mol$ mass = moles x gfm

$= 0.781\ mol \times 169.8729$

$= 132.67\ g$

5) How many grams are there in 5.70×10^{23} molecules of H_2SO_4?

$moles = \frac{5.70 \times 10^{23}}{6.02 \times 10^{23}} = 0.947\ mol$ mass = moles x gfm

$= 0.947\ mol \times 98.07848$

$= 92.88\ g$

6) How many molecules are there in 221 grams of $Cu(NO_3)_2$?

$moles = \frac{221}{187.555} = 1.178\ mol$ molecules $= 1.178 \times (6.02 \times 10^{23})$

$= 7.09 \times 10^{23}$ molecules

7) How many grams are there in 4.90×10^{25} molecules of H_2?

$moles = \frac{4.90 \times 10^{25}}{6.02 \times 10^{23}} = 81.4\ moles$ mass = moles x gfm

$= 81.4 \times 2.01588$

$= 164.09\ g$

8) How many molecules are there 230. grams of $CoCl_2$?

$moles = \frac{230}{129.8392} = 0.177\ moles$ molecules $= 0.177 \times (6.02 \times 10^{23})$

$= 1.07 \times 10^{23}$ molecules

Regents Chemistry **Mass-Mole Calculations**

1. Which sample contains a mole of atoms?

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

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

A) 12.0×35.5 moles B) $\frac{12.0}{71.0}$ mole
C) 12.0 moles D) $\frac{12.0}{35.5}$ mole

3. One mole of O_2 has approximately the same mass as one mole of

A) S B) Cl_2 C) CH_4 D) LiH

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

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

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

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

6. What is the total mass of oxygen in 1.00 mole of $Al_2(CrO_4)_3$?

A) 48.0 g B) 192 g
C) 112 g D) 64.0 g

7. What is the total mass of 2.0 moles of $H_2(g)$?

A) 1.0 g B) 2.0 g C) 3.0 g D) 4.0 g

8. 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

9. What is the mass in grams of 1.00 mole of O_2 gas?

A) 32.0 B) 22.4 C) 11.2 D) 16.0

10. What is the gram-molecular mass of a compound if 5 moles of the compound has a mass of 100 grams?

A) 100 g B) 5 g
C) 500 g D) 20 g

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

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

12. Which sample contains the same number of atoms as a gram of He?

A) 9 g of F B) 7 g of Li
C) 4 g of O D) 6 g of C

13. The gram molecular mass of CO_2 is the same as the gram molecular mass of

A) C_3H_8 B) SO_2
C) CO D) C_2H_6

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

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

15. What is the total number of moles in 80.0 grams of C_2H_5Cl (gram-formula mass = 64.5 grams/mole)?

$\frac{80}{64.5} = 1.24$ mol

2 4 4 4

Balancing Equations

1) 1 $C_2H_4O_2$ + 2 O_2 → 2 CO_2 + 2 H_2O

C 2 | C x 2
H 4 | H 2 4
O 4 6 | O 3 6

2) 6 AgI + 1 $Fe_2(CO_3)_3$ → 2 FeI_3 + 3 Ag_2CO_3

Ag x 6 | Ag 2 6
I x 6 | I 3 6
Fe 2 | Fe x 2
CO_3 3 | CO_3 x 3

3) 1 V_2O_5 + 5 CaS → 5 CaO + 1 V_2S_5

V 2 | V 2
O 5 | O x 5
Ca x 5 | Ca x 5
S x 5 | S 5

4) 2 $NaNO_3$ + 1 PbO → 1 $Pb(NO_3)_2$ + 1 Na_2O

Na x 2 | Na 2
NO_3 x 2 | NO_3 2
Pb 1 | Pb 1
O 1 | O 1

5) 3 AgBr + 1 $GaPO_4$ → 1 Ag_3PO_4 + 1 $GaBr_3$

Ag x 3 | Ag 3
Br x 3 | Br 3
Ga 1 | Ga 1
PO_4 1 | PO_4 1

Regents Chemistry **Balancing Equations Practice**

1. Given the balanced equation with an unknown compound represented by *X*:

$$C_6H_{12}O_6(aq) \xrightarrow{\text{enzyme}} 2X + 2CO_2(g)$$

Which compound is represented by *X*?

A) $CH_3CH_2OH(aq)$
B) $CH_3OH(aq)$
C) $CH_2OHCH_2OH(aq)$
D) $CH_2(OH)_4(aq)$

2. Given the incomplete equation for the combustion of ethane:

$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6$ ___
What is the formula of the missing product?

A) H_2O_2 B) HCOOH
C) CH_3OH D) H_2O

3. Given the unbalanced equation:

$$\_\_\_ Fe_2O_3 + \_\_\_ CO \rightarrow \_\_\_ Fe + \_\_\_ CO_2$$

When the equation is correctly balanced using the *smallest* whole-number coefficients, what is the coefficient of CO?

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

4. Given the unbalanced equation:

$$\_\_\_ Al + \_\_\_ CuSO_4 \rightarrow \_\_\_ Al_2(SO_4)_3 + \_\_\_ Cu$$

When the equation is balanced using the *smallest* whole-number coefficients, what is the coefficient of Al?

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

5. Given the unbalanced equation:

$$\_\_\_ Mg(ClO_3)_2(s) \rightarrow \_\_\_ MgCl_2(s) + \_\_\_ O_2(g)$$

What is the coefficient of O_2 when the equation is balanced correctly using the *smallest* whole number coefficients?

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

Balancing Equations Practice

6. Given the unbalanced equation:

$$\_\_ Al(s) + \_\_ O_2(g) \rightarrow \_\_ Al_2O_3(s)$$

When this equation is correctly balanced using smallest whole numbers, what is the coefficient of $O_2(g)$?

A) 6 B) 2 C) 3 D) 4

7. Given the unbalanced equation:

$$\_\_ Na + 2\ H_2O \rightarrow \_\_ H_2 + \_\_ NaOH$$

When the equation is correctly balanced using the smallest whole-number coefficients, the coefficient for H_2O is

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

8. Given the unbalanced equation:

$$\_\_ N_2(g) + \_\_ O_2(g) \rightarrow \_\_ N_2O_5(g)$$

When the equation is balanced using smallest whole numbers, the coefficient of $N_2(g)$ will be

A) 1 B) 2 C) 5 D) 4

9. Given the unbalanced equation:

$$\_\_ CaSO_4 + \_\_ AlCl_3 \rightarrow Al_2(SO_4)_3 + \_\_ CaCl_2$$

What is the coefficient of $Al_2(SO_4)_3$ when the equation is completely balanced using the smallest whole-number coefficients?

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

10. Given the unbalanced equation:

$$NaOH + H_3PO_4 \rightarrow Na_3PO_4 + H_2O$$

When the equation is correctly balanced, the coefficient of H_2O will be

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

11. When the equation

$$1\ Cu + 2\ H_2SO_4 \rightarrow 1\ CuSO_4 + 2\ H_2O + 1\ SO_2$$

is correctly balanced, what is the coefficient of $CuSO_4$?

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

$1\ Cu + 2\ H_2SO_4 \rightarrow 1\ CuSO_4 + 2\ H_2O + 1\ SO_2$

Cu H S O | Cu H S O

Identifying Reaction Types

Determine if the following are synthesis (S), decomposition (D), single replacement (SR), or double replacement (DR) reactions.

ex: 1. $2NaClO_3 \rightarrow 2NaCl + 3O_2$ D

2. $2AgNO_3 + Ni \rightarrow Ni(NO_3)_2 + 2Ag$ SR

3. $H_2CO_3 \rightarrow H_2O + CO_2$ D

4. $BaCO_3 \rightarrow BaO + CO_2$ D

5. $4Cr + 3\ O_2 \rightarrow 2\ Cr_2O_3$ S

6. $Ca + 2HCl \rightarrow CaCl_2 + H_2$ SR

7. $Ca(C_2H_3O_2)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaC_2H_3O_2$ DR

8. $Cu(OH)_2 + 2HC_2H_3O_2 \rightarrow Cu(C_2H_3O_2)_2 + 2H_2O$ DR

9. $8Cu + S_8 \rightarrow 8CuS$ S

10. $P_4 + 5\ O_2 \rightarrow 2\ P_2O_5$ S

11. $2K + 2H_2O \rightarrow 2KOH + H_2$ SR

12. $3AgNO_3 + K_3PO_4 \rightarrow Ag_3PO_4 + 3KNO_3$ DR

13. $H_2 + Cl_2 \rightarrow 2HCl$ S

14. $NaOH + HCl \rightarrow NaCl + H_2O$ DR

15. $2NH_3 \rightarrow N_2 + 3H_2$ D

16. $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ SR

17. $F_2 + 2HBr \rightarrow Br_2 + 2HF$ SR

18. $Zn(NO_3)_2 + CaCO_3 \rightarrow Ca(NO_3)_2 + ZnCO_3$ DR

19. $4Al + 3O_2 \rightarrow 2Al_2O_3$ S

20. $2H_2O_2 \rightarrow 2H_2O + O_2$ D

Balancing Different Types of Reactions

Balance the following equations and indicate the type of reaction taking place:

1) 3 NaBr + 1 H_3PO_4 → 1 Na_3PO_4 + 3 HBr

Na x3	Na 3
Br x3	Br x3
PO_4 1	PO_4 1
H 3	H x3

Type of reaction: Double Replacement

2) 3 $Ca(OH)_2$ + 1 $Al_2(SO_4)_3$ → 3 $CaSO_4$ + 2 $Al(OH)_3$

Ca x3	Ca x3
OH x6	OH x6
Al 2	Al x2
SO_4 3	SO_4 x3

Type of reaction: Double Replacement

3) 2 Mg + 1 Fe_2O_3 → 2 Fe + 3 MgO

Mg x2	Mg x3
Fe x4	Fe x4
O x6	O x6

6 2 4 6 / 2 2 2 2 → 3 1 2 3

Type of reaction: Single R

4) 1 C_2H_4 + 3 O_2 → 2 CO_2 + 2 H_2O

C 2	C x2
H 4	H x4
O x6	O x6

Type of reaction: Combustion

Regents Chemistry **Mole-Mole Calculations**

1. Which sample contains a mole of atoms?

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

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

A) 12.0×35.5 moles B) $\frac{12.0}{71.0}$ mole
C) 12.0 moles D) $\frac{12.0}{35.5}$ mole

3. One mole of O_2 has approximately the same mass as one mole of

A) S B) Cl_2 C) CH_4 D) LiH

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

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

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

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

6. What is the total mass of oxygen in 1.00 mole of $Al_2(CrO_4)_3$?

A) 48.0 g B) 192 g
C) 112 g D) 64.0 g

7. What is the total mass of 2.0 moles of $H_2(g)$?

A) 1.0 g B) 2.0 g C) 3.0 g D) 4.0 g

8. 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

9. What is the mass in grams of 1.00 mole of O_2 gas?

A) 32.0 B) 22.4 C) 11.2 D) 16.0

10. What is the gram-molecular mass of a compound if 5 moles of the compound has a mass of 100 grams?

A) 100 g B) 5 g
C) 500 g D) 20 g

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

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

12. Which sample contains the same number of atoms as a gram of He?

A) 9 g of F B) 7 g of Li
C) 4 g of O D) 6 g of C

13. The gram molecular mass of CO_2 is the same as the gram molecular mass of

A) C_3H_8 B) SO_2 C) CO D) C_2H_6

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

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

15. Given the balanced equation representing the reaction between methane and oxygen:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

According to this equation, what is the mole ratio of oxygen to methane?

A) $\frac{2 \text{ moles } O_2}{1 \text{ mole } CH_4}$ B) $\frac{1 \text{ mole } O_2}{2 \text{ moles } CH_4}$
C) $\frac{2 \text{ grams } O_2}{1 \text{ gram } CH_4}$ D) $\frac{1 \text{ gram } O_2}{2 \text{ grams } CH_4}$

16. 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

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

17. 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)?

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

18. 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?

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

Regents Chemistry **Mass-Mole-Molecule Calculations**

1. Given the balanced equation representing a reaction:

$CaO(s) + CO_2(g) \rightarrow CaCO_3(s) + heat$

What is the total mass of CaO(s) that reacts completely with 88 grams of $CO_2(g)$ to produce 200. grams of $CaCO_3(s)$?

A) 288 g B) 56 g
C) 112 g D) 88 g

2. Given the balanced equation representing a reaction:

$2H_2 + O_2 \rightarrow 2H_2O$

What is the total mass of water formed when 8 grams of hydrogen reacts completely with 64 grams of oxygen?

A) 18 g B) 36 g C) 56 g D) 72 g

3. Given the reaction:

$2\ H_2 + O_2 \rightarrow 2\ H_2O$

The total number of grams of O_2 needed to produce 54 grams of water is

A) 48 B) 61 C) 75 D) 36

4. Given the balanced equation:

$NaOH + HCl \rightarrow NaCl + H_2O$

What is the total number of grams of H_2O produced when 116 grams of the product, NaCl, is formed?

A) 9.0 g B) 54 g C) 18 g D) 36 g

5. Given the reaction:

$Cu + 4\ HNO_3 \rightarrow Cu(NO_3)_2 + 2\ H_2O + 2\ NO_2$

What is the total mass of H_2O produced when 32 grams of Cu is completely consumed?

A) 18 g B) 72 g C) 36 g D) 9.0 g

6. Given the balanced equation:

$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$

What total mass of iron is necessary to produce 1.00 mole of copper?

A) 55.8 g B) 112 g
C) 192 g D) 26.0 g

7. Given the reaction:

$4\ Al(s) + 3\ O_2(g) \rightarrow 2\ Al_2O_3(s)$

What is the minimum number of grams of oxygen gas required to produce 1.00 mole of aluminum oxide?

A) 32.0 g B) 192 g
C) 96.0 g D) 48.0 g

8. Given the reaction:

$4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$

What is the total number of moles of aluminum oxide that can be formed when 54 grams of aluminum reacts completely with oxygen?

A) 1.0 mole B) 2.0 moles
C) 3.0 moles D) 4.0 moles

9. Given the reaction:

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

What is the total number of grams of $O_2(g)$ needed to react completely with 0.50 mole of $C_2H_2(g)$?

A) 40. g B) 80. g
C) 160 g D) 10. g

10. According to the reaction

$H_2 + Cl_2 \rightarrow 2\ HCl,$

the production of 2.0 moles of HCl would require 70. grams of Cl_2 and

A) 1.0 g of H_2 B) 2.0 g of H_2
C) 3.0 g of H_2 D) 4.0 g of H_2

Regents Chemistry **Moles-Liters Calculations**

1. Which gas sample at STP has the same total number of molecules as 2.0 liters of $CO_2(g)$ at STP?

A) 2.0 L of $Cl_2(g)$ B) 6.0 L of He(g)
C) 5.0 L of $CO_2(g)$ D) 3.0 L of $H_2S(g)$

2. 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

3. What is the total volume occupied by 132 grams of $CO_2(g)$ at STP?

A) 44.8 L B) 67.2 L
C) 22.4 L D) 33.6 L

4. At STP, 3×10^{23} molecules of $SO_2(g)$ occupy the same volume as

A) 1 mole of $H_2(g)$
B) 6×10^{23} molecules of $H_2(g)$
C) 0.5 mole of $H_2(g)$
D) 4 grams of $H_2(g)$

5. The volume occupied by 9.03×10^{23} molecules of N_2 gas at STP is closest to

A) 0.500 liter B) 33.6 liters
C) 1.50 liters D) 22.4 liters

6. 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

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

A) *E* B) *B* C) *C* D) *D*

7. A sample of neon gas at STP has a mass of 20. grams. An equal volume of argon gas at STP will have a mass of

A) 10. g B) 20. g C) 30. g D) 40. g

Moles-Liters Calculations

8. Which contains the same number of molecules as 22.4 liters of N_2 at STP?

A) 20.0 grams of argon
B) 4.00 grams of helium
C) 10.0 grams of nitrogen
D) 8.00 grams of oxygen

9. Which quantity represents 1.00 mole at STP?

A) 22.4 liters of $O_2(g)$
B) 22.4 liters of $H_2O(\ell)$
C) 16.0 grams of $O_2(g)$
D) 16.0 grams of $H_2O(\ell)$

10. What is the total volume, in liters, occupied by 56.0 grams of nitrogen gas at STP?

A) 11.2 B) 44.8 C) 33.6 D) 22.4

11. The mass of 11.2 liters of a gas is 20. grams at STP. What is the mass of 6.02×10^{23} molecules of this gas?

A) 80. g B) 20. g C) 40. g D) 10. g

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

A) 1.0 mole B) 2.0 moles
C) 14.0 grams D) 28.0 grams

13. Which quantity contains a total of 3.01×10^{23} molecules of Cl_2 at STP?

A) 17.0 g B) 70.0 g
C) 11.2 ℓ D) 22.4 ℓ

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

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

15. At STP, 170. grams of NH_3 gas will occupy a total of

A) 2240 L B) 22.4 L
C) 2.24 L D) 224 L

16. At STP, 32 grams of O_2 would occupy the same volume as

A) 64 g of H_2 B) 32 g of SO_2
C) 8.0 g of CH_4 D) 4.0 g of He

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

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

18. The total quantity of molecules contained in 5.6 liters of an ideal gas at STP is

A) 1.0 mole B) 0.75 mole
C) 0.50 mole D) 0.25 mole

19. At STP, 1 mole of He(g) contains the same number of atoms as

A) 44.8 L of $H_2(g)$ B) 22.4 L of $H_2(g)$
C) 22.4 L of Ar(g) D) 44.8 L of Ar(g)

20. Which quantity represents the total amount of $N_2(g)$ in a 22.4 liter sample at STP?

A) 1.00 mole
B) 14.0 grams
C) 3.01×10^{23} molecules
D) 6.02×10^{23} atoms

21. At STP, 44.8 liters of CO_2 contains the same number of molecules as

A) 1.00 mole of He B) 2.00 moles of Ne
C) 0.500 mole of H_2 D) 4.00 moles of N_2

22. What is the total number of carbon atoms contained in 22.4 liters of CO gas at STP?

A) 1.00 B) 0.500
C) 3.01×10^{23} D) 6.02×10^{23}

Determining Empirical Formulas based on Given mole ratios

1) Cu = 1.15 moles, S = 1.15 moles, O = 4.60 moles

ratio $\frac{1.15}{1.15}$: $\frac{1.15}{1.15}$: $\frac{4.60}{1.15}$ $CuSO_4$

ratio 1 : 1 : 4

2) Na = 0.67 moles, N = 0.67 moles, O = 2.01 moles

$NaNO_3$

3) Ag = 3.6 moles, P = 1.2 moles, O = 4.8 moles

Ag_3PO_4

4) Zn = 1.53 moles, Cl = 3.06 moles

$ZnCl_2$

5) Si = 0.52 moles, F = 3.12 moles

SiF_6

6) C = 3 moles, O = 6 moles

CO_2

7) H = 3.61 moles, O = 1.8 moles

H_2O

8) Al = 1.2 moles ,O = 3.6 moles, H = 3.6 moles

$Al(OH)_3$

9) Na = 0.82 moles, Cl = 0.82 moles

$NaCl$

10) Zn = 21.1 moles, N = 42.2 moles, O = 126.6 moles

$Zn(NO_3)_2$

Empirical Formula from Percent Composition

1) 92.24% C; 7.76% H

92.24% C = 92.24 g C
7.76% H = 7.76 g H

mol of C = $\frac{92.24}{12.0111} = \frac{7.68 \text{ mol}}{7.68} = 1$

mol of H = $\frac{7.76}{1.00794} = 7.69 \text{ mol} \rightarrow \frac{7.69}{7.68} = 1.002$ ≈ 1:1 ratio

CH

2) 36.48% Na; 25.44% S; 38.08% O

Na_2SO_3

3) 49.99% C; 5.61% H; 44.40% O

$C_3H_4O_2$

4) 38.76% Ca; 19.97% P; 41.27% O

$Ca_3P_2O_8$

5) A compound composed of 0.556g carbon and 0.0933g hydrogen.

CH_2

Molecular Formula from Empirical Formula and Percent Composition

1) Calculate the molecular formula for the following:

a.) empirical formula CH, molar mass = 78 g/mol

Emp: CH = 13g
Molecular C_6H_6 = 78g

b.) empirical formula NO_2, molar mass = 46.01 g/mol

Emp: NO_2 = 46.01g = molar

c.) caffeine, 49.5% C, 5.15% H, 28.9% N, 16.5% O by mass, molar mass = 195 g

Emp: $C_4H_5N_2O$ = 97g
Molecular: $C_8H_{10}N_4O_2$ = 195g

2) A compound analyzes as 79.08% C; 5.54% H and 15.38% N. What is the molecular formula if the molar mass is 273.36 g/mol?

Emp: $C_6H_5N_1$ = 91g
Molecular: $C_{18}H_{15}N_3$ = 273.36g

Molecular Formula from Empirical Formula and Percent Composition

1. Freons are gaseous compounds that we used to use in air conditioners and refrigerators. Freon contains 9.93% carbon, 58.6% chlorine and 31.4% fluorine by mass. What is the empirical formula?

CCl_2F_2

2. Find the empirical formula for a compound made of 0.295g of Ca, 0.236g of S, and 0.469g of O.

$CaSO_4$

3. The molecular mass of benzene is 78 amu and its empirical formula is CH. What is the molecular formula for benzene?

C_6H_6

4. Vitamin C, formally known as ascorbic acid, contains 40.9% carbon, 4.58% hydrogen and 54.5 % oxygen. It has a molecular mass of 176.1 amu. What is its molecular formula? (first, find its empirical formula).

$C_6H_8O_6$

5. Find the formula for a crystal hydrate containing 76.9% $CaSO_4$, 19.9% water.

$CaSO_4 \cdot 2H_2O$