Name ANSWER KEY Date _____ Class _____

10.1 THE MOLE: A MEASUREMENT OF MATTER

Section Review

Objectives

- Relate Avogadro's number to a mole of a substance
- Calculate the mass of a mole of any substance
- Describe methods of measuring the amount of something
- Compare and contrast the atomic mass of an element and its molar mass

Vocabulary

- mole (mol)
- Avogadro's number
- representative particle
- molar mass

Key Equations

- moles = representative particles $\times \frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ representative particles}}$
- representative particles = moles $\times \frac{6.02 \times 10^{23} \text{ representative particles}}{1 \text{ mole}}$

Part A Completion

Use this completion exercise to check your knowledge of the terms and your understanding of the concepts introduced in this section. Each blank can be completed with a term, short phrase, or number.

Chemists relate units of counting, of mass, and of volume to a single quantity called the __1__. The number of representative particles in a mole of a substance is __2__.

To find the mass of a mole of a compound, scientists add together the __3__ of the atoms making up the compound. When you substitute the unit *grams* for amu, you obtain the __4__ of the compound. There are __5__ representative particles in a mole of any substance.

1. mole
2. Avogadro's #
3. atomic masses
4. molar mass
5. 6.02×10^{23}

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Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

ST **6.** A mole of a pure substance contains 6.02×10^{23} atoms.

ST **7.** The representative particle of a compound is the molecule.

_____ **8.** A mole of CCl_4 is composed of one atom of carbon and four atoms of chlorine.

AT **9.** A mole of carbon atoms has a mass approximately three times as great as the mass of a mole of helium atoms.

NT **10.** The molar mass of nitrogen gas is 14.0 g. $N_2 = 28.02 g$

Part C Matching

Match each description in Column B to the correct term in Column A.

	Column A	Column B
B **11.**	Avogadro's number	**a.** the atoms, molecules, or ions present in a substance
C **12.**	molar mass	**b.** 6.02×10^{23}
D **13.**	mole	**c.** the mass of one mole of a substance
C **14.**	representative particles	**d.** SI unit that measures the amount of a substance

Part D Problems

Solve the following problems in the space provided. Show your work.

15. How many moles of Pb is 9.3×10^{15} atoms of Pb?

$9.3 \times 10^{15} \text{ atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} = 1.5 \times 10^{-8} \text{ mol Pb}$

16. What is the molar mass of ethane, C_2H_6?

$2 \text{ mol} \times \frac{12.0 g}{1 \text{ mol}} = 24 g + 6 \times \frac{1.01 g}{1 \text{ mol}} = 30.0 g/\text{mol } C_2H_6$

17. Find the mass of 3.65×10^{-2} mol K_2SO_4.

$3.65 \times 10^{-2} \text{ mol} \times \frac{174.3 g}{1 \text{ mol}} = 6.36 g \, K_2SO_4$

18. How many representative particles are in 2.5 mol H_2O_2?

$2.5 \text{ mol } H_2O_2 \times \frac{6.02 \times 10^{23} \text{ r.p}}{1 \text{ mol}} = 1.5 \times 10^{24} \text{ rp } H_2O_2$

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10.2 MOLE-MASS AND MOLE-VOLUME RELATIONSHIPS

Section Review

Objectives

- Convert the mass of a substance to the number of moles of a substance, and the number of moles of a substance to mass
- Calculate the volume of a quantity of gas at STP

Vocabulary

- Avogadro's hypothesis
- standard temperature and pressure (STP)
- molar volume

Key Equations

- mass (grams) = number of moles $\times \frac{\text{mass (grams)}}{\text{1 mole}}$
- moles = mass (grams) $\times \frac{\text{1 mole}}{\text{mass (grams)}}$
- $\frac{\text{grams}}{\text{mole}} = \frac{\text{grams}}{\text{L}} \times \frac{\text{22.4 L}}{\text{1 mole}}$
- volume of gas = moles of gas $\times \frac{\text{22.4 L}}{\text{1 mole}}$

Part A Completion

Use this completion exercise to check your knowledge of the terms and your understanding of the concepts introduced in this section. Each blank can be completed with a term, short phrase, or number.

At STP (0°C and 1 atmosphere pressure), one mole of any gas occupies a volume of ___1___ L. This quantity is known as the ___2___ of the gas. To determine the volume in liters of 2.00 mol of SO_2 gas at STP, you would use ___3___ as a conversion factor. ___4___, expressed in the units g/L, is used as a conversion factor when converting from volume to molar mass. When converting between numbers of representative particles, masses, and volumes, you must always convert to ___5___ as an intermediate step.

1. 22.4
2. molar volume
3. 22.4 L SO_2 / 1.00 mol SO_2
4. Density
5. mol

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Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

ST 6. One mole of any gas occupies a volume of 22.4 L.

AT 7. For a substance of known molar mass, the number of moles of a sample can be calculated from the mass of the sample.

NT 8. The volume occupied by one mole of a gas is dependent on the molar mass of the gas.

AT 9. The volume of a gas at STP can be calculated from the number of molecules of the gas.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A		Column B
D	10. molar mass	a. 22.4 L of a gas at STP
C	11. standard temperature	b. 101.3 kPa or 1 atm
A	12. molar volume	c. 0°C
B	13. standard pressure	d. mass (in grams) of one mole of a substance
E	14. molar road map	e. a means of relating mass, number of representative particles, and gaseous volume of a substance

Part D Problems

Solve the following problems in the space provided. Show your work.

15. What is the density of N_2O, a gas, at STP?

N_2O (16+) $\quad \frac{44.02\text{ g}}{1\text{ mol}} \times \frac{1\text{ mol}}{22.4\text{ L}} = 1.97\text{ g/L}\ N_2O$

16. What is the mass of two moles of NaCl?

$m_{NaCl} = 2\text{ mol} \times \frac{58.44\text{ g}}{1\text{ mol}} = 1 \times 10^2\text{ g NaCl}$

17. How many moles are in 16 grams of O_2?

$n_{O_2} = 16\text{ g} \times \frac{1\text{ mol}}{32.00\text{ g}} = 0.50\text{ mol } O_2$

18. What is the volume of 16 grams of O_2 at STP?

$V_{O_2} = 16.0\text{ g} \times \frac{1\text{ mol}}{32.00\text{ g}} \times \frac{22.4\text{ L}}{1\text{ mol}} = 11\text{ L}$

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10.3 PERCENT COMPOSITION AND CHEMICAL FORMULAS

Section Review

Objectives

- Calculate the percent by mass of an element in a compound
- Interpret an empirical formula
- Compare and contrast empirical and molecular formulas

Vocabulary

- percent composition
- empirical formula

Key Equation

- % mass of element = $\frac{\text{mass of element}}{\text{mass of compound}} \times 100\%$

Part A Completion

Use this completion exercise to check your knowledge of the terms and your understanding of the concepts introduced in this section. Each blank can be completed with a term, short phrase, or number.

The __1__ of a compound is the percent by mass of each element in a compound. The percent by mass of an element in a compound is the number of grams of the element per __2__ g of the compound, multiplied by 100%. To calculate the percent by mass of an element in a known compound, divide the mass of the element in one mole by the __3__ and multiply by 100%.

A(n) __4__ formula represents the lowest __5__ ratio of the elements in a compound. It can be calculated from a compound's percent composition. The __6__ formula of a compound is either the same as its empirical formula, or it is some whole-number multiple of it.

1. percent composition
2. 100
3. molar mass
4. empirical
5. whole number
6. molecular

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

ST 7. It is necessary to know the formula of a compound in order to calculate its percent composition.

AT 8. If the percent by mass of carbon in methane, CH_4, is 75%, then 100 grams of methane contain 25.0 grams of hydrogen.

AT 9. The formula for methane, CH_4, is both a molecular and an empirical formula.

NT 10. The empirical formula for glucose, $C_6H_{12}O_6$, is $C_2H_4O_2$.

Part C Matching

Match each description in Column B to the correct term in Column A.

	Column A	Column B
C	11. percent composition	a. describes the actual number of atoms of each element in a molecule of a compound
B	12. empirical formula	b. the lowest whole-number ratio of atoms of the elements in a compound
A	13. molecular formula	c. the percent by mass of each element in a compound

Part D Problems

Solve the following problems in the space provided. Show your work.

14. What is the percent composition of each of the following?

a. Cr_2O_3

Cr $2 \times 52 = 104$ Cr 68.4% $\frac{104}{152}$

O $3 \times 16 = 48$ O 31.6% $\frac{48}{152}$

b. $Mn_2P_2O_7$

Mn $2 \times 54.94 = 109.88$

P $2 \times 30.97 = 61.94$

O $7 \times 16.00 = 112$

283.82 Mn 38.7% P 21.8%

c. HgS

Hg 200.59 $\frac{200.59}{232.66} = 86.3\%$

S 32.07 $\frac{32.07}{232.66} = 13.7\%$

d. $Ca(NO_3)_2$

Ca $1 \times 40.08 = 40.08$

N $2 \times 14.01 = 28.02$

O $6 \times 16.00 = 96$

164.10

O $\frac{96}{164.10}$ 58.5%

Ca $\frac{40.08}{164.10}$ 24.4%

N $\frac{28.02}{164.10} = 17.1\%$

15. Determine the empirical formula of the compound with the percent composition of 29.1% Na, 40.5% S, and 30.4% O.

40.5 g S $\times \frac{1 \text{ mol}}{32.07 \text{ g}} = 1.26 \text{ mol} : \frac{1.26}{1.26} = 1 \times 2 = 2$

30.4 g O $\times \frac{1 \text{ mol}}{16.0 \text{ g}} = 1.9 \text{ mol} : \frac{1.9}{1.26} = 1.5 \times 2 = 3$

29.1 g Na $\times \frac{1 \text{ mol}}{22.99 \text{ g}} = 1.26 : \frac{1.26}{1.26} = 1 \times 2 = 2$

$Na_2S_2O_3$

16. How many kilograms of iron can be recovered from 639 kilograms of the ore Fe_2O_3?

Fe $2 \times 55.85 = 111.66$ g

O $3 \times 16.00 = 48.00$ g

159.66 g

$\%\text{Fe} = \frac{111.66 \text{ g}}{159.66 \text{ g}} \times 100\% = 70\%$

639 Kg $\times$ 0.70 (70%) = 447 Kg Fe