Chemistry Name: ____________________

Section ______ THE MOLE NOTES KEY Date: ____________________

The Mole

Measuring matter

Mole (mol): the SI base unit used to measure the amount of a substance

Just like bakers use the dozen ,

scientists use mole

The dozen is defined as 12 items

The mole is defined as: 6.022×10^{23} particles

the number of atoms in exactly 12 grams of carbon-12

is called Avogadro's number or $\mathcal{N}_A$

$\mathcal{N}_A$ is 6.022×10^{23} representative particles

Representative particles could be molecules , atoms ,

or formula units for ionic compounds

Review of calculating formula mass

Example: Calculate the formula mass for $Mg(NO_3)_2$

	Mg	= 1 (24.305 amu)	=	24.305 amu
	N	= 2 (14.0067 amu)	=	28.0134 amu
+	O	= 6 (15.9994 amu)	=	95.9964 amu
	$Mg(NO_3)_2$		=	148.3148 amu

For one formula unit, the mass is 148.315 amu

The gram-formula mass is 148.315 g/mol

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Measuring molecules, atoms, and formula units is based upon:

The fact that elements

can not be broken down by chemical means

do not vary do not vary in atomic mass from place to place

have proportional atomic mass since all are based on $^{12}C \equiv 12$ amu

The fact that compounds

can be broken down by chemical means

have fixed mole ratios of elements

whereas mixtures have variable ratios of substances

are composed of elements in small, whole-number ratios

And the fact that chemical reactions are bound by the conservation

of atoms (and therefore mass), energy,

and charge.

Why is one mole 6.022×10^{23}?

Example: find the length of 5280 steel rods that are each 7.15 feet long.

$$5280 \text{ rods} \times \frac{7.15 \text{ ft}}{1 \text{ rod}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = 7.15 \text{ mi}$$

Example: find the length of 5280 aluminum rods that are each 3.14 feet long.

$$5280 \text{ rods} \times \frac{3.14 \text{ ft}}{1 \text{ rod}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = 3.14 \text{ mi}$$

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Scientists chose 6.022×10^{23} because there are that many feet in one mile

Example: find the mass of 6.022×10^{23} formula units of NaOH (mass = 40.0 amu).

$$6.02 \times 10^{23}{}_{\text{NaOH}} \times \frac{40.0\ \text{amu}}{1_{\text{NaOH}}} \times \frac{1\ \text{g}}{6.02 \times 10^{23}\ \text{amu}} = 40.0\ \text{g}$$

Example: how many water molecules are equal to 3.15 moles of water?

$$3.15\ \text{mol}_{\ H_2O} \times \frac{6.02 \times 10^{23}\ \text{molecules}_{\ H_2O}}{1\ \text{mol}_{\ H_2O}} = 1.90 \times 10^{23}\ \text{molecules}_{\ H_2O}$$

Example: how many moles of water are equal to 4.27×10^{24} molecules of water?

$$4.27 \times 10^{24}\ \text{molecules}_{\ H_2O} \times \frac{1\ \text{mol}_{\ H_2O}}{6.02 \times 10^{23}\ \text{molecules}_{\ H_2O}} = 7.09\ \text{mol}_{\ H_2O}$$

Example: how many moles of water are equal to 37.2 grams of water?

$$32.7\ \text{g}_{\ H_2O} \times \frac{1\ \text{mol}_{\ H_2O}}{18.0\ \text{g}_{\ H_2O}} = 2.07\ \text{mol}_{\ H_2O}$$

Example: how many grams of water are equal to 2.75 moles of water?

$$2.75\ \text{mol}_{\ H_2O} \times \frac{18.0\ \text{g}_{\ H_2O}}{1\ \text{mol}_{\ H_2O}} = 49.5\ \text{g}_{\ H_2O}$$

Example: how many molecules of water are equal to 7.23 grams of water?

$$7.32\ \text{g}_{\ H_2O} \times \frac{1\ \text{mol}_{\ H_2O}}{18.0\ \text{g}_{\ H_2O}} \times \frac{6.02 \times 10^{23}\ \text{molecules}_{\ H_2O}}{1\ \text{mol}_{\ H_2O}} = 2.42 \times 10^{23}\ \text{molecules}_{\ H_2O}$$

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