Mass Relationships of Atoms

Atomic masses

- **synonymous with atomic weight**
- **is a relative scale**
- **mass-12 isotope of carbon (carbon-12) is the reference atom and assigned an atomic mass of exactly 12**
- **one atomic mass unit (amu) is defined as a mass exactly equal to $^{1}/_{12th}$ the mass of one carbon-12 atom**

relative masses of carbon-12 and carbon-13 in a random sample carbon has a ratio of 1.0836129

$$\frac{{}^{13}_{6}\mathrm{C}}{{}^{12}_{6}\mathrm{C}} = 1.0836129$$

Since the atomic mass unit is defined such that the mass of ^{12}C is exactly 12 atomic mass units, then

$$\frac{{}^{13}_{6}C}{{}^{12}_{6}C} = 1.0836129$$

$$\text{Mass of } {}^{13}_{6}C = (1.0836129)(12 \text{ amu})$$

$$= 13.003355 \text{ amu}$$

The Mole

- **the fundamental SI measure of "amount of substance"**
- **the amount of substance that contains as many elementary entities as there are atoms in exactly 12 g of carbon-12**
- **this number of atoms is 6.022045×10^{23}**

  Avogadro's number

The Mole vs. The Dozen

The Dozen - the amount of substance that contains 12 entities.

The Mole - the amount of substance that contains Avogadro's number (6.022×10^{23}) of entities.

Dozen Apples = 10 Lbs.

Mole of Helium atoms = 4.0026g

Dozen Apples = 12 Apples

Mole of Helium atoms = 6.022×10^{23} atoms

Converting to Dozens

Example

How many dozens of apples are represented by 1.3 Lbs. of apples.

$$1.3 \text{ Lbs} \times \frac{1 \text{ dozen}}{10 \text{ Lbs}} = .13 \text{ dozen}$$

Converting to Moles
Example

How many moles of He are in 6.46 g of He?

$$6.46\ \text{g He} \times \frac{1\ \text{mol}}{4.003\ \text{g}} = 1.61\ \text{mol}$$

The Mole

- since 6.022045×10^{23} atoms of carbon have a mass of 12 grams,

$$6.022045 \times 10^{23} \text{ atoms} \times \frac{12 \text{ amu}}{1 \text{ atom}} = 12 \text{ g}$$

then

$$6.022045 \times 10^{23} \text{ amu} = 1 \text{ g}$$

Mass Relationships of Atoms - Extended

pg. 311 problem 1

Determine the number of atoms in 2.5 mol Zn.

$$2.5 \text{ mol Zn} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol Zn}} = 1.50 \times 10^{24} \text{ atoms Zn}$$

pg. 312 problem 4a

How many moles in 5.75×10^{24} atoms Al ?

$$5.75 \times 10^{24}\ \text{atoms Al} \times \frac{1\ \text{mol Al}}{6.02 \times 10^{23}\ \text{atoms Al}} = 9.55\ \text{mol Al}$$

pg. 316 problem 11a

Determine the mass in grams of 3.57 mol Ag.

$$3.57 \text{ mol Ag} \times \frac{107.86 \text{ g Ag}}{1 \text{ mol Ag}} = 385.1 \text{ g Ag}$$

pg. 316 problem 12a

Determine the number of moles in 25.5g Ag.

$$25.5\ \text{g Ag} \times \frac{1\ \text{mol Ag}}{107.86\ \text{g Ag}} = 0.24\ \text{mol Ag}$$

pg. 318 problem 13a

How many atoms in 55.2 g Li ?

$$55.2\ \text{g Li} \times \frac{1\ \text{mol Li}}{6.94\ \text{g Li}} = 7.95\ \text{mol Li}$$

$$7.95\ \text{mol Li} \times \frac{6.02 \times 10^{23}\ \text{atoms Li}}{1\ \text{mol Li}} = 4.79 \times 10^{24}\ \text{atoms Li}$$

pg. 318 problem 13a

Or

How many atoms in 55.2 g Li ?

$$55.2\ \text{g Li} \times \frac{1\ \text{mol Li}}{6.94\ \text{g Li}} \times \frac{6.02 \times 10^{23}\ \text{atoms Li}}{1\ \text{mol Li}}$$

$$= 4.79 \times 10^{24}\ \text{atoms Li}$$

pg. 318 problem 14b

What is the mass in grams of 1.00×10^{24} atoms Mn ?

$$1.00 \times 10^{24}\ \text{atoms Mn} \times \frac{1\ \text{mol Mn}}{6.02 \times 10^{23}\ \text{atoms Mn}} = 1.66\ \text{mol Mn}$$

$$1.66\ \text{mol Mn} \times \frac{54.9\ \text{g Mn}}{1\ \text{mol Mn}} = 91.2\ \text{g Mn}$$

pg. 318 problem 14b

Or

What is the mass in grams of 1.00×10^{24} atoms Mn ?

$$1.00 \times 10^{24}\ \text{atoms Mn} \times \frac{1\ \text{mol Mn}}{6.02 \times 10^{23}\ \text{atoms Mn}} \times \frac{54.9\ \text{g Mn}}{1\ \text{mol Mn}}$$

$$= 91.2\ \text{g Mn}$$

pg. 321 problem 20

Determine the number of moles of chloride ions in 2.50 mol $ZnCl_2$.

$$2.50 \text{ mol } ZnCl_2 \times \frac{2 \text{ mol } Cl^-}{1 \text{ mol } ZnCl_2} = 5.00 \text{ mol } ZnCl_2$$

pg. 321 problem 21

Determine the number of moles of each element in 1.25 mol glucose $C_6H_{12}O_6$.

$$1.25 \text{ mol } C_6H_{12}O_6 \times \frac{6 \text{ mol C}}{1 \text{mol } C_6H_{12}O_6} = 7.50 \text{ mol C}$$

$$1.25 \text{ mol } C_6H_{12}O_6 \times \frac{12 \text{ mol H}}{1 \text{mol } C_6H_{12}O_6} = 15.0 \text{ mol H}$$

$$1.25 \text{ mol } C_6H_{12}O_6 \times \frac{6 \text{ mol O}}{1 \text{mol } C_6H_{12}O_6} = 7.50 \text{ mol O}$$

Example

Calculate the number of grams of lead (Pb) In 12.4 moles of lead.

$$12.4 \text{ mol} \times \frac{207.2 \text{ g}}{1 \text{ mol}} = 2569 \text{ g}$$

Example

Calculate the number of atoms in 0.551 g of Potassium (K).

$$0.551\ \text{g} \times \frac{1\ \text{mol}}{39.10\ \text{g}} \times \frac{6.022 \times 10^{23}\ \text{atoms}}{1\ \text{mol}}$$

$$= 8.48 \times 10^{21}\ \text{atoms K}$$

Example

Calculate the number of molecules in a sample of oxygen gas (O_2) with a mass of 64.0g.

$$64.0\ \text{g} \times \frac{1\ \text{mol}}{32.0\ \text{g}} \times \frac{6.02 \times 10^{23}\ \text{molec.}}{1\ \text{mol}}$$

$$= 1.20 \times 10^{24}\ \text{molec. } O_2$$