Notes key

Mole Notes:

One mole is defined as the number of carbon atoms in exactly 12g of carbon.
1mole = 6.02 x 10^{23} things

The **molar mass** is the mass of one mole of particles. It is equal to the mass shown on the periodic table and is expressed in grams (g).

Finding the Molar Mass of a Compound

Example: To calculate the molar mass of sugar $C_{12}H_{22}O_{11}$ add the masses of 12 C's, 22 H's and 11 O's.

12 C = 12 x 12.0 = 144.0

22 H = 22 x 1.0 = 22.0

11 O = 11 x 16.0 = 176.0

Molar Mass = 342.0 g/mol "grams per mole"
(round mass to 1 decimal place)

↑ 1 decimal place : This will apply to sig figs later

To Do: Read pg. 77-80 in your <u>Hebdon</u> text and do #6 a,e,l,m and #7a
Check your answers in the back of the book!

Calculations Relating to the number of moles and mass of a substance:

The use of the molar mass allows the calculation of the mass of a given number of moles of a substance and the calculation of the numer of mole in a given mass of a substance.

This can be done by using the formula:

$$\text{Molar mass(g/mol)} = \frac{\text{mass (g)}}{\text{mols (mol)}}$$

Or by using a conversion factor: 1 mol of X = (molar mass of X)g

$$\frac{\text{1 mol}}{\text{(molar mass of X)g}} \quad \text{OR} \quad \frac{\text{(molar mass of X)g}}{\text{1 mol}}$$

Example: What is the mass of 3.25 mol of CO_2?

molar mass $(1 \times 12.0) + 2(16.0) = 44.0\ g/mol$

$$3.25\ mol \times \frac{44.0\ g}{1\ mol} = 143\ g$$

3sf 3sf 3sf.

Example: How many moles of CH_3OH are there in 0.250g of CH_3OH?

$1(12.0) + 4(1.0) + 1(16.0) = 32.0\ g/mol$

$$0.250\ g \times \frac{1\ mol}{32.0\ g} = 0.00781\ mol \quad \text{or} \quad 7.81 \times 10^{-3}\ mol$$

3s.f 3s.f. 3s.f.

To do: Read pg. 81- 82 in your Hebdon Text and do #8-10 a,b,c
Check your answers in the back of the book!

Calculations Relating the number of moles and the volume of a gas:

Avagadro's Hypothesis = Equal volumes of different gases, at the same temperature and pressure, contain the same number of particles

Standart Temperature and Pressure (STP) = 0°C and 101.3 KPa

Experimentally determined fact: 1 mol of any gas at STP has a volume of 22.4L/mol

This allows us to convert between moles and volume of gases at STP by using the following formula:

Molar volume (L/mol) = $\frac{\text{Volume}}{\text{moles}}$

--> 22.4L/mol = $\frac{\text{volume}}{\text{moles}}$ SATP

OR the conversion factors: $\frac{1\text{ mol}}{22.4\text{L}}$ OR $\frac{22.4\text{L}}{1\text{ mol}}$

Example: What is the volume occupied by 0.350mol of SO_2(g) at STP?

$$0.350\text{ mol} \times \frac{22.4\text{ L}}{1\text{ mol}} = 7.84\text{ L}$$

Example: How many moles of gas are contained in a balloon with a volume of 10000 mL at STP?

s.f? assume all sig.

$$10000\text{ mL} \times \frac{10^{-3}\text{ L}}{1\text{ mL}} \times \frac{1\text{ mol}}{22.4\text{ L}} = 0.446\text{ mol}$$

To do: Read pg. 82-83 in your Hebdon Text and do #11-12 a,b,c

Number of particles:

Avogadro's number says that 1 mole = 6.02×10^{23} things (particles, molecules, atoms etc.)

Calculations between moles and #particles can be done using the following **formula**:

$$\text{moles} = \frac{\text{number of particles}}{6.02 \times 10^{23}}$$

OR Conversion Factors:

$$\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ particles}} \quad \text{OR} \quad \frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mol}}$$

Example:
How many moles of Nitrogen are there in 5.00×10^{17} nitrogen atoms?

$$5.00 \times 10^{17} \text{ atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} = 8.30 \times 10^{-7} \text{ mol}$$

$17 - 23 = -6$

Example:
How many hydrogen atoms are there in 3mol of H_3PO_4?

Step 1 - find molecules of H_3PO_4

$$3 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 1.81 \times 10^{24} \text{ molecules.}$$

Step 2 - find atoms of hydrogen (3 per molecule)

$$1.81 \times 10^{24} \text{ molecules} \times \frac{3 \text{ atoms H}}{1 \text{ molecule}} = 5.43 \times 10^{24} \text{ atoms H}$$

To do: Read pg. 83- 87 and do #15-18 a,b,c and 22-24 a,b,c

Calculations using density to convert between volume and mass:

If density is mentioned in a problem you should recall that d=m/v and understand the following points:

1. If the volume of a solid or liquid is unknown, calculate the volume from v=m/d. (If the mass is not known, find the mass from the moles of the substance present first.)

2. If the density is unknown, you will need both mass and volume to calculate: d=m/v. The mass can be found if the moles are known. If neither the mass nor volume is given, the density of a gas at STP can be found by using the mass of 1 mole and and the volume of 1 mol.

or use density as a conversion factor

3. If the number of moles in unknown, use the density and volume to calculate m=d x v and then convert the mass to moles.

Example:
What is the volume occupied by 3.00mol of ethanol, CH_3CH_2OH (l)? (d = 0.790 g/ml)

$2(12.0) + 6(1.0) + 1(16.) = 46.0$

$$3.00\text{ mol} \times \frac{46.0\text{ g}}{1\text{ mol}} \times \frac{1\text{ mL}}{0.790\text{ g}} = 175\text{ mL}$$

Example:
How many mol of Hg(l) are contained in 100ml of Hg(l)? (d= 13.6g/ml)

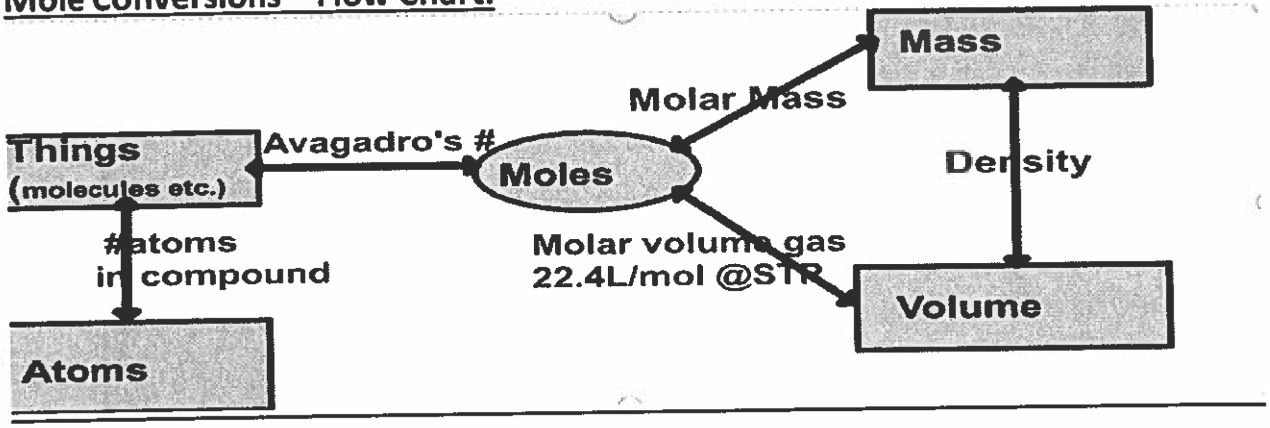
$$100\text{ mL} \times \frac{13.6\text{ g}}{1\text{ mL}} \times \frac{1\text{ mol}}{200.6\text{ g}} = 6.78\text{ mol}$$

Example:
What is the density of O_2(g) at STP?

$$D = \frac{m}{v} = \frac{32.0\text{ g/mol}}{22.4\text{ L/mol}} = 1.43\text{ g/L}$$

To Do: Read pg. 87-88 and do # 25-29

Mole Conversions – Flow Chart:



Mole Conversions:

Conversion	Conversion Factor	Formula
Moles → particles	$\frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mole}}$	Moles (mol) = $\frac{\text{particles}}{6.02 \times 10^{23}}$ *("particles" refers to molecules or given compound or atoms of an element)*
particles → Moles	$\frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ particles}}$	
Moles → Mass	$\frac{\text{(molar mass) g}}{1 \text{ mole}}$	Molar Mass (g/mol) = $\frac{\text{Mass (g)}}{\text{Moles(mol)}}$
Mass → Moles	$\frac{1 \text{ mole}}{\text{(molar mass) g}}$	
Moles → Volume (gases)	$\frac{\text{Molar Volume (L)}}{1 \text{ mole}}$	Molar Volume (L/mol) = $\frac{\text{Volume (L)}}{\text{Moles (mol)}}$ *(Molar Volume (STP) = 22.4 L/mol Molar Volume (SATP) = 24.8 L/mol)*
Volume (gases) → Moles	$\frac{1 \text{ mole}}{\text{Molar Volume (L)}}$	
Mass → Volume	$\frac{1\text{L}}{\text{"x" g}}$	Density (g/L) = $\frac{\text{Mass (g)}}{\text{Volume (L)}}$ *("x" = numerical value of density for the given compound)*
Volume → Mass	$\frac{\text{"x"g}}{1\text{L}}$	