The Mole and Calculations

The Mole is the SI unit of measure of Quantity in the same category as meter , kilogram and seconds.
Its definition is the number of particles, i.e. atoms that re in 12.000 grams of Carbon 12. This is commonly accepted to be 6.02 X 10^{23}., also referred to a Avogadro's constant or number.

$$\text{amount of substance} = \frac{mass}{molar\_mass}$$

For an atom, molar mass is = Atomic Weight
For a molecule, molar mass = Molecular Weight

Amounts of Gases

PV = nRT , where R = 8.31 $JK^{-1}mol^{-1}$, when pressure is in kPa and volume in litres

Molar Volume of a Gas

Volume of one mole of a gas depends on the gas temperature and pressure
At Standard Temperature and Pressure (STP, 0°C and 1 atm) the molar volume of a gas is 22.4 L mol^{-1}
At Standard Laboratory Conditions (SLC, 25°C and 1 atm) the molar volume of a gas is 24.5 L mol^{-1}

The following formula can be used to calculate the amount of gas

$n = \frac{V}{Vm}$ n = no. of moles, V = volume of gas Vm = molar volume

Calculating Masses of Reactants and Products

Need to follow these three steps

1. Write a balanced equation
2. Calculate the amount of substance consumed
3. Use the ratio of amounts of substances to calculate the amount of substance formed

example if 8 g of CH_4 reacts with excess oxygen gas, what mass of $2H_2O$ will be produced
Write a balanced equation
$CH_4 + 2\ O_2 \rightarrow CO_2 + 2H_2O$

Calculate the amount of substance consumed

$n(CH_4) = \frac{8}{16} = 0.5$ mol

Use the ratio of amounts of substances to calculate the amount of substance formed
mole ratio of CH_4 to $2H_2O$ is 1 to 2

so if 0.5 mol of CH_4 is consumed, then 1.0 mol of H_2O is produced

mass of H_2O = 1.0 X 18 = 18 g

Calculations involving Excess Reactants

If the masses of both reactants are known, the process becomes more complex. You need to determine which of the two reactants are in excess. This is achieved by calculating the number of moles of both reactants, the taking into account the mole ratio, the lower of the two mole amounts must be used in further calculations.

Take the above example again

if 12 g of CH_4 reacts with 16g of oxygen gas, what mass of $2H_2O$ will be produced

$n(CH_4) = \frac{12}{16}$ = 0.75 mol

$n(O_2) = \frac{16}{32}$ = 0.5 mol

which reactant is in excess?

0.75 mol of CH_4 would require 0.75 X 2 = 1.50 mol of O_2

0.5 mol of O_2 would require 0.5 / 2 = 0.25 mol of CH_4

We do not have enough of O_2 if we use all of the CH_4

but if we use all of the O_2 we will have an excess of CH_4

As a consequence, we will use the quantity of O_2 in our calculations

mole ratio of O_2 to $2H_2O$ is 2 to 2 or simplified, 1 to 1

so n (H_2O) = n (O_2) = 0.5 mol

mass of H_2O = 0.5 X 18 = 9g