Chemical Quantities

Mole

$6.022 \times 10^{23} = 1$ mole

eg. $6.022 \times 10^{23}\ CO + 2(6.022 \times 10^{23})\ H_2 \rightarrow 6.022 \times 10^{23}\ CH_3OH$

⇕

$1\ mol\ CO + 2\ mol\ H_2 \rightarrow 1\ mol\ CH_3OH$

Mass

26.98
Al

← Represent 26.98g / 1mol Al
Average Atomic Mass

eg. $2Al + 3I_2 \rightarrow 2AlI_3$

Now we got 35g Al, how much I_2 we need?

2 mol Al NEED 3 mol I_2.

From table, we get 1mol Al = 26.98g

$\Rightarrow 35/26.98 = 1.3$ mol Al $\Leftrightarrow \frac{3}{2} \cdot 1.3 = 1.95$ mol I_2

253.8
I

Gram of $I_2 = 253.8 \cdot 1.95 = 495$g I_2

Stoichiometry: Use chemical equation to calculate the relative masses of reactant

Limiting Reacting

The reactant left after reaction

- Also called limiting reagent

eg. 25kg of nitrogen gas and 5kg of hydrogen gas are mix together to form ammonia. Calculate the mass of ammonia produced

$$N_2 + 3H_2 \rightarrow 2NH_3$$

N_2: 25kg $= 2.5\times10^4/28$ mol $= 8.9\times10^2$ mol

H_2: 5kg $5\times10^3/2$ mol $= 2.5\times10^3$ mol.

So. N_2 ran out need 2.67×10^3 mol H_2.

↓

N_2 is limiting.

For 2.5×10^3 mol H_2, we get $2/3 \cdot 2.5\times10^3$

$= 1.67\times10^3$ mol

$NH_3 = 14+3 = 17$ g/mol

$= 1.67\times10^3 \cdot 17 = 28.39$ kg

percent yield

Theoretical Yield: Maximum Amount of possible yield

Actual Yield.

$$\text{percent yield} = \frac{\text{Actual}}{\text{Theoritical}} \times 100\%$$

Energy

- The ability to do work or produce heat
- potential / Kinetic
- Conservation of energy

Temperature and heat

heat: flow of energy due to a temperature difference

$$T_{Final} = \frac{T_{hot\ init} + T_{cold\ init}}{2}$$

when the mass of hot and cold are equal

Exothermic and Endothermic

Exothermic: out of energy

Endothermic: energy flow inside.

Thermodynamics

The study of energy

$$\Delta E = q + w$$

where q=heat w=work.

Calorie: Amount of energy required to raise temperature of one gram of water by one Celsius degree.

- 1 calorie = 4.184 joules

eg. energy (heat) in joules need to take 7.4g water from 29°C to 46°C.

1 cal = heat 1g water by 1°C

⇒ 29°C - 46°C of 7.4g water need:

$(46-29) \cdot 7.4$

And to joule:

$(46-29) \cdot 7.4 \cdot 4.184 = 526.3472 J$

heat capacity

The amount of energy need to change temperature of one gram of a substance by one Celsius degree.

eg. Water = 4.184 J

eg 2. Known that iron's heat capacity = 0.45 J/g°C
Ask energy required to heat 1.3g from 25°C to 46°C.

$0.45 \cdot 1.3 \cdot (46-25) = 12.285 J$

In Celsius: $12.285 / 4.184 = 2.936$ cal

$$Q = s \cdot m \cdot \Delta T$$

Q: energy (J)
S: heat capacity
m: mass of the sample in gram
ΔT = change in temperature

eg. 1.6g need 5.8J to change T from 23°C - 41°C.
Is it gold?

$5.8J / (1.6g \cdot (41-23)) = S = 0.2\ J/g°C$
∵ S for gold = 0.13 J/g°C.
⇒ Not gold.

Thermochemistry (Enthalpy)

Enthalpy (ΔH) = heat

under constant pressure and condition

eg. when 1 mole of $C(H_4)$ burned. 890 kJ of energy released as heat. Get ΔH which 5.8g sample of methane is burned.

$$\frac{\Delta Q_1}{\Delta Q_2} = \frac{m_1}{m_2} \Rightarrow \frac{890}{\Delta Q_2}$$

mole mass of CH_4 = 12 + 4 = 16 g/mol

$\Rightarrow m_1 = 16g$ when CH_4 have 1mole.

$\Rightarrow \frac{16}{5.8} = \frac{890}{\Delta Q_2} \Rightarrow Q_2 = 322.625 J = \Delta H$

Hess's Law

enthalpy can be stated as a function

eg. $N_2 + 2O_2 \rightarrow 2NO_2(g)$ $\Delta H_1 = 68 kJ$

or

$N_2 + O_2 \rightarrow 2NO$ $\rightarrow \Delta H_2 = 180 kJ$

$2NO + O_2 \rightarrow 2NO_2$ $\rightarrow \Delta H_3 = -112 kJ$

$N_2 + 2O_2 \rightarrow 2NO_2$ $\Delta H_2 + \Delta H_3 = 68 kJ$

Character of Enthalpy change

1. Reaction Reversed, Sign of ΔH reversed
2. Magnitude of ΔH proportional to the quantitte of reactants and products in reaction

eg. $Xe(g) + 2Fe \rightarrow XeF_4$ $\Delta H = -251 kJ$ exo

$XeF_4 \rightarrow Xe + 2F_2$ $\Delta H = +251 kJ$ end

$2Xe + 4F_2 \rightarrow 2XeF_4$ $\Delta H = 502 kJ$

eg. Two form of carbon are graphite and diamond. Combustion of graphite (−394 kJ/mol) and dimond (−396 kJ/mol), calculate ΔH for the conversion of graphite to diamond

C graphite → C diamond.

① $C_{(P)} + O_2 \rightarrow CO_2\uparrow$ $\Delta H = -394\ kJ$

② $C_{(D)} + O_2 \rightarrow CO_2\uparrow$. $\Delta H = -396\ kJ$

According to porperty:

③ $CO_2 \rightarrow C_{(D)} + O_2$ $\Delta H = 396\ kJ$

①+③ ⇒ $C_{(P)} \rightarrow C_{(D)} = 396 - 394 = 2\ kJ$

Driven Force.

- Energy Spread
- Matter Spread

Entropy

Measure of disorder or randomness

Disorder ↑ Entropy ↓

Second Law of thermodynamics: The entropy of the universe is Always increased.