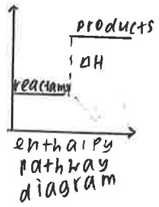
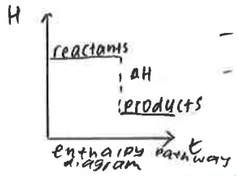
# enthalpy changes

## TYPES OF REACTIONS

### ENDOTHERMIC
- Reactions that absorb energy
- Temperature of the surroundings decreases
- $\Delta H$ is positive
- Enthalpy of the products is higher than the enthalpy of the reactants




### EXOTHERMIC
- Reactions that release energy
- Temperature of the surroundings increases
- $\Delta H$ is negative.
- Enthalpy of the reactants is higher than the enthalpy of the products.




### STANDARD CONDITIONS
- Pressure of $10^5$ Pa (1 atm)
- 298°K (25°C)
- Each substance involved in the reaction is in its normal physical state

## STANDARD ENTHALPY CHANGES

**STANDARD ENTHALPY CHANGE OF REACTION, $\Delta H_r^\ominus$**

Enthalpy change when the amounts of reactants shown in the equation reacts to give products under standard conditions.
The reactants & products must be in their standard states.
Can be exothermic or endothermic.

**STANDARD ENTALPY CHANGE OF FORMATION, $\Delta H_f^\ominus$**

Enthalpy change when 1 mole of a compound is formed from its elements under standard conditions.
The reactants & products must be in their standard conditions.
Can be exothermic / endothermic

$C_{(graphites)} + 2S_{(s)} \rightarrow CS_2(l)$

Graphite is the most stable form.
$\Delta H_f^\ominus$ of any element in its standard state is 0.

**STANDARD ENTHALPY CHANGE OF COMBUSTION, $\Delta H_c^\ominus$**

- Enthalpy change when 1 mole of a substance is burnt in excess $O_2$ under standard conditions.
- The reactants & products must be in their standard states.
- Always exothermic

**STANDARD ENTHALPY CHANGE OF NEUTRALISATION, $\Delta H_n^\ominus$**

- Enthalpy change when 1 mole of $H_2O$ is formed by the reaction of an acid with alkali under standard conditions.
- $\Delta H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O(l)$

**STANDARD ENTHALPY CHANGE OF SOLUTION, $\Delta H_{sol}^\ominus$**

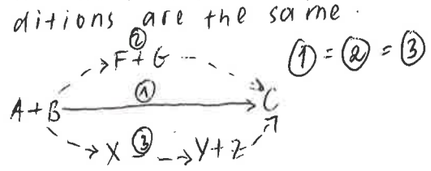
- Enthalpy change when 1 mole of solute is dissolved in a solvent to form an infinitely dilute solution under standard conditions.
- Infinitely dilute solution - One that doesn't produce any further EC when more solvent is added.

**STANDARD ENTHALPY CHANGE OF ATOMISATION, $\Delta H_{at}^\ominus$**

- Enthalpy change when 1 mole of gaseous atoms is formed from its elements under standard conditions.
- $\frac{1}{2}H_{2(g)} \rightarrow H_{(g)}$

## HESS'S LAW

- Definition: The total enthalpy change is independent of the route by which the chemical reaction takes place as long as the initial and final conditions are the same.




### EXAMPLES

① Reactants $\xrightarrow{\Delta H_r}$ Products
$\Delta H_{f1}$ ↑ ↑ $\Delta H_{f2}$
elements

$\Delta H_{f2} = \Delta H_{f1} + \Delta H_r$

② elements + $[O_2]$ $\xrightarrow{\Delta H_f}$ compound + [oxygen]
$\Delta H_{c1}$ ↓ ↓ $\Delta H_{c2}$
combustion products

$\Delta H_{c1} = \Delta H_f + \Delta H_{c2}$

## BOND ENERGIES

- Bond (dissociation) energy: the specific energy required to break a certain covalent bond
- Bond breaking: endothermic
- Bond making: exothermic
- Units: $kJmol^{-1}$
- Average bond energy taken due to the same bond having different bond energies in different environments. (EX: O-H in ethanol O-H in water)

## $Q = cm\Delta t$

- c = specific heat capacity $[k]g^{-1}C^{o-1}$
- m = mass
- $\Delta t$ = change in temperature (can be in celcius or kelvin, doesn't matter 1°K = 1°C)