MOLAR ENTHALPY

For any system:

- an exothermic change involves a decrease in enthalpy

⇒gives off energy to the surroundings

⇒ΔH is negative.

- an endothermic change involves an increase in enthalpy.

⇒takes in energy from the surroundings

⇒ΔH is positive.

The enthalpies for substances undergoing phase changes have been measured experimentally. (TABLE 17.3 p. 522)

- enthalpies are reported as molar enthalpies and are expressed as kJ/mol.

Endothermic Phase Changes

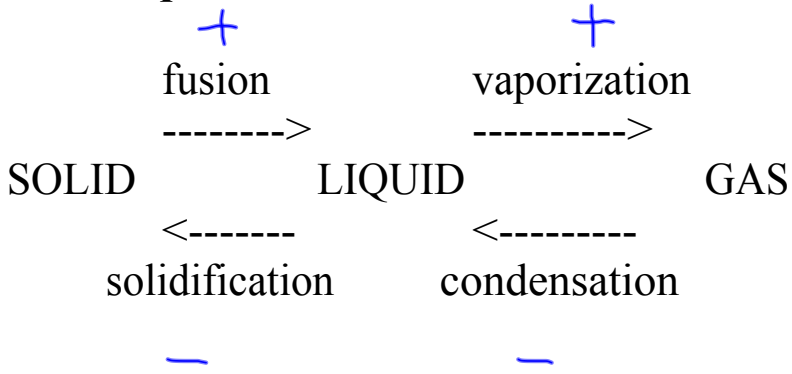
- the molar enthalpy of fusion (H_{fus}) represents the quantity of heat that the substance absorbs per mole as it changes state from **solid to liquid**.

- the molar enthalpy of vaporization (H_{vap}) represents the quantity of heat that the substance absorbs per mole as it changes state from **liquid to gas**.

Exothermic Phase Changes

- the molar enthalpy of condensation (H_{cond}) represents the quantity of heat that the substance releases per mole as it changes state from **gas to liquid**

- the molar enthalpy of solidification (H_{solid}) represents the quantity of heat that the substance releases per mole as it changes state from **liquid to solid**.



$$\Delta H_{fus} = - \Delta H_{solid}$$

$$\Delta H_{vap} = - \Delta H_{cond}$$

$$H_{solid} = -H_{fus}$$

$H_{solid} = -6.01\ kJ/mol$

$H_2O \Rightarrow \quad H_{fus} = 6.01\ kJ/mol.$

$H_{vap} = 40.7\ kJ/mol$

$H_{cond} = -40.7\ kJ/mol$

$$H_{cond} = -H_{vap}$$

Example

If 500. g of $CCl_2F_{2(l)}$ is vaporized at SATP, find the enthalpy change of the system (H_{vap} = 34.99 kJ/mol).

$m = 500.\ g$

CCl_2F_2

$H_{vap} = 34.99\ kJ/mol$

$\Delta H_{vap} = ?$

$$\Delta H_{vap} = n H_{vap}$$

$$\Delta H_{vap} = \left(\frac{500.\ g}{120.9\ g/mol}\right)\left(34.99\ \frac{kJ}{mol}\right)$$

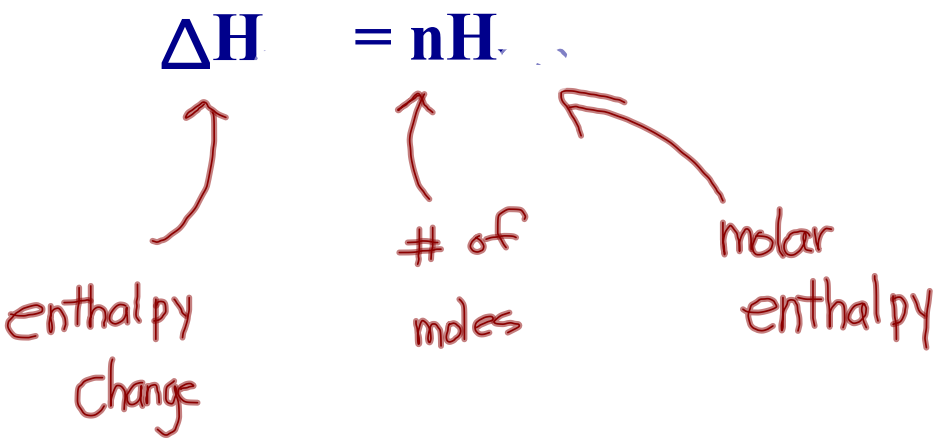
$$\Delta H_{vap} = 145\ kJ$$

CCl_2F_2

↳ $(1 \times 12.01) + (2 \times 35.45) + (2 \times 19.00)$

C Cl F

$= 120.91\ g/mol$


ΔH = nH
enthalpy change
# of moles
molar enthalpy

Example

Determine the enthalpy change associated with converting 250. g of water to ice (H_{fus} = 6.01 kJ/mol).

$m = 250.\ g$

H_2O

$H_{solid} = -6.01\ kJ/mol$

$\Delta H_{solid} = ?$

$\Delta H_{solid} = n H_{solid}$

$\Delta H_{solid} = \left(\frac{250.\ g}{18.02\ g/mol}\right)\left(-6.01\ \frac{kJ}{mol}\right)$

$\Delta H_{solid} = -83.4\ kJ$

	H_{fus} (kJ/mol)	H_{vap} (kJ/mol)
Ammonia (NH_3)	5.65	23.4
Ethanol (C_2H_3OH)	4.60	43.5
Hydrogen (H_2)	0.12	0.90
Methanol (CH_3OH)	3.16	35.3
Oxygen (O_2)	0.44	6.82
Water (H_2O)	6.01	40.7
ethylene glycol ($C_2H_4(OH)_2$		58.8

Heat (q)

- change in kinetic energy
- measures transfer of energy when there are temperature changes (heating or cooling)

Enthalpy (H)

- measures potential energy
- change in energy transfer when system is at constant pressure and same initial and final temperatures

Worksheet