Warm Up

Calculate the amount of heat released when a 375 g piece of aluminum is heated from 15.6^{o}C to 24.3^{o}C.

$q = ?$

$m = 375 g$

$C = 0.900 \frac{J}{g \cdot °C}$

$\Delta T = 8.7 °C$

$q = mC\Delta T$

$q = (375 g)(0.900 \frac{J}{g \cdot °C})(8.7 °C)$

$q = 2940 J$

Homework - Worksheet

7. $m = 550 g$

$T_i = 95.0°C$

$T_f = 30.0°C$

$q = -1.63 \times 10^3 J$

$C = ?$

$q = mC\Delta T$

$-1630 J = (550 g) C (-65.0°C)$

$$C = \frac{-1630 J}{(550 g)(-65.0°C)}$$

$$C = 0.046 \frac{J}{g°C}$$

1) 31 200 J

2) -31 700 J

3) 120^{o}C

4) 28^{o}C

5) 1100 J

6) 14 900 J

7) 0.0456 J/g^{o}C

8) 424 g

9) 2.60 J/g^{o}C

10) 6.21 J

11) 42.6 L

PHASE CHANGE AND ENTHALPY

Classifying types of systems:
1. Open system - a system where both matter and energy can flow into or out of the system.
2. Closed system - a system where energy is allowed to be transferred into and out but matter cannot be transferred.
3. Isolated system - a system where neither matter nor energy is allowed to enter or leave the system.

ENTHALPY (H) - The total internal (potential) energy and kinetic energy of a system under constant pressure.
⇒Enthalpy is usually expressed in kJ.

ENTHALPY CHANGE (ΔH) - A change under constant pressure where the surroundings of a system absorb energy or release it to the system.

PHASE CHANGE - is a change in the state of matter without a change in the chemical composition of the system.
Ex. $H_2O_{(l)} \longrightarrow H_2O_{(g)}$

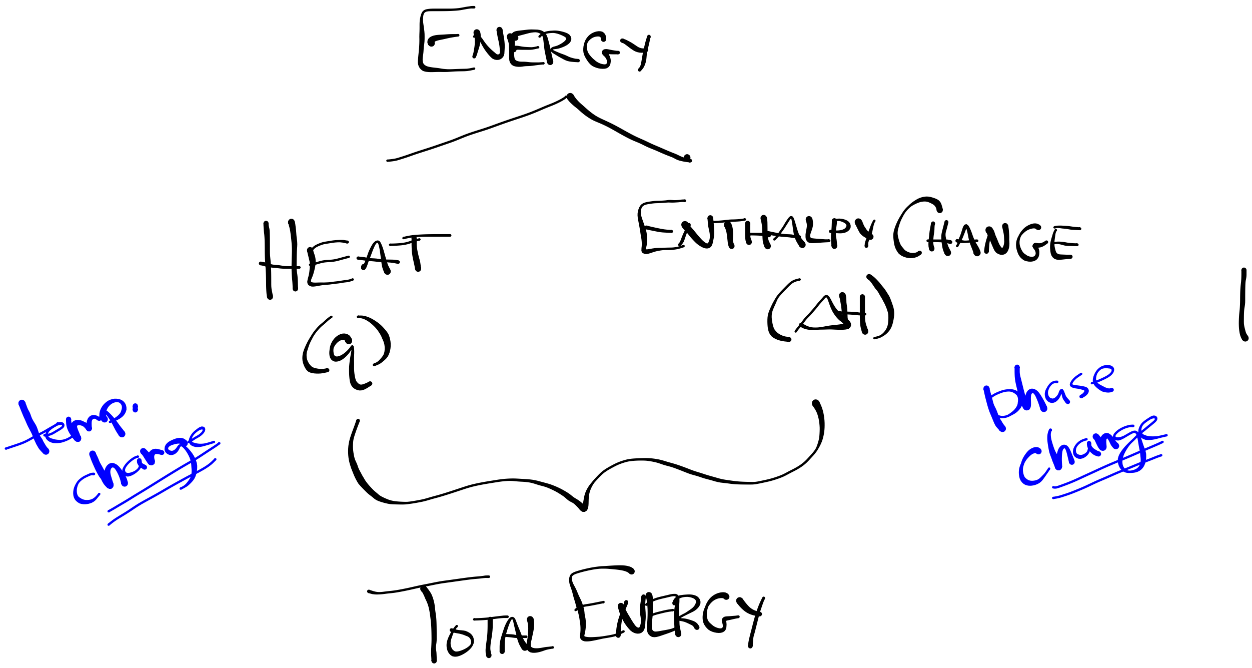
⇒**always involve a change in energy but never involve a change in temperature.**

Question:

(i) What is the temperature where water just starts boiling?
(ii) What is the temperature when water is boiling violently?
(iii) If energy is still going into the water and the temperature is not increasing, where is the energy going?

Consider melting ice to water and then boiling water to steam:

$$H_2O_{(s)} \xrightarrow{\text{heat}} H_2O_{(l)} \xrightarrow{\text{heat}} H_2O_{(g)}$$


ENERGY
HEAT
(q)
ENTHALPY CHANGE
(ΔH)
temp. change
phase change
TOTAL ENERGY

MOLAR ENTHALPY (H)

For any system:

- an exothermic change involves a decrease in enthalpy

⇒ gives off energy to the surroundings

⇒ ΔH is negative. (H negative)

- an endothermic change involves an increase in enthalpy.

⇒ takes in energy from the surroundings

⇒ ΔH is positive. (H 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**.

- 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**.

ΔH_{fus} ΔH_{vap} * ENDOTHERMIC

fusion vaporization
--------> ---------->
SOLID LIQUID GAS
<-------- <---------
solidification condensation

* EXOTHERMIC

ΔH_{solid} ΔH_{cond}

$H_{fus} = 6.03$ kJ/mol
$H_{solid} = -6.03$ kJ/mol

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

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

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** .

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              fusion          vaporization
              -------->       ---------->
SOLID                LIQUID                 GAS
              <-------        <---------
         solidification      condensation
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$$\Delta H_{fus} = - \Delta H_{solid}$$

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

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

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

$\Delta H_{vap} = ?$

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

$\Delta H_{vap} = \left(\frac{500.\,g}{120.91\,g/mol}\right)\left(34.99\,\frac{kJ}{mol}\right)$

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

$CCl_2F_2 \rightarrow (1 \times 12.01) + (2 \times 35.45) + (2 \times 19.00)$

$= 120.91\,g/mol$

$$Mm = \frac{m}{n}$$

$$(Mm)n = m$$

$$n = \frac{m}{Mm}$$