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

Homework - Worksheet

(7) $m = 550g$

$T_i = 95.0°C$

$T_f = 30.0°C$

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

$C = ?$

$q = mC\Delta T$

$-1.63 \times 10^3 J = (550g)C(-65.0°C)$

$C = \frac{-1.63 \times 10^3 J}{(550g)(-65.0°C)}$

$C = 0.046 \frac{J}{g \cdot °C}$

PHASE CHANGE AND ENTHALPY

[redacted]

<u>ENTHALPY</u> (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:

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

$$q = mC\Delta T$$

$$\Delta T = 0$$

MOLAR ENTHALPY

For any system:

- an exothermic change involves a decrease in enthalpy

⇒ gives off energy to the surroundings

⇒ ΔH is negative. solidification, condensation

- an endothermic change involves an increase in enthalpy.

⇒ takes in energy from the surroundings

⇒ ΔH is positive. fusion, vaporization

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.

$H_{fus} = 6.01 \frac{kJ}{mol}$ $H_{vap} = 40.7 \frac{kJ}{mol}$

$H_{solid} = -6.01 \frac{kJ}{mol}$ $H_{cond} = -40.7 \frac{kJ}{mol}$

	H_{fus} $\frac{kJ}{mol}$	H_{vap} $\frac{kJ}{mol}$
H_2O	6.01	40.7
Cl_2		

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**.

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

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

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

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

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

$\Delta H_{vap} = ?$

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

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

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

CCl_2F_2

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

Calculate the energy change required to condense 150.g of steam to water. (H_{vap} = 40.7 kJ/mol)

$m = 150. g$

H_2O

$\Delta H_{cond} = ?$

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

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

$\Delta H_{cond} = \left(\frac{150.g}{18.02 g/mol}\right)\left(-40.7 \frac{kJ}{mol}\right)$

$\Delta H_{cond} = -339 kJ$

Worksheet