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**Answer the following questions:**

(a) Define each of the following (6 marks)

(i) **Internal energy**

The internal energy of a system is the sum of all kinetic and potential energies in its component parts.

(ii) **Standard enthalpy of formation.**

It is the enthalpy change when 1 mole of a compound is formed from its constituent elements at standard condition (1 atm, 25°C).

(iii) **P-V Work.**

A common type of work associated with chemical process its work done by gas through expansion or work done to a gas through compression.

(iv) **Thermochemical Equation**

Thermochemical Equation is a balanced chemical equation together with its value of  $\Delta H$ .

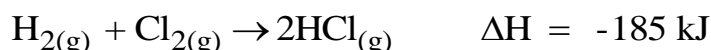
(b) Calculate the internal energy change for a piston is compressed from a volume of 8.30 L to 2.80 L against a constant pressure of 1.90 atm. In the process, there is 350 J of heat gains by the system. (3 Marks)

**Answer**

$$w = -P\Delta V = -1.90 \text{ atm}(2.80\text{L} - 8.30\text{L}) = 10.45 \text{ L.atm} \times \frac{101.3\text{J}}{\text{L.atm}} = 1058.585 \text{ J}$$

$$\Delta E = q + w = 350.0\text{J} + 1058.585\text{J} = 1408.585\text{J}$$

(c) Consider the following thermo chemical equation: (3 Marks)



Calculate  $\Delta H$  when:

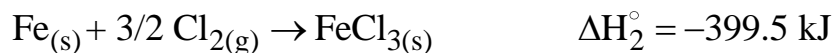
(i) One mol of HCl is formed.

(ii) 1.0g of  $\text{Cl}_2$  reacts.

**Answer**

2 mole $\rightarrow \Delta H = -185 \text{ kJ}$	1 mole $\rightarrow \Delta H = -185 \text{ kJ}$
1 mole $\rightarrow \Delta H = ???$	$\frac{1}{71} = 0.01408 \text{ mol} \rightarrow \Delta H = ???$
$\Delta H = \frac{-185}{2} = -92.5 \text{ kJ}$	$\Delta H = \frac{-185}{71} = -2.6 \text{ kJ}$

(d) Calculate the standard molar enthalpy of formation of  $\text{FeCl}_{2(s)}$  using the following standard enthalpies of reaction:



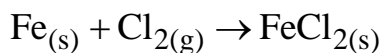
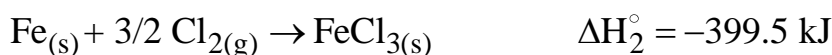
( 3 Marks)

### Answer

First equation is reversed

second equation is kept the same

we then add the two equations and their enthalpy changes according to Hess's law



$$\Delta H_1^\circ + \Delta H_2^\circ = 57.7 \text{ kJ} - 399.5 \text{ kJ} = -341.8 \text{ kJ}$$

### Another solution

$$\Delta H_{\text{rxn}}^\circ = \sum n \Delta H_f^\circ(\text{product}) - \sum m \Delta H_f^\circ(\text{reactants})$$

For the first equation

$$\Delta H_{\text{rxn}}^\circ = \left[ \Delta H_f^\circ \text{ FeCl}_{3(s)} \right] - \left[ \Delta H_f^\circ \text{ FeCl}_{2(s)} + 0 \right]$$

$$-57.7 \text{ kJ} = \Delta H_f^\circ \text{ FeCl}_{3(s)} - \Delta H_f^\circ \text{ FeCl}_{2(s)} \quad (1)$$

for the second equation

$$\Delta H_{\text{rxn}}^\circ = \left[ \Delta H_f^\circ \text{ FeCl}_{3(s)} \right] - \left[ \frac{3}{2} \Delta H_f^\circ \text{ Cl}_{2(s)} + \Delta H_f^\circ \text{ Fe}_{(s)} \right]$$

$$-399.5 \text{ kJ} = \Delta H_f^\circ \text{ FeCl}_{3(s)} - [0 + 0] \quad (2)$$

$$\boxed{\Delta H_f^\circ \text{ FeCl}_{3(s)} = -399.5 \text{ kJ}}$$

substitute from 2 in 1

$$-57.7 \text{ kJ} = -399.5 \text{ kJ} - \Delta H_f^\circ \text{ FeCl}_{2(s)}$$

$$\Delta H_f^\circ \text{ FeCl}_{2(s)} = -399.5 \text{ kJ} + 57.7 \text{ kJ} = -341.8 \text{ kJ}$$

$$\boxed{\Delta H_f^\circ \text{ FeCl}_{2(s)} = -341.8 \text{ kJ}}$$