Benha University
Faculty of Engineering – Shoubra
Mathematics and Engineering Physics Department

Chemistry Mid Term Exam
22November 2018
Time allowed: One Hours

Group ( )	**Sec ( )**	**اسم الطالب :**

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 ΔH .

(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)**

$$H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)} \qquad \Delta H = -185\ \text{kJ}$$

Calculate ΔH when:

(i) One mol of HCl is formed.

(ii) 1.0g of Cl_2 reacts.

Answer

$2\ \text{mole} \rightarrow \Delta H = -185\ \text{kJ}$

$1\ \text{mole} \rightarrow \Delta H = ???$

$\Delta H = \frac{-185}{2} = -92.5\ \text{kJ}$

$1\ mole \rightarrow \Delta H = -185\ \text{kJ}$

$\frac{1}{71} = 0.01408\ \text{mol} \rightarrow \Delta H = ???$

$\Delta H = \frac{-185}{71} = -2.6\ \text{kJ}$

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

$1/2\ Cl_{2(g)} + FeCl_{2(s)} \rightarrow FeCl_{3(s)} \qquad \Delta H_1^\circ = -57.7\ kJ$

$Fe_{(s)} + 3/2\ Cl_{2(g)} \rightarrow FeCl_{3(s)} \qquad \Delta H_2^\circ = -399.5\ kJ$

(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

$FeCl_{3(s)} \rightarrow 1/2\ Cl_{2(g)} + FeCl_{2(s)} \qquad \Delta H_1^\circ = +57.7\ kJ$

$Fe_{(s)} + 3/2\ Cl_{2(g)} \rightarrow FeCl_{3(s)} \qquad \Delta H_2^\circ = -399.5\ kJ$

$Fe_{(s)} + Cl_{2(g)} \rightarrow FeCl_{2(s)}$

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

Another solution

$\Delta H^\circ_{r\times n} = \sum\ n\,\Delta H^\circ_f(\text{product}) - \sum\ m\,\Delta H^\circ_f(\text{rectants})$

For the first equation

$\Delta H^o_{r\times n} = \left[\Delta H^o_f\ \ FeCl_{3(s)}\right] - \left[\Delta H^o_f\ \ FeCl_{2(s)} + 0\right]$

$-57.7\ kJ = \Delta H^o_f\ \ FeCl_{3(s)} - \Delta H^o_f\ \ FeCl_{2(s)} \qquad (1)$

for the second equation

$\Delta H^o_{r\times n} = \left[\Delta H^o_f\ \ FeCl_{3(s)}\right] - \left[\frac{3}{2}\Delta H^o_f\ Cl_{2(s)} + \Delta H^o_f\ Fe_{(s)}\right]$

$-399.5\ kJ = \Delta H^o_f\ \ FeCl_{3(s)} - [0+0] \qquad (2)$

$$\boxed{\Delta H^o_f\ \ FeCl_{3(s)} = -399.5\ kJ}$$

substitute from 2 in 1

$-57.7\ kJ = -399.5 kJ - \Delta H^o_f\ \ FeCl_{2(s)}$

$\Delta H^o_f\ \ FeCl_{2(s)} = -399.5\ \ kJ + 57.7\ \ kJ = -342\ \ kJ$

$$\boxed{\Delta H^o_f\ \ FeCl_{2(s)} = -341.8\ \ kJ}$$