

JEE previous year questions:

Chemical Thermodynamics-V

1. An ideal gas undergoes isothermal compression from 5 m^3 to 1 m^3 against a constant external pressure of 4 Nm^{-2} . Heat released in this process is used to increase the temperature of 1 mole of Al. If molar heat capacity of Al is $24\text{ J mol}^{-1}\text{ K}^{-1}$, the temperature of Al increases by
(Mains, 2019)

- A) $2/3\text{ K}$
B) $3/2\text{ K}$
C) 1 K
D) 2 K

Ans: A) $2/3\text{ K}$

Explanation:

Work done on isothermal irreversible for ideal gas

$$\begin{aligned} &= -P_{\text{ext}}(V_2 - V_1) \\ &= -4\text{ N/m}^2(1\text{ m}^3 - 5\text{ m}^3) \\ &= 16\text{ Nm} \end{aligned}$$

Isothermal process for ideal gas

$$\Delta U = 0 \text{ so, } Q = -W = -16\text{ Nm} = -16\text{ J}$$

Heat used to increase temperature of Al,

$$\begin{aligned} Q &= nC_m\Delta T \\ 16 &= 1 \times 24 \times \Delta T \\ \text{So, } \Delta T &= 2/3\text{K} \end{aligned}$$

2. For which of the following reactions, ΔH is equal to ΔU ? (Mains, 2018)

- A) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
B) $2\text{HI}(\text{g}) \rightarrow \text{H}_2(\text{g}) + \text{I}_2(\text{g})$
C) $2\text{NO}_2(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g})$
D) $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$

Ans: B)

Explanation:

Both in the reactants and products side number of moles of gas molecules = 2. So, $\Delta n_g = 0$

3. The enthalpy change on freezing of 1 mol of water at 5°C to ice at -5°C is

(Given $\Delta_{\text{fus}}H = 6 \text{ kJ mol}^{-1}$ at 0°C,

$C_p(\text{H}_2\text{O}, \ell) = 75.3 \text{ J mol}^{-1} \text{ K}^{-1}$)

$C_p(\text{H}_2\text{O}, \text{s}) = 36.8 \text{ J mol}^{-1} \text{ K}^{-1}$ (Mains, 2017)

A) 5.44 kJ/mol

B) 5.81 kJ/mol

C) 6.56 kJ/mol

D) 6.00 kJ/mol

Ans: 6.56 kJ/mol

Explanation:

$$\Delta H = \Delta H_1 + \Delta_{\text{fus}}H + \Delta H_2$$

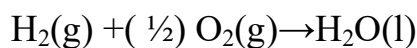
ΔH_1 : Enthalpy change for solid ice from -5 °C to 0 °C

ΔH_2 : Enthalpy change for liquid water from 0 °C to 5 °C

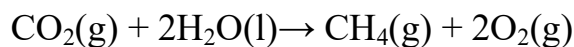
$$\text{So, } \Delta H = 1 \times 36.8/1000 \times (0 - (-5)) + 6 + 1 \times 75.3/1000 \times (5 - 0) = 6.56$$

4. Given, $\text{C}(\text{graphite}) + \text{O}_2 \rightarrow \text{CO}_2(\text{g})$

$$\Delta_r H_o = - 393.5 \text{ kJ mol}^{-1}$$



$$\Delta_r H_o = - 285.8 \text{ kJ mol}^{-1}$$



$$\Delta_r H_o = + 890.3 \text{ kJ mol}^{-1}$$

Based on the above thermochemical equations, the value of $\Delta_r H_o$ at 298 K

for the reaction $\text{C}(\text{graphite}) + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_4(\text{g})$ will be:

A) + 144 kJ/mol

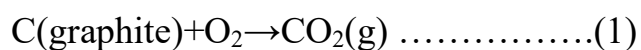
B) -74.8 kJ/mol

C) -144 kJ/mol

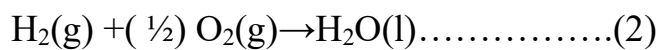
D) +74.8 kJ/mol

Ans: B) -74.8 kJ/mol

Explanation:



$$\Delta_r H_o = - 393.5 \text{ kJ mol}^{-1}$$



$$\Delta_r H_o = - 285.8 \text{ kJ mol}^{-1}$$



$$\Delta_r H_o = + 890.3 \text{ kJ mol}^{-1}$$



$$\Delta H = \Delta_r H_{o,1} + 2 * \Delta_r H_{o,2} + \Delta_r H_{o,3}$$

$$= -393.5 + 2 * (-285.8) + 890.3 = -74.8$$