JEE previous year questions:

Chemical Thermodynamics-V

1. An ideal gas undergoes isothermal compression from $5m^3$ 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 J mol^{-1} K^{-1}, the temperature of Al increases by
(Mains, 2019)

A) 2/3 K
B) 3/2 K
C) 1 K
D) 2 K

Ans: A)2/3 K

Explanation:

Work done on isothermal irreversible for ideal gas
$= -P_{ext} (V_2 - V_1)$
$= -4\ N/m^2 (1\ m^3 - 5m^3)$
$= 16$ Nm
Isothermal process for ideal gas
$\Delta U = 0$ so, $Q = -W = -16$ Nm $= -16$ J

Heat used to increase temperature of Al,
$Q = nC_m\Delta T$
$16 = 1 \times 24 \times \Delta T$
So, $\Delta T = 2/3K$

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

A) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

B) $2HI(g) \rightarrow H_2(g) + I_2(g)$

C) $2NO_2(g) \rightarrow N_2O_4(g)$

D) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

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 $\Delta_{fus}H$ = 6 kJ mol^{-1} at 0°C,
$C_p(H_2O, \ell = 75.3J\ mol^{-1}\ K^{-1})$
$C_p(H_2O, s) = 36.8\ J\ mol^{-1}\ K^{-1})$ (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:
$\Delta H = \Delta H_1 + \Delta_{fus}H + \Delta H_2$

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

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

4. Given, $C(graphite)+O_2 \rightarrow CO_2(g)$
Δ_rH_o = - 393.5 kJ mol^{-1}
$H_2(g) +(½) O_2(g) \rightarrow H_2O(l)$
Δ_rH_o = - 285.8 kJ mol^{-1}
$CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g)$
Δ_rH_o = + 890.3 kJ mol^{-1}
Based on the above thermochemical equations, the value of Δ_rH_o at 298 K for the reaction $C(graphite) + 2H_2(g) \rightarrow CH_4(g)$ 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:

$C(graphite)+O_2 \rightarrow CO_2(g)$ …….(1)

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

$H_2(g) + (\frac{1}{2}) O_2(g) \rightarrow H_2O(l)$…….(2)

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

$CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g)$….(3)

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

Given reaction: $C(graphite) + 2H_2(g) \rightarrow CH_4(g)$

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

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