Blue Print (As per PU Board)

Topic	1 mark questions	2 marks questions	3 marks questions	5 marks questions	Total Marks
Thermodynamics	1	–	–	1	10

One mark questions

1. **What is an open system? Give one example.**
   Answer: A system is said to be open if both matter and energy can be exchanged with the surroundings. Example: Water kept in an open beaker.
2. **What is an isolated system? Give one example.**
   Answer: system is said to be isolated if it neither exchanges matter nor energy. Example: Coffee taken in a thermos flask.
3. **What is isothermal process?**
   Answer: A process is said to be isothermal if the temperature of the system remains constant. $(dT = 0)$
4. **Define entropy.**
   Answer: Entropy is a measure of randomness or disorder of a system.

Two marks questions

5. **Define standard enthalpy of fusion or molar enthalpy of fusion.**
   Answer: The enthalpy change that accompanies melting of one mole of a solid substance in standard state is called standard enthalpy of fusion or molar enthalpy of fusion. $\Delta_{fus}H^{\Theta}$
6. **Explain the spontaineity of endothermic reactions using Gibb's equation.**
   Answer: Gibb's equation is $\Delta G = \Delta H - T\Delta S \rightarrow (1)$

   For endothermic reaction, ΔH is +ve
   (i) If ΔS is +ve according to equation (1)
   ΔG is –ve, at high temperature
   such that $T\ \Delta S > \Delta H$. Reaction is spontaneous
   (ii) If ΔS is –ve, according to equation (1)
   ΔG is always +ve. Reaction is nonspontaneous at all temperature.
7. **Define standard enthalpy of sublimation.**
   Answer: Standard enthalpy of sublimation, $\Delta_{sub}H^{\Theta}$ is the change in enthalpy when one mole of a solid substance sublimes at a constant temperature and under standard pressure. (1 bar)
8. **Define : specific heat capacity, Molar heat capacity.**
   Answer: Specific heat capacity : It is defined as the quantity of heat required to raise the temperature of 1 gram of a substance by $1^{\circ}C$ or 1 K. Molar heat capacity: It is defined as the quantity of heat required to raise the temperature of 1 mol of a substance by one degree celsius or one Kelvin.

Three marks questions

9. **The reaction of cyanamide, $NH_2CN(s)$ with oxygen was affected in a bomb calorimeter and ΔU was found to be -742.7 kJ mol^{-1} of cyanamide at 298K. Calculate the enthalpy change for the reaction at 298 K.**

   $$NH_2CN(s) + \frac{3}{2}O_2(g) \rightarrow N_2(g) + CO_2(g) + H_2O(l)$$

   Answer: $\Delta U - 742.7$ kJ mol^{-1}; $\Delta^{ng} = 2 - \frac{3}{2} = +\frac{1}{2}$ mol

$R = 8.314 \times 10^{-3}$ kJ k^{-1} mol^{-1}; $T = 298$ K

According to the relation, $\Delta H = \Delta U + \Delta^{ng}$ RT

$\Delta H = (-742.47 \text{ kJ}) + \left(\frac{1}{2} \text{mol}\right) \times \left(8.314 \times 10^{-3} \text{ kJ k}^{-1} \text{mol}^{-1}\right) \times 298 \text{K}$

$= -742.7 \text{ kJ} + 1.239 \text{ kJ} = -741.5 \text{kJ}$

10. **Enthalpy of combustion of carbon to carbon-di-oxide is** 393.5 k J mol^{-1}**. Calculate the heat released upon formation of 35.2g of** CO_2 **from carbon and oxygen gas.**

Answer: The combustion equation is

$C(s) + O_2(g) \rightarrow \underset{(44g)}{CO_2(g)}; \Delta cH = -393.5 \text{k J mol}^{-1}$

Heat released in the formation of 44 g of

$CO_2 = 393.5k$ J

Heat released in the formation of 35.2 g of

$\text{CO}_2 = \frac{(393.5 \text{ kJ}) \times (35.2\, g)}{(44g)} = 314.8 \text{ kJ}$

11. **The equilibrium constant for the reaction is 10. Calculate the value of** ΔG^{Θ} **; given**

R = 8 J k −1mol^{-1} ; T = 300 K

Answer: $\Delta G^{\Theta} = -RT$ in $K = -2.303 \text{RT} \log$ K

$R = 8.0$ J k^{-1} mol^{-1}; $T = 300$ K; k = 10

$\Delta G^{\Theta} = -2.303 \times \left(8 \text{ J k}^{-1} \text{ mol}^{-1}\right) \times (300 \text{ K}) \times \log 10$

$= -5527 \text{ J mol}^{-1} = -5.527 \text{ kJ mol}^{-1}$

12. Calculate the standard enthalpy of formation of $\text{CH}_3\text{OH}(\ell)$ from the following data.

(i) $CH_3OH(\ell) + \frac{3}{2} O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell); \Delta_f H^{\Theta} = -726 \text{ kJ mol}^{-1}$ **…(1)**

(ii) $C(s) + O_2(g) \rightarrow CO_2(g); \Delta_c H^{\Theta} = -393 \text{ kJ mol}^{-1}$ **…(2)**

(iii) $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(\ell); \Delta_f H^{\Theta} = -286 \text{kJ mol}^{-1}$ **…(3)**

Answer: The equation we aim at:

$C(s) + 24_2(g) + \frac{1}{2} O_2(g) \rightarrow CH_3OH(\ell); \Delta_f H^{\Theta} = \pm ?$

Multiply equation (iii) by 2 and add to equation (ii)

$C(s) + 2H_2(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$

$\Delta H = -(393 + 522) = -965 \text{ kJ mol}^{-1}$

Subtract equation (i) from equation (iv)

$CH_3OH(\ell) + \frac{3}{2} O_2(g) \rightarrow CO_2(g + 2H_2)O(\ell); \Delta H = -726 \text{ kJ mol}^{-1}$

Subtract $C(s) + 2H_2(g) + \frac{1}{2} O_2(g) \rightarrow CH_3OH(\ell)$; $\Delta_f H^{\Theta} = -239 \text{ kJ mol}^{-1}$