



## INDIAN SCHOOL MUSCAT

CLASS: XI

CHEMISTRY



### THERMODYNAMICS

- Which one of the following thermodynamic quantities is not a state function?
  - Gibbs free energy
  - enthalpy
  - entropy
  - internal energy
  - work
- A system has an increase in internal energy of 80 J and at the same time has 50 J of work done on it. What is the heat change of the system?
  - +130 J
  - +30 J
  - 130 J
  - 30 J
  - 0 J
- The entropy will usually increase when
  - a molecule is broken into two or more smaller molecules.
  - a reaction occurs that results in an increase in the number of moles of gas.
  - a solid changes to a liquid.
  - a liquid changes to a gas.
  - I only
  - II only
  - III only
  - IV only
  - I, II, III, and IV
- For the following reaction at 25°C,  $\Delta H^\circ = +115 \text{ kJ}$  and  $\Delta S^\circ = +125 \text{ J/K}$ . Calculate  $\Delta G^\circ$  for the reaction at 25°C.  
 $\text{SBr}_4(\text{g}) \rightleftharpoons \text{S}(\text{g}) + 2\text{Br}_2(\text{l})$ 
  - +152 kJ
  - 56.7 kJ
  - +77.8 kJ
  - +37.1 kJ
  - 86.2 kJ

- 5 Which statement is false?
- The thermodynamic quantity most easily measured in a "coffee cup" calorimeter is  $\Delta H$ .
  - No work is done in a reaction occurring in a bomb calorimeter.
  - $\Delta H$  is sometimes exactly equal to  $\Delta E$ .
  - $\Delta H$  is often nearly equal to  $\Delta E$ .
  - $\Delta H$  is equal to  $\Delta E$  for the reaction:
- 6 What will be the sign of entropy change for the following changes?
- In an isolated system, two identical gases are allowed to mix under identical conditions.
  - $I_2(g) \rightarrow I_2(s)$
  - $H_2(g) + I_2(g) \rightarrow 2HI(g)$
  - Dissolution of sugar in water contained in a thermos flask.
- 7 Calculate the  $K_c$  at 298 K for the reaction  $H_2 + I_2 \rightleftharpoons 2HI$ , if  $\Delta G_f^\circ (HI) = 1.3 \text{ kJ/mole}$ .
- 8 For the equilibrium  $PCl_5 \rightleftharpoons PCl_3 + Cl_2$  at  $25^\circ \text{C}$ ,  $K = 1.8 \times 10^{-7}$ . Calculate  $\Delta G^\circ$  of reaction.
- 9 For the reaction  $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ , calculate the  $\Delta G$  at 600 K if enthalpy and entropy changes are  $-110 \text{ kJ/mole}$  and  $150 \text{ J/Kmole}$ .
- 10  $\Delta H$  and  $\Delta S$  for the reaction  $Ag_2O \rightleftharpoons 2Ag + \frac{1}{2} O_2$  are  $30.56 \text{ kJ/mole}$  and  $60 \text{ J/K}$  respectively. Calculate the temperature at which the free energy change for this reaction will be zero. Predict whether the forward reaction will be favoured above/below this T.
- 11 For the synthesis of  $NH_3$ ,  $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ , calculate  $K_p$  at 300K if  $\Delta H_f^\circ$  of  $NH_3$  as  $-46.2 \text{ kJ/mole}$  and  $\Delta S^\circ$  for the reaction is  $198.3 \text{ J/Kmole}$ .
- 12 Differentiate between a) closed system and an isolated system b) heat of formation and heat of reaction c) heat of hydration and heat of solution
- 13 The  $\Delta H_{\text{vap}}$  of water at  $100^\circ \text{C}$  is  $41 \text{ kJ/mole}$ . Calculate the internal energy change.
- 14 Define  $C_v$  and  $C_p$  for an ideal gas. Derive a relationship between  $C_v$  and  $C_p$ .
- 15 Calculate the  $\Delta H_f^\circ$  of benzene if  $\Delta H_{\text{comb}}$  of benzene, carbon and hydrogen are  $3267$ ,  $393$  and  $286 \text{ kJ/mole}$  respectively.
- 16 The mean bond enthalpies of  $N \equiv N$  and  $H-H$  are  $946$  and  $436 \text{ kJ/mole}$  respectively. If heat of formation of ammonia is  $-46 \text{ kJ/mole}$ , calculate the mean BE in ammonia.
- 17 Explain the formation of  $NaBr$  using Born-Haber cycle.
- 18 Calculate heat change at constant pressure if heat change at constant volume for the reaction  $NH_2CN(g) + \frac{3}{2} O_2(g) \rightarrow N_2(g) + CO_2(g) + H_2O(l)$  at 298K is  $-742 \text{ kJ/mole}$ .
- 19 Calculate the entropy change in surroundings when  $36 \text{ g}$  of water is formed under standard conditions.  $\Delta H_f^\circ$  of water =  $-286 \text{ kJ/mole}$
- 20 What is the work done on a gas when  $10 \text{ lt}$  of the gas is compressed to  $4.5 \text{ lt}$  under

- a constant pressure of  $10^3$  kPa?
- 21 Calculate the work done when 2.5 moles of an ideal gas at 300K is isothermally and reversibly compressed from a volume of  $5\text{m}^3$  to a volume of  $2\text{m}^3$ .
  - 22 What would be the work done when the pressure of 2 moles of an ideal gas is changed from 2 bar to 5 bar isothermally and reversibly at  $25^\circ\text{C}$ ?
  - 23 When will heat change at constant volume and heat change at constant pressure be equal?
  - 24 Dissolution of ammonium chloride in water is endothermic yet it is a spontaneous process. Explain.
  - 25 Define
    - (i) Heat capacity
    - (ii) Molar heat capacity
    - (iii) Enthalpy of a reaction
    - (iv) Entropy
    - (v) Gibb's free energy
    - (vi) Residual entropy
  - 26 Derive the relationship between  $C_p$  and  $C_v$
  - 27 State
    - i. Hess's law of constant heat summation
    - ii. Second law of thermodynamics
    - iii. Third law of thermodynamics
  - 28 Discuss the role of temperature in determining the spontaneity of a process
  - 29 Derive the relation  $\Delta H = \Delta U + \Delta n_g RT$
  - 30 Comment on the following statements
    - (i) An exothermic reaction is always thermodynamically spontaneous.
    - (ii) The entropy of a substance increases when going from liquid state to vapour state at any temperature.
    - (iii) A reaction with  $\Delta G^0 > 0$  always has an equilibrium constant greater than one