PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 54

Total Marks : 32

Max. Time : 33 min.

Topic : Thermodynamics & Thermochemistry

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.4, 6, 7, 9, 10	(8 marks, 8 min.)	[24, 24]
Multiple choice objective ('–1' negative marking) Q.5	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.8	(4 marks, 5 min.)	[4, 5]

1. In which of the following cases, generally entropy decreases :

(A) Solid changing to liquid
(B) Expansion of a gas
(C) Crystal dissolves
(D) Polymerisation

2. Predict which of the following reaction(s) have a positive entropy change ?

I. $Ba^{2+}\,(aq) + SO_4^{2-}\,(aq) \longrightarrow BaSO_4\,(s)$

II. $CaCO_3\,(s) \longrightarrow CaO\,(s) + CO_2\,(g)$

III. $2SO_3\,(g) \longrightarrow 2SO_2\,(g) + O_2\,(g)$

(A) I and II
(B) III
(C) II and III
(D) II

3. Which of the following reactions is expected to have the most negative change in entropy ?

(A) $N_2\,(g) + 3H_2\,(g) \longrightarrow 2NH_3\,(g)$
(B) $C_2H_2\,(g) + 2H_2\,(g) \longrightarrow C_2H_6\,(g)$
(C) $C\,(s) + O_2 \longrightarrow CO_2(g)$
(D) $2NO_2\,(g) \longrightarrow N_2O_4\,(s)$

4. Which statement regarding entropy is correct ?

(A) A completely ordered deck of cards has more entropy than a shuffled deck in which cards are arranged randomly.

(B) A perfect ordered crystal of solid nitrous oxide has more entropy than a disordered crystal in which the molecules are oriented randomly.

(C) 1 mole N_2 gas at STP has more entropy than 1 mole N_2 gas at 273 K in a volume of 11.2 litre.

(D) 1 mole N_2 gas at STP has more entropy than 1 mole N_2 gas at 273 K and 0.25 atm.

5*. Select the correct option(s) :

(A) Specific volume and molar heat capacity are intensive parameters.

(B) For an irreversible adiabatic compression process, entropy change of surrounding will be equal to zero.

(C) Change in internal energy for an ideal gas for an isobaric process is expresed as $\Delta U = nC_V\,(T_2 - T_1)$, where the terms used have their usual meaning.

(D) Free expansion is a reversible process.

6. Two moles of an ideal gas ($\gamma = 4/3$) is made to expand reversibly and adiabatically to 4 times its initial volume. The change in entropy of the system during expansion is : (Given : R = 2 cal/K/mole, $\log_{10}2 = 0.3$, $\log_{10}3 = 0.48$)

(A) 5.6 cal/k
(B) 11.2 cal/k
(C) 2.8 cal/k
(D) None of these

7. Two moles of an ideal monoatomic gas expands isothermally against a constant external pressure of 2 atm from an initial volume of 22.4 L to a state where its final pressure becomes equal to external pressure. If the initial temperature of gas is 273°C, then the entropy change of system in the above process is :
[Given : 1 mole of an ideal gas occupies 22.4 L at STP conditions]

(A) R ln 16 (B) R ln 4 (C) R ln 8 (D) Zero

8. The enthalpy of vapourisation of liquid diethyl ether is 26 kJ/mol at its boiling point (52°C). Calculate ΔS for conversion of : (a) liquid to vapour, and (b) vapour to liquid at 52°C.

9. When two equal sized pieces of the same metal, each of mass m at different temperatures T_h (hot piece) and T_C(cold piece) are brought into contact and isolated from surrounding, the total change in entropy of system is given by : (Specific heat capacity of metal = s)

(A) $ms \ln \frac{T_C + T_h}{2T_C}$ (B) $ms \ln \frac{T_h}{T_C}$ (C) $ms \ln \frac{(T_C + T_h)^2}{2T_hT_C}$ (D) $ms \ln \frac{(T_C + T_h)^2}{4T_hT_C}$

10. One mole of an ideal monoatomic gas at 27ºC is subjected to a reversible isoentropic compression until final temperature reached to 327ºC. If the initial pressure was 1.0 atm, then find the value of ln P_2:
(Given : ln 2 = 0.7).

(A) 1.75 atm (B) 0.176 atm (C) 1.0395 atm (D) 2.0 atm

Answer Key

DPP No. # 54

1. (D) **2.** (C) **3.** (D) **4.** (C)

5.* (ABC) **6.** (D) **7.** (B)

8. (a) 80 JK^{-1} mol^{-1} (b) – 80 $JK^{-1}mol^{-1}$ **9.** (D) **10.** (A)

Hints & Solutions

DPP No. # 54

1. Polymerisation leads to more ordered structure.

2. Δn_g is + ve

3. Δn_g is most – ve

4. For same amount of gas at constant temperature, lesser is the volume, lower will be the entropy.

6. For a reversible adiabatic process,
$\Delta S_{sys} = \Delta S_{surr} = \Delta S_{univ} = 0$

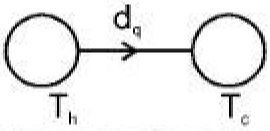
7. For initinal state $P_i \times 22.4 = 2 \times R \times 546$ $\therefore P_i = 4$ atm
Now, $P_i V_i = P_f V_f$ ($\because$ process is Isothermal)
$4 \times 22.4 = 2 \times V_f$ $\therefore V_f = 44.8$ L

$$\therefore \Delta S_{sys} = nR \ln\left(\frac{V_f}{V_i}\right) = 2R\ln\left(\frac{44.8}{22.4}\right) = 2R\ln 2 = R\ln 4$$

8. **(a)** $\Delta S_{vap.} = \frac{\Delta H_{vap.}}{T} = \frac{26 \times 10^3}{325} = 80 \text{ JK}^{-1}\text{ mol}^{-1}$.

(b) $\Delta S_{cond.} = \frac{\Delta H_{cond}}{T} = -80 \text{ JK}^{-1}\text{ mol}^{-1}$.

9.



For a small exchange in heat at time 't'

change entropy for hot piece = $\frac{dq}{T_h^1}$

where T_h^1 is temp of hot piece at time 't'

change of entropy by cold piece = $\frac{dq}{T_c^1}$.

As heat capacities of the pieces is same.
$T_c + T_h = T_c^1 + T_h^1 = 2T_f$
where T_f is final temperature of each piece.

ΔS for hot piece = $\int \frac{dq}{T_h{}^1} = mS \int_{T_h}^{T_f} \frac{dT}{T_h{}^1}$ $= mS \ln \frac{T_f}{T_h}$

ΔS for cold piece = $mS \ln \frac{T_f}{T_c}$.

$\therefore$ Total $\Delta S = mS \ln \frac{T_f{}^2}{T_h T_c}$ $= ms \ln \frac{(T_C + T_h)^2}{4T_h T_C}$

10. For isoentropic process $\Delta S_{\text{system}} = 0$

$$\therefore nC_{p,\,m} \ln \frac{T_2}{T_1} + nR \ln \frac{P_1}{P_2} = 0$$

$$\Rightarrow \ln (P_2) = \frac{5}{2} \times \ln \left(\frac{600}{300}\right) \quad = 1.75 \text{ atm}$$