CHEMISTRY COACHING CIRCLE

+1

GRAND TEST-5

TEST-24

Topic:

Thermodynamics & Classification and Nomenclature of Organic Compound

Test Date: 22.10.2018 (Monday)
Test Time: 2:30 pm to 4:30 pm

Test Venue:
Lajpat Bhawan, Madhya Marg,
Sector 15-B, Chandigarh

Empowered By:

TEST SERIES

PCB
QUANTUM +Plus

PCM
INTELLIQUEST

Dr. Sangeeta Khanna, Ph.D

S.C.O. 208 (TF) Sector 24-D, Chandigarh. Ph. No. 0172-2713289 (O), 09888007880 (M).

READ THE INSTRUCTIONS CAREFULLY

1. The test is of **2 hour** duration.
2. The maximum marks are **280**.
3. This test consists of **65 questions.**
4. Keep your **mobiles switched off** during Test in the Halls.

SECTION – A (Single Correct Choice Type)

This Section contains **40 multiple choice questions.** Each question has four choices A), B), C) and D) out of which **ONLY ONE** is correct. (Mark only One choice)   **40 × 4 = 160 Marks**

1. Change in entropy is negative for:

   (a) Bromine (ℓ) $\longrightarrow$ Bromine (g)   (b) C(s) + O_2(g) $\longrightarrow$ CO_2(g)

   (c) N_2(g, 10 atm) $\longrightarrow$ N_2 (g, 1 atm)   (d) Fe(1 mol, 400 K) $\longrightarrow$ Fe(1 mol, 300 K)
   D

Sol. The gaseous phase have more entropy and thus, ΔS is +ve in (A) and (B). Also decrease in pressure increases disorder and thus, ΔS is +ve in (C). In (D) the disorder decreases in liquid state due to decrease in temperature. Thus, ΔS = - ve.

2. The internal energy when a system goes from state A to B is ΔU 40 kJ/mol. If the system goes from A to B by a reversible path and returns to state A by an irreversible path. What would be the net change in internal energy?

   (a) 40 kJ   (b) > 40 kJ   (c) < 40 kJ   (d) zero
   D

Sol. In a cyclic process ΔE = 0

3. One mole of an ideal gas
   (C_V = 20 JK^{-1} mol^{-1}) initially at STP is heated at constant volume to twice the initial temperature. For the process, W and q will be

   (a) W = 0; q = 5.46 kJ   (b) W = 0; q = 0
   (c) W = - 5.46 kJ; q = 5.46 kJ   (d) W = 5.46 kJ; q = 5.46 kJ
   A

Sol. W = $P\Delta V$ = P × 0 = 0
   Q = $C_V(\Delta T)$ = 20 × 273 = 5460 J = 5.46 kJ

4. The standard enthalpy of formation of octane (C_8H_{18}) is -250kJ/mol. Find the enthalpy of combustion of C_8H_{18}. The enthalpy of formation of CO_2(g) and $H_2O(\ell)$ are -394 kJ/mol and -286kJ/mol respectively
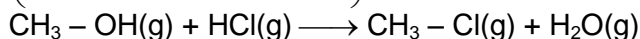
   (a) -5200 kJ/mol   (b) -5726 kJ/mol   (c) -5476 kJ/mol   (d) -5310 kJ/mol
   C

Sol. $C_8H_{18} + \dfrac{17}{2}O_2 \longrightarrow 8CO_2 + 9H_2O$

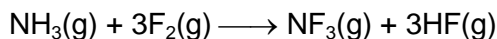 $\Delta_r H^0$ = 8 × (–394) + 9 × (–286) – (–250)
   = –5476kJ/mol

5. Calculate the enthalpy for the following reaction using the given bond energies (kJ/mol)

   $\begin{pmatrix} C-H = 414; \ H-O = 463; \\ H-Cl = 431, C \text{-} Cl = 326; \\ C \text{-} O = 335 \end{pmatrix}$

   $CH_3 - OH(g) + HCl(g) \longrightarrow CH_3 - Cl(g) + H_2O(g)$

   (a) – 23 kJ/mol   (b) – 43 kJ/mol   (c) – 59 kJ/mol   (d) – 511 kJ/mol
   A

6. Using given standard enthalpies of formation (in kJ/mol) determine the enthalpy of the following reaction?

$NH_3(g) + 3F_2(g) \longrightarrow NF_3(g) + 3HF(g)$

$\Delta H_f^0 (NH_3, g) = -46.2 \text{ kJ/mol}$

$\Delta H_f^0 (NF_3, g) = -113.0 \text{kJ/mol}$

$\Delta H_f^0 (HF, g) = -269.0 \text{kJ/mol}$
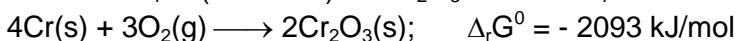
(a) – 335.8kJ/mol   (b) – 873.8 kJ/mol   (c) – 697.2 kJ/mol   (d) – 890.4 kJ/mol

B

7. Calculate $\Delta_f H^0$ (in kJ/mol) for Cr_2O_3 from the $\Delta_r G^0$ and the S^0 values provided at 27^0C

$4Cr(s) + 3O_2(g) \longrightarrow 2Cr_2O_3(s);$ $\Delta_r G^0 = -2093 \text{ kJ/mol}$

S^0 (J/K mol) : $S^0(Cr, s) = 24;$

$S^0 (O_2, g) = 205;$ $S^0 (Cr_2O_3, s) = 81 \text{ JK}^{-1} \text{mol}^{-1}$

(a) – 2258.1 kJ/mol   (b) – 1129.05 kJ/mol   (c) – 964.35 kJ/mol   (d) 3462 kJ/mol

B

Sol. $\Delta_r G^0 = \Delta_r H^0 - T \times \Delta_r S^0$

$\Delta r S^0 = 2 \times 81 - 4 \times 24 - 3 \times 205 \text{ J/mol}$

$= 162 - 96 - 615 = -549 \text{ J}$

$\Delta G° = \Delta H° - T\Delta S°$

$= -2093 - \dfrac{300 \times 549}{1000}$

$= -2093 - \dfrac{164700}{1000}$

$= -2093 - 164.7$

$= -2257.7$

$\therefore \Delta_r H^0 = -2257.7 \text{ kJ/mol}$

$\Delta_r H^0 = 2 \times \Delta_f H^0 (Cr_2O_3, s)$

$\therefore \Delta_f H^0(Cr_2O_3, s) = -\dfrac{2257.7}{2} = -1128.85 \text{ kJ/mol}$

8. At 25°C, a 0.01 mole sample of a gas is compressed in volume from 4.0 L to 1.0 L at constant temperature. What is work done for this process if the external pressure is 4.0 bar?

a. 1.6×10^3 J   b. 8.0×10^2 J   c. 4.0×10^2 J   d. 1.2×10^3 J

D

Sol. $4 \times 3 = 12$ lit atm $= 12 \times 101.3$ J

9. For the reaction: $FeCO_3(s) \longrightarrow FeO(s) + CO_2(g);$ $\Delta H = 82.8$ kJ at 25°C, what is (ΔE or ΔU) at 25°C?

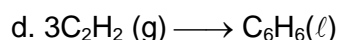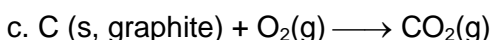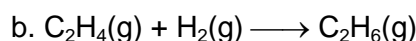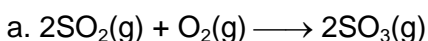a. 82.8 kJ   b. 80.32 kJ   c. – 2394.77 kJ   d. 85.28 kJ

B

Sol. $\Delta H = \Delta E + \Delta n_g RT$

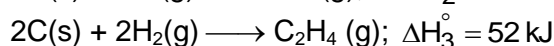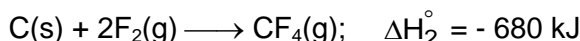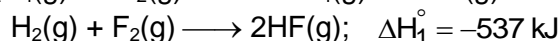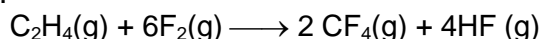$\Rightarrow 82.8 = \Delta E + \dfrac{1 \times 8.314 \times 298}{1000}$

$\Rightarrow \Delta E = 80.32$

10. Which of the following reactions is associated with the most negative change in entropy?

a. $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$ b. $C_2H_4(g) + H_2(g) \longrightarrow C_2H_6(g)$

c. C (s, graphite) $+ O_2(g) \longrightarrow CO_2(g)$ d. $3C_2H_2 (g) \longrightarrow C_6H_6(\ell)$

D

11. Given the following equations and ΔH° values, determine the enthalpy of reaction at 298 K for the reaction:

$$C_2H_4(g) + 6F_2(g) \longrightarrow 2\ CF_4(g) + 4HF\ (g)$$
$$H_2(g) + F_2(g) \longrightarrow 2HF(g); \quad \Delta H_1^\circ = -537\ kJ$$
$$C(s) + 2F_2(g) \longrightarrow CF_4(g); \quad \Delta H_2^\circ = -680\ kJ$$
$$2C(s) + 2H_2(g) \longrightarrow C_2H_4\ (g); \quad \Delta H_3^\circ = 52\ kJ$$

    a. – 1165   b. – 2486   c. + 1165   d. + 2486

B

Sol. $\Delta H° = 2 \times \Delta H_1^\circ + 2 \times \Delta H_2^\circ - \Delta H_3^\circ$
         $= -2 \times 537 - 680 \times 2 - 52$

12. The enthalpy change for the reaction, $C_2H_6(g) \longrightarrow 2C(g) + 6H(g)$ is X kJ. The bond energy of C – H bond is:

    a. $\dfrac{X}{2}$ b. $\dfrac{X}{3}$ c. $\dfrac{X}{6}$ d. data insufficient

D

13. Which of the following statement(s) is/are correct?
Statement (i) : The entropy in isolated system with P – V work only, is always maximized at equilibrium
Statement (ii) : It is possible for the entropy of close system to decrease substantially in an irreversible process.
Statement (iii): Total Entropy of all spontaneous process is positive
Statement (iv) : ΔS_{system} is zero for reversible process in an isolated system.
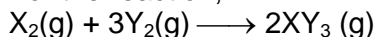
    a. Statement i, ii, iii   b. Statement ii, iv   c. Statement i, ii, iv   d. All of these

D

14. For the reaction,
$X_2(g) + 3Y_2(g) \longrightarrow 2XY_3\ (g)$
if ΔH – ΔE = z, at 27°C, the ratio of z/R is:

    a. zero   b. unit   c. $+6 \times 10^2$ d. -6×10^2

D

Sol. $\Delta n_g = 2\ (of\ XY_3) - [1(of\ X_2) + 3\ (of\ Y_2)] = -2$
$\Delta H - \Delta E = \Delta n_g RT$
But, given value is z.
So, $z = \Delta n_g RT$

      $\dfrac{Z}{R} = \Delta n_g T = -2 \times (27 + 273) = -600 = -6 \times 10^2$

15. Certain amount of an ideal gas absorbs 300 calories at 298 K and expands by 10 L at 1 atm. The increase in internal energy of the gas is:

    a. 242 cal   b. 24.2 cal   c. 58 cal   d. 358 cal

C

Sol. q = 300 calorie
W = - PΔV = - 1 × 10 litre-atm = - 10 × 24.2 cal = - 242 cal
ΔE = q + W = 300 – 242 = 58 cal

16. 1 mol of water does 3.1 kJ of work during conversion to steam at 1 atm and 100°C. If heat of vaporisation is 40.65 kJ mol⁻¹, the change in internal energy is:

    a. 37.55 kJ   b. 43.75 kJ   c. – 37.55 kJ   d. – 40.65 kJ

A

Sol. $q = + 40.65\ kJ\ mol^{-1}$
$W_{exp.} = -3.1\ kJ$
   $\Delta E = q + W$
     $= 40.65 - 3.1 = 37.55\ kJ$

17. The work done on the system when 1 mol of ideal gas at 500 K is compressed to one-tenth of its original volume is :(R = 2 cal)

a. + 2.303 kcal   b. – 2.303 kcal   c. + 23.03 kcal   d. – 23.03 kcal

A
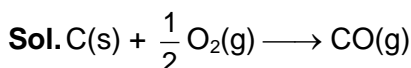
Sol. $\dfrac{V_2}{V_1} = \dfrac{1}{10}$

W (on the system) = - 2.303nRT log $\dfrac{V_2}{V_1}$

$= -2.303 \times 1 \times 2 \times 500 \log \dfrac{1}{10}$ cal

$= +\dfrac{2.303 \times 2 \times 500}{1000}$ kcal $= +2.303$ kcal

18. The difference between heat of reaction at constant pressure and constant volume for the reaction,

$C(s) + \dfrac{1}{2} O_2 (g) \longrightarrow CO (g)$ is:

(Assume that R = 0.002 kcal and temperature = T K)

a. T cal   b. – T cal   c. $-\dfrac{T}{2}$ cal   d. $\dfrac{T}{2}$ cal

A

Sol. $C(s) + \dfrac{1}{2} O_2(g) \longrightarrow CO(g)$

$\Delta H - \Delta E = \Delta n_g RT$

$= \left(1 - \dfrac{1}{2}\right) \times (0.002 \times 1000) \times T$ cal $= T$ cal

19. Zn (s) + CuSO$_4$(aq) $\longrightarrow$ ZnSO$_4$ (aq) + Cu (s) ; $\Delta H = x$.
What is the value of x if 31.75 g copper is liberated with the evolution of 106.15 kJ? (At. wt. of Zn = 65.3 and Cu = 63.5)
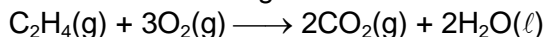
a. 53.075 kJ   b. 106.15 kJ   c. – 212.30 kJ   d. None of these

C

Sol. 31.75 g Cu $\equiv$ - 106.15 kJ

63.5 g Cu (1 mol Cu from balanced equation) $= -\dfrac{106.15 \times 63.5}{31.75}$ kJ $= -212.30$ kJ

20. Heat of the following reaction in bomb calorimeter is – 1415 kJ/mol
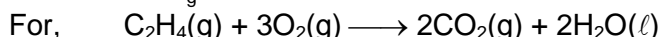$C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(\ell)$
What is the heat released if 1.4g C_2H_4 is combusted in open atmosphere at 27°C?
(R = 8.3 JK^{-1} mol^{-1})

a. – 70.999 kJ   b. – 1419.98 kJ   c. – 709.99 kJ   d. – 1415 kJ

A

Sol. $\Delta H = \Delta E + \Delta n_g RT$

For, $C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(\ell)$

ΔE = - 1415 kJ, $\Delta n_g = 2 - (3 + 1) = - 2$,

Mol. wt. of C_2H_4 = 28g

$\Delta H = - 1415 - 2 \times \dfrac{8.3}{1000} \times 300$

$= - 1415 - 4.98 = - 1419.98$ kJ mol^{-1}

For 1.4 gm $= \dfrac{1419.98}{28} \times 1.4$

$= 70.999$ kJ

21. A system undergoes a process in which $\Delta E = +300$ J while absorbing 400 J of heat energy and undergoing an expansion against 0.5 bar. What is the change in the volume (in L)?

    a. 4   b. 5   c. 2   d. 3

    C

Sol. $\Delta E = q + w$; $300 = 400 + W$; $W = -100$ J; $-P\Delta V = W$

$$= \frac{100x}{101.3} \text{ lit. atm}$$

$$\Delta V = \frac{W}{P}$$

22. A sample of liquid in a thermally insulated container (a calorimeter) is stirred for 2 hr. by a mechanical linkage to a motor in the surrounding, for this process:

    a. $w < 0$; $q = 0$; $\Delta U = 0$ b. $w > 0$; $q > 0$; $\Delta U > 0$

    c. $w < 0$; $q > 0$; $\Delta U = 0$ d. $w > 0$; $q = 0$; $\Delta U > 0$

    D

23. Which of the following equations represents a reaction that provides the enthalpy of formation of CH_3Cl?

    a. $C(s) + HCl(g) + H_2(g) \longrightarrow CH_3Cl(g)$ b. $C(s) + 3H(g) + Cl(g) \longrightarrow CH_3Cl(g)$

    c. $C(s) + 3/2H_2(g) + 1/2Cl_2(g) \longrightarrow CH_3Cl(g)$ d. $CH_4(g) + Cl_2(g) \longrightarrow CH_3Cl(g) + HCl(g)$

    C

24. The enthalpy change for the following reaction is 368 kJ. Calculate the average O – F bond energy.

    $OF_2(g) \longrightarrow O(g) + 2F(g)$

    a. 184 kJ/mol   b. 368 kJ/mol   c. 536 kJ/mol   d. 736 kJ/mol

    A

25. If the bond dissociation energies of XY, X_2 and Y_2 (all diatomic molecules) are in the ratio 1 : 1 : 0.5 and $\Delta_f H$ for the formation of XY is -200 kJ mol^{-1}, the bond dissociation energy of X_2 will be:

    a. 100 kJ mol^{-1} b. 200 kJ mol^{-1} c. 800 kJ mol^{-1} d. 400 kJ mol^{-1}

    C

Sol. Let the bond dissociation energy of X_2 be 'm' kJ mol^{-1}. Hence, $B.E._{XY} = m$, $B.E._{X_2} = m$ and $B.E._{Y_2}$ =0.5m.

$$\frac{1}{2}X_2 + \frac{1}{2}Y_2 \longrightarrow XY; \qquad\qquad \Delta H = -200 \text{ kJ}$$

$$-200 = \frac{1}{2}m + \frac{1}{2}m \times 0.5 - m = \frac{1}{2}m + \frac{1}{4}m - m = -\frac{1}{4}m$$
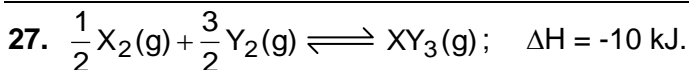
$$m = 800 \text{ kJ mol}^{-1}$$

26. From the following data, what is the ΔC_P of reaction?

$$A_2 + B_2 \xrightarrow{\;273\,K\;} 2AB; \qquad \Delta H_1 = -50 \text{ kJ}$$

$$A_2 + B_2 \xrightarrow{\;373\,K\;} 2AB; \qquad \Delta H_2 = -125 \text{ kJ}$$
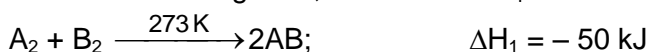
    a. -2.0 kJ K^{-1} b. -0.75 kJ K^{-1} c. -0.31. kJ K^{-1} d. Unpredictable

    B

Sol. $\Delta C_P = \dfrac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \dfrac{-125 - (-50)}{373 - 273} = \dfrac{-75}{100} = -0.75 \text{ kJ K}^{-1}$

27. $\frac{1}{2}X_2(g) + \frac{3}{2}Y_2(g) \rightleftharpoons XY_3(g)$; $\quad \Delta H = -10$ kJ.

The temperature at which the reaction will be at equilibrium is: (Given that, $\Delta_f S°$ for $X_2 = 40$, $Y_2 = 60$ and $XY_3 = 50$ JK^{-1} mol^{-1})

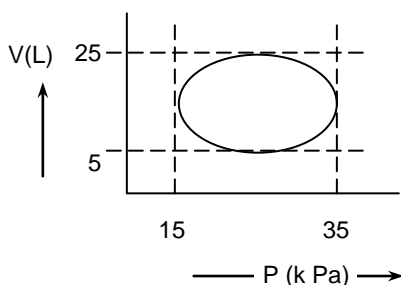a. 200 K $\qquad$ b. 166.67 K $\qquad$ c. – 333 K $\qquad$ d. 333 K

B

Sol. For equilibrium, T = $\frac{\Delta H}{\Delta S}$

$\Delta S = 50 - \frac{1}{2} \times 40 - \frac{3}{2} \times 60$

$= 50 - 20 - 90 = -60$ JK^{-1} mol^{-1}

$T = \frac{-10 \times 1000 \, J\,mol^{-1}}{-60 \, JK^{-1} \, mol^{-1}} = 166.67$ K

28. How much of heat change is represented by the cyclic process shown by the following diagram?

a. $10^{-2}\,\pi J$ $\qquad$ b. $10^2\,\pi J$ $\qquad$ c. πJ $\qquad$ d. $10^3\,\pi J$

B

Sol. $\Delta H = $ Area $= \pi[r_{V(m^3)}][r_{P(Pa)}]$

$= \pi \times 10 \times 10^{-3} \times 10 \times 10^3$

$= 10^2 \pi Pa\,m^3 = 10^2 \pi J$

29. The value of $\log_{10} K$ for a reaction $A \rightleftharpoons B$ is:

(Given: $\Delta r H^0_{298\,K} = 54.07$ kJ mol^{-1},

$\Delta S^0_{298\,K} = 10$ JK^{-1} mol^{-1} and $R = 8.314$ JK^{-1} mol^{-1};

$2.303 \times 8.314 \times 298 = 5705$

a. 5 $\qquad$ b. 10 $\qquad$ c. 95 $\qquad$ d. 100

B

Sol. $\Delta G° = \Delta H° - T\Delta S° = -2.303RT \log_{10}K$

$\therefore$ -2.303 RT $\log_{10}K = \Delta H° - T\Delta S$

-2.303 × 8.314 × 298 × $\log_{10}K$ = -54.07 × 1000 – 298 × 10

-5705 $\log_{10}$ K = -54070 – 2980 = -57050

or $\log_{10}K = 10$

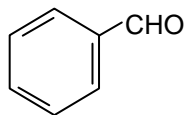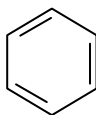**30.** Which of the following equal to specific heat of a monoatomic gas at constant volume?

a. $\left[\frac{\partial E}{\partial T}\right]_P$ $\qquad$ b. $\left[\frac{\partial T}{\partial P}\right]_H$ $\qquad$ c. $\left[\frac{\partial E}{\partial T}\right]_V$ $\qquad$ d. $\left[\frac{\partial E}{\partial H}\right]_T$
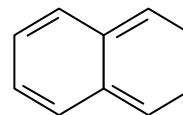
C

Sol. $C_V = \frac{q_V}{\Delta T} = \left(\frac{\partial E}{\partial T}\right)_V$

$\therefore$ At constant volume $\quad q_v = \Delta E$

31. Which class of organic compounds do

 and
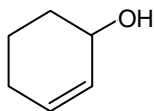
    a. Alicyclic   b. Acyclic   c. Benzenoid   d. Heterocyclic

    C

Sol. These are bezene ring containing compounds.

32. The correct IUPAC name of
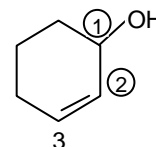
    a. 3 – Hydroxycyclohex – 1 – ene   b. Cyclohex -2 – en –1 – ol
    c. Cyclohex – 1 – en – 3 – ol   d. Cyclohex – 5 – en – 1 – ol
    B

Sol. 'OH' 'ol' is the main group. Its location will get number '1' and then lowest possible for

33. Match the facts of Column – I with those of Column – II and select the correct option:
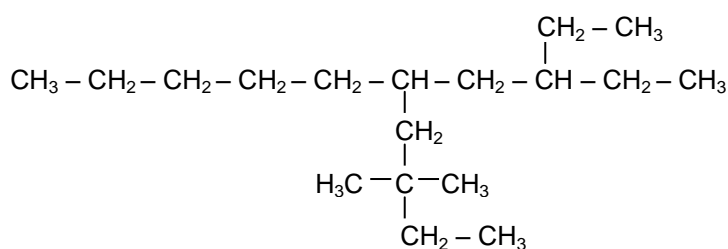
	Column – I		**Column – II**

(p)	$CH_3 - CH - CH_2 -$
	         $\mid$
	         CH_3
		(i)	Neopentyl

(q)	$\mid$
	 $CH_3 - C - CH_3$
	        $\mid$
	       CH_3
		(ii)	Tert-butyl

(r)	$CH_3 - CH_2 - CH -$
	             $\mid$
	           CH_3
		(iii)	Isobutyl

(s)	CH_3
	        $\mid$
	 $CH_3 - C - CH_2 -$
	        $\mid$
	       CH_3
		(iv)	Sec-Butyl

       P   **Q**   **R**   **S**   **P**   **Q**   **R**   **S**
a. (iv)   (i)   (ii)   (iii)   b. (iii)   (i)   (iv)   (ii)
c. (iv)   (i)   (iii)   (ii)   d. (iii)   (ii)   (iv)   (i)
    D

34. Select the correct IUPAC name of:

$$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - \underset{\underset{\underset{\underset{CH_2-CH_3}{|}}{H_3C-\overset{|}{\underset{|}{C}}-CH_3}}{\underset{|}{CH_2}}}{CH} - CH_2 - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_2-CH_3}{|}}{CH}} - CH_2 - CH_3$$

    a. 3–Ethyl–5–(2,2–dimethylbutyl) decane   b. 5–(2,2–Dimethylbutyl) –3–ethyl decane
    c. 5–(2–Ethylbutyl) –3,3–dimethyl decane   d. All are correct
    C

Sol.
$$\overset{10}{CH_3}-\overset{9}{CH_2}-\overset{8}{CH_2}-\overset{7}{CH_2}-\overset{6}{CH_2}-\overset{5}{CH}-\overset{1}{CH_2}-\overset{2}{CH}-\overset{3}{CH_2}-\overset{4}{CH_3}$$

with side chain:

$\overset{4}{CH_2}$

$H_3C-\overset{3}{C}-CH_3$

$\overset{2}{CH_2}-\overset{1}{CH_3}$

and on the boxed branch: CH_2-CH_3
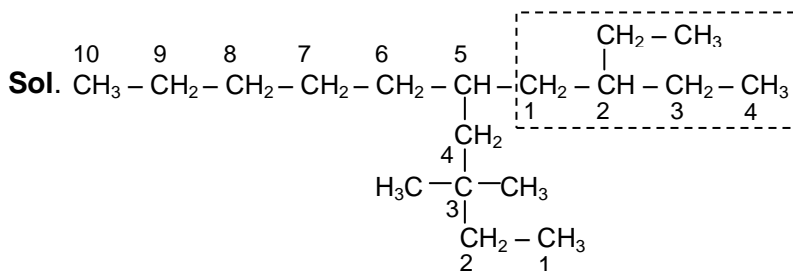
From lower part and right side both give longest carbon chain of 10C – atom, but lower part gives more number of side chains.

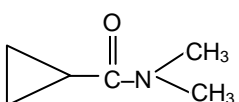**35.** Which of the following is the correct order of priority of some of the functional grops?

a. –COOH > –SO₃H >–COOR > – COCl

b. –COOH > – COOR> –SO₃H >– COCl

c. –SO₃H>–COOH>–COOR > – COCl

d. – COCl >– COOR>–COOH>–SO₃H

A

36. If a liquid has very high boiling point or decomposes at or below its b.p., is purified by using:

a. steam distillation

b. reduced pressure distillation
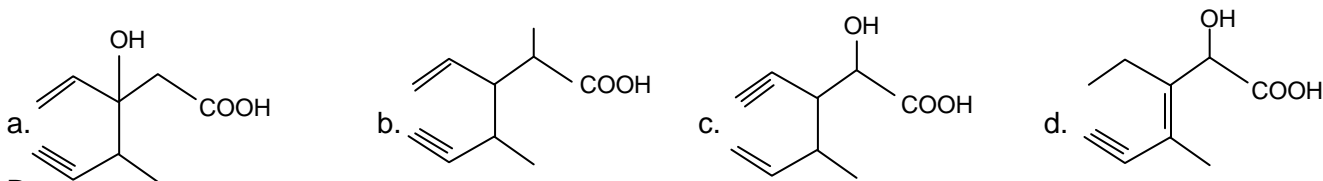
c. fractional distillation

d. None of these

B

37. IUPAC name of compound, (cyclopropyl–C(=O)–N(CH₃)CH₃) is :

a. N, N – Dimethylcyclopropane carboxamide

b. N – methylcyclopropanamide

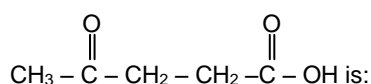c. Cyclopropionamide

d. Cyclopropyl-N,N-dimethyl-methanamide

A

Sol. –CONH₂ group is the main group.

38. The structure of the compound whose IUPAC name is
3–Ethyl–2–hydroxyl–4–methylhex–3–en–5–ynoic acid, is:

a. (structure with OH, COOH, vinyl, alkyne, methyl)
b. (structure with vinyl, COOH, methyl, alkyne)
c. (structure with OH, COOH, alkyne, vinyl, methyl)
d. (structure with OH, COOH, ethyl, alkyne, methyl)

D

39. The IUPAC name for

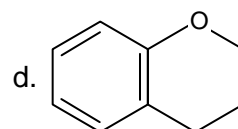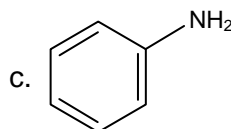$$CH_3-\overset{O}{\overset{\|}{C}}-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-OH \text{ is:}$$

a. 1 – hydroxypentane – 1, 4 – dione

b. 1, 4 – dioxopentanol

c. 1 – carboxybutan – 3 – one

d. 4 – oxopentanoic acid

D

Sol. $\overset{5}{H_3C}-\overset{4}{\overset{O}{\overset{\|}{C}}}-\overset{3}{CH_2}-\overset{2}{CH_2}-\overset{1}{\overset{O}{\overset{\|}{C}}}-OH$
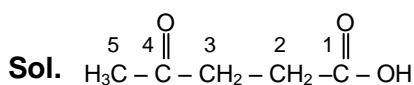
40. Which of the following compound is Heterocyclic and aromatic.

a. (pyridine)
b. (pyrrolidine)
c. (aniline, NH₂)
d. (chromane, O)
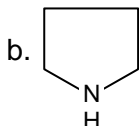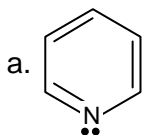
A

SECTION – B (Assertion & Reason) Negative Marking [-1]

This Section contains **6 questions.** Each question has four choices A), B), C) and D) out of which **ONLY ONE** is correct. **6 × 4 = 24 Marks**

(A) Statement –1 is true, Statement–2 is true, Statement–2 is a correct explanation for Statement – 1
(B) Statement –1 is true, Statement–2 is true, Statement–2 is not a correct explanation for Statement–1
(C) Statement – 1 is true, Statement – 2 is false
(D) Statement – 1 is false, Statement – 2 is true

1. **Statement – 1:** Cyclocta-1,3,5,7-tetraene is non-aromatic compound
   Statement – 2: It is nonplaner molecule having Tub-shape.

   a. (A)   b. (B)   c. (C)   d. (D)
   A

2. **Statement – 1:** Due to adiabatic free expansion temperature of real gas may increase
   Statement – 2: In adiabatic free expansion, temperature is always constant irrespective of real or ideal gas

   a. (A)   b. (B)   c. (C)   d. (D)
   C

3. **Statement – 1**: The heat absorbed during the isothermal expansion of an ideal gas against vacuum is zero.
   Statement – 2: The volume occupied by the molecules of an ideal gas is negligible

   a. (A)   b. (B)   c. (C)   d. (D)
   A

4. **Statement – 1:** ΔH and ΔE are the same for the reaction, $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$,
   Statement – 2: All reactants and products are gases with $\Delta ng = 0$.

   a. (A)   b. (B)   c. (C)   d. (D)
   A

5. **Statement – 1:** Enthalpy and entropy of any elementary substance in the standard states are taken as zero.
   Statement – 2: At absolute zero, particles of the perfectly crystalline substance become completely motionless.

   a. (A)   b. (B)   c. (C)   d. (D)
   D

6. **Statement – 1**: Internal energy change in a cyclic process is always +ve (i.e., >0).
   Statement – 2: Internal energy is a state function.

   a. (A)   b. (B)   c. (C)   d. (D)
   D
Sol. Correct Statement -1: Internal energy change in a cyclic process is always zero.

SECTION – C (Paragraph Type) Negative Marking [-1]

This Section contains **2 paragraphs.** Each of these questions has four choices A), B), C) and D) out of which **ONLY ONE** is correct. **5 × 4 = 20 Marks**

Passage – 1

Given at 25°C,

ΔH_f^0 HF(aq) = -320.1 kJ/mol

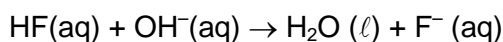ΔH_f^0 OH⁻(aq) = -229.6 kJ/mol

ΔH_f^0 F⁻ (aq) = -329.1 kJ/mol

ΔH_f^0 H₂O (ℓ) = -285.8 kJ/mol

1. Calculate the standard enthalpy of neutralization of HF(aq) by NaOH (aq).

    a. -57.1 kJ   b. -65.2 kJ   c. +57.1 kJ   d. -60.2 kJ

B

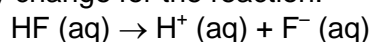**Sol.** The reaction for the neutralisation of HF by NaOH is

HF(aq) + OH⁻(aq) → H₂O (ℓ) + F⁻ (aq)

∴ $\Delta H° = [\Delta H_f^0 H_2O (\ell) + \Delta H_f^0 F^- (aq)] - [\Delta H_f^0 HF(aq) + \Delta H_f^0 OH^-(aq)]$

$\Delta H° = [-285.8 + (-329.1)] - [-320.1 + (-229.6)]$
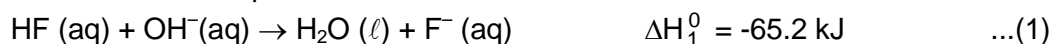
$= -614.9 - (-549.7)$

$\Delta H° = -65.2$ kJ

2. If the enthalpy change for the formation of H₂O (ℓ) from its aqueous ion is -57.1 kJ, calculate the enthalpy change for the reaction:
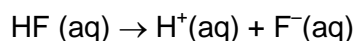
HF (aq) → H⁺ (aq) + F⁻ (aq)

    a. 65.2 kJ   b. 10 kJ   c. -8.1 kJ   d. +8.1 kJ

C

Sol. The ionization of HF into H⁺ and F⁻ can be expressed in terms of ΔH_{neut}^0 of HF and OH⁻ and $\Delta H°$ formation of H₂O from its aqueous ions

HF (aq) + OH⁻(aq) → H₂O (ℓ) + F⁻ (aq) ΔH_1^0 = -65.2 kJ   ...(1)

H⁺(aq) + OH⁻(aq) → H₂O (ℓ) ΔH_2^0 = -57.1 kJ   ...(2)

Reverse equation (2) + equation (1) gives

HF (aq) → H⁺(aq) + F⁻(aq) $\boxed{\Delta H° = -\Delta H_2^0 + \Delta H_1^0}$

                                                     $= +57.1 - 65.2$

                                                     $= -8.1$ kJ

Passage – 2

The entropies of methyl chloride and hydrogen are plotted as a function of temperature from 0K to 300K. Data are for molar quantities. The phase present at various temperature are noted. The first vertical line segment on each graph represents fusion (s) + (ℓ) the second represents vaporization (ℓ) + (g).
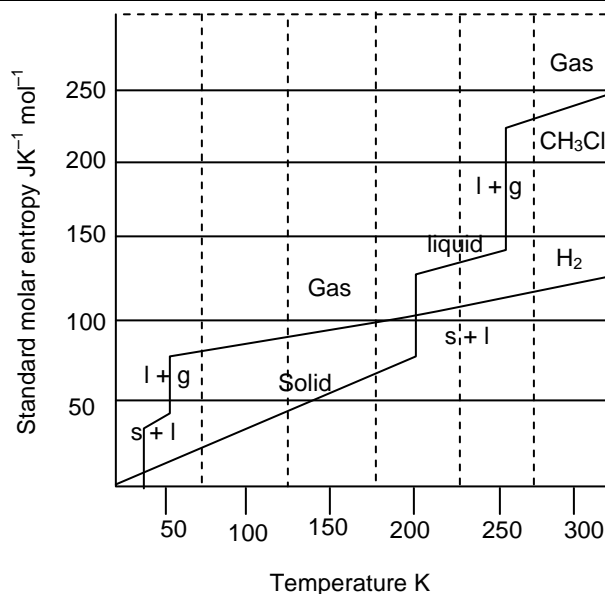
3. The entropy of methyl chloride is more than hydrogen due to:

a. molecular mass of CH_3Cl is more than H_2
b. H_2 has more vibrational mode than CH_3Cl
c. CH_3Cl has more vibrational mode than H_2
d. None of these
C

Sol. It is clear from the plot that at low temperatures entropy of hydrogen is higher than methyl chloride. As temperature decreases vibrations decrease. It follows that the higher entropy of CH_3Cl is due to vibrational modes.

4. Which of the following character of entropy is not correct?

a. It is an extensive property
b. It is an intensive property
c. It depends on molecularity of compound
d. It depend on temperature
B

Sol. Entropy is an extensive property since it depends on number of moles of the compounds.

5. The boiling point of CH_3Cl on the basis of entropy graph is:

a. 175 K   b. 300 K   c. 250 K   d. 200 K
C

Sol. Boiling point is the temperature when liquid changes to vapour.

SECTION – D (More than One Answer Type) No Negative Marking

This Section contains **6 multiple choice questions.** Each question has four choices A), B), C) and D) out of which **MORE THAN ONE ANSWER** is correct. **6 × 5 = 30 Marks**

1. Predict in which of the following, entropy increases/decreases:

(a) A liquid crystallizes into a solid
(b) Temperature of a crystalline solid is raised from 0 K to 115 K
(c) $2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$
(d) $H_2(g) \longrightarrow 2H(g)$
A,B,C,D

2. Identify the extensive quantities from the following :

a. Gibb's energy   b. Entropy   c. Refractive index   d. Specific heat
A,B

3. Which is true about entropy?

a. $\Delta S = \dfrac{\Delta q_{rev}}{T}$ b. $\Delta S = \dfrac{\Delta q_{irr}}{T}$ c. $\Delta S \neq \dfrac{\Delta q_{irr}}{T}$ d. $\Delta S^{\circ}_{fusion} = \dfrac{\Delta H^{\circ}_{fusion}}{B.pt.}$

A,B

4. The enthalpy change for the process
C (graphite) $\longrightarrow$ C(g) is called

a. heat of vaporization   b. heat of sublimation
c. heat of allotropic change   d. heat of atomisation
B,C,D

Sol. C(s) $\longrightarrow$ C(g). The process is sublimation as well conversion of crystalline allotropic form (graphite) to amorphous form (gas carbon). Hence (b) (c) and (d) are correct.

5. The normal boiling point of a liquid 'X' is 400 K. Which of the following statement is true about the process $X(\ell) \longrightarrow X(g)$?

a. at 400 K and 1 atm pressure $\Delta G = 0$ b. at 400 K and 2 atm pressure $\Delta G = +$ ve
c. at 400 K and 0.1 atm pressure $\Delta G = $ -ve   d. at 410 K and 1 atm pressure $\Delta G = +$ ve
A,B,C

Sol. At 2 atm, normal boiling point will be increased & more than 400 K.

6. Using Huckel rule, predict which of the following hydrocarbons will exhibit aromatic stabilisation:

a.   b.   c.   d.

A,C

SECTION – E (Matrix Type) No Negative Marking

This Section contains **2 questions.** Each question has four choices (A, B, C and D) given in **Column I** and five statements (p, q, r, and s) in **Column II.** Any given statement in **Column I** can have correct matching with one or more statement(s) given in **Column II.**   **2 × 8 = 16 Marks**

1. Match Column – I with Column – II.

	Column I		Column II
(A)	$\Delta H = +$ve, $\Delta S = +$ve	(p)	Spontaneous at all temperature
(B)	$\Delta H = +$ve, $\Delta S = -$ve	(q)	Spontaneous at low temperature
(c)	$\Delta H = -$ve, $\Delta S = +$ve	(r)	Non-spontaneous at low temperature
(d)	$\Delta H = -$ve, $\Delta S = -$ve	(s)	Non-spontaneous at high temperature
		(t)	Non-spontaneous at any temperature

Sol. A = r; B = t may be r, s; C = p may q; D = q, s

$\Delta G = \Delta H - T\Delta S$. for spontaneity ΔG is –ve and for non – spontaneity, ΔG is +ve.

(A) $\Delta H = +$ve, $\Delta S = +$ve
At low T, $\Delta G = +$ve (non – spontaneous)
At high T, $\Delta G = $ -ve (spontaneous)
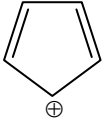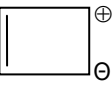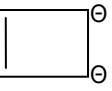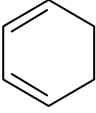(B) $\Delta H = +$ve, $\Delta S = -$ve ,
ΔG will be always – ve and hence spontaneous at all temperatures.

(D) ΔH = -ve, ΔS = - ve

At low T, ΔG = +ve (Spontaneous)

At high, T, ΔG = +ve (Non – spontaneous)

2. Match the following **(One or more than one match)**

	Column – I		Column – II
(A)		(P)	Aromatic
(B)		(Q)	Non-aromatic
(C)		(R)	Anti aromatic
(D)		(S)	4n π electrons

Sol. A $\rightarrow$ r,s; B $\rightarrow$ r,s; C $\rightarrow$ p; D $\rightarrow$ q,s

SECTION – F (Integer Type) No Negative Marking

This Section contains **6 Questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 10. **6 × 5 = 30 Marks**

1. Temperature of one mole of helium gas is increased by 1°C, find the increase in internal energy in cal.

Sol. 3

$\Delta E = \dfrac{3}{2} nR\Delta T = \dfrac{3}{2} \times 1 \times 2 \times 1 = 3$

2. An ideal gas is taken through the cycle A $\rightarrow$ B $\rightarrow$ C $\rightarrow$ A as shown in figure. If net heat supplied to the gas in the cycle is 5 J. Find the work done in the cyclic process in Joule.
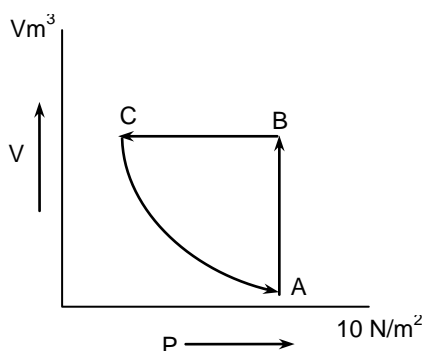
Sol. 5

3. The enthalpy change involved in the oxidation of glucose is – 2880 kJ mol^{-1}. Twenty five percent of this energy is available for muscular work. If 100 kJ of muscular work is needed to walk one kilometre, what is the maximum distance that a person will be able to walk after eating 125 g of glucose?

Sol. 5 km

Energy available for muscular work = $\dfrac{2880 \times 25}{100}$ = 720 kJ/mol

$\therefore$ Energy available for muscular work from 125 gm glucose = $\dfrac{720}{180} \times 125$ = 500 KJ

$\therefore$ Distance travelled = $\dfrac{500}{100}$ = 5KM

4. Heat of neutralization between HCl and NaOH is – 13.7 k cal. If heat of neutralization between CH_3COOH and NaOH is - 11.7 kcal. Calculate heat of ionization of CH_3COOH.

Sol. 2

Q = 13.7 – 11.7 = 2

5. A gas occupies 2 litres at STP. It is provided 58.63 joule heat so that its volume becomes 2.5 litre at 1 atm. Calculate change in internal energy in Joules.

Sol. 8 Joule

Work done = - P × dV = 1 × (2.5 – 2.0)

= -0.5 litre – atm   or   1 lit atm = 101.3 J

$= -\dfrac{0.5 \times 1.987 \times 4.184}{0.0821}$ = joule = -50.63 J

∵ Work is carried out at constant P and thus irreversible.

From 1st law of thermodynamics

∵   q = ΔU – W

58.63 = Δu + 50.63

$\therefore$ ΔU = 8 joule

6. What is the value of n in Huckel's rule when a compound has 9 pairs of π electrons?

Sol. 4

4n + 2π i.e. n = 4;   18πe^-