Master JEE CLASSES
Kukatpally, Hyderabad.

IIT-JEE-MAINS PAPER-4 Max.Marks:360

IMPORTANT INSTRUCTIONS:

1) Immediately fill in the particulars on this page of the Test Booklet with Blue/Black Ball Point Pen. Use of pencil is strictly prohibited.
2) The test is of 3 hours duration.
3) The Test Booklet consists of 90 questions. The maximum marks are 360.
4) There are three parts in the question paper A, B, C consisting of **Mathematics, Chemistry** and **Physics** having 30 questions in each part of equal weight age. Each question is allotted 4 (four) marks for correct response.
5) Candidates will be awarded marks as stated above in instruction No. 4 for correct response of each question. (1/4) (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
6) There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 5 above.

SYLLABUS

MATHS:

Transformation formulae, Conditional Identities, Graphs of Trigonometric Functions, Periodicity and extreme values (30%); Trigonometric Equations (70%)

CHEMISTRY:

Enthalpy of reaction - different types of enthalpies, Hess's law, Effect of temperature on enthalpy of reaction - Kirchhoff's equation, Hess's law and its applications, Determination of enthalpy of hydration of CuSO4, Resonance energy, Limitations of first law of thermodynamics; Second law of Thermodynamics; Carnot cycle, efficiency of thermodynamic system ,Entropy - physical significance, expressions in all types of processes ,Gibb's free energy - physical significance, spontaneity of processes(70%) Thermodynamics: Terms involved in thermodynamics - System & Surrounding, Extensive and Intensive Properties, Path and State function, types of processes, First law of thermodynamics , Reversible and irreversible processes; Work - expressions for reversible, irreversible isothermal and adiabatic processes, Heat and Heat capacity, Thermo chemistry: Enthalpy(30%)

PHYSICS:

Non - uniform accelerated motion in 1D & related graphs, Motion in 2D, Projectile motion (Excluding projection on inclined planes) (70%)

Kinematics: Motion in 1D, Uniform motion, uniform accelerated motion, motion under gravity and related graphs (30%)
Cumulative syllabus covered till now (10%)

MATHS

1. If $\sin(\sin x+\cos x)=\cos(\cos x-\sin x)$ then the largest possible value of $\sin x$ is

1) $\frac{1}{\sqrt{2}}$ 2) 1

3) $\frac{\sqrt{16-\pi^2}}{4}$ 4) $\frac{\pi}{4}$

2. Sum of the common solutions of the simultaneous equations

$$\left.\begin{array}{l}\cos 2x+\sin 2x=\cot x\\ 2\cos^2 x+\cos^2 2x=1\end{array}\right\},x\in[-\pi,\pi]$$

1) $\frac{\pi}{2}$ 2) 0

3) π 4) $\frac{3\pi}{2}$

3. No of solutions of

$\sin x+\sin y=\sin(x+y)$ *and* $|x|+|y|=1$

1) 2 2) 4

3) 6 4) 0

4. The number of values of y in $[-2\pi,2\pi]$ satisfying the equations $|\sin 2x|+|\cos 2x|=|\sin y|$ is

1) 1 2) 2

3) 3 4) 4

5. Total no of solutions of the equation, $f(x)=Max\{\sin x,\cos x\}=\frac{1}{2}$ in $x\in(-2\pi,5\pi)$

1) 3 2) 5

3) 7 4) 9

6. The total number of values of x in $(-2\pi,2\pi)$ satisfying $\log_{|\cos x|}|\sin x|+\log_{|\sin x|}|\cos x|=2$

1) 2 2) 4

3) 6 4) 8

7. If $Tan(A-B)=1$, and $Sec(A+B)=\frac{+2}{\sqrt{3}}$, and A and B are the smallest positive values satisfying both the equations A+B=

1) $\frac{11\pi}{6}$ 2) $\frac{13\pi}{6}$

3) $\frac{17\pi}{6}$ 4) $\frac{3\pi}{6}$

8. Number of solutions of $\cos(sinx)=\sin(\cos x)$, $x\in[-2\pi,2\pi]$

1) 0 2) 2

3) 1 4) 4

9. The smallest positive values of x and y satisfying $x-y=\frac{\pi}{4}, \cot x+\cot y=2$

1) $\frac{5\pi}{12},\frac{\pi}{6}$ 2) $\frac{7\pi}{12},\frac{\pi}{3}$

3) $\frac{9\pi}{7},\frac{\pi}{4}$ 4) $\frac{5\pi}{12},\frac{\pi}{4}$

10. The number of real solutions of the equation $\sin(e^x).\cos(e^x)=2^{x-2}+2^{-x-2}$

1) 0 2) 1

3) 2 4) infinite

11. The number of points of intersection of the $y=\cos x, y=\sin 3x$ in $-\frac{\pi}{2}\le x\le\frac{\pi}{2}$

1) 3 2) 4

3) 5 4) 6

12. The smallest positive root of the equation $\sqrt{\sin(1-x)}=\sqrt{\cos x}$ is

1) $\frac{1}{2}+\frac{7\pi}{4}$ 2) $\frac{1}{2}+\frac{3\pi}{4}$

3) $\frac{3}{4}+\frac{\pi}{4}$ 4) $\frac{1}{2}+\frac{5\pi}{4}$

13. $(0,2\pi)$, the equation $Sec\theta+Co\sec\theta=C$ has x_1 solutions if $C^2<8$ and has x_2 solutions if $C^2>8$, the ordered pair (x_1,x_2) is

1) (4,2) 2) (2,4)

3) (3,3) 4) (3,5)

14. If $x\in(0,2\pi)$ *and* $y\in(\pi,2\pi)$, the number of solutions of the system of equations $|\sin x|\sin y=-\frac{1}{4}, \cos(x+y)+\cos(x-y)=\frac{3}{2}$

1) 3 2) 4

3) 5 4) 6

15. If $\sin x+\cos x+\tan x+\cot x+\sec x+\cos ecx=7$ and $\sin 2x=a-b\sqrt{7}$, then the ordered pair (a,b) can be

1) (6,2) 2) (8,3)

3) (22,8) 4) (11,4)

16. The number of solutions of the equation $Tan^2x-Sec^{10}x+1=0$ in (0,10) is

1) 3 2) 6

3) 10 4) 0

17. If [ ] denotes the greatest integer function then number of solutions of $\sin x=[1+\sin x]+[1-\cos x]$ in $[-2\pi,2\pi]$ is

1) 0 2) 1

3) 2 4) 4

18. The number of solutions of

$\theta \in (-\frac{\pi}{2}, \frac{\pi}{2})$ satisfying

$(\sqrt{3})^{\sec^2\theta} = \tan^4\theta + 2\tan^2\theta$ is

1) 4 2) 2

3) 1 4) 3

19. $\frac{\sec^4\theta}{a} + \frac{\tan^4\theta}{b} = \frac{1}{a+b}$,then

1) $|b| < |a|$ 2) $|a| = |b|$

3) $|b| > |a|$ 4) $\left|\frac{b}{a}\right| = 2$

20. If $[\sin x] + [\sqrt{2}\cos x] = -3, x \in [0, 2\pi]$

where [ ] is the greatest integer function ,then $x \in$

1) $\left[\frac{5\pi}{4}, 2\pi\right]$ 2) $\left(\frac{5\pi}{4}, 2\pi\right)$

3) $\left(\pi, \frac{5\pi}{4}\right)$ 4) $\left[\pi, \frac{5\pi}{4}\right]$

21. T he number of solutions in $x \in [0, 2\pi]$ for which

$[\sin x + \cos x] = 3 + [-\sin x] + [-\cos x]$

([ ] is greatest integer function)

1) 0 2) 4

3) infinite 4) 1

22. If $a\cos^2 3\alpha + b\cos^4\alpha = 16\cos^6\alpha + 9\cos^2\alpha$ is identity, then

1) $a = 1, b = 24$ 2) $a = 3, b = 24$

3) $a = 4, b = 2$ 4) $a = 7, b = 18$

23. If

$f(x) = \sin^2 x + \sin^2\left(x + \frac{\pi}{3}\right) + \cos x \cos\left(x + \frac{\pi}{3}\right)$

and $g\left(\frac{5}{4}\right) = 1$, then $gof\left(\frac{\pi}{8}\right) =$

1) $\frac{5}{4}$ 2) 1

3) 2 4) π

24. If

$u_n = \sin n\theta \sec^n\theta, v_n = \cos n\theta \sec^n\theta \neq 1$

then $\frac{v_n - v_{n-1}}{u_{n-1}} + \frac{1}{n}\frac{u_n}{v_n}$ is equal to

1) 0 2) $\tan\theta$

3) $-\tan\theta + \frac{\tan n\theta}{n}$ 4) $\tan\theta + \frac{\tan n\theta}{n}$

25. If $K_1 = \tan 27\theta - \tan\theta$ and

$K_2 = \frac{\sin\theta}{\cos 3\theta} + \frac{\sin 3\theta}{\cos 9\theta} + \frac{\sin 9\theta}{\cos 27\theta}$, then

1) $K_1 = 2K_2$ 2) $K_1 = K_2 + 4$

3) $K_1 = K_2$ 4) None of these

26. If $\alpha, \beta, \gamma, \delta$ are the smallest positive angles in ascending order of magnitude which

have their sines equal to the positive quantity k, then the value of $4\sin\frac{\alpha}{2}+3\sin\frac{\beta}{2}+2\sin\frac{\gamma}{2}+\sin\frac{\delta}{2}$ is equal to

1) $2\sqrt{1-k}$ 2) $2\sqrt{1+k}$

3) $2\sqrt{k}$ 4) None of these

27. If $\tan\alpha=\frac{x^2-x}{x^2-x+1}$ and $\tan\beta=\frac{1}{2x^2-2x+1}, 0<\alpha,\beta<\frac{\pi}{2}$ then $\alpha+\beta$

1) $\frac{\pi}{4}$ 2) $\frac{\pi}{2}$

3) $\frac{\pi}{3}$ 4) $\frac{3\pi}{4}$

28. The value of $\sin\frac{2\pi}{7}+\sin\frac{4\pi}{7}+\sin\frac{8\pi}{7}$ is

1) 1 2) $\frac{\sqrt{7}}{2}$

3) $\frac{3\sqrt{3}}{4}$ 4) $\frac{\sqrt{15}}{4}$

29. If $a_1\cos\alpha_1+a_2\cos\alpha_2+.....+a_n\cos\alpha_n=0$ and $\begin{matrix}a_1\cos(\alpha_1+\theta)+a_2\cos(\alpha_2+\theta)\\+...a_n\cos(\alpha_n+\theta)=0(\theta\neq k\pi)\end{matrix}$, then

$a_1\cos(\alpha_1+\lambda)+a_2\cos(\alpha_2+\lambda)+...+a_n\cos(\alpha_n+\lambda)=$

1) 0 2) λ

3) $\theta+\lambda$ 4) $\theta-\lambda$

30. If the mapping $f(x)=ax+b, a<0$ maps $[-1,1]$ onto $[0,2]$, then for all values of $\theta, A=\cos^2\theta+\sin^4\theta$ is such that

1) $f\left(\frac{1}{4}\right)\leq A\leq f(0)$

2) $f(0)\leq A\leq f(-2)$

3) $f\left(\frac{1}{3}\right)\leq A\leq f(0)$

4) $f(-1)<A\leq f(-2)$

CHEMISTRY

31. Assuming that water vapour is an ideal gas, the internal energy (ΔU) when 1 mol of water is vapourized at 1 bar pressure and $100^0 C$. (Given: Molar enthalpy of vapourization of water at 1 bar and $373K = 41 kJ\, mol^{-1}$ and $R = 8.3 J\, mol^{-1} K^{-1}$) will be

1) $4.1 kJ\, mol^{-1}$ 2) $3.7904 kJ\, mol^{-1}$

3) $37.904 kJ\, mol^{-1}$ 4) $41.0 kJ\, mol^{-1}$

32. Oxidizing power of chlorine in aqueous solution can be determined by the parameters indicated below:

$$\frac{1}{2}Cl_2(g) \xrightarrow{\frac{1}{2}\Delta_{diss}H^0} Cl(g) \xrightarrow{\Delta_{eg}H^0} Cl^-(g) \xrightarrow{\Delta_{hyd}H^0} Cl^-(aq).$$

The energy involved in the conversion of $\frac{1}{2}Cl_2(g)$ to $Cl^-(g)$ (using the data, $\Delta_{diss}H^0(Cl_2) = 240 kJ\, mol^{-1}$, $\Delta_{eg}H^0(Cl) = -349 kJ\, mol^{-1} \Delta_{hyd}H^0(Cl) = -381 kJ\, mol^{-1}$)

1) $+152 kJ\, mol^{-1}$ 2) $-610 kJ\, mol^{-1}$

3) $-850 kJ\, mol^{-1}$ 4) $+120 kJ\, mol^{-1}$

33. The standard enthalpy of formation of NH_3 is $-46.0 kJ\, mol^{-1}$. If the enthalpy of formation of H_2 from its atoms is $-436 kJ\, mol^{-1}$ and that of N_2 is $-712 kJ\, mol^{-1}$, the average bond enthalpy of N-H bond in NH_3 is

1) $-1102 kJ\, mol^{-1}$ 2) $-964 kJ\, mol^{-1}$

3) $+352 kJ\, mol^{-1}$ 4) $+1056 kJ\, mol^{-1}$

34. The lattice energy of NaCl is $-780 kJ\, mol^{-1}$. The enthalpies of hydration of $Na^+(g)$ and $Cl^-(g)$ ions are $-406 kJ\, mol^{-1}$ and $-364 kJ\, mol^{-1}$ respectively. The enthalpy of solution of NaCl(s) in water is

1) $738 kJ\, mol^{-1}$ 2) $10 kJ\, mol^{-1}$

3) $-10 kJ\, mol^{-1}$ 4) $-822 kJ\, mol^{-1}$

35. The entropy change involved in the isothermal reversible expansion of 2 mol of an ideal gas from a volume of $10 dm^3$ to a volume of 100 dm^3 at $27^0 C$ is

1) $35.8 J\, mol^{-1} K^{-1}$ 2) $32.3 J\, mol^{-1} K^{-1}$

3) $42.3 J\, mol^{-1} K^{-1}$ 4) $38.3 J\, mol^{-1} K^{-1}$

36. Standard entropies of X_2, Y_2 and XY_3 are 60, 40 and $50\,JK^{-1}mol^{-1}$, respectively. For the reaction, $\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightarrow XY_3; \Delta H = -30\,kJ$ to be at equilibrium, the temperature will be

1) 1250 K
2) 500 K
3) 750 K
4) 1000 K

37. What is the sign of ΔG for the process of melting of ice at 280 K?

1) $\Delta G > 0$
2) $\Delta G = 0$
3) $\Delta G < 0$
4) None of these

38. For a reversible isothermal expansion of an ideal gas

1) $\Delta S_{sys} = \Delta S_{surr} = positive$
2) $\Delta S_{sys} = -\Delta S_{surr}$
3) $\Delta S_{sys} = \Delta S_{surr} = negative$
4) $\Delta S_{sys} = \Delta S_{surr} = 0$

39. Among mass, volume, density and specific volume of a gas, the intensive properties are

1) density and specific volume
2) volume and density
3) specific volume and mass
4) density only

40. Which one of the following statements is false?

1) Work is a state function
2) Temperature is a state function
3) Work appears at the boundary of the system
4) Change in the state is completely defined when the initial and final states are specified.

41. Calculate the work, in joules, done by a gas as it expands at constant temperature from a volume of 3.00 L and a pressure of 5.00 atm to a volume of 8.00 L. The external pressure against which the gas expands is 1.00 atm. (1 atm = 101,325 pa.)

1) $-405J$
2) $-532J$
3) $-458J$
4) $-507J$

42. Which one of the following equations does not correctly represent the first law of thermodynamics for the given process?

1) Isothermal process: q = - w
2) Cyclic process: q = - w
3) Isochoric process: $\Delta U = q$
4) Adiabatic process: $\Delta U = -w$

43. The enthalpy of neutralization of HCl by NaOH is $-55.9\,kJ\,mol^{-1}$. If the enthalpy of neutralization of HCN by NaOH is $-12.1\,kJ\,mol^{-1}$, the enthalpy of dissociation of HCN is

1) 43.8 kJ 2) -43.8 kJ

3) 68 kJ 4) -68 kJ

44. In a fuel cell, methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is

$CH_3OH(l)+\frac{3}{2}O_2(g)\rightarrow CO_2(g)+2H_2O(l)$. At 298K, standard Gibbs energies of formation for $CH_3OH(l), H_2O(l)\,and\,CO_2(g)$ are $-166.2\,kJ\,mol^{-1}, -237.2\,kJ\,mol^{-1}$ and $-394.4\,kJ\,mol^{-1}$, respectively. If the standard enthalpy of combustion of methanol is $-726\,kJ\,mol^{-1}$, efficiency of the fuel cell will be

1) 90% 2) 97%

3) 80% 4) 87%

45. For which change $\Delta H \neq \Delta U$?

1) $H_2(g)+I_2(g)\rightleftharpoons 2HI(g)$

2) $HCl(aq)+NaOH(aq)\rightarrow NaCl(aq)+H_2O(l)$

3) $C(s)+O_2(g)\rightleftharpoons 2CO_2(g)$

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

46. If water kept in an insulated vessel at -10^0C suddenly freezes, the entropy change of the system

1) decreases

2) increases

3) is zero

4) equals to that of the surroundings

47. Estimate the average $S-F$ bond energy in SF_6. The standard heat of formation values of $SF_{6(g)}, S_{(g)}\,and\,F_{(g)}$ are: - 1100, 275 and 80 kJ mol^{-1} respectively.

1) 309.17 kJ 2) 212.5 kJ

3) 126.2 kJ 4) 182.5 kJ

48. When one mole anhydrous $CuSO_4$ is dissolved in excess of water, $-66.4\,kJ$ heat is evolved. When one mole of $CuSO_4.5H_2O$ is dissolved in water, the

heat change is +11.7 kJ. Calculate enthalpy of hydration of $CuSO_{4(anh.)}$.

1) -87.1 kJ 2) -78.1 kJ

3) -44.2 kJ 4) -28.1 kJ

49. ΔH_f^0 values (i.e., enthalpy of formation) for O_3, CaO, NH_3 and HI are $34.01, -151.9, -11.0$ and $+6.20\, kcal\, mol^{-1}$ respectively. Arrange these in decreasing order of stability with respect to thermal decomposition.

1) $CaO > HI > NH_3 > O_3$

2) $NH_3 > HI > CaO > O_3$

3) $CaO > NH_3 > HI > O_3$

4) $CaO > HI > O_3 > NH_3$

50. Calculate the free energy change when 1 mole of NaCl is dissolved in water at $25^0 C$. Lattice energy of NaCl = 777.8 kJ mol^{-1}; ΔS for dissolution $= 0.043\, kJ\, mol^{-1}$ and hydration energy of $NaCl = -774.1\, kJ\, mol^{-1}$

1) $-9.114\, kJ\, mol^{-1}$ 2) $-91.14\, kJ\, mol^{-1}$

3) $-911.4\, kJ\, mol^{-1}$ 4) $-0.9114\, kJ\, mol^{-1}$

51. Calculate the work done when 156g potassium reacts with water in an open container of water at $300\, K$.

1) -2866.5 J 2) -4988.4 J

3) -1234.6 J 4) -862.5 J

52. The enthalpy change for a reaction does not depend upon

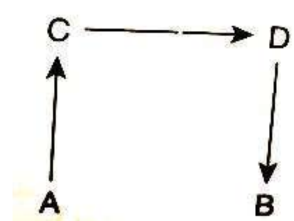
1) the physical states of reactants and products

2) use of different reactants for the same product

3) the nature of intermediate reaction steps

4) the differences in initial or final temperatures of involved substances

53. The direct conversion of A to B is difficult; hence it is carried out by the following shown path.



Given

$\Delta S_{(A\to C)} = 50\,eu$

$\Delta S_{(C\to D)} = 30\,eu$

$\Delta S_{(B\to D)} = 20\,eu$

Where eu is entropy unit, then $\Delta S_{(A\to B)}$ is

1) $+100\,eu$ 2) $+60\,eu$

3) $-100\,eu$ 4) $-60\,eu$

54. For a reaction at equilibrium,

1) $\Delta G = \Delta G^0 = 0$

2) $\Delta G = 0$ but not ΔG^0

3) $\Delta G^0 = 0$ but not ΔG

4) $\Delta G = \Delta G^0 \neq 0$

55. Standard molar enthalpy of formation of CO_2 is equal to

1) zero

2) the standard molar enthalpy of combustion of gaseous carbon

3) the sum of standard molar enthalpies of formation of CO and O_2

4) the standard molar enthalpy of combustion of carbon (graphite).

56. Boiling water in a closed steel tank is an example of

1) Closed system

2) Insulated system

3) Open system

4) Adiabatic system

57. In which of the following reactions the entropy change is positive?

1) $H_{2(g)} + \frac{1}{2}O_{2(g)} \to H_2O_{(l)}$

2) $Na^+_{(g)} + Cl^-_{(g)} \to NaCl_{(s)}$

3) $NaCl_{(g)} \to NaCl_{(s)}$

4) $H_2O_{(l)} \to H_2O_{(g)}$

58. Which of the following process is non-spontaneous

1) Heat flow from hot end to cold end

2) Water flow from higher level to lower level

3) Gas flow from lower pressure region to higher pressure region

4) Gas flow from higher pressure region to lower pressure region

59. Human body requires 2370 K. cal of energy daily. If the heat of combustion of glucose is $790 K.cal/mole$ the amount of glucose required for daily consumption is

1) 650 g 2) 540 g

3) 327 g 4) 490 g

60. In an insulated container 1 mole of a liquid. Molar volume 100 ml at 1 bar. Liquid is steeply taken to 100 bar, when volume of liquid decreases by 1 ml. Find ΔH for the process.

1) 7900 bar mL 2) 8900 bar Ml

3) 9900 bar mL 4) 10900 bar mL

PHYSICS

61. A stone is dropped from a hill of height 180m. Two seconds later another a stone is dropped from a point P below the top of the hill. If the two stones reach the ground simultaneously, the height of P from the ground is ($g = 10\ ms^{-2}$)

1) 100 m 2) 90 m

3) 80 m 4) none of these

62. Water drops fall from the roof of a building 20m high at regular time interval. If the first drop strikes the floor when the sixth drop begins the fall, the height of the second drop from the ground at that instant is ($g = 10\ ms^{-2}$)

1) 3.2 m 2) 0.8 m

3) 7.2 m 4) none of these

63. A body freely falling from a height h describes 11h/36 in the last second of its fall. The height h is ($g = 10ms^{-2}$)

1) 125 m 2) 180 m

3) 360 m 4) none of these

64. A ball dropped from a point P crosses a point Q in t seconds. The time taken by it to travel from Q to R, if PQ = QR

1) t 2) $\sqrt{2}$ t

3) 2t 4) ($\sqrt{2}$-1)t

65. A boy throws a ball in air in such a manner that when a ball is at its maximum height he throws another ball. If the balls are thrown with the time difference 1 second, the maximum height attained by each ball is

1) 9.8 m 2) 19.6 m

3) 4.9 m 4) none of these

66. A body projected vertically up reaches a maximum height h in time t. The time taken to reach the half of the maximum height may be

1) t/2 2) t/4

3) $\frac{t}{\sqrt{2}}$ 4) $t\left[1-\frac{1}{\sqrt{2}}\right]$

67. A player kicks a football obliquely at a speed of 20 m/s so that its range is maximum. Another player at a distance of 24m away in the direction of the kick starts running at that instant to catch the ball. Before the ball hits the ground to catch it, the speed with which the second player has to run is (g = 10 m/s^2)

1) 4 ms^{-1} 2) $4\sqrt{2}$ ms^{-1}

3) 8 $\sqrt{\ }$ 2 ms^{-1} 4) none of these

68. From the top of a tower, a stone is thrown up and it reaches the ground in time t_1. A second stone is thrown down with the same speed and it reaches the ground in time t_2. A third stone is released from rest and it reaches the ground in time t_3

1) $t_3 = \frac{1}{2}(t_1 + t_2)$ 2) $t_3 = \sqrt{t_1 t_2}$

3) $\frac{1}{t_3} = \frac{1}{t_2} - \frac{1}{t_1}$ 4) $t_3^2 = t_1^2 - t_2^2$

69. A body starts with velocity V and moves on a straight path with constant acceleration. When its velocity becomes 5V the acceleration is reversed in direction without change in magnitude.

When it returns to the starting point, its velocity becomes

1) -7 V 2) -3 V

3) 7 V 4) -5 V

70. A train length 200 m switches on its headlight when it starts moving with acceleration $0.5\,m/s^2$. Sometime later, its tail light is switched on. An observer on the ground notices that the two events occur at the same place. The time interval between the two events is

1) $10\sqrt{2}\,s$ 2) $20\,s$

3) $20\sqrt{2}\,s$ 4) $40\,s$

71. The distance traveled by a body during last second of its upward journey is d when the body is projected with certain velocity vertically up. If the velocity of projection is doubled, the distance traveled by the body during last second of its upward journey is

1) 2d 2) 4d

3) d/2 4) d

72. A boy sees a ball go up and then down through a window 2.45 m high. If the total time that the ball in is sight is 1s, the height above the window the ball rises is approximately.

1) 2.45 m 2) 4.9 m

3) 0.3 m 4) 0.49 m

73. A ball thrown horizontally with velocity V from the top of a tower of height h reaches the ground in t seconds. If another ball of double the mass is thrown horizontally with velocity 3V from the top of another tower of height 4h it reaches the ground in (seconds)

1) 3t 2) t/2

3) 4t 4) 2t

74. A balloon starts rising from the ground with an acceleration of $1.25\,m/s^2$. After 8 s, a stone is released from the balloon. The stone will

1) Cover a distance of 40 m

2) have a displacement of 50 m

3) reach the ground in 4 s

4) begin to move down after being released.

75. A ball rolls of the top of a stair way with a horizontal velocity u m/s. If the steps are h metre high and b metres wide, the ball with hit the edge of the nth step, if

1) $n = 2hu / gb^2$

2) $n = 2hu^2 / gb^2$

3) $n = 2hu^2 / gb$

4) $n = hu^2 / gb^2$

76. A ball is thrown with velocity u making an angle θ with the horizontal. Its velocity vector is normal to initial velocity (u) vector after a time interval of

1) $\frac{u\sin\theta}{g}$ 2) $\frac{u}{g\cos\theta}$

3) $\frac{u}{g\sin\theta}$ 4) $\frac{u\cos\theta}{g}$

77. A projectile aimed at a mark which is in the horizontal plane through the point of projection falls "a" distance short of it when the elevation is α and goes "b" distance too far when the elevation is β. If the velocity of projection is same in all the cases, the proper elevation is

1) $\frac{1}{2}\sin^{-1}\left[\frac{a\sin 2\alpha - b\sin 2\beta}{a+b}\right]$

2) $\frac{1}{2}\sin^{-1}\left[\frac{a\sin 2\alpha + b\sin 2\beta}{a+b}\right]$.

3) $\frac{1}{2}\sin^{-1}\left[\frac{a\sin 2\alpha - b\sin 2\beta}{a-b}\right]$

4) $\frac{1}{2}\sin^{-1}\left[\frac{a\sin 2\alpha + b\sin 2\beta}{a-b}\right]$

78. Velocity of the body on reaching the ground is same in magnitude in the following cases

A) a body projected vertically from the top of tower of height 'h' with velocity 'V'

b) a body thrown downwards with velocity 'V' from the top of tower of height 'h'

c) a body projected horizontally with a velocity 'V' from the top of tower of height 'h'

d) a body dropped from the top tower of height 'h'

1) a, b, c & d are correct

2) a b & c are correct

3) a & d are correct

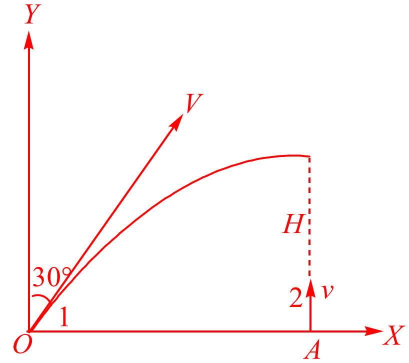
4) d only correct

79. A cannon ball has a horizontal range R on a horizontal plane. If h and h' are the greatest heights in the two paths for which this possible, then:

1) $R = 4\sqrt{(hh')}$ 2) $R = \frac{4h}{h'}$

3) $R = 4hh'$ 4) $R = \sqrt{hh'}$

80. A particle 1 is projected with speed V from a point O making an angle of $30°$ with the vertical. At the same instant, a second particle 2 is thrown vertically upwards from a point A. The two particles reach H, the highest point on the parabolic path of particle 1 simultaneously. What is the ratio of V / v?



1) $\frac{\sqrt{3}}{2}$ 2) $\frac{2}{\sqrt{3}}$

3) $\frac{5}{\sqrt{7}}$ 4) $\frac{7}{\sqrt{5}}$

81. A stone is dropped from a height of 10cm above the top of a window 80cm high. The time taken by the stone to cross the window is

1)1/7 s 2) 2/7 s

3) 3/7 s 4) 4/7 s

82. A projectile is thrown at an angle 30^{o} with a velocity of 10 m/s. The change in velocity during the time interval in which it reaches the highest point is

1) 10 m/s 2) 5 m/s

3) $5\sqrt{3}$ m/s 4) $10\sqrt{3}$ m/s

83. A body is projected with velocity V so that the maximum height is thrice the horizontal range. Then the maximum height is

1) $\frac{72V^2}{145g}$ 2) $\frac{6}{\sqrt{145}}\frac{V^2}{g}$

3) $\frac{V^2}{2g}$ 4) none of these

84. The range of a projectile, when launched at an angle of 15^o with the horizontal in 1.5km. The additional horizontal distance the projectile would cover when projected with same velocity at 45^o is

1) 3 km 2) 4.5 km

3) 1.5 km 4) 2.5 km

85. A boy aims a gun at a bird from a point, at a horizontal distance of 100 m. If the gun can impart a velocity of 500 m/sec to the bullet, at what height above the bird must he aim his gun in order to hit it?

(take $g = 10\,m/\sec^2$)

1) 100 cm 2) 50 cm

3) 40 cm 4) 20 cm

86. Let two bodies be projected horizontally in opposite directions with velocities u_1 and u_2 from certain height. The time instant from the start at which displacement vectors perpendicular to each other is

1) $\frac{2u_1u_2}{g}$ 2) $\frac{u_1u_2}{g}$

3) $\frac{2\sqrt{u_1u_2}}{g}$ 4) $\frac{\sqrt{u_1u_2}}{g}$

87. The horizontal and vertical displacement of a projectile are given by x = 12t and y = $16t - 5t^2$, all the quantities being measured in S.I system. The maximum height of the projectile is ($g = 10\ m/s^2$)

1) 25.6 m 2) 12.8 m

3) 64 m 4) none of these

88. A ball is projected from the bottom of a tower and is found to go above the tower and is caught by the thrower at the bottom of the tower after a time interval t_1. An observer at the top of the tower sees the same ball go up above him and

then come back it his level in a time interval t_2. The height of the tower is

1) $\frac{1}{2}gt_1t_2$ 2) $g\frac{t_1t_2}{8}$

3) $\frac{g}{8}\left(t_1^2-t_2^2\right)$ 4) $\frac{g}{2}\left(t_1-t_2\right)^2$

89. Two bodies are projected at angle 30^o and 60^o to the horizontal from the ground such then the maximum heights reached by them are equal. Then

1) their times of flight are equal

2) their horizontal ranges are equal

3) the ratio of their initial speeds of projection is $\sqrt{3}$: 1

4) both take same time to reach the maximum height

Mark the answer as

1) If a, b, c & d are correct

2) If only a, b & c are correct

3) If only a & c are correct

4) If a, c & d are correct

90. Two thin wood screens A & B are separated by 200m. A bullet traveling horizontally at a speed of 600 m/s hits the screen A, penetrates through it and finally emerges out from B making holes in A & B. If the resistance of air and wood are negligible, the difference of heights of the holes in A & B is

1) 5m

2) $\frac{49}{90}$ m

3) $\frac{7}{\sqrt{90}}$ m

4) none of the above

Master JEE CLASSES

Kukatpally, Hyderabad.

IIT-JEE-MAINS PAPER-4 **Max. Marks: 360**

KEY SHEET

MATHS

1	**4**	2	**2**	3	**3**	4	**4**	5	**3**	6	**4**
7	**1**	8	**1**	9	**1**	10	**1**	11	**1**	12	**1**
13	**2**	14	**2**	15	**3**	16	**1**	17	**1**	18	**2**
19	**1**	20	**3**	21	**1**	22	**1**	23	**2**	24	**3**
25	**1**	26	**2**	27	**1**	28	**2**	29	**1**	30	**1**

CHEMISTRY

31	**3**	32	**2**	33	**3**	34	**2**	35	**4**	36	**3**
37	**1**	38	**2**	39	**1**	40	**1**	41	**4**	42	**4**
43	**1**	44	**2**	45	**4**	46	**3**	47	**1**	48	**2**
49	**3**	50	**1**	51	**2**	52	**3**	53	**2**	54	**2**
55	**4**	56	**1**	57	**4**	58	**3**	59	**2**	60	**3**

PHYSICS

61	**3**	62	**3**	63	**2**	64	**4**	65	**3**	66	**4**
67	**2**	68	**2**	69	**1**	70	**3**	71	**4**	72	**3**
73	**4**	74	**3**	75	**2**	76	**3**	77	**2**	78	**2**
79	**1**	80	**2**	81	**1**	82	**2**	83	**1**	84	**1**
85	**4**	86	**3**	87	**2**	88	**3**	89	**1**	90	**2**

SOLUTIONS:
MATHS

1. $\cos(\cos x - \sin x) = \cos(\frac{\pi}{2} - (\sin x + \cos x)$

Taking +ve sign, $\cos x = n\pi + \frac{\pi}{4}$

Taking -ve sign, $\sin x = \frac{\pi}{4}$

2. Expressing both the equations in terms of $\text{Tan}x$,we get $\text{Tan}^2 x = 1$, $x = n\pi \pm \frac{\pi}{4}$,For n=-2,0,-1,1,+2, sum=0

3. using transformations for $\sin x + \sin y = \sin(x+y)$,we get 6 solution

4. The Max value of $|\sin y| = 1$,while min of L.H.S is 1

$\therefore \sin y = \pm 1, y = \pm\frac{\pi}{2}, \pm\frac{3\pi}{2}$

5. f(x) is a periodic function with period 2π and $y = f(x)$ and $y = \frac{1}{2}$ meet 2 times in $(0, 2\pi)$

6. $|\sin x| \neq 1, |\cos x| \neq 1, |\text{Tan}x| = 1 \therefore x = \pm\frac{\pi}{4}, \pm\frac{3\pi}{4}, \pm\frac{5\pi}{4}, \pm\frac{7\pi}{4}. - 8 \text{values}$

7. $\text{Tan}(A-B) = 1, A - B = \frac{\pi}{4}, \frac{3\pi}{4}, \frac{-3\pi}{4} --$

$\sec(A+B) = \frac{2}{\sqrt{3}}, A + B = \frac{\pi}{6}$

$A = \frac{19\pi}{24}, B = \frac{25\pi}{24}$

8. From the graph , analise that L.H.S always greater than R.H.S

9. $\sin(x+y) + \cos(x+y) = \frac{1}{\sqrt{2}}$

$\therefore x = \frac{5\pi}{12}, y = \frac{\pi}{6}$

10. The given equation is $2\sin(e^x).\cos(e^x) = \frac{1}{2}[2^x + 2^{-x}]$

$\text{RHS} \geq 1 \text{and LHS} \leq 1$

For a solution $\sin(2.e^x) = 1$

$\therefore x = 0, \text{but } \sin 2 \neq 1$
$\therefore \text{No solution}$

11. $\sin 3x = \sin(\frac{\pi}{2} - x)$

$3x = n\pi + (-1)^n (\frac{\pi}{2} - x)$

considering even and odd cases

$x=\frac{\pi}{8},\frac{\pi}{4},\frac{-3\pi}{8}$

12. Consistant with $\cos x \geq 0$ and $\sin(1-x)\geq 0$

after solving $1-x=n\pi+(-1)^n(\frac{\pi}{2}-x)$

$x=\frac{1}{2}-(\frac{4m+1}{4})\pi, m\in I$

13. Draw the graph of $\sec\theta+\operatorname{cosec}\theta$

14. If $0<x<\pi, \cos(x-y)=\frac{1}{2}$ and $\cos(x+y)=1:(x_1,y_1)=(\frac{5\pi}{6},\frac{7\pi}{6}),(\frac{\pi}{6},\frac{11\pi}{6})$ as the 2 solutions . Similarly,

for $x\in(\pi,2\pi)$ there are 2 solutions $(\frac{7\pi}{6},\frac{7\pi}{6})\text{and}(\frac{11\pi}{6}-\frac{11\pi}{6})$

15. Re-write the equation as $(\sin x+\cos x)(1+\frac{2}{\sin 2x})=(7-\frac{2}{\sin 2x})$

where , $\sin^3 2x-44\sin^2 2x+36\sin 2x=0$, $\sin 2x=22-8\sqrt{7}$

16. $\sin^2 x \leq {}_{10} \sec x^{10}$

$\therefore -1=\text{Tan}^3x-\text{sex}^{10}x\leq \text{Tan}^2x-\sec^2 x\leq -1$

$\therefore |\sec x|=1, \quad \therefore \cos x=\pm 1$

17. $\sin x-[\sin x]=2-[\cos x]\geq 1$

which is not possible

18. put $\sec^2\theta=t$

$(\sqrt{3})^t=(t^2-1)(t^2+1)$

$\therefore t^2=2$

19. $\frac{\sec^4\theta}{a}+\frac{\tan^4\theta}{b}=\frac{\sec^2\theta-\tan^2\theta}{a+b}$

$\sec^2\theta=\frac{-b}{a}\leq 1$

20. we must have $[\sin x]=-1,[\sqrt{2}\cos x]=-2$

21. $\text{LHS}\leq 1$, $\text{RHS}\geq 1$

$\therefore[-\sin x]=-1,[-\cos x]=-1$

which is not possible

22. Given $a\cos^2 3\alpha+bc0s^4\alpha=16\cos^6\alpha+9\cos^2\alpha$

$\Rightarrow 9\cos^2\alpha+16\cos^6\alpha=a(4\cos^3\alpha-3\cos\alpha)^2+b\cos^4\alpha$

$a(16\cos^6\alpha+9\cos^2\alpha-24\cos^4\alpha)+b\cos^4\alpha=9a\cos^2\alpha+(b-24a)\cos^4\alpha+16a\cos^6\alpha$

comparing ,we get $9a=0\Rightarrow a=1, b-24a=0 \;\therefore b=24a=24$

23. $f(x)=\frac{1}{2}(1-\cos 2x)+\frac{1}{2}\left\{1-\cos(2x+\frac{2\pi}{3})\right\}+\frac{1}{2}\left[\cos(2x+\frac{\pi}{3})+\cos\frac{\pi}{3}\right]$

$$\frac{5}{4}-\frac{1}{2}\left\{\cos 2x+\cos(2x+\frac{2\pi}{3})-\cos(2x+\frac{\pi}{3})\right\}$$
$$=\frac{5}{4}-\frac{1}{2}\left\{2\cos(2x+\frac{\pi}{3})\cos\frac{\pi}{3}-\cos(2x+\frac{\pi}{3})\right\}=\frac{5}{4}\text{ for all x}$$
$$\therefore f(\frac{\pi}{8})=\frac{5}{4}\text{and therefore gof}(\frac{\pi}{8})=g(\frac{5}{4})=1$$

24. we have $\frac{u_n}{v_n}=\tan n\theta$ and $\frac{v_n-v_{n-1}}{u_{n-1}}=\frac{\cos n\theta\sec^n\theta-\cos(n-1)\theta\sec^{n-1}\theta}{\sin(n-1)\theta\sec^{n-1}\theta}$

$$=\frac{\cos n\theta\sec^n\theta-\cos(n-1)\theta}{\sin(n-1)\theta}=\frac{\cos n\theta-\cos(n-1)\theta\cos\theta}{\cos\theta\sin(n-1)\theta}$$
$$=\frac{\cos(n-1)\theta\cos\theta-\sin(n-1)\theta\sin\theta-\cos(n-1)\theta\cos\theta}{\cos\theta\sin(n-1)\theta}=-\tan\theta$$
$$\text{sothat}\frac{v^n-v_{n-1}}{u_{n-1}}+\frac{1}{n}\frac{u_n}{v_n}-\tan\theta+\frac{\tan n\theta}{n}\neq 0$$

25.

$$K_1=\text{Tan }27\theta-\tan\theta=(\tan 27\theta-\tan 9\theta)+(\tan 9\theta-\tan 3\theta)+(\tan 3\theta-\tan\theta)$$
$$\text{now},\tan 3\theta-\tan\theta=\frac{\sin 2\theta}{\cos 3\theta\cos\theta}=\frac{2\sin\theta}{\cos 3\theta}$$

$$\text{similarly},\tan 9\theta-\tan 3\theta=\frac{2\sin 3\theta}{\cos 9\theta}\text{and}\tan 27\theta-\tan 9\theta=\frac{2\sin 9\theta}{\cos 27\theta}$$
$$\therefore K_1=2\left[\frac{\sin 9\theta}{\cos 27\theta}+\frac{\sin 3\theta}{\cos 9\theta}+\frac{\sin\theta}{\cos 3\theta}\right]=2K_2$$

26. $\alpha,\beta,\gamma,\delta$ and $\sin\alpha=\sin\beta=\sin\gamma=\sin\delta=k$

$$\Rightarrow\beta=\pi-\alpha,\gamma=2\pi+\alpha,\delta=\sin\delta=k$$

so that the given expression is equal to

$$4\sin\frac{\alpha}{2}+3\sin(\frac{\pi-\alpha}{2})+2\sin\frac{2\pi+\alpha}{2}+\sin\frac{3\pi-\alpha}{2}$$
$$=4\sin\frac{\alpha}{2}+3\cos\frac{\alpha}{2}-2\sin\frac{\alpha}{2}-\cos\frac{\alpha}{2}=2(\sin\frac{\alpha}{2}+\cos\frac{\alpha}{2})=2\sqrt{1+2\sin\frac{\alpha}{2}\cos\frac{\alpha}{2}}=2\sqrt{1+k}$$

27. $\tan(\alpha+\beta)=\frac{\tan\alpha+\tan\beta}{1-\tan\alpha\tan\beta}=\frac{\frac{a}{a+1}+\frac{1}{2a+1}}{1-\frac{a}{(a+1)(2a+1)}}$ where $x^2-x=a$

$$\frac{\frac{a}{a+1}+\frac{1}{2a+1}}{1-\left\{\frac{1}{a+1}-\frac{1}{2a+1}\right\}}=\frac{\frac{a}{a+1}+\frac{1}{2a+1}}{\frac{a}{a+1}+\frac{1}{2a+1}}=1$$

hence $\alpha+\beta=\frac{\pi}{4}$(note : $\alpha+\beta$ can not be $\frac{5\pi}{4}$

28. let $S=\sin\frac{2\pi}{7}+\sin\frac{4\pi}{7}\sin\frac{8\pi}{7}$ and $C=\cos\frac{2\pi}{7}+\sin\frac{4\pi}{7}+\sin\frac{8\pi}{7}$

then

$C + iS = \alpha + \alpha^2 + \alpha^4 \quad -(i)$

$\alpha = \cos\frac{2\pi}{7} + i\sin\frac{2\pi}{7}$ is complex 7^{th} root of unity and

$C - iS = \alpha^6 + \alpha^5 + \alpha^3 \quad -(ii) \qquad \therefore \alpha^6 = \alpha$, etc

add (i) and (ii)

$$2C = \alpha + \alpha^2 + \alpha^{3+} ... + \alpha^6 = \frac{\alpha^7 - \alpha}{\alpha - 1} = -1(\alpha^7 = 1)$$

$\therefore C = -\frac{1}{2}$ also multiple (i) and (ii), $C^2 + S^2 = 2 \Rightarrow S = \frac{\sqrt{7}}{2}$

29. $a_1\cos(\alpha_1 + \theta) + a_2\cos(\alpha_2 + \theta) ...... + a_n\cos(\alpha_n + \theta) = 0$

$\Rightarrow (a_1\cos\alpha_1 + a_2\cos\alpha_2 + ... + a_n\cos\alpha_n)\cos\theta - (a_1\sin\alpha_1 + \sin\alpha_2 + ... + a_n\sin\alpha_n)\sin\theta = 0$

$\Rightarrow a_1\sin\alpha_1 + a_2\sin\alpha_2 + ... + a_n\sin\alpha_n = 0$ (since $\sin\theta \neq 0$)

and $a_1\cos\alpha_1 + a_2\cos\alpha_2 + ... + a_n\cos\alpha_n = 0$

now $a_1\cos(\alpha_1 + \lambda) + a_2\cos(\alpha_2 + \lambda) + ... + a_n\cos(\alpha_n + \lambda)$

$= (a_1\cos\alpha_1 + a_2\cos\alpha_2 + ... + a_n\cos\alpha_n)\cos\lambda - (a_1\sin\alpha_1 + a_2\sin\alpha_2 + ... + a_n\sin\alpha_n)\sin\lambda = 0$

30. given $f(x) = ax + b \therefore f(x) = a$

since a<0, $f(x)$ is a decreasing function $\therefore f(-1) = 2$ and $f(1) = 0$

$\Rightarrow -a + b = 2$ and $a + b = 0 \quad \therefore a = -1$ and $b = 1$. thus $f(x) = -x + 1$

clearly

$$f(0) = 1, f(\frac{1}{4}) = \frac{3}{4}, f(-2) = 3, f(\frac{1}{3}) = \frac{2}{3, f(-1) = 2}$$

$$\text{also}, A = \frac{1 + \cos 2\theta}{2} + (\frac{1 - \cos 2\theta}{2})^2$$

$$= \frac{1}{2} + \frac{1}{2}\cos 2\theta + \frac{1}{4} - \frac{1}{2}\cos 2\theta + \frac{1}{4}\cos^2 2\theta = \frac{3}{4} + \frac{1}{4}(\frac{1 + \cos 4\theta}{2}) = \frac{7}{8} + \frac{1}{8}\cos 4\theta$$

$$\therefore \frac{3}{4} \le A \le 1 \Rightarrow f(\frac{1}{4}) \le A \le f(0)$$

CHEMISTRY

31. 3

The reaction involved is $H_2O(l) \rightarrow H_2O(g)$, where Δn_g = 1 mol, $\Delta_{vap}H = 41\,kJ\,mol^{-1}$. Now,

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

$$= 41\,kJ\,mol^{-1} - 1 \times 8.3 \times 10^{-3}\,kJ\,K^{-1}mol^{-1} \times 373\,K$$

$$= 41 - 3.096\,kJ\,mol^{-1} = 37.904\,kJ\,mol^{-1}$$

32. Given that

$$\frac{1}{2}Cl_2(g) \rightarrow Cl^-(aq); \Delta H = ?$$

$$Cl_2 \rightarrow 2Cl; \Delta H_1 = 240kJ\,mol^{-1}$$

$Cl \rightarrow Cl^-; \Delta H_2 = -349\, kJ\, mol^{-1}$

$Cl^- \xrightarrow[medium]{Aqueous} Cl^-(aq); \Delta H_3 = -381\, kJ\, mol^{-1}$

Therefore,

$$\Delta H = \frac{\Delta H_1}{2} + \Delta H_2 + \Delta H_3 = \frac{240}{2} - 349 - 381 = -610\, kJ\, mol^{-1}$$

33. $NH_3(g) \rightarrow N(g) + 3H(g) \quad \Delta_{N-H}{}^{H^0} = \frac{\Delta H}{3}$

The value of ΔH for this reaction can be obtained from summation of following equations.

$2NH_3 \rightarrow 2N + 6H \qquad \Delta_{N-H}H^0 = \frac{\Delta H}{6}$

$2NH_3 \rightarrow N_2 + 3H_2 \qquad \Delta_r H^0 = 92$

$N_2 \rightarrow 2N \qquad \Delta_r H^0 = 712$

$3H_2 \rightarrow 6H \qquad \Delta_r H^0 = 436 \times 3$

$2NH_3 \rightarrow 2N + 6H \ \Delta_r H^0 = 2112$

Thus, at this condition $\Delta_{N-H}H^0 = \frac{2112}{6} = 352 kJ\, mol^{-1}$

34. $NaCl(s) \rightarrow Na^+(g) + Cl^-(g) \qquad \Delta H = +780\, kJ\,(Lattice\, energy)$

$Na^+(g) + H_2O(l) \rightarrow Na^+(aq)\ \Delta H = -406\, kJ\,(Hydration)$

$Cl^-(g) + H_2O(l) \rightarrow Cl^-(aq)\ \Delta H = -364 kJ\,(Hydration)$

The net reaction of dissolution of $NaCl(s)$ is $NaCl(s) + 2H_2O(l) \rightarrow Na^+(aq) + Cl^-(aq)$

$\Delta_{sol}H = 780 - (406 + 364) = 10\, kJ\, mol^{-1}$

35. For an ideal gas, for isothermal reversible process,

$$\Delta S = 2.303 nR \log\left(\frac{V_2}{V_1}\right) = 2.303 \times 2 \times 8.314 \times \log\left(\frac{100}{10}\right) = 38.3\, J\, mol^{-1} K^{-1}$$

36. For the reaction, $\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightarrow XY_3$

$$\Delta_r S = 50 - \left(\frac{1}{2} \times 60 + \frac{3}{2} \times 40\right) = -40 Jmol^{-1}$$

Since, $\Delta G = \Delta H - T\Delta S$ and at equilibrium $\Delta G = 0$, so, $T = \frac{\Delta H}{\Delta S} = \frac{-30}{-40} \times 10^3 = 750K$

37. Melting of ice at 280 K is a non-spontaneous process

38. Conceptual

39. Density is mass per unit volume and specific volume is volume per unit mass

40. Work is not a state function; instead it is dependent on the path of the reaction

41. $w = -p\Delta V$

$\Delta V = 8.00\,L - 3.00\,L = 5.00\,L$

$w = -(1\,atm)\times(5.00\,L) = -5.00\,L\,atm$

In joules: - 5.00 L atm $\left(\frac{101.325J}{1L\,atm}\right) = -507\,J$

42. According to the first law of thermodynamics, $\Delta U = q + w$

For isothermal process, $\Delta U = 0.$ Hence, q = -w.

For cyclic process, $\Delta U = 0.$ Hence q = -w.

For isochoric process, $\Delta V = 0.$ Hence, $\Delta U = q\left(w = p\Delta V = 0\right),$

For adiabatic process, q = 0. Hence $\Delta U = w.$

43. $HCl + NaOHK \rightarrow NaCl + H_2O \;\; \Delta H_1 = -55.9\,kJ\,mol^{-1}$

$HCl + NaOHK \rightarrow NaCl + H_2O \;\; \Delta H_2 = -12.1\,kJ\,mol^{-1}$

Enthalpy of dissociation of HCN $= \Delta H_2 - \Delta H_1 = -12.1 - (-55.9) = +43.8\,kJ$

44. Conceptual

45. Conceptual

46. As the system is insulated from the surroundings, no heat enters or leaves the system. Hence, $\Delta S = q/T = 0.$

47. Conceptual

48. We have to calculate enthalpy of reaction for

$CuSO_4 + 5H_2O \rightarrow CuSO_4.5H_2O; \Delta H = ?$

Given that

$CuSO_{4(anh.)} + 5H_2O + aq. \rightarrow CuSO_4.5H_2O_{(aq)}; \;\; \Delta H_1 = -66.4\,kJ \;\; \ldots(1)$

And $CuSO_4.5H_2O + aq. \rightarrow CuSO_4.5H_2O_{(aq)}; \Delta H_2 = +11.7\,kJ$

On the basis of two equations

49. A compound with more negative ΔH_f^0 value will have less energy associated with it and so more stable. On the basis of given data $CaO > NH_3 > HI > O_3$