

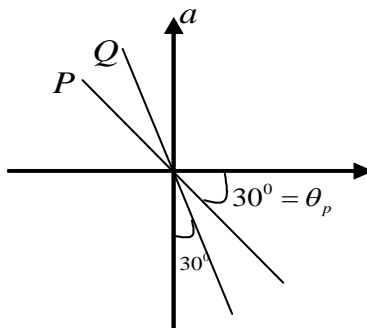


MATHS

**SYLLABUS: Properties of triangles (based on in radius), Addition of vectors
Increasing & Decreasing functions, Maxima & minima**

- 1. If in a triangle ABC, $\frac{1}{r^2} + \frac{1}{r_1^2} + \frac{1}{r_2^2} + \frac{1}{r_3^2} =$**
1) $\frac{a+b+c}{\Delta}$ 2) $\frac{a^2+b^2+c^2}{\Delta^2}$ 3) $\frac{1}{2Rr}$ 4) R
- 2. If in a triangle ABC, $\left(\frac{1}{r} - \frac{1}{r_1}\right)\left(\frac{1}{r} - \frac{1}{r_2}\right)\left(\frac{1}{r} - \frac{1}{r_3}\right) =$**
1) $\frac{abc}{\Delta^3}$ 2) 0 3) $4Rr^2$ 4) $\frac{1}{r}$
- 3. If in a triangle ABC, $(r_3 + r_1)\sqrt{\frac{rr_2}{r_3 + r_1}} =$**
1) a 2) b 3) c 4) 0
- 4. If in a triangle ABC, $r\left(\cot\frac{B}{2} + \cot\frac{C}{2}\right) =$**
1) a 2) b 3) c 4) 0
- 5. If in a triangle ABC, $r_1 \cot\frac{A}{2} + r_2 \cot\frac{B}{2} + r_3 \cot\frac{C}{2} =$**
1) s 2) 2s 3) 3s 4) 4s
- 6. If in a triangle ABC, $r\left(r_1 \cot\frac{A}{2} + r_2 \cot\frac{B}{2} + r_3 \cot\frac{C}{2}\right) =$**
1) 3s 2) 3Δ 3) $\frac{3}{\Delta}$ 4) $\frac{2}{\Delta}$
- 7. If in a triangle ABC, $\frac{r_1 + r_2}{1 + \cos C} =$**
1) $\frac{2ab}{c\Delta}$ 2) $\frac{a+b}{c\Delta}$ 3) $\frac{abc}{2\Delta}$ 4) $\frac{abc}{\Delta^3}$
- 8. If in a triangle ABC, if $\angle A = 90^\circ$ then $\cos^{-1}\left(\frac{R}{r_2 + r_3}\right) =$**
1) 90° 2) 30° 3) 60° 4) 45°
- 9. If in a triangle ABC, $\cos^2\frac{A}{2} + \cos^2\frac{B}{2} + \cos^2\frac{C}{2} =$**
1) $\frac{1}{r} - \frac{1}{2R}$ 2) $1 + \frac{r}{R}$ 3) $2 + \frac{r}{2R}$ 4) $1 - \frac{r}{2R}$
- 10. If in a triangle ABC, if $\left(1 - \frac{r_1}{r_2}\right)\left(1 - \frac{r_1}{r_3}\right) = 2$ then the triangle is**
1) isosceles 2) equilateral 3) right angled 4) none
- 11. The dimensions of the rectangle of perimeter 36 cm. Which will sweep out a volume as large as possible when revolved about one of its sides are**

26. A particle starts its SHM from mean position at $t = 0$. If its time period is T and amplitude A . The distance travelled by the particle in the time from $t = 0$ to $t = \frac{5T}{4}$ is
- 1) A 2) $2A$ 3) $4A$ 4) $5A$
27. The minimum phase difference between two SHM's $y_1 = \sin \frac{\pi}{6} \sin \omega t + \sin \frac{\pi}{3} \cos \omega t$;
 $y_2 = \cos \frac{\pi}{6} \sin \omega t + \cos \frac{\pi}{3} \cos \omega t$ is
- 1) $\frac{\pi}{3}$ 2) $\frac{\pi}{6}$ 3) $\frac{\pi}{12}$ 4) 0
28. A particle of mass m executes SHM with amplitude A and frequency n . The average kinetic energy during its motion from mean to extreme positions is
- 1) $\pi^2 mn^2 A^2$ 2) $2\pi^2 mn^2 A^2$ 3) $\frac{\pi^2 mn^2 A^2}{2}$ 4) zero
29. If a simple harmonic motion is represented by $\frac{d^2x}{dt^2} + \alpha x = 0$, its time period is
- 1) $2\pi\alpha$ 2) $2\pi\sqrt{\alpha}$ 3) $\frac{2\pi}{\alpha}$ 4) $\frac{2\pi}{\sqrt{\alpha}}$
30. Average kinetic energy in one time period of a simple harmonic oscillator whose amplitude is A angular velocity ω and mass M is
- 1) $\frac{1}{4} M\omega^2 A^2$ 2) $\frac{1}{2} M\omega^2 A^2$ 3) $M\omega^2 A^2$ 4) 0
31. Two masses M and m are suspended together by a massless spring of force constant k . When the masses are in equilibrium, M is removed without disturbing the system. Then the amplitude of oscillation is
- 1) Mg/k 2) mg/k 3) $(M+m)g/k$ 4) $(M-m)g/k$
32. A particle is executing SHM with a frequency of $\frac{1}{8} Hz$. If starts from the mean position at time $t=0$, the ratio of distances covered by it in 1st and 2nd second is
- 1) 1 2) $1/(\sqrt{2}-1)$ 3) $1/(\sqrt{3}-1)$ 4) $\sqrt{2}-1$
33. The acceleration - displacement graph of two particles P and Q executing SHM are represented as shown in the figure. The ratio of time period of P, Q respectively is



- 1) $\sqrt{3}:1$ 2) $1:\sqrt{3}$ 3) $3:1$ 4) $1:3$

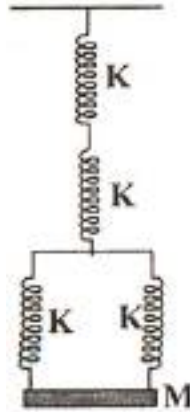
34. Two simple pendulums of length $100m$ and $121m$ start swinging together. They will swing together again after

- 1) the longer pendulum makes 10 oscillations 2) the shorter pendulum makes 10 oscillations
 3) the longer pendulum makes 11 oscillations 4) the shorter pendulum makes 20 oscillations

35. The change in the length of a simple pendulum of length 1m, when its period of oscillation changes from 2s to 1.5s is

- 1) increased by $\frac{7}{8}m$ 2) decreased by $\frac{7}{8}m$ 3) increased by $\frac{7}{16}m$ 4) decreased by $\frac{7}{16}m$

36. The frequency of oscillation of the system shown in the figure will be

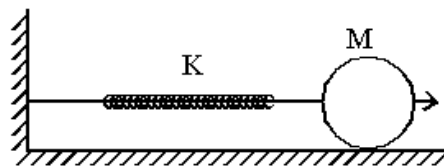


- 1) $\frac{1}{2\pi} \sqrt{\frac{k}{M}}$ 2) $\frac{1}{2\pi} \sqrt{\frac{2k}{M}}$ 3) $\frac{1}{2\pi} \sqrt{\frac{k}{5M}}$ 4) $\frac{1}{2\pi} \sqrt{\frac{2k}{5M}}$

37. Two simple pendulums are drawn to same side from their mean positions and are released simultaneously. Their time periods are 2s and 3s. The phase difference between the pendulums when the longer pendulum completes one oscillation is

- 1) $\pi/3\text{rad}$ 2) $\pi/2\text{rad}$ 3) $2\pi/3\text{rad}$ 4) πrad

38. A disc of mass M is attached to a horizontal massless spring of force constant K so that it can roll without slipping along a horizontal surface. If the disc is pushed a little towards right and then released, its centre of mass executes SHM with a period of



- 1) $2\pi \sqrt{\frac{M}{K}}$ 2) $2\pi \sqrt{\frac{3M}{K}}$ 3) $2\pi \sqrt{\frac{M}{2K}}$ 4) $2\pi \sqrt{\frac{3M}{2K}}$

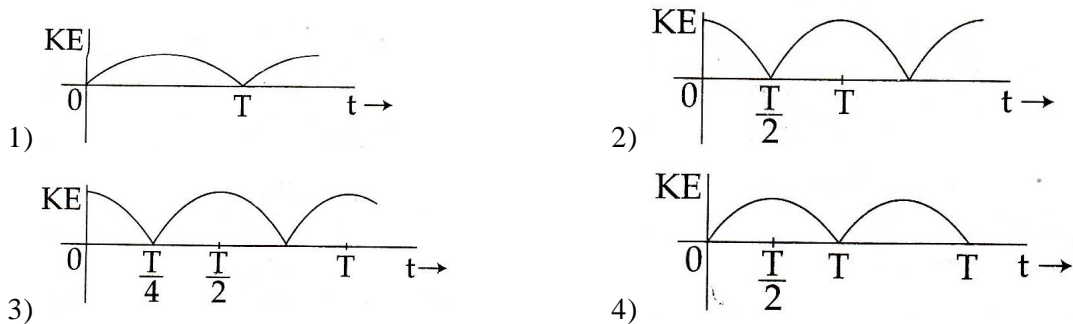
39. The mass and the diameter of a planet are three times the respective values for the Earth. The period of oscillation of a simple pendulum on the Earth is 2 s. The period of oscillation of the same pendulum on the planet would be

- 1) $\frac{2}{\sqrt{3}}s$ 2) $\frac{3}{2}s$ 3) $\frac{\sqrt{3}}{2}s$ 4) $2\sqrt{3}s$

40. A spring whose unstretched length is l has a force constant k . The spring is cut into two pieces of unstretched lengths l_1 and l_2 where, $l_1 = nl_2$ and n is an integer. The ratio k_1/k_2 of the corresponding force constants, k_1 and k_2 will be :

- 1) n^2 2) $\frac{1}{n}$ 3) $\frac{1}{n^2}$ 4) n

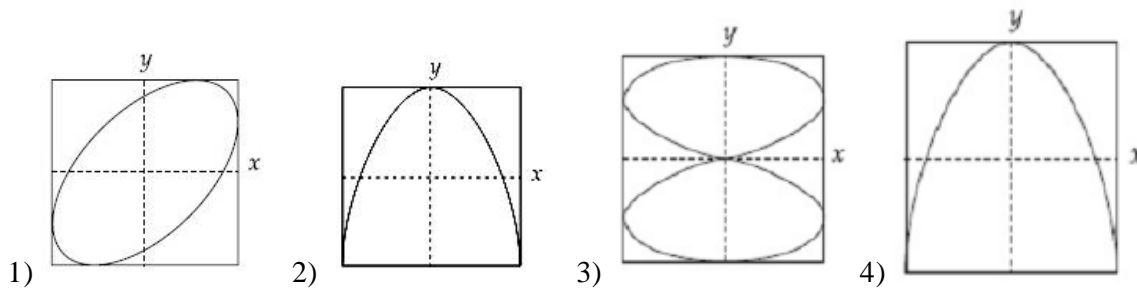
41. A particle is executing simple harmonic motion with a time period T. A time $t = 0$, it is at its position of equilibrium. The kinetic energy - time graph of the particle will look like:



42. A particle performs simple harmonic motion with amplitude A . Its speed is trebled at the instant that it is at a distance $\frac{2A}{3}$ from equilibrium position. The new amplitude of the motion is :

- 1) $\frac{A}{3}\sqrt{41}$ 2) $3A$ 3) $A\sqrt{3}$ 4) $\frac{7A}{3}$

43. x and y displacements of a particle are given as $x(t) = a \sin \omega t$ and $y(t) = a \sin 2\omega t$. Its trajectory will look like :



44. An aluminium sphere of 20 cm diameter is heated from 0°C to 100°C . Its volume changes by (given that coefficient of linear expansion for aluminium $\alpha_{Al} = 23 \times 10^{-6} / ^\circ\text{C}$)

- 1) 28.9 cc 2) 2.89 cc 3) 9.28 cc 4) 49.8 cc

45. The freezing point on a thermometer is marked as 20° and the boiling point as 150° . A temperature of 60°C on this thermometer will be read as

- 1) 40° 2) 65° 3) 98° 4) 110°

NUMERICAL VALUE QUESTIONS

46. A damped harmonic oscillator has a frequency of 5 oscillations per second. The amplitude drops to half its value for every 10 oscillations. The time it will take to drop to $\frac{1}{1000}$ of the original amplitude is close to :

47. The displacement of a damped harmonic oscillator is given by $x(t) = e^{-0.1t} \cos(10\pi t + \phi)$. Here t is in seconds. The time taken for its amplitude of vibration to drop to half of its initial value is close to:

48. In an engine the piston undergoes vertical simple harmonic motion with amplitude 7 cm. A washer rests on top of the piston and moves with it. The motor speed is slowly increased. The frequency of the piston at which the washer no longer stays in contact with the piston, is close to:

49. A spring balance has a scale that reads 0 to 20 kg. The length of the scale is 10cm. A body suspended from this balance, when displaced and released, oscillates with period of $\frac{\pi}{10}$ s. The mass of the body is

50. Two pendulums with lengths 1.44 m and 1 m start oscillating simultaneously. After how many oscillations of longer pendulum will they be in the same phase?

CHEMISTRY

SYLLABUS: States of Matter, Thermodynamics

51. The enthalpy of fusion of water is $6.01 \text{ KJ mole}^{-1}$. The entropy change of 1 mole of ice at its melting point will be
 1) 22 KJ mole^{-1} 2) 109 KJ mole^{-1} 3) 44 KJ mole^{-1} 4) 11 KJ mole^{-1}
52. For a reaction $\Delta H = +29 \text{ KJ mole}^{-1}$ $\Delta S = -35 \text{ JK}^{-1} \text{ mole}^{-1}$ at what temperature the reaction will be spontaneous
 1) 828.7°C 2) 828.7 K
 3) Spontaneous at all temperature 4) Not possible
53. What is ΔG^0 for this reaction $\frac{1}{2} \text{N}_{2(g)} + \frac{3}{2} \text{H}_{2(g)} \rightleftharpoons \text{NH}_{3(g)}$ $K_p = 4.42 \times 10^4$ at 25°C
 1) $-26.5 \text{ KJ mole}^{-1}$ 2) $-11.5 \text{ KJ mole}^{-1}$ 3) $-2.2 \text{ KJ mole}^{-1}$ 4) $-0.97 \text{ KJ mole}^{-1}$
54. The standard free energy change of a reaction is $\Delta G^0 = -115 \text{ KJ}$ at 298 K . Calculate the equilibrium constant in log K_p
 1) 20.16 2) 2.303 3) 2.016 4) 13.83
55. Which of the following is correct expression that relates change of entropy with the change of pressure for an ideal gas at constant temperature among the following.
 1) $\Delta S = nRT \ln \frac{p_2}{p_1}$ 2) $\Delta S = T(p_2 - p_1)$ 3) $\Delta S = nR \ln \frac{p_1}{p_2}$ 4) $\Delta S = 2.303 nR \ln \frac{p_1}{p_2}$
56. Standard entropies of X_2, Y_2 and XY_3 are $60, 40, 50 \text{ JK}^{-1} \text{ mole}^{-1}$ respectively. For the reaction
 $\frac{1}{2} X_2 + \frac{3}{2} Y_2 \longrightarrow XY_3$ $\Delta H = -30 \text{ KJ}$ to be at equilibrium, the temperature will be
 1) 1000 K 2) 1250 K 3) 500 K 4) 750 K
57. 4.48 L of an ideal gas at requires 12 calories to rise its temperature by 15°C at constant volume the C_p of the gas is
 1) 3 cal 2) 4 cal 3) 7 cal 4) 6 cal
58. What is the value of internal energy change (ΔU) at 27°C of a gaseous reaction $2A_{2(g)} + 5B_{2(g)} \longrightarrow 2A_2B_{5(g)}$ (Heat change at constant pressure is -50700 J)
 1) -50700 J 2) -63171 J 3) -38229 J 4) $+38229 \text{ J}$
59. For the process $H_2O_{(l)} \longrightarrow H_2O_{(g)}$ at $t = 100^\circ \text{C}$ and 1 atm pressure the correct choice is
 1) $\Delta S_{\text{system}} > 0, \Delta S_{\text{surroundings}} > 0$ 2) $\Delta S_{\text{system}} > 0, \Delta S_{\text{surroundings}} < 0$
 3) $\Delta S_{\text{system}} < 0, \Delta S_{\text{surroundings}} > 0$ 4) $\Delta S_{\text{system}} < 0, \Delta S_{\text{surroundings}} < 0$
60. What is the sign of ΔG^0 and the values of K for an electro chemical cell for which $E_{\text{Cell}}^0 = 0.80 \text{ Volt}$
 1) $\Delta G = -ve$ $K > 1$ 2) $\Delta G^0 = +ve$ $K > 1$
 3) $\Delta G = +ve$ $K < 1$ 4) $\Delta G = -ve$ $K < 1$
61. The difference between the heats of reaction at constant pressure and a constant volume for the reaction $2C_6H_{6(l)} + 15 O_{2(g)} \rightarrow 12 CO_{2(g)} + 6H_2O_{(l)}$ at 25°C in KJ is
 1) -7.43 2) $+3.72$ 3) -3.72 4) $+7.43$
62. Two moles of an ideal gas expanded isothermally and reversibly from 1L to 10L at 300 K. What is the enthalpy change?
 1) 4.98 KJ 2) 11.47 KJ 3) -11.47 KJ 4) 0 KJ
63. The species which by definition has zero standard molar enthalpy of formation at 298 K

- 1) $Br_{2(g)}$ 2) $Cl_{2(g)}$ 3) $H_2O_{(g)}$ 4) $CH_{4(g)}$
64. Which of the following thermodynamic relation is correct
 1) $dG = VdP - SdT$ 2) $dU = PdV + TdS$ 3) $dH = -VdP + TdS$ 4) $dG = VdP + SdT$
65. Although the dissolution of a NH_4Cl in water is an endothermic reaction, it is spontaneous because
 1) $\Delta H = +Ve, \quad \Delta S = -Ve$ 2) $\Delta H = +Ve, \quad \Delta S = 0$
 3) $\Delta H = +Ve, \quad T\Delta S < \Delta H$ 4) $\Delta H = +Ve, \quad \Delta S = +Ve$ and $\Delta H < T\Delta S$
66. The amount of heat liberated when one mole of NH_4OH react with one mole of HCl is
 1) 13.7 K cal 2) more than 13.7 K cal 3) Less than 13.7 K cal 4) Can't be predicted
67. For the reaction $Ag_2O_{(g)} \rightarrow 2Ag_{(g)} + \frac{1}{2}O_{2(g)}$ which one the following is true
 1) $\Delta H = \Delta U$ 2) $\Delta H < \Delta U$ 3) $\Delta H > \Delta U$ 4) $\Delta H = \frac{1}{2}\Delta U$
68. The dissociation energy of CH_4 is 400 K cal/mole and that of ethane is 670 K cal mole⁻¹. The C – C bond energy is
 1) 270 K cal 2) 70 K cal 3) 200 K cal 4) 240 K cal
69. The heat of combustion of methane is –880 KJ mole⁻¹. If 3.2 gr of methane is burnt the heat evolved is
 1) 88 KJ 2) 264 KJ 3) 176 KJ 4) 440 KJ
70. The enthalpy change of a reaction does not depends on
 1) Initial and final state of the reaction 2) State of the reactions and products
 3) Nature of the reactants 4) Different intermediate states
- (Numerical Value Answer Type)**
71. The emf of the cell reaction $Zn_{(s)} + Cu_{(aq)}^{+2} \rightarrow Zn_{(aq)}^{+2} + Cu_{(s)}$ is 1.1 V calculate free energy change. Enthalpy for the reaction is – 216.7 KJ mole⁻¹ by using free energy & enthalpy calculate entropy change for this reaction.
72. Oxygen gas weighing 64 gr is expanded from 1 atm to 0.25 atm at 30⁰ C calculate entropy change
73. The enthalpies of combustion at 25⁰ C of H_2 , cyclo hexane and cyclo hexene (C_6H_{10}) are – 241, – 3920 and –3800 KJ/mole respectively. The heat of hydrogenation of cyclo hexene is
74. Enthalpy of formation of methane at constant pressure and 300 K is –75.83 KJ. What will be the heat of formation at constant volume?
75. Calculate the amount of work done (J) by 2moles of an ideal gas at 298 K in a reversible isothermal expansion from 10 lit to 20 lit



SRIGAYATRI EDUCATIONAL INSTITUTIONS

INDIA

SR MPC
Time: 3 Hours

JEE MAINS MODEL

Date:02-04-2020
Max. Marks: 300

KEY SHEET

MATHS

1) 2	2) 1	3) 2	4) 1	5) 3	6) 2	7) 3	8) 3	9) 4	10) 3
11) 3	12) 1	13) 1	14) 2	15) 2	16) 3	17) 2	18) 3	19) 3	20) 2
21) 16	22) 2	23) 0.87	24) 7	25) 0.5					

PHYSICS

26) 4	27) 2	28) 1	29) 4	30) 1	31) 1	32) 2	33) 1	34) 1	35) 4
36) 4	37) 4	38) 4	39) 4	40) 3	41) 3	42) 4	43) 2	44) 1	45) 3
46) 20	47) 7	48) 1.9	49) 4.9	50) 5					

CHEMISTRY

51) 1	52) 4	53) 1	54) 1	55) 3	56) 4	57) 4	58) 3	59) 2	60) 1
61) 1	62) 4	63) 2	64) 1	65) 4	66) 3	67) 3	68) 2	69) 3	70) 4
71) -0.014	72) 23.05	73) -121	74) -73.34	75) -3434.9					

HINTS & SOLUTIONS

MATHS-A

$$1. \frac{(s-a)^2}{\Delta^2} + \frac{(s-b)^2}{\Delta^2} + \frac{(s-c)^2}{\Delta^2} + \frac{s^2}{\Delta^2} = \frac{1}{\Delta^2} [3S^2 - 2S(a+b+c) + a^2 + b^2 + c^2 + s^2]$$

$$= \frac{1}{\Delta^2} [(a^2 + b^2 + c^2)] = \frac{a^2 + b^2 + c^2}{\Delta^2}$$

$$2. \left(\frac{r_1 - r}{rr_1} \right) \left(\frac{r_2 - r}{rr_2} \right) \left(\frac{r_3 - r}{rr_3} \right) = \frac{4Rr^2}{r^2\Delta^2}$$

$$= \frac{abc/\Delta}{\Delta^2} = \frac{abc}{\Delta^3}$$

$$3. \left(4R \cos^2 \frac{B}{2} \right) \frac{\sqrt{\frac{\Delta}{s} \cdot \frac{\Delta}{s-b}}}{\frac{\Delta}{s-c} - \frac{\Delta}{s-a}} = 4R \frac{\sqrt{s(s-b)}}{ac} \cdot \frac{\sqrt{(s-c)(s-a)}}{s(s-b)} = \frac{4R\Delta}{ac}$$

4. Use $\cot \frac{B}{2}, \cot \frac{C}{2}$ formulæ in terms of Δ and s

$$5. r_1 \cdot \cot(A/2) + r_2 \cot(B/2) + r_3 \cot(C/2) =$$

$$S+S+S=3S$$

$$6. \text{G.E is } r(s+s+s) = 3rs = 3\Delta$$

7. $\frac{r_1+r_2}{1+\cos c} = \left[\frac{\Delta}{s-a} + \frac{\Delta}{s-b} \right] \times \frac{1}{2\cos^2(C/2)} = \frac{\Delta abc}{2\Delta^2} = \frac{abc}{2\Delta}$
8. $4RCos\frac{A}{2}Sin\frac{B+C}{2} = 4RCos^2\frac{A}{2} = 4R\left(\frac{1}{2}\right) = 2R$
 $= \frac{R}{r_2+r_3} = \frac{1}{2} \Rightarrow \cos^{-1}\frac{R}{r_2+r_3} = \cos^{-1}1/2 = 60^\circ$
9. $\frac{1-\cos 2A}{2} + \frac{1-\cos 2B}{2} + \frac{1-\cos 2C}{2}$
 $\frac{3}{2} - \frac{1}{2}[\cos 2A + \cos 2B + \cos 2C]$ (apply transformations method)
10. $\left(1 - \frac{r_1}{r_2}\right)\left(1 - \frac{r_1}{r_3}\right) = 2 \Rightarrow \left(1 - \frac{s-b}{s-a}\right)\left(1 - \frac{s-c}{s-a}\right) = 2$
 $\Rightarrow (b-a)(c-a) = 2(s-a)^2 \Rightarrow b^2 + c^2 = a^2 \Rightarrow \underline{A} = 90$
11. Let volume $v = \pi x^2 y \rightarrow (1)$
 $P = 2(x+y) \quad 36 = 2(x+y) \rightarrow (2)$
12. $f(x) = (\sin^{-1}x)^2 + (\cos^{-1}x)^2$
 $f'(x) = 0$ (\because f has stationary)
 $\Rightarrow \sin^{-1}x = \cos^{-1}x \Rightarrow x = \frac{1}{\sqrt{2}}$
13. $y = x+1 \quad x = y^2$ Let $d = \frac{|x-y+1|}{\sqrt{2}} = \frac{|y^2-y+1|}{\sqrt{2}}$
 $d^1 = 0 \Rightarrow d$ has maxima or minima
 $\Rightarrow d' = \frac{2y-1}{\sqrt{2}} = 0 \Rightarrow y = \frac{1}{2}, x = \frac{1}{4}$
14. $x^2 - (a-2)x - (a+1) = 0$
 $\alpha + \beta = -\frac{b}{a} \quad \alpha.\beta = c/a$
Let $S = \alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha.\beta$
15. $f(x) = a \log|x| + bx^2 + x$
 $f'(x) = \frac{a}{x} + 2bx + 1 \Rightarrow f'(x) = 0$
Solve $f'(-1) = 0, f'(2) = 0$
16. $f(x) = 2^{(x^2-3)^3+27} \Rightarrow \log f(x) = \left((x^2-3)^3 + 27\right) \log 2$
 $\Rightarrow f'(x) = 0$
17. $S = \frac{t^4}{4} - 2t^3 + 4t^2 + 7$
 $S^1 = t^3 - 6t^2 + 8t \Rightarrow S^{11} = a = 3t^2 - 12t + 8\sigma_x^2$
 $\Rightarrow S^{111}(t) = 0 \Rightarrow S$ has max. or min.
18. $y = \sum_{i=1}^n (x-x_i)^2 = \sum x^2 - 2x \sum x_i + \sum x_i^2$

$$\frac{dy}{dx} = 0 \Rightarrow n(2x) - 2 \sum x_i + 0 = 0 \Rightarrow x = \frac{\sum x_i}{n}$$

19. $\frac{x}{a} + \frac{y}{b} = 1 \Rightarrow \frac{3}{a} + \frac{4}{b} = 1$

$$\frac{4}{b} = 1 - \frac{3}{a} \Rightarrow \frac{1}{b} = \frac{(a-3)}{a} \times \frac{1}{4}$$

$$b = \frac{4a}{a-3}$$

$$A = \frac{1}{2}|ab| \Rightarrow A' = 0 \Rightarrow A \text{ has max. or min.}$$

20. Let $f(x) = x \log x + y \log y$

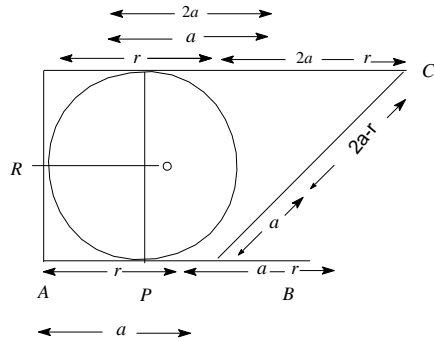
$$x + y = 1 \Rightarrow y = 1 - x$$

$$f(x) = x \log x + (1-x) \log(1-x)$$

$$f'(x) = 0 \Rightarrow f \text{ has maxima (or) minima}$$

21. $\frac{1}{r_1} = \frac{1}{8}, \frac{1}{r_2} = \frac{1}{12}, \frac{1}{r_3} = \frac{1}{24}$

22.



Given $AB \parallel CD, CD = 2AB$. Let $AB = a$, then $CD = 2a$.

let radius of the circle be r .

let the circle touches $AB=r, BP=a-r, DR=DS=r$ and $CS = 2a - r$

In $\triangle BEC$,

$$BC^2 = BE^2 + EC^2 \Rightarrow (a-r+2a-r)^2 = (2r)^2 = 9a^2 + 4r^2 - 12ar$$

$$4r^2 + a^2 \Rightarrow a = \frac{3}{2}r \dots (i)$$

Also, area (quad ABCD) = 18

$$\Rightarrow \text{area (quad ABCD)} + \text{area } (\triangle BCE) = 18$$

$$= a \times 2r + \frac{1}{2} \times a \times 2r = 18 = ar = 6$$

$$= \frac{3r^2}{2} = 6 = r^2 = 4 = r = 2$$

23. $R = 8r = 8 \left(4r \sin \frac{A}{2} \sin \frac{B}{2} \sin \frac{C}{2} \right) \therefore 2 \sin \frac{A}{2} \sin \frac{B}{2} \sin \frac{C}{2} = \frac{1}{16}$

$$\Rightarrow \left(\cos \frac{A-B}{2} - \cos \frac{A+B}{2} \right) \sin \frac{C}{2} = \frac{1}{16}$$

$$\Rightarrow \sin \frac{C}{2} \left(\frac{1}{2} - \sin \frac{C}{2} \right) = \frac{1}{16} = \sin^2 \frac{C}{2} = \frac{1}{4} \Rightarrow \cos c = 1 - 2 \sin^2 \frac{C}{2} = 1 - \frac{1}{8} = \frac{7}{8}$$

24. $f'(x) = 3(x^2 - 2(a-2)x + a)$

$$f'(1) = 0$$

$$\Rightarrow a = 5$$

$$\therefore \frac{f(x) - 14}{(x-1)^2} = \frac{x^3 - 9x^2 + 15x - 7}{(x-1)^2} = x - 7 = 0 \Rightarrow x = 7$$

25. Maxima of $f(x)$ occurred at $x = 2$ i.e. $\alpha = 2$
 Minima of $g(x)$ occurred at $x = -1$ i.e. $\beta = -1$

$$\therefore \lim_{x \rightarrow 2} \frac{(x-1)(x-2)(x-3)}{(x-2)(x-4)} = \frac{1}{2}$$

PHYSICS

26. $y = A \sin \omega t$

$$T \rightarrow 4A$$

$$T + \frac{T}{4} \rightarrow 4A + A = 5A$$

27. $y_1 = \sin \frac{\pi}{6} \sin \omega t + \cos \frac{\pi}{6} \cos \omega t$

$$y_1 = \cos \left(\omega t - \frac{\pi}{6} \right)$$

$$y_2 = \sin \frac{\pi}{3} \sin \omega t + \cos \frac{\pi}{3} \cos \omega t$$

$$= \cos \left(\omega t - \frac{\pi}{3} \right)$$

28. $KE_{\text{avg}} = \frac{\frac{1}{2} m \omega^2 A^2}{2} = \frac{1}{4} m 4 \pi^2 n^2 A^2$

29. $\frac{d^2 x}{dt^2} = -\alpha x$

$$a = -\omega^2 x$$

30. $KE_{\text{avg}} = \frac{1}{2} KE_{\text{max}}$

31. $A = \frac{\text{Weight of removed mass}}{\text{Spring constant}}$

32. $n = \frac{1}{8} \text{ Hz}$

$$\text{in one second } S = A \sin \left[\frac{2\pi}{T} \times 1 \right] = \frac{A}{\sqrt{2}}$$

$$\text{in two seconds } S_1 = A \sin [90^\circ] = A$$

$$S_2 = S_1 - S$$

$$\frac{S_1}{S_2} = \frac{\frac{A}{\sqrt{2}}}{\left[A - \frac{A}{\sqrt{2}} \right]} = \frac{1}{\sqrt{2} - 1}$$

33.

$$a = \omega^2 \theta$$

$$\frac{a}{\theta} = \frac{4\pi^2}{T^2} = \tan \theta$$

$$T^2 \propto \frac{1}{\tan \theta}$$

$$\frac{T_1^2}{T_2^2} = \frac{\tan \theta_2}{\tan \theta_1}$$

$$= \frac{\tan 60}{\tan 30}$$

$$\frac{T_1^2}{T_2^2} = \frac{3}{1}$$

$$\frac{T_1}{T_2} = \sqrt{3} : 1$$

$$34. \quad t_{sp} = t_{lp}$$

$$(n+1)T_{sp} = n(t_{lp})$$

$$(n+1)\sqrt{l_{SP}} = n\sqrt{l_{LP}}$$

$$35. \quad T_1^2 - T_2^2 = \frac{4\pi^2}{g}(l_1 - l_2)$$

$$1.75 = 4(l_1 - l_2)$$

$$36. \quad n = \frac{1}{2\pi} \sqrt{\frac{k_{eff}}{m}} = \frac{1}{k_{eff}} = \frac{1}{2k} + \frac{1}{k} + \frac{1}{k}$$

$$37. \quad \omega_1 t_1 \sim \omega_2 t_2 = \frac{2\pi}{T_1} t \sim \frac{2\pi}{T_2} t$$

$$2\pi\left(\frac{2}{3} \sim \frac{2}{3}\right) = \pi$$

$$38. \quad T = 2\pi \sqrt{\frac{M \left(1 + \frac{k^2}{R^2}\right)}{k}}$$

$$39. \quad T = 2\pi \sqrt{\frac{l}{g}}$$

$$\frac{T_1}{T_2} = \sqrt{\frac{g_2}{g_1}}$$

$$T_2 = 2\sqrt{\frac{g_1}{g_2}}$$

$$g_2 = \frac{3GM}{(3R)^2} = \frac{g}{3}$$

$$T_2 = 2\sqrt{3}s$$

$$40. \quad k_1 = \frac{C}{\ell_1}$$

$$k_2 = \frac{C}{\ell_2}$$

$$\frac{k_1}{k_2} = \frac{C\ell_2}{\ell_1 C} \ell_2 = \frac{\ell_2}{n\ell_2} = \frac{1}{n}$$

41. At $t = 0$ KE is maximum

$$\text{At } t = \frac{T}{4} \text{ KE is zero}$$

KE oscillates with time period $\frac{T}{2}$

42. $V_{\max} = A\omega$

$$v = \omega\sqrt{A^2 - x^2}$$

$$\text{at } x = \frac{2A}{3}$$

$$v = \omega\sqrt{A^2 - \frac{4A^2}{9}}$$

$$v = \frac{\omega A\sqrt{5}}{3}$$

For new amplitude

$$\text{at } x = \frac{2A}{3}$$

$$v' = 3 \times v$$

$$v' = \omega A\sqrt{5}$$

as ω is same

$$\omega A\sqrt{5} = \omega\sqrt{A'^2 - \frac{4A^2}{9}} \Rightarrow 5A^2 = A'^2 - \frac{4A^2}{9}$$

$$A'^2 = \frac{49A^2}{9} \Rightarrow A' = \frac{7A}{3}$$

43. $x = a \sin wt$, $y = a \sin 2wt$

$$y = 2a \sin wt \cos wt, \quad y = 2x\sqrt{1 - \frac{x^2}{a^2}}$$

$$y = \frac{2}{a} x\sqrt{(a-x)(a+x)}$$

44. Cubical expansion $\Delta V = \gamma V \Delta T = 3\alpha V \Delta T$

$$= 3 \times 23 \times 10^{-6} \times \left(\frac{4}{3} \pi (10)^3\right) \times 100$$

$$\left(r = \frac{d}{2} = 10 \text{ cm}\right)$$

$$= 28.9 \text{ cc}$$

45. 100div=130div

$$1\text{div}=130/100$$

$$60\text{div}=60 \times 130/100\text{div on new scale}$$

$$\therefore \text{reading on new scale} = 78^{\circ} + 20 = 98^{\circ}$$

46. $A = \frac{A_0}{2}$ after 10 oscillations

∴ After 2 seconds

$$\frac{A_0}{2} = A_0 e^{-\gamma(2)}$$

$$2 = e^{2\gamma}$$

$$\ln 2 = 2\gamma$$

$$\gamma = \frac{\ln 2}{2}$$

$$\therefore A = A_0 e^{-\gamma t}$$

$$\ln \frac{A_0}{A} = \gamma t$$

$$\ln 1000 = \frac{\ln 2}{2} t$$

$$2 \left(\frac{3 \ln 10}{\ln 2} \right) = t$$

$$t = 19.931 \text{ sec}$$

$$t \approx 20 \text{ sec}$$

47. $A = A_0 e^{-0.1t} = \frac{A_0}{2}$

$$\ln 2 = 0.1t$$

$$t = 10 \ln 2 = 6.93 \approx 7 \text{ sec}$$

48. $\omega^2 A = g, T = \frac{2\pi}{\omega} \quad \omega = 2\pi t$

$$\omega^2 (0.07) = 10 \text{ m/s}^2,$$

$$4\pi^2 f^2 (0.07) = 10 \text{ m/s}^2$$

$$f = \frac{5}{\sqrt{7}} \text{ Hz} = 1.9 \text{ Hz}$$

49. $T = 2\pi \sqrt{\frac{m}{k}}$

50. $t_{sp} = t_{lp}$

$$(n+1)\sqrt{l_{sp}} = n\sqrt{l_{lp}}$$

$$(n+1)\sqrt{l} = n\sqrt{1.44l}$$

CHEMISTRY

51. $\Delta S_{fusion} = \frac{\Delta H_{fusion}}{T_{mp}} = \frac{6.01 \times 1000}{273} = 22 \text{ KJ mole}^{-1}$

52. $\Delta G = \Delta H - T\Delta S$

$$\Delta H = +Ve \quad \Delta S = -Ve \quad \text{then } \Delta G = +Ve \text{ at all temperature}$$

53. $\Delta G^\circ = -2.303 RT \log K_p$

$$= -2.303 \times 8.314 \times 298 \log(4.42 \times 10^4)$$

$$= -26.5 \text{ KJ mole}^{-1}$$

54. $\log K_p = \frac{-\Delta G^\circ}{2.303 RT} = \frac{-(-115 \times 1000)}{2.303 \times 8.314 \times 298} = 20.16$

55. From first law

$$\Delta U = q - w$$

$$0 = q - w \text{ (for isothermal process)}$$

$$q = w = PdV$$

$$dS = nR \cdot \frac{T \cdot dV}{T} \left(P = \frac{nRT}{V} \right)$$

$$dS = nR \frac{dV}{V}$$

$$\text{On integration } \Delta S = nR \ln \frac{V_2}{V_1}$$

$$P_1 V_1 = P_2 V_2$$

$$\frac{V_2}{V_1} = \frac{P_1}{P_2}$$

$$\Delta S = nR \ln \left(\frac{P_1}{P_2} \right)$$

56. $\frac{1}{2} X_2 + \frac{3}{2} Y_2 \rightarrow XY_3$

$$\begin{aligned} \Delta S_{\text{Reaction}}^{\circ} &= \Delta S_{XY_3}^{\circ} - \frac{1}{2} \Delta S_{X_2}^{\circ} - \frac{3}{2} \Delta S_{Y_2}^{\circ} \\ &= 50 - \frac{1}{2} \times 60 - \frac{3}{2} \times 40 = -40 \text{ JK}^{-1} \text{ mole}^{-1} \end{aligned}$$

$$\Delta G = \Delta H - T \Delta S = 0 \quad \text{at equilibrium}$$

$$T = \frac{\Delta H}{\Delta S} = \frac{-30 \times 1000}{40} = 750 \text{ K}$$

57. $C_v = \frac{\Delta U}{n \Delta T} \quad n = \frac{4.48}{2.24} = 0.2$

$$C_v = \frac{12}{0.2 \times 15} = 4 \text{ cal}$$

$$C_p = C_v + R = 4 + 2 = 6 \text{ cal}$$

58. $\Delta H = \Delta U + \Delta n_g RT$

$$-50700 = \Delta U + (-5) 8.314 \times 300$$

$$\Delta U = -38229 \text{ J}$$

59. At equilibrium $H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$ 1 atm, 100°C

$$\Delta S_{\text{Total}} = 0$$

$$\Delta S_{\text{System}} + \Delta S_{\text{Surrounding}} = 0$$

$$\Delta S_{\text{System}} > 0 \text{ and } \Delta S_{\text{Surrounding}} < 0$$

60. $\Delta G^{\circ} = -nFE_{\text{cell}}^{\circ} \quad \Delta G^{\circ} = -2.303 RT \log K$

61. $\Delta H = \Delta U + \Delta n RT \quad \Delta n = 12 - 15 = -3$

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

$$= -3 \times 8.314 \times 298$$

$$= -7432 \text{ J} = -7.43 \text{ KJ}$$

62. Isothermal process $\Delta T = 0$

$$\Delta H = nC_p \Delta T$$

$$\Delta H = 0$$

63. Standard enthalpy of formation zero for $Cl_{2(g)}$ but not $Br_{2(g)}$.

$Cl_{2(g)}$ is natural exist but $Br_{2(l)}$ is exist naturally.

64. $G = H - TS$

$$dG = dH - TdS - SdT$$

$$H = U + PV$$

$$dH = dU + PdV + VdP$$

$$dU = TdS - PdV$$

$$\therefore dG = TdS - PdV + PdV + VdP - TdS - SdT$$

$$dG = VdP - SdT$$

65. The reaction to be spontaneous $\Delta G = -Ve$

$$\Delta G = \Delta H - T\Delta S$$

If ΔH & ΔS are +Ve

$\Delta H < T\Delta S$ in order to be reaction spontaneous

66. NH_4OH is weak base hence heat of neutralization less than 13.6 K cal.

67. $\Delta H = \Delta U + \Delta n RT$

$$\Delta n = \frac{1}{2} - 0 = \frac{1}{2}$$

Thus $\Delta H > \Delta U$

68. The dissociation energy of CH_4 is 400 K cal

$$\text{The C - H bond energy} = \frac{400}{4} = 100 \text{ K cal}$$

In ethane 6C - H bonds and one C - C bond present

$$\text{Hence C - C bond energy} = 670 - 6 \times 100 = 70 \text{ K cal}$$

69. CH_4 (1 mole) 16gr \rightarrow Heat of combustion 880KJ

$$3.2 \text{ gr} \rightarrow x$$

$$x = \frac{3.2 \times 880}{16} = 176 \text{ KJ}$$

70. The enthalpy change does not depends upon no of intermediate states (Hess law)

71. $-\Delta G^\circ = nFE^\circ$

$$= 2 \times 96500 \times 1.1 = 212.3 \text{ KJ}$$

$$\Delta G^\circ = \Delta H - T\Delta S$$

$$\Delta S = \frac{\Delta H - \Delta G}{T} = \frac{-216.7 - (-2123)}{298}$$

$$= -0.01476 \text{ KJ K}^{-1} \text{mole}^{-1}$$

72. $n = \frac{w}{M.wt} = \frac{64}{32} = 2$

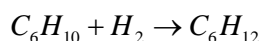
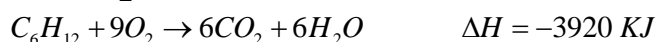
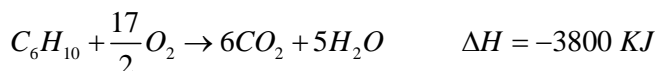
$$\Delta S = 2.303 nR \log \frac{P_1}{P_2}$$

$$= 2.303 \times 2 \times 8.314 \times \log \frac{1}{0.25}$$

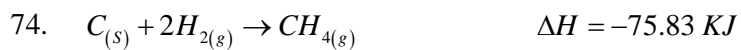
$$= 2.303 \times 2 \times 8.314 \times \log 4$$

$$= 23.053 \text{ JK}^{-1}$$

73. $H_2 + \frac{1}{2}O_2 \rightarrow H_2O_{(l)} \Delta H = -24 \text{ KJ}$



$$\Delta H = -241 - 3800 - (-3920) = -121 \text{ KJ}$$



$$\Delta n = (1 - 2) = -1$$

$$\Delta H = \Delta U + \Delta nRT$$

$$\Delta U = \Delta H - \Delta nRT$$

$$= -75.83 - (-1) \times 8.314 \times 300$$

$$= -75.83 + 2.49 = -73.34 \text{ KJ}$$

75. $w = -2.303 nRT \log \frac{V_2}{V_1}$

$$= -2.303 \times 2 \times 8.314 \times 298 \times \log \frac{20}{10}$$

$$= -3434.9 \text{ Joules}$$