PART-1 : PHYSICS

SECTION-I

1) During a rainy day, rain is falling vertically down with a velocity 2 m/s. A boy at rest starts his motion with a constant acceleration of 2 m/s^2 along a straight road. Find the rate at which the angle of the axis of the umbrella with vertical should be changed so that the rain always appears to fall parallel to the axis of the umbrella.

(A) $\frac{1}{1+t^2}$

(B) $\frac{2}{1+t^2}$

(C) $\frac{1}{2+t^2}$

(D) $\frac{1}{1+2t^2}$

2) A resistance of 2 Ω is connected across one gap of a metre-bridge and unknown resistance, greater than 2Ω, is connected across the other gap. When these resistances are interchanged, the balance point shifts by 20 cm, neglecting any end correction, the unknown resistance is

(A) 3Ω

(B) 4Ω

(C) 5Ω

(D) 6Ω

3) A cobalt (atomic no. = 27) target is bombarded with electrons and the wavelengths of its characteristic X-rays spectrum are measured. A second weak characteristic spectrum is also found due to an impurity in the target. The wavelength of the K_α lines are 225.0 pm (cobalt) and 100.0 pm (impurity). Atomic number of the impurity is

(A) 39

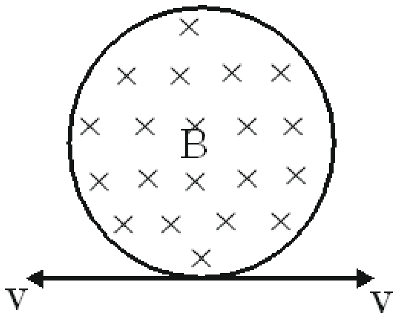
(B) 40

(C) 59

(D) 60

4) A circular conducting loop of radius r_0 and having resistance λ per unit length as shown in the figure is placed in a magnetic field B which is constant. The ends of the loop are crossed and pulled in opposite directions with a velocity v such that the loop always remains circular and the radius of

the loop goes on decreasing, then



(A) current induced in the loop is $\frac{Bv}{2\pi\lambda}$

(B) current induced in the loop is $\frac{Bv}{\pi\lambda}$

(C) current induced in the loop is $\frac{2Bv}{\pi\lambda}$

(D) current induced in the loop is $\frac{Bv}{2\pi}$

5) When a particle of mass m is suspended vertically by a spring of unstretched length 'a', the spring is stretched to a total length ℓ. The particle is pulled down by a small distance 'b' from equilibrium position and then released. The angular frequency of the simple harmonic motion executed by the particle is

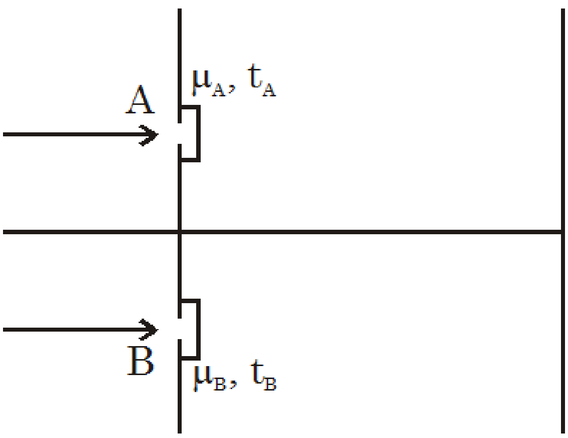
(A) $\sqrt{\frac{g\ell}{(\ell-a)^2}}$

(B) $\sqrt{\frac{ga}{(\ell-a)^2}}$

(C) $\sqrt{\frac{g}{(\ell-a)}}$

(D) $\sqrt{\frac{gb}{(\ell-a)^2}}$

6) In YDSE, let A and B be two slits as shown. Thin films of thickness t_A and t_B and refractive indices μ_A and μ_B are placed in front of A and B respectively. If $\mu_A t_A = \mu_B t_B$, then the central maxima will



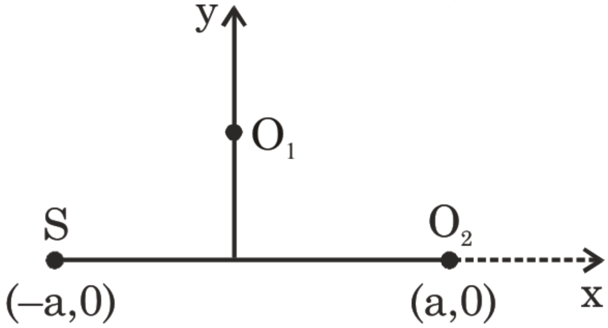
(A) not shift

(B) shift towards A, if $t_B > t_A$

(C) shift towards B, if $t_B > t_A$

(D) shift towards A, if $t_A > t_B$

7) A sound source S and observer O_1 and O_2 are placed as shown in figure. S is always at rest and O_1 and O_2 start moving along positive y–axis and positive x-axis respectively with the same constant speed v_0 at t = 0 away from S. At t = 5 sec, f_1 and f_2 represent apparent frequencies of sound received by O_1 and O_2 respectively. Then the ratio $\left(\frac{f_1}{f_2}\right)$ is



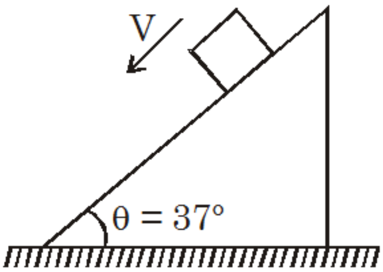
(A) zero

(B) between zero and one

(C) one

(D) more than one

8) A cubical block of side 'a' and density 'ρ' slides down a fixed inclined plane of inclination θ = 37° with a constant velocity v as shown. There is a thin film of viscous liquid of thickness t between the inclined plane and the block. Then the coefficient of viscosity of the liquid will be



(A) $\frac{3\rho agt}{5v}$

(B) $\frac{4\rho agt}{5v}$

(C) $\frac{\rho agt}{v}$

(D) $\frac{5\rho agt}{3v}$

9) A diverging lens of focal length f_1 is placed infront of and coaxially with a concave mirror of focal length f_2. The separation between the lens and the mirror is d. A parallel beam of light incident on the lens returns as a parallel beam from the arrangement.

(A) The beam diameter of the incident and reflected beams will be same.

(B) $d = 2|f_2| - |f_1|$

(C) If the entire arrangement is immersed in water, the conditions will remains unaltered,

(D) none of the above

10) A parallel plate capacitor with initial plate distance d_0 is charged upto voltage V_0 and then detached from the charger. Now the distance between the plates is varied periodically according to the law $d = d_0 + d_1 \sin\omega t$. The value of d_1 if the potential difference across the capacitor changes according to the law $V = V_0\left(1 + \frac{1}{2}\sin\omega t\right)$ is

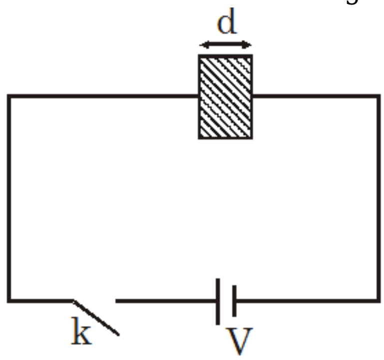
(A) d_0

(B) $\frac{d_0}{2}$

(C) $\frac{3d_0}{2}$

(D) $2d_0$

11) The area of each plate of a capacitor is S and it is completely filled with a dielectric as shown in figure. The dielectric constant and resistivity of the material of the slab inserted in the capacitor are K and ρ respectively. The emf of the ideal cell is V. The current flowing through dielectric slab immediately after the key is switched on is



(A) $\frac{V}{\rho d}S$

(B) $\frac{2V}{\rho d}S$

(C) $\frac{V}{2\rho d}S$

(D) zero

12) A thin insulating rod of length ▯ carries a charge q distributed uniformly on it. The rod is pivoted at its mid point and is rotated at a frequency f about a fixed axis perpendicular to the rod and passing through the pivot. The magnetic moment of the rod system is

(A) $\frac{1}{12}\pi q f \ell^2$

(B) $\pi q f \ell^2$

(C) $\frac{1}{6}\pi q f \ell^2$

(D) $\frac{1}{3}\pi q f \ell^2$

13) A particle of charge q and mass m starts moving from the origin under the action of an electric field $\vec{E} = E_0\hat{i}$ and $\vec{B} = B_0\hat{i}$ with a velocity $\vec{v} = v_0\hat{j}$. The speed of the particle will become $2v_0$ after a time

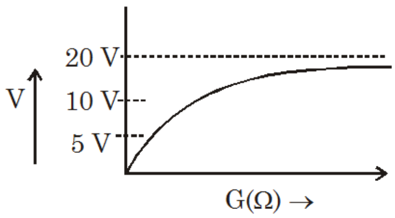
(A) $t = \frac{2mv_0}{qE_0}$

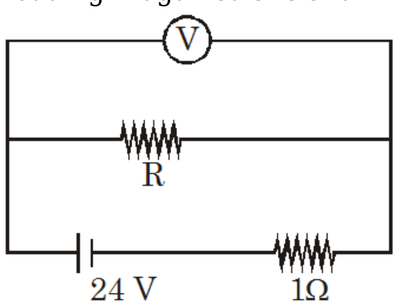
(B) $t = \frac{2B_0q}{mv_0}$

(C) $t = \frac{\sqrt{3}B_0q}{mv_0}$

(D) $t = \frac{\sqrt{3}mv_0}{qE_0}$

14) A cell of internal resistance 1Ω is connected across a resistor R. A voltmeter having variable resistance G is used to measure potential difference across the resistor. The plot of voltmeter reading V against G is shown. What is the value of external resistor R?





(A) 5 Ω

(B) 4 Ω

(C) 3 Ω

(D) 1 Ω

15) Consider the equation $\frac{d}{dt}\left[\int \vec{F}.d\vec{s}\right] = A\left[\vec{F}.\vec{P}\right]$. Then dimensions of A will be (where $\vec{F}$ = force, $d\vec{s}$ = small displacement, t = time and $\vec{P}$ = linear momentum)

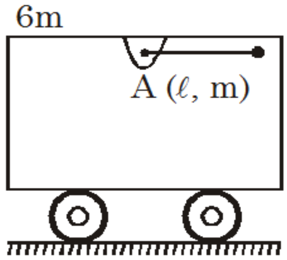
(A) $[M^0L^0T^0]$

(B) $[M^{-1}L^0T^0]$

(C) $[M^1L^0T^0]$

(D) $[M^0L^0T^{-1}]$

16) In the figure shown the cart of mass 6 m is initially at rest on a smooth horizontal surface. A particle of mass m is attached to the end of the light rigid rod which can rotate freely about end A in a vertical plane. If the rod is released from rest from the horizontal position as shown, find the velocity (v_{rel}) of the particle with respect to the cart when the rod is vertical.



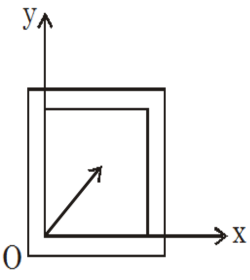
(A) $\sqrt{\frac{7}{3}g\ell}$

(B) $\sqrt{\frac{7}{6}g\ell}$

(C) $\sqrt{\frac{14}{3}g\ell}$

(D) $\sqrt{\frac{8}{3}g\ell}$

17) The figure shows a square carrom board without any pockets. A coin is pushed from the corner, which is the origin, with a velocity $\vec{v} = (2\hat{i} + 3\hat{j})$. Assume gravity and friction to be absent. The coin collides with edges of the carrom board elastically. What is the velocity vector of coin after the 3rd collision?



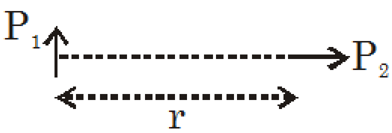
(A) $2\hat{i} + 3\hat{j}$

(B) $2\hat{i} - 3\hat{j}$

(C) $-2\hat{i} + 3\hat{j}$

(D) $-2\hat{i} - 3\hat{j}$

18) Two point electric dipoles with dipole moments P_1 and P_2 are separated by a large distance 'r' with their dipole axes mutually perpendicular as shown. The electric force between the dipoles is (where $K = \frac{1}{4\pi\varepsilon_0}$)



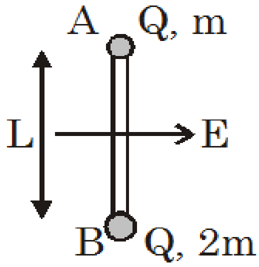
(A) $\frac{6KP_1P_2}{r^4}$

(B) $\frac{3KP_1P_2}{r^4}$

(C) $\frac{2KP_1P_2}{r^4}$

(D) $\frac{KP_1P_2}{r^4}$

19) Two small balls A and B of positive charge Q each and masses m and 2m respectively are connected by a non conducting light rigid rod of length L. This system is released in a uniform electric field of strength E as shown. Just after the release (assume no other force acts on the system).



(A) rod has zero angular acceleration.

(B) rod has angular acceleration $\frac{QE}{2mL}$ in anticlockwise direction.

(C) acceleration of point A is $\frac{2QE}{mL}$ towards right

(D) acceleration of point A is $\frac{QE}{m}$ towards right

20) The plane polarised light is passed through a polaroid. On viewing through the polaroid, we find that when the polaroid is given a complete rotation about an axis coinciding with the direction of the incident light, one of the following is observed,

(A) the intensity of light gradually decreases to zero and remains zero.

(B) the intensity of light gradually increases to a maximum and remains maximum.

(C) there is no change in intensity

(D) the intensity of light is twice maximum and twice zero.

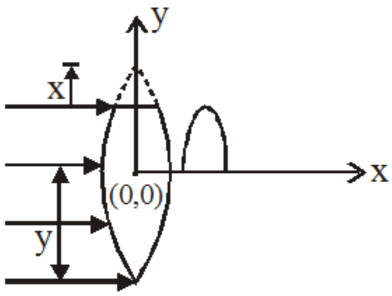
SECTION-II

1) Two identical conducting rods are first connected independently to two vessels, one containing water at 100° C and the other containing ice at 0° C. In the second case, the rods are joined end to end and connected to the same vessels. Let q_1 and q_2 be the rate of melting of ice in two cases respectively. The ratio of $\frac{q_1}{q_2}$ is x. Find value of x.

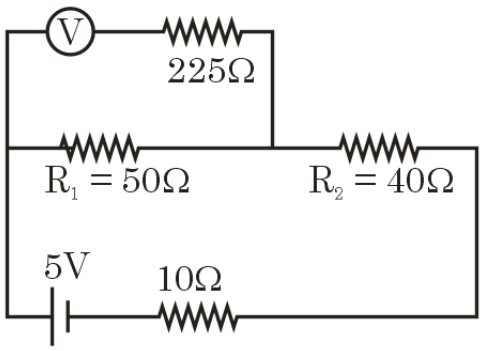
2) An ambulance blowing a siren of frequency 700 Hz is travelling slowly towards vertical reflecting wall with a speed of 2 m/s. The speed of sound is 350 m/s. How many beats are heard per sec to the driver of the ambulance?

3) The dotted part of the lens is cut and kept on the x axis as shown in the diagram. If parallel paraxial rays are falling on this system then the coordinate of image formed after refraction from

both the lenses is (30, –1). If x = 2.5 then find the value of 2y. (all the distances are in cm) (Assume lens have no spherical aberration) :-



4) A battery of EMF 5 V and internal resistance 10 Ω is connected with a resistance R_1 = 50Ω and a resistance R_2 = 40 Ω. A voltmeter of resistance 225 Ω is used to measure the potential difference across R_1. The percentage error made in the reading is 5n. Find n.



5) In YDSE, light of wavelength 60 nm is used. The separation between the sources is 17 mm and between the sources and the screen is 1/2 m. Find the position of a point lying between third maxima and third minima (in μm) where the intensity is three-fourth of the maximum intensity on the screen.

PART-2 : CHEMISTRY

SECTION-I

1) 0.15 M aqueous solution of potassium sulfate has on osmotic pressure of 8.21 atm at 27ºC. Which of the following is correct about the properties of solution?

(A) The value of Van't Hoff factor of K_2SO_4 is 3.

(B) The value of Van't Hoff factor for K_2SO_4 is less than 3 due to partial dissociation of solute.

(C) The value of Van't Hoff factor for K_2SO_4 is more than 3 due to complete dissociation of solute.

(D) The freezing point of solution would be more than 0°C.

2) A solution is made by equilibrating the two solids barium sulfite (K_{sp} = 8 × 10^{-7}) and barium sulfate (K_{sp} = 1.0 × 10^{-8}) with water. What are the concentrations of the three ions at equilibrium, if some of each of the solid remains ?

(A) $[Ba^{2+}]$ = 9 × 10^{-4}M

(B) $\left[SO_4^{2-}\right] = \frac{1}{9} \times 10^{-3}M$

(C) $\left[SO_3^{2-}\right] = \frac{1}{9} \times 10^{-3}M$

(D) All are correct.

3) Which of the following combinations in an aqueous medium will give a red colour or precipitate?

(A) $Fe^{2+} + [Fe(CN)_6]^{3-}$

(B) $Co^{2+} + SCN^-$

(C) $Cu^{2+} + OH^-$

(D) $Fe^{3+} + SCN^-$

4) The value of CFSE of the complex formed in Brown ring test is :

(A) $-1.8\Delta_0$

(B) $-2.4\ \Delta_0$

(C) $-0.4\Delta_0$

(D) $-0.8\Delta_0$

5) $Mn^{3+} + e^- \rightarrow Mn^{2+}$ $E^o = 1.50V$ $Fe^{3+} + e^- \rightarrow Fe^{2+}$ $E^o = 0.77V$
$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ $E^o = 1.23V$
Which of the following statement is correct, based on the information given above?

(A) O_2 oxidizes Mn^{2+} to Mn^{3+}

(B) Mn^{3+} oxidizes H_2O to O_2

(C) O_2 oxidizes both Mn^{2+} to Mn^{3+} and Fe^{2+} to Fe^{3+}

(D) O_2 can not oxidizes Fe^{2+} to Fe^{3+}

6) Which of the following relationship between radii of Gallium and nitrogen in GaN and the lattice parameter, for gallium nitride is correct ? Gallium nitride has hcp lattice of nitride ions and Ga^{3+} occupying half of the tetrahedral voids, without disturbing the lattice of N^{3-} ion

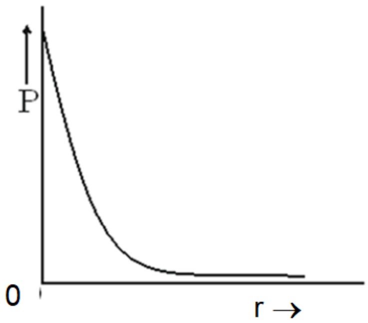
(A) $c = \sqrt{\frac{2}{3}}.r_{N^{3-}}$

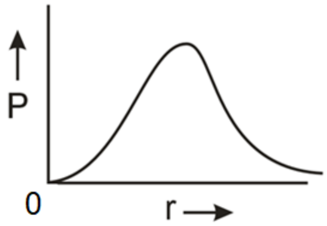
(B) $r_{Ga^{3+}} = 0.42\ r_{N^{3-}}$

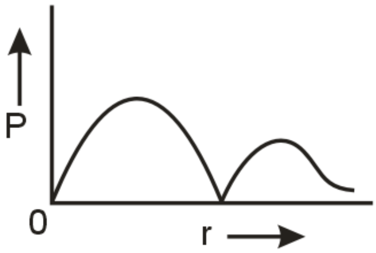
(C) $a = 2 \times r_{N^{3-}}$

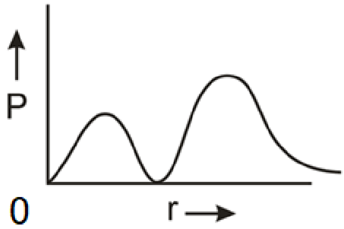
(D) $a = 0.89\ r_{N^{3-}}$

7) P is the probability of finding the 2s electron of hydrogen atom in a spherical shell of infinitesimal thickness, dr at a distance r from nucleus, the volume of this shell is $4\pi r^2 dr$. The qualititative sketch of the dependence of $\left(\frac{P}{dr}\right)$ on r is

(A) 

(B) 

(C) 

(D) 

8) Which one of the following is pyrosilicate?

(A) Forsterite
(B) Hemimorphite
(C) Barysilite
(D) Thortveitite

9) Among the following, the incorrect statement is

(A) P_4O_{10} is an oxidizing agent
(B) P_4O_{10} is an simple anhydride of H_3PO_4
(C) When P_4O_{10} react with HNO_3 than N_2O_5 and HPO_3 are formed
(D) P_4O_{10} is a dehydrating agent.

10) Which among the following has highest E.A.?

(A) Ne
(B) Mg

(C) Ar

(D) Li

11) 90 gm mixture of H_2 and O_2 is taken in stoichiometric ratio and gives H_2O with 50% yield. The produced mass of H_2O (in gm) is :

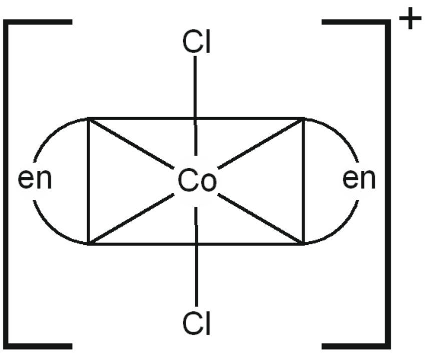
(A) 45 gm

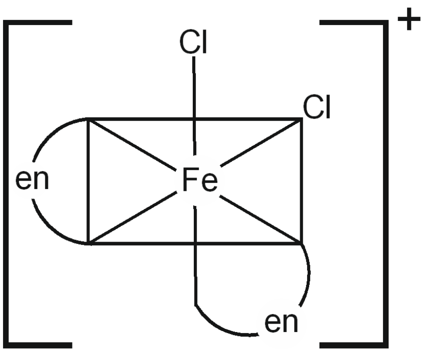
(B) 36 gm

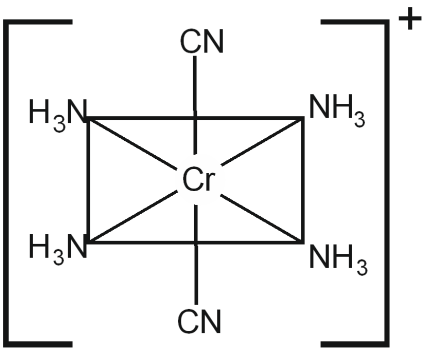
(C) 20 gm

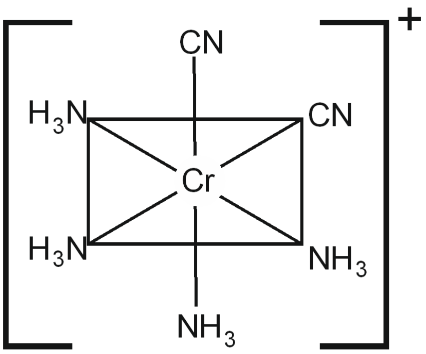
(D) 90 gm

12) Which of the following complex displays optical activity?

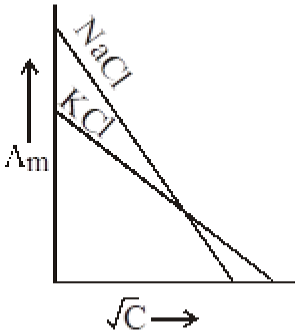
(A) 

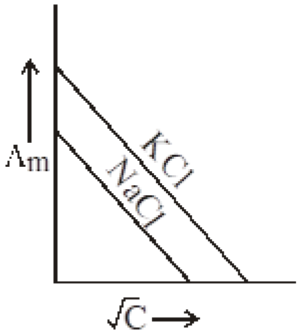
(B) 

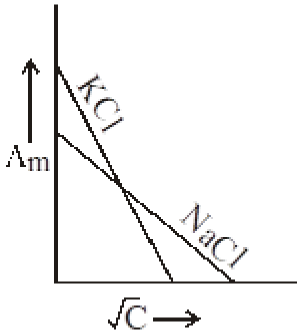
(C) 

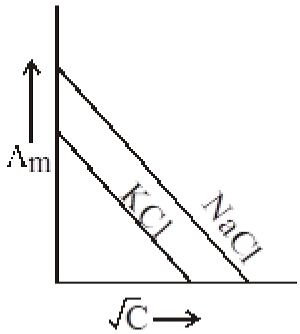
(D) 

13) Which one of the following graphs between molar conductivity (Λ_m) versus $\sqrt{C}$ is correct?

(A) 

(B) 

(C) 

(D) 

14) The compound formed by the reaction between borazine $(B_3N_3H_6)$ and HCl is :

(A) $B_3N_3H_7Cl$

(B) $B_3N_3H_8Cl_2$

(C) $B_3N_3H_9Cl_3$

(D) $B_3N_3H_{10}Cl_4$

15) Which of the following is NOT a property of borax?

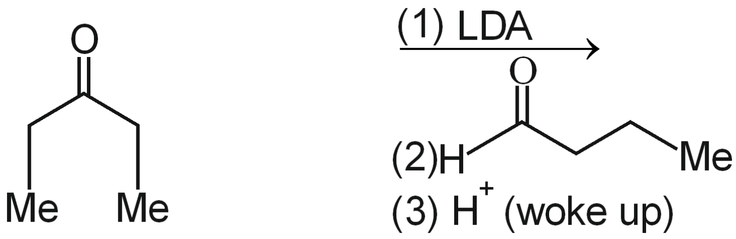
(A) It is soluble in water

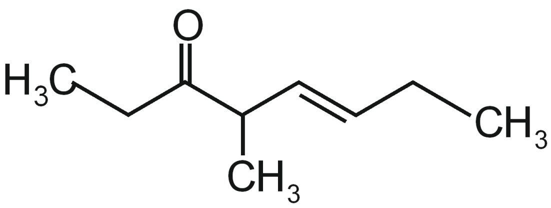
(B) It is crystallized from aqueous solution as a decahydrated salt

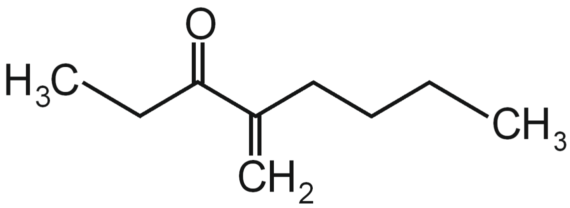
(C) It's anion undergoes hydrolysis in water

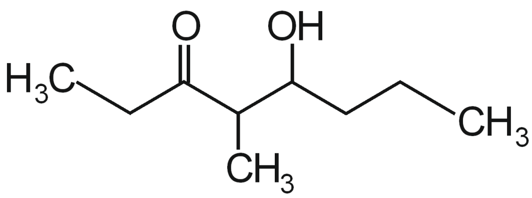
(D) On heating it forms sodium boride

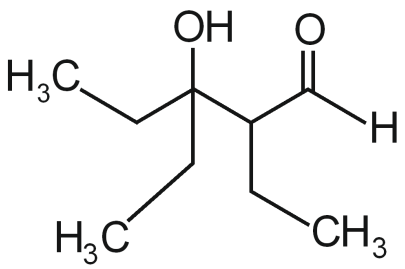
16) Provide the product of the following crossed aldol reaction?



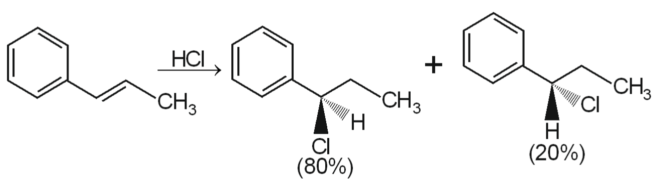
(A) 

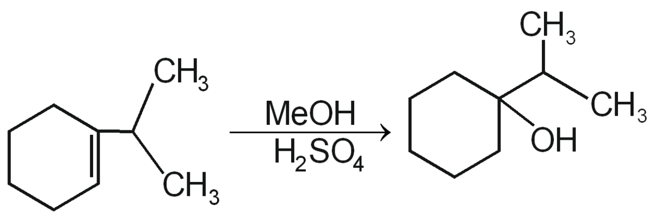
(B) 

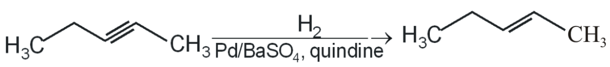
(C) 

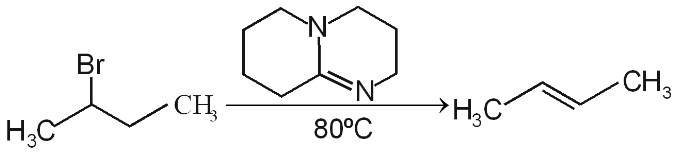
(D) 

17) Which of the following reactions are correctly matched with the product?

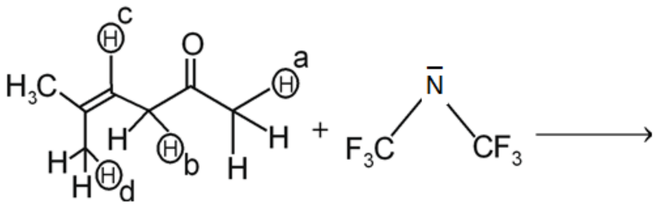
(A) 

(B) 

(C) 

(D) 

18) Which of the following labelled can be removed by base in the above reaction?

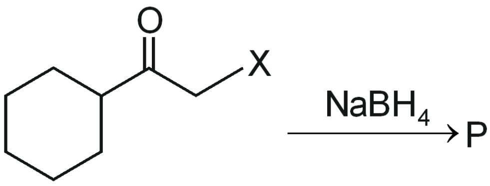


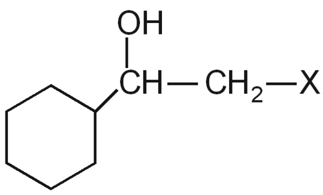
(A) a

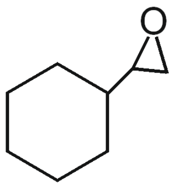
(B) b

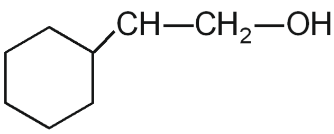
(C) c

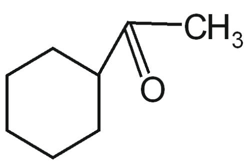
(D) d

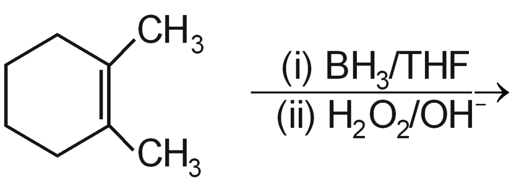
19)  P (Major)is

(A) 

(B) 

(C) 

(D) 

20) 

Among the following correct statement is :

(A) Number of product in given reaction is one.

(B) Reaction is anti-addition

(C) Number of products in given reaction is four.

(D) Number of products in given reaction is two.

SECTION-II

1) What is resistance (in ohm) in a cell (with cell constant 0.18 cm^{-1}) of 0.18 M solution of acetic acid at 25ºC? Given, $K_a = 1.8 \times 10^{-5}$, $\Lambda_m^0 (CH_3COOH) = 400\ ohm^{-1}\ cm^2\ mol^{-1}$

2) Pressure over an ideal binary liquid solution containing 10 moles of each of liquid A and B is gradually decreased isothermally. At what pressure (in torr), half of the total amount of liquid will get converted into vapour? ($P_A^0 = 400$ torr, $P_B^0 = 100$ torr)

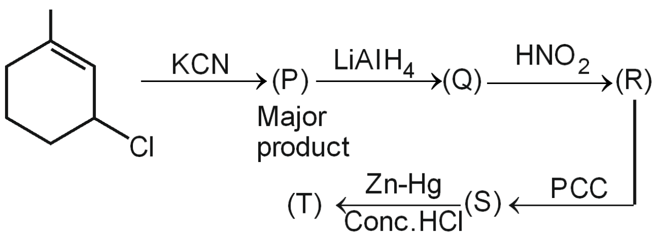
3) How much heat (in kcal) is absorbed when two moles of N_2 gas is heated from 1000 K to 1500 K at constant pressure? [R = 2cal K^{-1} mol^{-1}] $\left[C_p = \frac{7R}{2}\right]$

4) $H_3C-\overset{Cl}{\underset{*}{C}}H-CH_2-CH_3 \longrightarrow X$ [Number of dihalogen derivatives including stereo isomers] (At $\underset{*}{'C'}$ carbon configuration is fixed)

$\downarrow$ Fractional distillation

Y

Then the value of (X + Y) is

5) 

What is the molar mass of (T) in g mol^{-1} unit?

PART-3 : MATHEMATICS

SECTION-I

1) The value of $\tan^{-1}\left(\sqrt{\frac{x(x+y+z)}{yz}}\right)+\tan^{-1}\left(\sqrt{\frac{y(x+y+z)}{zx}}\right)+\tan^{-1}\left(\sqrt{\frac{z(x+y+z)}{xy}}\right)$ is :-

(where x, y, z are distinct positive real numbers)

(A) π

(B) $\frac{\pi}{4}$

(C) $\frac{\pi}{2}$

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

2) A line 'L' passing through P(1, 2, 1) and perpendicular to both the line $\frac{x-1}{1} = \frac{y-1}{-1} = \frac{z+1}{-2}$ and $\frac{x+2}{2} = \frac{y-4}{1} = \frac{z+1}{1}$. If the position vector of point Q on 'L' is (a, b, c) such that $(PQ)^2 = 35$, then (a + b + c) can be

(A) 4

(B) 5

(C) 6

(D) 7

3) If $A_1, A_3, A_5, \ldots\ldots, A_{2n-1}$ are 'n' skew symmetric matrices of same order, then B = $\sum_{r=1}^{n} (2r-1)\,(A_{2r-1})^{2r-1}$ will be :-

(A) Symmetric matrix

(B) Skew symmetric matrix

(C) Neither symmetric nor skew symmetric matrix

(D) Data is inadequate

4) Given that $\sum_{i=0}^{n} {}^{n}C_i \cdot p^i(1-p)^{n-i}$ = 1. The value of $\sum_{i=0}^{n} i \cdot {}^{n}C_i \cdot p^i(1-p)^{n-i}$ is

(A) np(1 – p)

(B) np

(C) $\frac{n(n+1)}{2}$

(D) $\frac{n^2(n+1)}{2}$

5) A box contains 12 mangoes out of which 5 are rotten. Two mangoes are taken out together. If one of them is found to be good then the probability that the other is also good is

(A) $\frac{3}{8}$

(B) $\frac{7}{22}$

(C) $\frac{28}{33}$

(D) None of these

6) If $I_1 = \int_0^2 \frac{[x^2]}{[x^2-4x-4]+[x^2]}\,dx$ and $I_2 = \int_0^2 \frac{4}{[x^2-4x]+[x^2-4]}\,dx$, then $I_1 - I_2$ = (where [k] denotes greatest integer function less than or equal to k.)

(A) 0

(B) 1

(C) 2

(D) $\frac{1}{2}$

7) The area bounded by $y = |x|$ and $y = x^2 - 2$, is :-

(A) $\frac{8}{3}$

(B) $\frac{20}{3}$

(C) $\frac{16}{3}$

(D) None of these

8) Solution of the differential equation $\frac{dx}{dy} - \frac{x \ln x}{1+\ln x} = \frac{e^y}{1+\ln x}$, if $y(1) = 0$, is :-

(A) $x^x = e^{ye^y}$

(B) $e^y = x^{e^y}$

(C) $x = ye^y$

(D) $y = e^{xy}$

9) ABCD is a quadrilateral with $\overrightarrow{AB} = \vec{a}$, $\overrightarrow{AD} = \vec{b}$ and $\overrightarrow{AC} = 2\vec{a} + 3\vec{b}$. If its area is k times of area of parallelogram with AB and AD as its adjacent sides, then k is :-

(A) 5

(B) $\frac{5}{2}$

(C) 4

(D) 6

10) The locus of centre of circle which cuts off the intercept on the co-ordinate axes of given length is a conic, whose eccentricity is :-

(A) 1

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

(C) $\sqrt{2}$

(D) $\sqrt{3}$

11) If $x - 2y + 4 = 0$ is a common tangent to $y^2 = 4x$ and $\frac{x^2}{4} + \frac{y^2}{b^2} = 1$, then the equation of other common tangent is :-

(A) $x + 2y + 4 = 0$

(B) $x + 2y - 4 = 0$

(C) $2x + y + 4 = 0$

(D) $2x - y + 8 = 0$

12) The vertex of a parabola is at $(4, 3)$ and directrix is $x - y + 1 = 0$. Then the equation of its latus rectum is :-

(A) $x - y = 2$

(B) $x - y = 3$

(C) $x - y = 1$

(D) $x + y = 2$

13) Water is dropped at the rate of $2cm^3$/sec into a cone of semivertical angle 45°. The rate at which periphery of water surface changes when height of the water in the cone is 2 cm, is :-

(A) 1 cm/sec

(B) 2 cm/sec

(C) 3 cm/sec

(D) 4 cm/sec

14) The eccentricity of locus of z satisfying $| z - 5 | - | z + 5 | = \pm 6$, is :- (where z is complex number)

(A) $\frac{5}{4}$

(B) $\frac{5}{3}$

(C) $\frac{4}{3}$

(D) 2

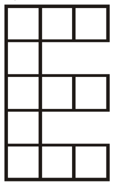
15) The dual of statement $(p \vee \sim q) \wedge (\sim p)$, is :-

(A) $(p \vee \sim q) \wedge (\sim p)$

(B) $(p \wedge \sim q) \wedge (\sim p)$

(C) $(p \vee \sim q) \vee (\sim p)$

(D) $(p \wedge \sim q) \vee (\sim p)$

16) The number of ways in which A A B B C C can placed in squares of given figure so that no row remains empty are :- 

(A) 2430

(B) 1620

(C) 810

(D) 7290

17) The value of $\lim\limits_{x\to 0} \frac{x}{\tan 7x}\left((8x+9)^{\frac{1}{\pi}\tan^{-1}\left(\frac{1}{x}\right)}\right)\cdot\left(\frac{x+\sin 6x}{\int_0^x e^{t^2}\,dt}\right)$ is :-

(A) 1

(B) 2

(C) 3

(D) Does not exists

18) If $f(x) = \lim\limits_{n\to\infty} \frac{x^n - x^{-n}}{x^n + x^{-n}}$, $x > 1$, then $\int \frac{x\,f(x)\,\ln(x+\sqrt{1+x^2})}{\sqrt{1+x^2}}\,dx$, is :-
(where c is constant of integration)

(A) $\ln\left(x+\sqrt{1+x^2}\right) - x + c$

(B) $\frac{1}{2}\left(x^2 + \ln(x+\sqrt{1+x^2}) - x^2\right) + c$

(C) $x\ln\left(x+\sqrt{1+x^2}\right) - \ln\left(x+\sqrt{1+x^2}\right) + c$

(D) $\left(\sqrt{1+x^2}\right)\ \ln\left(x+\sqrt{1+x^2}\right) - x + c$

19) The average salary of male employees in a firm was Rs. 520 and that of females was Rs. 420. the mean salary of all the employees was Rs. 500. The percentage of male employees is

(A) 80

(B) 60

(C) 40

(D) 20

20) Let $y = f(3x)$, where x takes all values only in $[-1, 1]$ and y takes all values only in $[-3, 5]$ then domain and range of $g(x) = 2 + 3f(2x + 1)$ are $[a, b]$ and $[c, d]$ respectively, then the value of $(a + b + c + d)$ is equal to

(A) 7

(B) 8

(C) 9

(D) 10

SECTION-II

1) The number of solution of the equation $x^3 + x^2 + 3x + 2\sin x = 0$ in $-2\pi \le x \le 4\pi$ is

2) Let $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. If $\vec{c}$ is a vector such that $\vec{a} \cdot \vec{c} = |\vec{c}|$, $|\vec{c} - \vec{a}| = 2\sqrt{2}$ then maximum value of $\left[\vec{a}\ \vec{b}\ \vec{c}\right]$ is :-

3) Point A (a, b) on the function $f(x) = x^2$ and B (r, s) on the function $g(x) = -\frac{8}{x}$, where $a > 0$ and $r > 0$.
If the line through A and B is also tangent to both the curve at these points respectively, then the value of $4r + s + b \div a$ is

4) If $a_1, a_2, a_3, \ldots\ldots, a_n$ are in H.P. and $a_4 = 5$, $a_5 = 4$, then $\begin{vmatrix} a_1 & a_3 & a_2 \\ a_4 & a_{20} & a_5 \\ a_2 & a_8 & a_4 \end{vmatrix}$ is equal to

5) The area of triangle with vertices $\left(\sqrt{3} + i\right) z$, $\left(-3 + \sqrt{3}i\right) z$ and $\left(\sqrt{3} - 3 + \left(\sqrt{3} + 1\right) i\right) z$ is 48, then | z | is equal to :- (where $i = \sqrt{-1}$ and z is complex number)

ANSWER KEYS

PART-1 : PHYSICS

SECTION-I

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	**A**	**A**	**B**	**B**	**C**	**B**	**D**	**A**	**B**	**B**	**A**	**A**	**D**	**A**	**B**	**A**	**C**	**B**	**D**	**D**

SECTION-II

Q.	21	22	23	24	25
A.	**4**	**8**	**9**	**2**	**5**

PART-2 : CHEMISTRY

SECTION-I

Q.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
A.	**B**	**A**	**D**	**D**	**B**	**C**	**D**	**B**	**A**	**D**	**A**	**B**	**B**	**C**	**D**	**C**	**D**	**B**	**B**	**D**

SECTION-II

Q.	46	47	48	49	50
A.	**250**	**200**	**7**	**10**	**147**

PART-3 : MATHEMATICS

SECTION-I

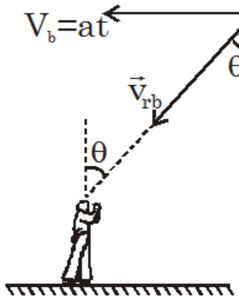
Q.	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
A.	**A**	**B**	**B**	**B**	**A**	**B**	**B**	**A**	**B**	**C**	**A**	**B**	**A**	**B**	**D**	**D**	**D**	**D**	**A**	**C**

SECTION-II

Q.	71	72	73	74	75
A.	**1**	**3**	**0**	**25**	**4**

PART-1 : PHYSICS

1) $\vec{v}_{r,b} = \vec{v}_r - \vec{v}_b$



$\tan\theta = \frac{at}{v} = t$

$\Rightarrow \sec^2\theta \frac{d\theta}{dt} = 1$

$\frac{d\theta}{dt} = \frac{1}{\sec^2\theta} = \frac{1}{\left(1-t^2\right)}$

2) $\frac{x}{2} = \frac{\ell}{1-\ell}\ \frac{2}{x} = \frac{\ell+0.2}{1-(\ell+0.2)} - \frac{\ell-0.2}{0.8-\ell}$

$\frac{\ell(\ell+0.2)}{(1-\ell)(0.8-\ell)} - 1$

$l^2 + 0.2l = 0.8 + l^2 - 0.8l - l$

$2l = 0.8$

$l = 0.4$ m

$\frac{x}{2} = \frac{0.4}{0.6} \Rightarrow x = \frac{4}{3}$

$\frac{2}{x} = \frac{\ell-0.2}{1-(\ell-0.2)} = \frac{\ell-0.2}{1.2-\ell}$

$1 = \frac{\ell(\ell-0.2)}{(1-\ell)(1.2-\ell)}$

$l^2 = 0.2l - 1.2 + l^2 = 2.2\,l$

$2l = 1.2$

$l = 0.6$

$\Rightarrow x = \frac{2 \times 0.6}{0.4} = 3\Omega$

3) Using Mosely's law for both cobalt and impurity

$\sqrt{v} = K(Z-1)$

$\Rightarrow \sqrt{\frac{c}{\lambda_{CO}}} = K(Z_{CO}-1)$ and $\sqrt{\frac{c}{\lambda_x}} = k(Z_x-1)$

$\sqrt{\frac{\lambda_{CO}}{\lambda_x}} = \frac{Z_x-1}{Z_{CO}-1} \Rightarrow Z_x = 40$

4) given that, perimeter is decreasing at a rate of 2v

$\therefore -\frac{d}{dt}(2\pi r) = 2v$

$\Rightarrow \frac{dr}{dt} = -\frac{v}{\pi}$

$\phi = B\pi r^2$

$\varepsilon = \left|-\frac{d\phi}{dt}\right|$

$\varepsilon = B2\pi r\left|\frac{dr}{dt}\right| = B2\pi r\frac{v}{\pi} = 2Brv$

$\Rightarrow I = \frac{\varepsilon}{R} = \frac{2Brv}{R}$

$I = \frac{2Brv}{\lambda(2\pi r)}$

$I = \frac{Bv}{\pi\lambda}$

5) $\omega = \sqrt{\frac{k}{m}}$

At equilibrium $k(l - a) = mg$

$\Rightarrow \frac{k}{m} = \frac{g}{(\ell - a)}$

$\Rightarrow$ Angular frequency, $\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{g}{(\ell - a)}}$

6) $\Delta r = (\mu_A - 1)t_A - (\mu_B - 1)t_B$

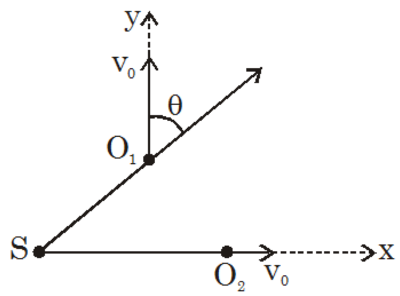
$= \mu_A t_A - t_A - m_B t_B + t_B$

$= t_B - t_A$

$\Rightarrow$ If $\Delta r > 0$, then fringe pattern will shift upwards (towards A)

$\Rightarrow$ If $\Delta r < 0$, then fringe pattern will shift upwards (towards B)

7) $f_1 = f_0\left(\frac{v - v_0\cos\theta}{v}\right)$



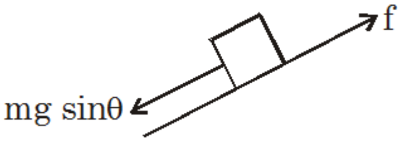
$f_2 = f_0\left(\frac{v - v_0}{v}\right)$

$f_1 > f_2$ $(\because v_0\cos\theta < v_0)$

$\Rightarrow \left(\frac{f_1}{f_2}\right) > 1$

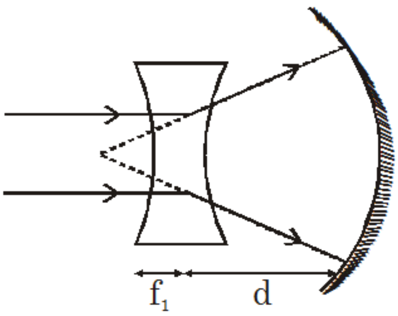
8) $mg\sin\theta = \eta A\frac{v}{t}$

$a^3\rho g \times \frac{3}{5} = \eta \times a^2 \times \frac{v}{t}$



$\frac{3}{5}a\rho g = \frac{\eta v}{t}$

$\eta = \frac{3\rho agt}{5v}$



9)

$(d + |f_1|) = 2|f_2|$

$\Rightarrow d = 2|f_2| - |f_1|$

10) As charge on the capacitor is conserved

$\Rightarrow C_0V_0 = C'V$

$\Rightarrow \frac{\varepsilon_0 A}{d_0}V_0 = \frac{\varepsilon_0 A}{d}V$

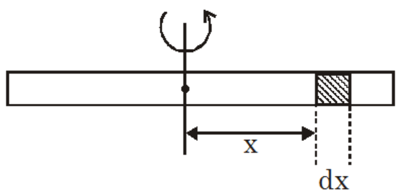
$\Rightarrow \frac{V_0}{d_0} = \frac{V_0}{d}\left(1 + \frac{1}{2}\sin\omega t\right)$

$d_1 = \frac{d_0}{2}$

11) Current, $I = \left(\frac{V}{\rho d/S}\right) = \frac{VS}{\rho d}$

12) $dM = IA = (dq)f\pi x^2$

$= \frac{q}{\ell}dxf\pi x^2$



$$M = \frac{qf\pi}{\ell}\int_{-\ell/2}^{\ell/2} x^2 dx = \frac{q\pi f\ell^2}{12}$$

13) $\vec{E}$ is parallel to $\vec{B}$. $\vec{v}_0$ is perpendicular to both. Therefore path of the particle is a helix with increasing pitch. Speed of particle at any time t is $v = \sqrt{v_x^2 + v_y^2 + v_z^2}$ ....(i)

Here, $v_y^2 + v_z^2 = v_0^2$

$v = 2v_0$

putting this in equation (i)

$v_x = \sqrt{3}v$ and $v_x = \frac{qE_0}{m}t$

$$t = \frac{\sqrt{3}mv_0}{qE_0}$$

14) $I = \frac{24}{\frac{RG}{R+G} + 1}$

V= 24 - potential difference across 1Ω

= 24-1

$$V = 24 - \left(\frac{24}{\frac{1}{\frac{1}{R}+\frac{1}{G}} + 1}\right)$$

For $G \to \infty \Rightarrow \frac{1}{G} \to 0$ and $V = 20$ volts

$$\Rightarrow 20 = 24 - \frac{24}{R+1} \Rightarrow R = 5\Omega$$

15) $A = \frac{\frac{d}{dt}\left[\int \vec{F}.d\vec{s}\right]}{\left[\vec{F}.\vec{P}\right]}$

$$= \frac{[\text{Work}]}{\text{time} \times \frac{\text{work}}{\text{displacement}} \times P} = \frac{1}{M}$$

16) Using conservation of momentum :

$m(v_r - v) = 6mv$

$\Rightarrow v_r = 7v$ ...(i)

Now, using conservation of energy:

$$mg\ell = \frac{1}{2}m(6v)^2 + \frac{1}{2}6mv^2$$

$$\therefore v_r = 7v = \sqrt{\frac{7g\ell}{3}}$$

17) After each collision normal components of velocity gets reversed.

∴ after 1st collision, velocity of coin, $\vec{v}_1 = 2\hat{i} - 3\hat{j}$

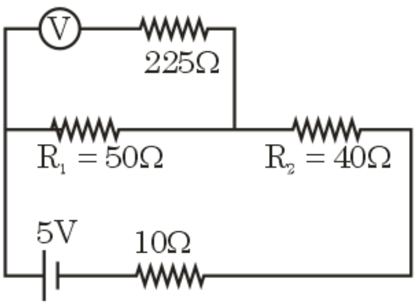
after 2^{nd} collision, velocity of coin, $\vec{v}_2 = -2\hat{i} - 3\hat{j}$
after 3^{rd} collision, velocity of coin, $\vec{v}_3 = -2\hat{i} + 3\hat{j}$

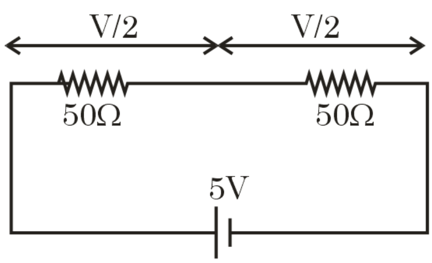
18) $E_1 = \frac{KP_1}{r^3}$
$F = P_2\left|\frac{dE_1}{dr}\right| = \frac{3KP_1P_2}{r^4}$

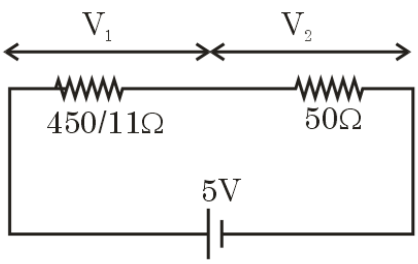
19) Acceleration of centre of mass of the system,
$a_c = \frac{2QE}{3m}$
$$QE\left(\frac{2L}{3}\right) - QE\left(\frac{L}{3}\right) = \left(m \times \frac{4L^2}{9} + 2m \times \frac{L^2}{9}\right)\alpha$$
$$\frac{QEL}{3} = \frac{2mL^2}{3}\alpha$$
$\alpha = \frac{QE}{2mL}$ clockwise
$$a_A = a_C + \alpha\left(\frac{2L}{3}\right) = \frac{2QE}{3m} + \frac{QE}{2mL}\left(\frac{2L}{3}\right) = \frac{QE}{m}$$

20) As it passes twice the transmission axis in one rotation.

23) Image distance is 30 cm $\frac{1}{F} = \frac{1}{f} + \frac{1}{f}$
$\frac{1}{30} = \frac{2}{f}$
f = 60 cm
As optical axis shifts down by (y – x) for second lens
$m = \frac{y - x - 1}{y - x}$
y = 4.5 cm



24)




$$\text{Error} = \frac{\frac{V}{2} - \frac{9V}{20}}{\frac{V}{2}} \times 100$$

Error = 10%

$$V_1 : V_2 :: \frac{450}{11} : 50$$

$V_1 : V_2 :: 9 : 11$

$$V_1 = \frac{9}{20}V$$

25) Since, $I = 4I^0 \cos^2\left(\frac{\phi}{2}\right)$

Where $I = \frac{3}{4}(4I_0) = 3I_0$

$$\Rightarrow \cos\left(\frac{\phi}{2}\right) = \pm\frac{\sqrt{3}}{2}$$

$$\Rightarrow \left(\frac{\phi}{2}\right) = n\pi \pm \frac{\pi}{6}$$

$$\Rightarrow \phi = 2n\pi \pm \frac{\pi}{3}$$

Since, $\phi = \frac{2\pi}{\lambda}\Delta x$ where $\Delta x = \frac{y_n d}{D}$

$$\Rightarrow y_n = \left(n \pm \frac{1}{6}\right)\frac{\lambda D}{d}$$

For the point lying between third minima and third maxima, We have n = 3

$$\Rightarrow y_3 = \left(3 - \frac{1}{6}\right)\frac{\lambda D}{d}$$

$$\Rightarrow y_3 = \frac{17}{6}\left(\frac{\lambda D}{d}\right)$$

Substituting l = 0.6×10^{-6} m, D = 1/2m, d = 17 mm, we get

$$y_3 = \frac{17}{6}\frac{\left(0.6 \times 10^{-6}\right)(1/2)}{17 \times 10^{-3}} = 5\ \mu\text{m}$$

PART-2 : CHEMISTRY

26) π = i.CRT

$$i = \frac{8.21}{0.15 \times 0.0821 \times 300} = 2.22$$

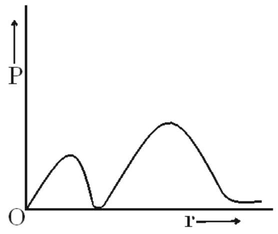
27) Let solubility barium sulphite is x mol/L and that of barium sulphate is y mol/L. $(x + y)x = 8 \times 10^{-7}$

$(x + y)y = 1 \times 10^{-8}$

28) $Fe(SCN)_3$ is red colour

29) Brown ring complex is $[Fe(H_2O)_5(NO)]^{+2}$

32) Sketch for 2s orbital is



33) Hemimorphite is pyrosilicate.

34) P_4O_{10} is not an oxidizing agent

$P_4O_{10} + NaCl \rightarrow POCl_3 + NaPO_4$

36)

H_2 + $\frac{1}{2}O_2$ → H_2O

2g 16g → 18g

For 18 gm mixture → 18 gm H_2O is produced

For 90g mixture → 90g H_2O is produced (100%) yield

If yield is 50% then 45 gm H_2O is produced

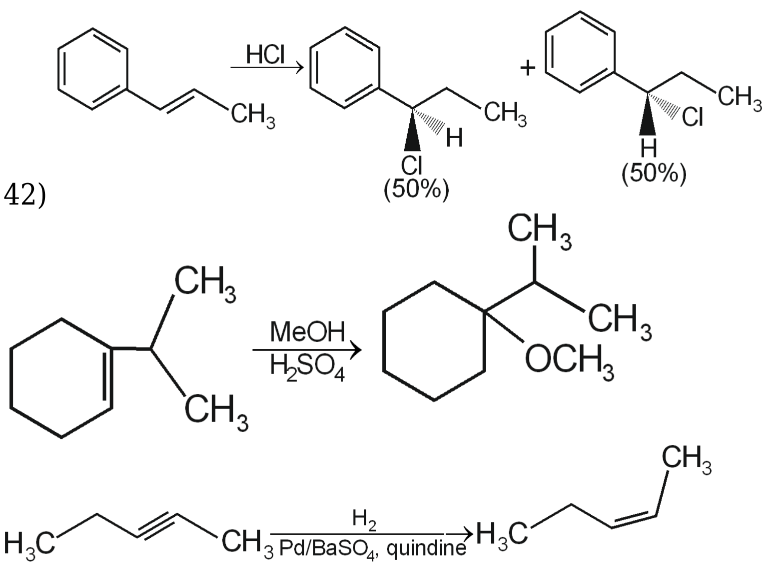
37) It contains no symmetry element.

38) Both NaCl and KCl are strong electrolytes and as Na^+(aq.) has less conductance than K^+(aq.) due to more hydration therefore the graph of option (2) is correct.

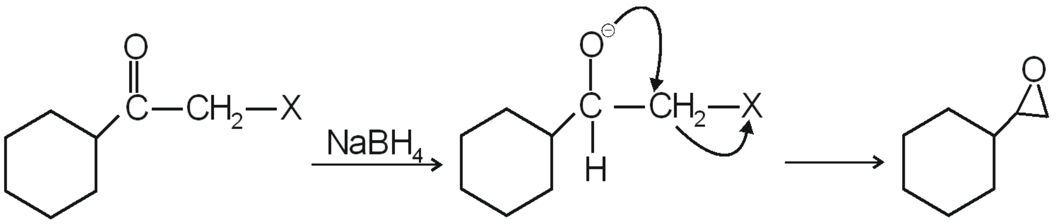
39) $B_3N_3H_6 + 3HCl \rightarrow B_3N_3H_9Cl_3$

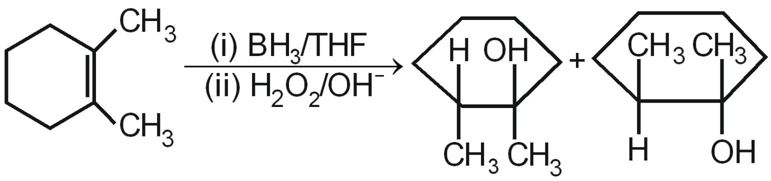
40) $Na_2B_4O_7 \xrightarrow{\Delta} 2NaBO_2 + B_2O_3$

42)



43) Conjugate base formed after removal of H (b) is resonance stabilized by both keto and alkene group.

44) 

45) 

46) Degree of dissociation (a) = $\frac{\wedge m}{\wedge_m^0} \Rightarrow \wedge m = \wedge_m^0 \times \alpha$

$= \wedge_m^0 \times \sqrt{\frac{K_a}{C}}$ (by Ostwald dilution law)

$= 400 \times \sqrt{\frac{1.8 \times 10^{-5}}{0.18}}$ $= 4.00\ ohm^{-1}\ cm^2\ mol^{-1}$

Conductivity= $\frac{\text{molarity} \times \wedge_m}{1000}$

$= 7.2 \times 10^{-4}\ ohm^{-1}\ cm^{-1}$

Also conductivity = Cell constant × $\frac{1}{\text{Resistance}}$

Resistance = $\frac{\text{Cell constant}}{\text{Conductivity}}$

$= \frac{0.18}{7.2 \times 10^{-4}}$ = 284.9 ohm

47) Let the final composition, liquid (10 mole) A = x mole, B = (10 – x) mole

Vapour (10 moles), A = 10 – x mole; B = x mole

Now, $\frac{Y_A}{Y_B} = \frac{X_A}{X_B}\frac{P_A^0}{P_B^0} \Rightarrow \frac{10 - x}{x} = \frac{x}{10 - x} \times \frac{400}{100}$

$x = \frac{10}{3}$

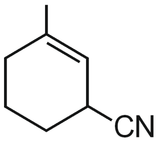
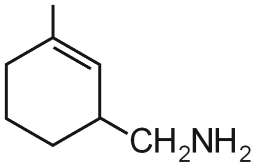
Now, $P = X_A P_A^0 + X_B P_B^0$

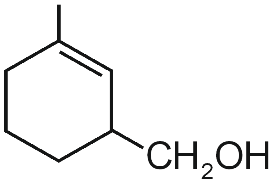
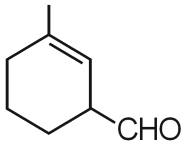
$= \frac{x}{10} \times 400 + \frac{10 - x}{10} \times 100$

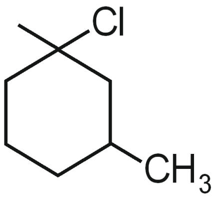
= 200.00

48) $\Delta H = nC_P\Delta T = 2 \times \frac{7}{2}R \times (1500 - 1000) = 2 \times \frac{7}{2} \times 2 \times 500 = 7000$ cal

49) Total 5 dihalogen derivatives are formed including stereoisomers in which two are diastereomers. ∴ x + y = 10

50) P =  Q = 

R =  S = 

T = 

PART-3 : MATHEMATICS

51)

Let $a = \sqrt{\dfrac{x+y+z}{xyz}}$

$\tan^{-1}(ax) + \tan^{-1}(ay) + \tan^{-1}(az)$

$= \pi + \tan^{-1}\left(\dfrac{ax+ay+az-a^3xyz}{1-(.....)}\right)$;

(where $a^2(xy+yz+zx) > 1$)

$= \pi + \tan^{-1}\left(\dfrac{a(x+y+z-a^2xyz)}{dr}\right)$

$= \pi + \tan^{-1}\left(\dfrac{0}{dr}\right) = \pi$

52) Line L : $\dfrac{x-1}{1} = \dfrac{y-2}{-5} = \dfrac{z-1}{3} = \lambda$(say)

Q = (λ + 1, 2 -5λ, 3λ +1)

$\overrightarrow{PQ} = (\lambda, -5\lambda, 3\lambda)$

$\Rightarrow \left|\overrightarrow{PQ}\right|^2 = 35$

$\Rightarrow \lambda = \pm 1$

$Q = (\lambda + 1,\ 2 - 5\lambda,\ 3\lambda + 1) \begin{cases} (2,-3,4) \\ (0,7,-2) \end{cases}$

then a + b + c $\begin{cases} (2,-3,4) \Rightarrow 3 \\ (0,7,-2) \Rightarrow 5 \end{cases}$

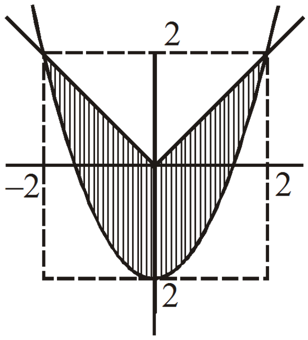
53) $B = A_1 + 3A_3^3 + 5A_5^5 + \dots\dots\dots + (2n-1)\,A_{2n-1}^{2n-1}$
taking transpose both sides, then we get
$\Rightarrow B^T = -B$
$\Rightarrow$ B is skew symmetric matrix

54) $\sum_{i=0}^{n} i \cdot {}^nC_i \cdot p^i(1-p)^{n-i}$
$= \sum_{i=1}^{n} n \cdot {}^{n-1}C_{i-1} \cdot p^{i-1} \cdot p\,(1-p)^{n-i}$
$= np\sum_{i=1}^{n} {}^{n-1}C_{i-1} \cdot p^{i-1}(1-p)^{n-i}$
$= np\,(1) = np$

55) $12 \begin{cases} 7G \\ 5R \end{cases} \Rightarrow$ P(other mango is also good)
$= \frac{{}^7C_2}{{}^7C_2 + {}^7C_1 \cdot {}^5C_1}$
$= \frac{3}{8}$

56) In $I_1 \rightarrow$ Apply king property and add $\Rightarrow \quad 2I_1 = 2 + 2I_2$
$\Rightarrow \quad I_1 - I_2 = 1$

57) Required area $= \frac{2}{3} \times 4 \times 4 - \frac{1}{2} \times 4 \times 2 = \frac{20}{3}$



58) $(1 + \ln x)\frac{dx}{dy} - x\ln x = e^y$
substitute $\left.\begin{aligned} x\ln x &= t \\ (1+\ln x)\frac{dx}{dy} &= \frac{dt}{dy} \end{aligned}\right\}$
$\Rightarrow \frac{dt}{dy} - t = e^y$
$\Rightarrow$ I.F. $= e^{-\int dy} = e^{-y}$

$\Rightarrow$ Sol. $te^{-y} = \int e^{-y} \cdot e^{y}\, dy + c$

$\Rightarrow t = ye^{y} + ce^{y}$

$\Rightarrow x \ln x = ye^{y} + ce^{y}$, put x = 1, y = 0

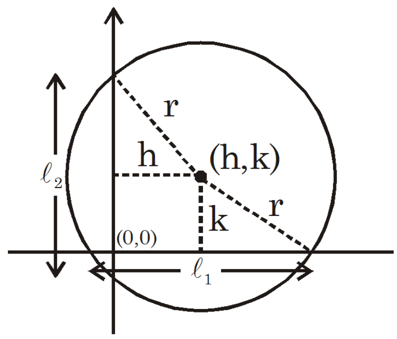
0 = c, then we get

$\Rightarrow \quad x \ln x = ye^{y}$

$\ln x^{x} = y\, e^{y}$

$x^{x} = e^{ye^{y}}$

59) $k = \left| \dfrac{\frac{1}{2}\left(\vec{a} \times (2\vec{a} + 3\vec{b}) + (2\vec{a} + 3\vec{b}) \times \vec{b}\right)}{\vec{a} \times \vec{b}} \right| = \dfrac{5}{2}$

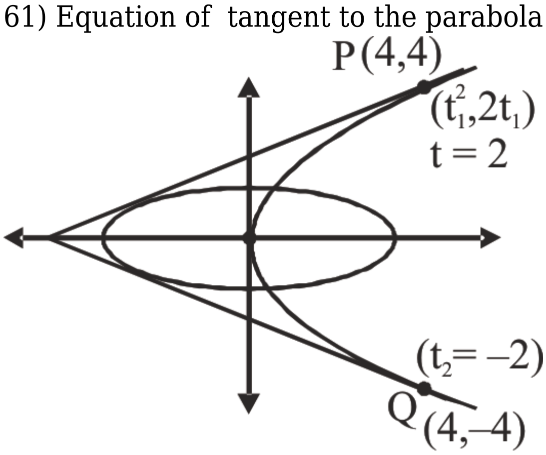
60) 

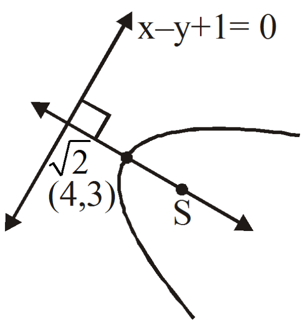
$r^2 = \dfrac{\ell_1^{\,2}}{4} + k^2 = \dfrac{\ell_2^{\,2}}{4} + h^2$

$h^2 - k^2 = \dfrac{\ell_1^{\,2} - \ell_2^{\,2}}{4}$

$\Rightarrow$ which is rectangular hyperbola whose eccentricity is $\sqrt{2}$

61) Equation of tangent to the parabola $y^2 = 4x$, at Q(4,–4) is :- $\Rightarrow$ – 4y = 2 (x + 4)





62) $\tan\theta = -1$, $s \equiv \left(4 - \sqrt{2}\left(-\dfrac{1}{\sqrt{2}}\right),\ 3 - \sqrt{2}\left(\dfrac{1}{\sqrt{2}}\right)\right)$ $\quad s \equiv (5, 2)$

63) $\frac{dv}{dt} = 2 = \frac{d}{dt}\left(\frac{\pi r^3}{3}\right)$ (h = r, θ = 45°) $\frac{dr}{dt} = \frac{2}{\pi r^2}$

P = 2πr

$\frac{dp}{dt} = 2\pi\frac{dr}{dt} = 2\pi \times \frac{2}{\pi r^2} = \frac{4}{r^2}$

$\left(\frac{dp}{dt}\right)_{r=2} = \frac{4}{4} = 1$ cm/sec

64) $\frac{x^2}{9} + \frac{y^2}{9-25} = 1 \Rightarrow \frac{x^2}{9} - \frac{y^2}{16} = 1$

$e = \sqrt{1 + \frac{16}{9}} = \frac{5}{3}$

65) In dual statement ∨ replace by ∧ and ∧ replace by ∨ so answer is (p ∧ ~ q) ∨ (~ p)

66) $\Rightarrow \frac{3!}{2! \cdot 1!} \cdot {}^3C_1 \cdot {}^3C_1 \cdot {}^3C_2 \cdot \frac{6!}{2! \cdot 2! \cdot 2!} = 81 \times 90 = 7290$

67) R.H.L. = $\lim\limits_{x\to0^+} \frac{x}{\tan 7x} \cdot \lim\limits_{x\to0^+} (8x+9)^{\frac{1}{\pi}\tan^{-1}\frac{1}{x}} \cdot \lim\limits_{x\to0^+} \frac{x + \sin 6x}{\int_0^x e^{t^2}\,dt}$

$= \frac{1}{7} \times (9)^{\frac{1}{\pi}\cdot\frac{\pi}{2}} \cdot \frac{1 + 6\cos 6x}{e^{x^2}}$

(Use L'Hopital rule in third part)

$= \frac{1}{7} \times (9)^{1/2} \cdot \left(\frac{1+6}{1}\right) = 3$

L.H.L. = $\lim\limits_{x\to0^-} \frac{x}{\tan 7x} \cdot \lim\limits_{x\to0^-} (8x+9)^{\frac{1}{\pi}\tan^{-1}\frac{1}{x}} \cdot \lim\limits_{x\to0^-} \frac{x + \sin 6x}{\int_0^x e^{t^2}\,dt}$

$= \frac{1}{7} \times (9)^{-1/2} \cdot 7 = \frac{1}{3}$

L.H.L. ≠ R.H.L.

Hence limit does not exist.

68) f (x) = 1,

$\Rightarrow \int \underbrace{\frac{x}{\sqrt{x^2+1}}}_{II} \cdot \underbrace{\ln\left(x + \sqrt{1+x^2}\right)}_{I} dx$

Apply by parts

$\Rightarrow \sqrt{x^2+1} \cdot \ln\left(x + \sqrt{1+x^2}\right) - \int 1 \cdot dx$

$\Rightarrow \sqrt{x^2+1} \cdot \ln\left(x + \sqrt{1+x^2}\right) - x + c$

69) $\bar{x}_1 = 520$, $\bar{x}_2 = 420$, $\bar{x} = 500$ Let n_1 is number of male employees

n_2 is number of female employees

$$\bar{x} = \frac{n_1\bar{x}_1 + n_2\bar{x}_2}{n_1 + n_2}$$

$500(n_1 + n_2) = 520n_1 + 420n_2$

$$\Rightarrow \frac{n_1}{n_2} = \frac{4}{1}$$

% male employees

$$\Rightarrow \frac{4}{4+1} \times 100 = 80\%$$

70) $y = f(t)$, $-3 \le t \le 3$ and $-9 \le 3y \le 15$ $-3 \le 2x + 1 \le 3$ $-7 \le (2 + 3y) \le 17$

$-2 \le x < 1$ $-7 \le g(x) \le 17$

$a = -2$, $b = 1$ $c = -7$, $d = 17$,

then $a + b + c + d = -2 + 1 + 17 - 7 = 9$

71) $f'(x) = 3x^2 + 2x + 3 + 2\cos x$

$$= \underbrace{3\left(x + \frac{1}{3}\right)^2}_{\geqslant 0} \underbrace{- \frac{1}{3} + 3 + 2\cos x}_{>0},$$

f (x) is strictly increasing and f (0) = 0]

72) $|\vec{c} - \vec{a}|^2 = 8$

$\Rightarrow (|\vec{c}| - 1)^2 = 0$

$\Rightarrow |\vec{c}| = 1$ and $|\vec{a} \times \vec{b}| = 3$,

$\Rightarrow \left(|\vec{a} \times \vec{b}|\ |\vec{c}|\cos\varphi\right)_{max}$,

when $\cos\phi = 1$

then $\left(|\vec{a} \times \vec{b}|\ |\vec{c}|\cos\varphi\right)_{max} = 3$

73) $b = a^2$ and $s = \frac{-8}{r}$

$\frac{s-b}{r-a} = 2a = \frac{8}{r^2}$

$\Rightarrow a = 4$ and $r = 1$,

$b = 16$, $s = -8$

74) $a_i = \frac{20}{i} \Rightarrow \frac{20 \times 20 \times 20}{6 \times 20 \times 8} \begin{vmatrix} 6 & 2 & 3 \\ 5 & 1 & 4 \\ 4 & 1 & 2 \end{vmatrix}$

$= \frac{50}{6} \times 3 = 25$

75) Area = $\frac{1}{2} \times 2\,|z| \times 2\sqrt{3}\,|z|\,\sin 120^\circ$ = 48 (given)

$|z|^2 \times 2\sqrt{3} \times \frac{\sqrt{3}}{2}$ = 48

$|z|$ = 4