JEE ADVANCED 2017 MOCK TEST-1

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disha
Nurturing Ambitions

TARGET IIT

MOCK TEST - 1

PAPER - 1

GENERAL INSTRUCTIONS :

1. **Section I : Q. No. 1 to 7, Q. No. 19 to 25, Q. No. 37 to 43** are Multiple Correct Choice Type questions. For this section, **4 marks** will be awarded for correct answer, **1 mark** for partial answer provided NO INCORRECT option is darkened and **zero mark** for no answer. In all other cases, **– 2 marks** will be awarded.
2. **Section II : Q. No. 8 to 12, Q. No. 26 to 30, Q. No. 44 to 48** are Integer Answer Type questions. For this section, **3 marks** will be awarded for correct answer and **zero mark** for all other cases.
3. **Section III : Q. No. 13 to 18, Q. No. 31 to 36, Q. No. 49 to 54** are Passage cum Matching based Single Correct Choice Type questions. For this section **3 marks** will be awarded for correct answer and **zero mark** for no answer. In all other cases, **–1 mark** will be awarded.

Time : 180 minutes *Max. Marks : 183*

Part - A : Mathematics

SECTION – I - Multiple Correct Choice Type

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE OR MORE is/are correct.

1. Let $f(x) = x^3 + px^2 + qx + 6$, where $p, q \in R$ and $f'(x) < 0$ in largest possible interval $\left(-\frac{5}{3}, -1\right)$ then $(p + q)$ is greater than

(a) –2 (b) 2 (c) 4 (d) 6

2. Choose the correct options

(a) The sum $\sum_{r=1}^{n} \tan^{-1}\left(\frac{2}{r^2}\right)$ equals $\frac{3\pi}{4}$

(b) $\lim_{n\to\infty} n \sin(2\pi\sqrt{1+n^2} - 2n\pi)\ (n \in N)$ equals π

(c) Period of the function $f(x) = \sin^2 2x + \cos^4 2x + 2$, is $\frac{\pi}{4}$

(d) $\int_{-1}^{1} (1+x)^{1/2}(1-x)^{3/2}dx$ equals $\frac{\pi}{2}$

3. Choose the incorrect statement

(a) If $\vec{a}.\vec{b} = \vec{a}.\vec{c} \Rightarrow \vec{b} = \vec{c}$ $(\vec{a} \neq 0)$

(b) If $\vec{a} \times \vec{b} = \vec{a} \times \vec{c} \Rightarrow \vec{b} = \vec{c}$ $(\vec{a} \neq 0)$

(c) If $\vec{a}.\vec{b} = \vec{a}.\vec{c}$ and $\vec{a} \times \vec{b} = \vec{a} \times \vec{c} \Rightarrow \vec{b} = \vec{c}$ $(\vec{a} \neq 0)$

(d) If $\vec{v}_1, \vec{v}_2, \vec{v}_3$ are non-coplanar vectors and

$\vec{k}_1 = \frac{\vec{v}_2 \times \vec{v}_3}{\vec{v}_1.(\vec{v}_2 \times \vec{v}_3)}$; $\vec{k}_2 = \frac{\vec{v}_3 \times \vec{v}_1}{\vec{v}_1.(\vec{v}_2 \times \vec{v}_3)}$ and

$\vec{k}_3 = \frac{\vec{v}_1 \times \vec{v}_2}{\vec{v}_1.(\vec{v}_2 \times \vec{v}_3)}$ then $\vec{k}_1.(\vec{k}_2 \times \vec{k}_3) = \frac{1}{\vec{v}_1.(\vec{v}_2 \times \vec{v}_3)}$

Space for Rough Work

4. Choose the correct options

(a) Locus of the feet of the perpendiculars drawn from the foci on a variable tangent to the hyperbola $16y^2 - 9x^2 = 1$ is $x^2 + y^2 = 1/16$

(b) A line passing through the point (21, 30) and normal to the curve $y = 2\sqrt{x}$ can have the slope equal to –5

(c) The magnitude of the gradient of the tangent at an extremity of latus rectum of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is equal to e (where e is the eccentricity of the hyperbola)

(d) TP and TQ are tangents to the parabola, $y^2 = 4ax$ at P and Q. If the chord PQ passes through the fixed point (–a, b) then the locus of T is $y = 2a(x - a)$

5. Equation of the plane containing the lines $\vec{r} = (1,1,0) + t(1,-1,2)$, $\vec{r} = (2,0,2) + s(-1,1,0)$ is

(a) $x + 3y + z = 4$ (b) $x + y - 2 = 0$

(c) $5x - 3y - 4z = 2$ (d) None of these

6. Given f an odd function periodic with period 2 continuous $\forall\ x$ and $g(x) = \int_0^x f(t)dt$, then

(a) $g(x)$ is odd function (b) $g(2n) = 1$

(c) $g(2n) = 0$ (d) $g(x)$ is even function

7. Let $y(x)$ be a solution of the differential equation $(1 + e^x)y' + ye^x = 1$. If $y(0) = 2$, then which of the following statement is (are) true?

(a) $y(-4) = 0$

(b) $y(-2) = 0$

(c) $y(x)$ has a critical point in the interval (–1, 0)

(d) $y(x)$ has no critical point in the interval (–1, 0)

SECTION – II - Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following:

X	Y	Z	W
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

8. If $n > 3$ and $n \in N$, then find the value of $\left({}^nC_r = C_r\right)$.

$C_0abc - C_1(a-1)(b-1)(c-1) + C_2(a-2)(b-2)(c-2) + \ldots + (-1)^n C_n(a-n)(b-n)(c-n)$.

9. Find the principle value of the argument of the complex number i^i.

10. If $\sin q \neq \cos q$ and x, y, z satisfy the equations

$x\cos p - y\sin p + z = \cos q + 1$

$x\sin p + y\cos p + z = 1 - \sin q$

$x\cos(p+q) - y\sin(p+q) + z = 2$

then find the value of $x^2 + y^2 + z^2$.

11. A person has 6 friends and during a certain vacation he met them during several dinners. He found that he dinned with all the 6 exactly on one day, with every 5 of them on 2 days, with every 4 of them on 3 days, with every 3 on 4 days; with every 2 on 5 days. Furthers every friend was present at 7 dinners and every friend was absent at 7 dinners. Then find the number of dinner(s) he had alone.

12. A straight line cuts the x-axis at point A (1, 0), and y-axis at point B, such that $\angle OAB = \alpha\left(\alpha > \frac{\pi}{4}\right)$. C is a middle point of AB, if B' is a mirror image of point B with respect to line OC and C' is a mirror image of point C with respect to line BB', then find the ratio of the areas of triangles ABB' and $BB'C'$.

SECTION – III - Matching Type

This section contains 6 questions of Matching Type, contains two tables each having 3 columns and 4 rows. Based on each table, there are three questions. Each question has four options (a), (b), (c) and (d) ONLY ONE of these four options is correct.

(Qs. 13–15): By appropriately matching the information given in the three columns of the following table, give the answer of the questions that follows.

Column 1 gives information about definitions of relations.

Column 2 gives information about domain and co-domain in which given relations are either reflexive, symmetric, transitive or anti-symmetric.

Column 3 gives information about types of given relations.

	Column 1		Column 2		Column 3
(I)	$R = \{(x, y) : 3x - y > 0\}$	(i)	$N \to N$	(P)	Reflexive
(II)	$R = \{(x, y) : y = x + 4 \text{ and } x < 4\}$	(ii)	$Z \to Z$	(Q)	Symmetric
(III)	$R = \{(x, y) : x - y \in Z\}$	(iii)	$R \to R$	(R)	Transitive
(IV)	$R = \{(x, y) : 2x^2 + 3y^2 - 5xy = 0\}$	(iv)	$A \to A$ where $A = \{1, 2, ...14\}$	(S)	Anti-symmetric

13. Which of the following options is the only correct combination?

(a) (II) (i) (R) (b) (III) (iv) (Q) (c) (I) (ii) (S) (d) (IV) (iii) (P)

14. Which of the following options is the only correct combination?

(a) (I) (iv) (Q) (b) (II) (i) (R) (c) (III) (ii) (P) (d) (IV) (iii) (R)

15. Which of the following options is the only incorrect combination?

(a) (I) (iv) (P) (b) (II) (i) (R) (c) (III) (ii) (S) (d) (IV) (iii) (P)

(Qs. 16–18): By appropriately matching the information given in the three columns of the following table, give the answer of the questions that follows.

It is given that $f(x) = \log(ax^2 + bx + c)$ where $a \neq 0$ and α, β are the roots of $ax^2 + bx + c = 0$.

Column 1 gives information about discriminant $D = b^2 - 4ac$

Column 2 gives information about conditions on a and $ax^2 + bx + c$

Column 3 gives information about domains of given function $f(x)$.

	Column 1		Column 2		Column 3
(I)	$b^2 - 4ac > 0$	(i)	$a < 0, ax^2 + bx + c \leq 0$	(P)	ϕ
(II)	$b^2 - 4ac < 0$	(ii)	$a > 0, ax^2 + bx + c \geq 0$	(Q)	R
(III)	$b^2 - 4ac = 0$	(iii)	$a > 0, ax^2 + bx + c > 0$	(R)	$(-\infty, \alpha) \cup (\beta, \infty)$
(IV)	$b^2 - 4ac \geq 0$	(iv)	$a < 0, ax^2 + bx + c > 0$	(S)	(α, β)

16. Which of the following options is the only correct combination?

(a) (I) (iii) (Q) (b) (II) (iv) (S) (c) (III) (i) (P) (d) (IV) (ii) (R)

17. Which of the following options is the only correct combination?

(a) (I) (iv) (S) (b) (I) (iii) (Q) (c) (III) (i) (R) (d) (IV) (ii) (R)

18. Which of the following options is the only incorrect combination?

(a) (II) (ii) (Q) (b) (III) (i) (P) (c) (I) (iv) (S) (d) (I) (iii) (Q)

Part - B : Physics

SECTION – I - Multiple Correct Choice Type

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE OR MORE is/are correct.

19. If the first minima in a Young's double slit experiment occurs directly in front of one of the slits, (distance between slit and screen D = 12cm and distance between slits d = 5cm.) then the wavelength of the radiation used can be

(a) 2 cm (b) 4 cm

(c) 2/3 cm (d) 4/3 cm

20. A small sphere of mass m suspended by a thread is first taken aside so that the thread forms the right angle with the vertical and then released, then

(a) total acceleration of sphere as a function of θ is $g\sqrt{1+3\cos^2\theta}$

(b) thread tension as a function of θ is T =3mg cos θ

(c) the angle θ between the thread and the vertical at the moment when the total acceleration vector of the sphere is directed horizontally is $\cos^{-1} 1/\sqrt{3}$

(d) the thread tension at the moment when the vertical component of the sphere's velocity is maximum will be mg.

21. A horizontal plank has a rectangular block placed on it. The plank starts oscillating vertically and simple harmonically with an amplitude of 40 cm. The block just loses contact with the plank when the latter is at momentary rest. Then

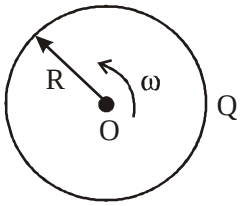
(a) the period of oscillation is (2π/5)

(b) the block weighs double its weight, when the plank is at one of the positions of momentary rest

(c) the block weighs 0.5 times its weight on the plank halfway up

(d) the block weighs 1.5 times its weight on the plank halfway down extreme.

22. A nonconducting disc having uniform positive charge Q, is rotating about its axis with uniform angular velocity ω. The magnetic field at the centre of the disc is



(a) directed outward

(b) having magnitude $\frac{\mu_0 Q\omega}{4\pi R}$

(c) directed inwards

(d) having magnitude $\frac{\mu_0 Q\omega}{2\pi R}$

23. The coordinates of a particle moving in a plane are given by $x(t) = a\cos(pt)$ and $y(t) = b\sin(pt)$ where $a, b (< a)$ and p are positive constants of appropriate dimensions. Then

(a) the path of the particle is an ellipse

(b) the velocity and acceleration of the particle are normal to each other at $t = \pi/(2p)$

(c) the acceleration of the particle is always directed towards a focus

(d) the distance travelled by the particle in time interval $t = 0$ to $t = \pi/(2p)$ is a

24. At time $t = 0$, terminal A in the circuit shown in the figure is connected to B by a key and an alternating current $I(t) = I_0\cos(\omega t)$, with $I_0 = 1$ A and $\omega = 500$ rad s^{-1} starts flowing in it with the initial direction shown in the figure. At $t = \frac{7\pi}{6\omega}$, the key is switched from B to D. Now onwards only A and D are connected. A total charge Q flows from the battery to charge the capacitor fully. If $C = 20$ μF, R = 10 Ω and the battery is ideal with emf of 50 V, identify the correct statement(s).

(a) Magnitude of the maximum charge on the capacitor before $t = \frac{7\pi}{6\omega}$ is 1×10^{-3} C

(b) The current in the left part of the circuit just before $t = \frac{7\pi}{6\omega}$ is clockwise

(c) Immediately after A is connected to D, the current in R is 10 A

(d) $Q = 2 \times 10^{-3}$ C

25. Which of the following statement(s) is (are) correct?

(a) The rest mass of a stable nucleus is less than the sum of the rest masses of its separated nucleons

(b) The rest mass of a stable nucleus is greater than the sum of the rest masses of its separated nucleons

(c) In nuclear fission, energy is released by fusing two nuclei of medium mass (approximately 100 amu)

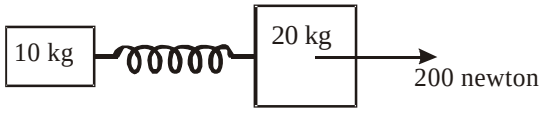
(d) In nuclear fission, energy is released by fragmentation of a very heavy nucleus

SECTION – II - Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following:

X	Y	Z	W
0	**0**	0	0
1	1	1	1
2	2	2	**2**
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	**9**	9

26. The masses of 10 kg and 20 kg respectively are connected by a massless spring in fig. A force of 200 newton acts on the 20 kg mass. At the instant shown, the 10 kg mass has acceleration 12 m/sec^2. What is the acceleration (in m/s^2) of 20 kg mass?

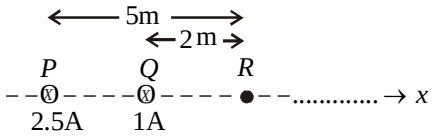


27. A particle is moving on x-axis has potential energy $U = 2 - 20x + 5x^2$ joules along x-axis. The particle is released at $x = -3$. If the mass of the particle is 0.1 kg, then find how many times of ten is the maximum velocity (in m/s) of the particle.

28. The length of a wire between the two ends of a sonometer is 105cm. If the sum of the distances of the positions of the two bridges from one end is expressed as $(182 - x)$ cm so that the fundamental frequencies of the three segments are in the ratio of 1 : 3 : 15. Find the value of x.

29. A brass rod of length 50 cm and diameter 3.0 mm is joined to a steel rod of the same length and diameter. If the change in length of the combined rod at 250 °C is $(A \times 10^{-2})$ cm, given the original lengths are at 40.0 °C, what is the sum of digits of A? The ends of the rod are free to expand (Co-efficient of linear expansion of brass = 2.0×10^{-5} K^{-1}, steel = 1.2×10^{-5} K^{-1}).

30. Two long parallel wires carrying current 2.5 amperes and 1 ampere in the same direction (directed into the plane of the paper) are held at P and Q respectively such that they are perpendicular to the plane of paper. The points P and Q are located at a distance of 5 metres and 2 metres respectively from a collinear point R (see figure). An electron moving with a velocity of 4×10^5 m/s along the positive x- direction experiences a force of magnitude 3.2×10^{-20} N at the point R. Find the value of I (in ampere).

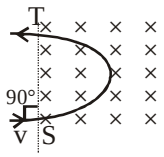
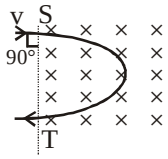
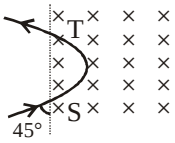
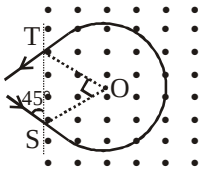


SECTION – III - Matching Type

This section contains 6 questions of Matching Type, contains two tables each having 3 columns and 4 rows. Based on each table, there are three questions. Each question has four options (a), (b), (c) and (d) ONLY ONE of these four options is correct.

(Qs. 31-33): By appropriately matching the information given in the three columns of the following table, give the answer of the questions that follows.

A charge particle of mass *m* moves at a speed of *v*. It enters a region of uniform magnetic field ($\vec{B}$) at a point S and leaves the region of the field at the point T as shown in column (II). Column (III) shows the corresponding length $\overrightarrow{ST}$ or arc length $\overset{\frown}{ST}$. Column (I) gives the charge on particle.

Column I	Column II	Column III
I. Q = + q	(i) 	(P) $\overrightarrow{ST} = \sqrt{2}\frac{mv}{qB}$
II. Q = – q	(ii) 	(Q) Arc $\overset{\frown}{ST} = \frac{11}{7}\frac{mv}{qB}$
III. Q = + 2q	(iii) 	(R) $\overrightarrow{ST} = \frac{mv}{qB}$
IV. Q = – 2q	(iv) 	(S) Arc $\overset{\frown}{ST} = \frac{33}{7}\frac{mv}{qB}$

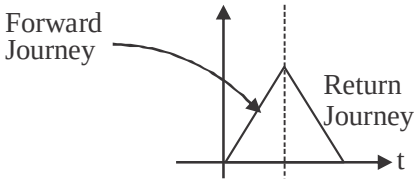
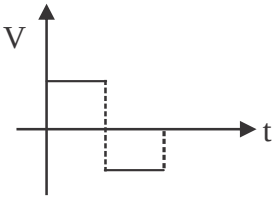
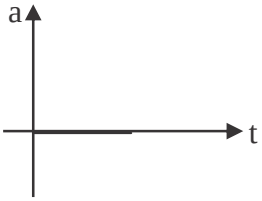
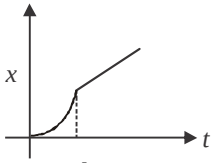
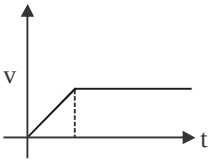
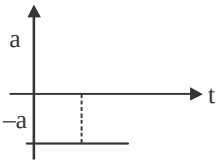
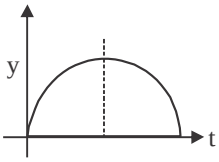
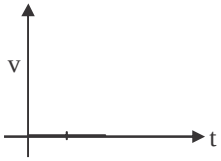
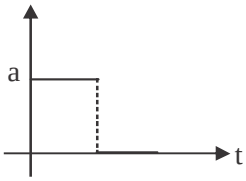
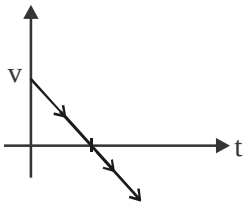
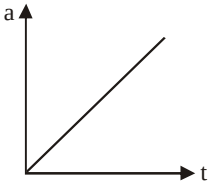
31. If a proton is projected in the uniform magnetic field, which of the following combination best explains the path of the proton ?
(a) I (i) P (b) III (iii) Q (c) I (iii) P (d) IV (iv) Q

32. If an electron is projected in the uniform magnetic field, which of the following combination best explains the path of the electron ?
(a) III (iii) R (b) II (iv) S (c) II (ii) S (d) IV (i) P

33. Which of the following combination is wrongly matched ?
(a) III (i) R (b) IV (ii) Q (c) III (i) Q (d) I (iii) R

(Qs. 34-36): By appropriately matching the information given in the three columns of the following table, give the answer of the questions that follows.

Displacement time graphs are given in column I and their, corresponding velocity–time graphs and acceleration –time graphs are given in column II and III respectively.

Column I	Column II	Column III
I. 	(i) 	(P) 
II.  Projectile	(ii) 	(Q) 
III. 	(iii) 	(R) 
IV. 	(iv) 	(S) 

34. A body of mass m projected at an angle θ with horizontal. Which of the following shows the correct matching for the position, velocity and acceleration of the body with respect to time?

(a) I (i) P (b) II (ii) R (c) III (iv) Q (d) I (i) S

35. Which of the following matching represents the body moving with constant acceleration?

(a) I (i) P (b) III (iv) Q (c) IV (iii) P (d) a, b and c

36. Which is wrongly matched?

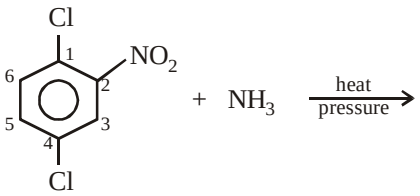
(a) IV (iv) R (b) III (iv) Q (c) II (ii) R (d) IV (iii) P

Part - C : Chemistry

SECTION – I - Multiple Correct Choice Type

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE OR MORE is/are correct.

37. Which of the following statement is false regarding following reaction ?



(a) No reaction is possible because —Cl is present on benzene ring.

(b) A nucleophilic substitution will take place in which both —Cl will be replaced by two —NH_2 groups.

(c) A nucleophilic substitution will take place in which only —Cl attached on C_1 will be replaced by —NH_2.

(d) A nucleophilic substitution will take place in which only —Cl attached on C_4 will be replaced by —NH_2.

38. Which of the following statement(s) is/are true ?

(a) ionisation energy $\propto \frac{1}{\text{Screening effect}}$

(b) The first ionisation energies of Be and Mg are more than ionisation energies of B and Al respectively

(c) Atomic and ionic radii of Niobium and Tantalum are almost same

(d) Metallic and covalent radii of potassium are 2.3 Å and 2.03 Å respectively.

39. Two elements A and B form compounds having molecular formula AB_2 and AB_4. When dissolved in 20g of C_6H_6. 1g of AB_2 lowers the freezing point by 2.3 K, whereas 1.0g of AB_4 lowers it by 1.3 K. The molar depression constant for benzene is 5.1 K kg mol^{-1}. Then –

(a) Atomic mass of A = 25.58 u

(b) Atomic mass of B = 42.64 u

(c) Atomic mass of A = 42.64 u

(d) Atomic mass of B = 25.58 u

40. Choose the correct options for inferences drawn.

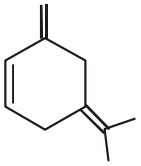
(a) Canary yellow precipitate with ammonium molybdate $\rightarrow PO_4^{3-}$

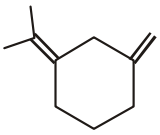
(b) Brown ring test with dil. $H_2SO_4 \rightarrow NO_2^-$

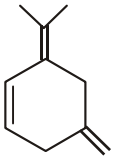
(c) Yellow ppt. with $HgCl_2$ solution $\rightarrow SO_4^{2-}$

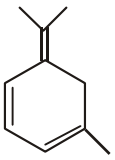
(d) Yellow ppt. with $HgCl_2$ solution $\rightarrow NO_3^-$

41. An unsaturated hydrocarbon on complete hydrogenation gives 1-isopropyl-3 methylcyclohexane, after ozonolysis it gives one mole of formaldehyde, one mole of acetone and one mole of 2,4-dioxohexanedial. The possible structures of the hydrocarbon may be

(a) 

(b) 

(c) 

(d) 

42. Pick out the correct statement(s) of the following

(a) Both Fe(II) and Fe(III) salts react with NO to give brown compound

(b) Fe(III) forms octahedral complexes but Fe(II) form either tetrahedral or square planar complexes

(c) Hexacyanoferrate(II) ion is diamagnetic but hexacyanoferrate(III) is paramagnetic

(d) $[Fe(H_2O)_6]^{3+}$ has greater degree of paramagnetism than $[FeF_6]^{4-}$.

43. A positive carbylamine test is given by

(a) N, N—dimethylaniline

(b) 2, 4–dimethylaniline

(c) N–methyl-*o*-methylaniline

(d) *p*-methylbenzylamine

SECTION – II - Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following:

X	Y	Z	W
0	(0)	0	0
1	1	1	1
2	2	2	(2)
3	3	3	3
4	4	4	4
5	5	5	5
(6)	6	6	6
7	7	7	7
8	8	8	8
9	9	(9)	9

44. The dipole moment of KCl is 3.332×10^{-29} Coulomb meters which indicates that it is a highly polar molecule. The interatomic distance between K^+ and Cl^- in this molecule is 2.6×10^{-10} m. The percentage ionic character of KCl is $10x$ then find the value of x.

45. At 27°C, hydrogen is leaked through a tiny hole into a vessel for 20 minutes. Another unknown gas at the same temperature and pressure as that of H_2 is leaked through the same hole for 20 minutes. After the effusion of the gases the mixture exerts a pressure of 6 atmosphere. The hydrogen content of the mixture is 0.7 mole in a container of volume 3 litres. If the molecular weight of the unknown gas is expressed as $(1040 - A)$, then what is the value of A.

46. How many dipeptides are possible from two molecules of a typical α-amino acid ?

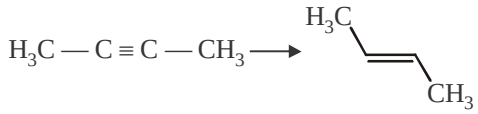
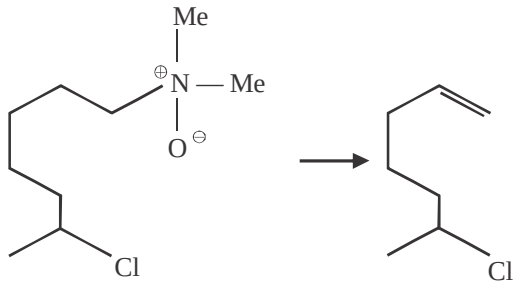
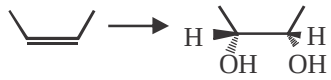
47. The edge length of unit cell of LiCl having rock salt type lattice is 5.14Å. If Li^+ ions precisely fit into the octahedral woids of closed packed structure of Cl^- ions. If the ionic radius (in pm) of Cl^- ions is expressed as $121x$ then what is the value of x?

48. We have taken a saturated solution of AgBr. K_{sp} of AgBr is 12×10^{-14}. When 10^{-7} mole of $AgNO_3$ are added to 1 litre of this solution then, conductivity (specific conductance) of this solution is find as $11x \times 10^{-7}$ (S m^{-1} units). Find the value of x. Given, molar conductance of Ag^+, Br^- and NO_3^- are 6×10^{-3} Sm^2mol^{-1}, 8×10^{-3} Sm^2mol^{-1} and 7×10^{-3} Sm^2mol^{-1}.

SECTION – III - Matching Type

This section contains 6 questions of Matching Type, contains two tables each having 3 columns and 4 rows. Based on each table, there are three questions. Each question has four options (a), (b), (c) and (d) ONLY ONE of these four options is correct.

(Qs. 49-51): By appropriately matching the information given in the three columns of the following table, give the answer of the questions that follows.
Column I contains reaction and Column II & Column III contains reagent and mechanism involved respectively.

Column I (Reaction)		Column II (Reagent)		Column III (Stereochemistry)
(I)		(i)	Δ	(P) Anti-addition
(II)		(ii)	Me_3CO^-, Δ	(Q) Syn-hydroxylation
(III)		(iii)	Aq. $KMnO_4$	(R) Syn-elimination
(IV)		(iv)	Li + Liq. NH_3 + EtOH	(S) Anti-elimination

49. Find the combination which follows the Hofmann's rule

(a) (II) (ii) (P) (b) (III) (i) (Q) (c) (IV) (iii) (S) (d) (II) (i) (R)

50. Birch reduction is

(i) (I) (iii) (R) (b) (I) (iv) (P) (c) (IV) (i) (P) (d) (II) (i) (S)

51. The incorrect combination is

(a) (IV) (iii) (R) (b) (III) (iii) (Q) (c) (I) (iv) (P) (d) (II) (i) (R)

(Qs. 52-54): By appropriately matching the information given in the three columns of the following table, give the answer of the questions that follows.

Bohr's theory successfully explains the hydrogen spectrum. It also explains the spectrum of some other one-electron system (H-like system) such as He^{+}, Li^{2+}, Be^{3+} etc. With the help of Bohr's theory we find out, Radius of the orbit in which the electron is revolving around the nucleus, Energy of electron in an orbits, velocity and wavelength.

Column I	Column II	Column III
(I) Radius	(i) $\frac{2\pi Ze^2}{nh}$	(P) $-\frac{Z^2}{n^2} \times 313.6$
(II) Velocity	(ii) $\frac{n^2h^2}{4\pi^2 mZe^2}$	(Q) $R \times Z^2\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)$
(III) Energy	(iii) $\frac{2\pi^2 me^4}{ch^2}$	(R) $\left(\frac{Ze^2}{rm}\right)^{1/2}$
(IV) Wavelength	(iv) $-\frac{2\pi^2 mZ^2e^4}{n^2h^2}$	(S) $\frac{n^2}{Z} \times 0.0529$

52. The only correct combination of formula for the radius give in column I is

(a) (I) (ii) (P) (b) (I) (iii) (R) (c) (I) (ii) (S) (d) (I) (iv) (Q)

53. The only correct combination of formula for the velocity given in column I is

(a) (II) (iii) (P) (b) (II) (i) (R) (c) (II) (ii) (S) (d) (II) (iv) (Q)

54. The only correct combination of formula for the energy given in column I is

(a) (III) (i) (Q) (b) (III) (ii) (R) (c) (III) (iv) (S) (d) (III) (iv) (P)

PAPER - 2

GENERAL INSTRUCTIONS :

1. **Section I : Q. No. 1 to 7, Q. No. 19 to 25, Q. No. 37 to 43** are Single Correct Choice Type questions. For this section, **3 marks** will be awarded for correct answer and **zero mark** for no answer. In all other cases, **–1 mark** will be awarded.
2. **Section II : Q. No. 8 to 14, Q. No. 26 to 32, Q. No. 44 to 50** are Multiple Correct Choice Type questions. For this section, **4 marks** will be awarded for correct answer, **1 mark** for partial answer provided NO INCORRECT option is darkened and **zero mark** for no answer. In all other cases, **–2 marks** will be awarded.
3. **Section III : Q. No. 15 to 18, Q. No. 33 to 36, Q. No. 51 to 54** are Comprehension based Single Correct Choice Type questions. For this section, **3 marks** will be awarded for correct answer and **zero mark** for all other cases.

Time : 180 minutes *Max. Marks : 183*

Part - A : Mathematics

SECTION – I - Single Correct Choice Type

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.

1. The complex numbers 1 + i and 1 + 2i are both roots of the equation $x^5-6x^4+Ax^3+Bx^2+Cx+D=0$, where $A, B, C, D \in R$. The value of D is

(a) -20 (b) 20 (c) 10 (d) 2

2. The set of values of x for which the identity

$\cos^{-1}x+\cos^{-1}\left(\frac{x}{2}+\frac{1}{2}\sqrt{3-3x^2}\right)=\frac{\pi}{3}$ holds good, is

(a) $[0,1]$ (b) $\left[0,\frac{1}{2}\right]$ (c) $\left[\frac{1}{2},1\right]$ (d) $\{-1,0,1\}$

3. Let $\int\frac{dx}{x^{2008}+x}=\frac{1}{p}\ln\left(\frac{x^q}{1+x^r}\right)+C$, where p, q, r $\in$ N and need not be distinct, then the value of (p + q + r) equals

(a) 6024 (b) 6022 (c) 6021 (d) 6020

4. $\lim\limits_{x\to\infty}\left(\frac{2\tan^{-1}x}{\pi}\right)^x$ equals e^L then L is equal to

(a) $\frac{2}{\pi}$ (b) $-\frac{2}{\pi}$ (c) $-\frac{\pi}{2}$ (d) 1

5. Let C_1 and C_2 are circles defined by $x^2+y^2-20x+64=0$ and $x^2+y^2+30x+144=0$. The length of the shortest line segment PQ that is tangent to C_1 at P and to C_2 at Q is

(a) 15 (b) 18 (c) 20 (d) 24

6. The sum of all positive integral values of 'a', $a \in [1, 500]$ for which the equation $[x]^3+x-a=0$ has solution is (where [ ] denote the greatest integer function)

(a) 462 (b) 512 (c) 784 (d) 812

7. Area enclosed by the graph of the function $y=\ln^2x-1$ lying in the 4th quadrant is

(a) $\frac{2}{e}$ (b) $\frac{4}{e}$

(c) $2\left(e+\frac{1}{e}\right)$ (d) $4\left(e-\frac{1}{e}\right)$

SECTION – II - Multiple Correct Choice Type

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE OR MORE is/are correct.

8. If b_1, b_2 and b_3 ($b_1 > 0$) are three successive terms of a G.P. with common ratio r, the value of r for which the inequality $b_3 > 4b_2 - 3b_1$ holds, is given by

(a) $r > 3$ (b) $r < 1$ (c) $1 < r < 2$ (d) $2 < r < 3$

9. Let $f : A \to B$ and $g : B \to C$ be functions and $gof : A \to C$. Which of the following statement is true?

(a) If gof is one-one then f and g both are one-one

(b) If gof is one-one then if is also one-one

(c) If gof is bijection then f is one-one and g is onto

(d) If f and g are both one-one then gof is one-one.

10. In the expansion of $(x + y + z)^{20}$

(a) coefficient of $x^7y^8z^7$ is zero

(b) total number of distinct terms is 231

(c) every term is of the form $\dfrac{20!x^{20-r}y^{r-k}z^k}{(20-r)!(r-k)!k!}$

(d) sum of coefficient is 3^{20}

11. The locus of the mid point of the focal radii of a variable point moving on the parabola, $y^2 = 4ax$ is a parabola whose

(a) latus rectum is half the latus rectum of the original parabola

(b) vertex is (a/2, 0)

(c) directrix is y-axis

(d) focus has the coordinate (a, 0)

12. For the hyperbola $9x^2 - 16y^2 - 18x + 32y - 151 = 0$

(a) one of the directrix is $x = 21/5$

(b) length of the latus rectum = 9/2

(c) focii are (6, 1) and (– 4, 1)

(d) eccentricity is 5/4

13. Let $E = \left[\frac{1}{3} + \frac{1}{50}\right] + \left[\frac{1}{3} + \frac{2}{50}\right] + \ldots..$ upto 50 terms, then

(a) E is divisible by exactly 2 primes

(b) E is prime

(c) $E \geq 30$

(d) $E < 35$

14. Let $P = \begin{bmatrix} 3 & -1 & -2 \\ 2 & 0 & \alpha \\ 3 & -5 & 0 \end{bmatrix}$, where $\alpha \in \mathbb{R}$. Suppose $Q = [q_{ij}]$ is a matrix such that $PQ = kI$, where $k \in \mathbb{R}$, $k \neq 0$ and I is the identity matrix of order 3. If $q_{23} = -\dfrac{k}{8}$ and $\det(Q) = \dfrac{k^2}{2}$, then

(a) $a = 0, k = 8$ (b) $4a - k + 8 = 0$

(c) $\det(P \text{ adj } (Q)) = 2^9$ (d) $\det(Q \text{ adj } (P)) = 2^{13}$

SECTION – III - Comprehension Type

This section contains 2 paragraphs. Each paragraph has 2 multiple choice questions based on a paragraph. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.

PARAGRAPH - 1

Let E : denotes the event that a student does his homework with P (E) = p and F : denotes the event that he answer the question correctly.

15. If p = 0.75, then the value of P (E/F) equals

(a) $\frac{8}{16}$ (b) $\frac{10}{16}$ (c) $\frac{12}{16}$ (d) $\frac{15}{16}$

16. The relation $P(E/F) \geq P(E)$ holds good for

(a) all values of p in [0, 1]

(b) all values of p in (0, 1) only

(c) all values of p in [0.5, 1] only

(d) p = 0, 1

PARAGRAPH - 2

Consider a polygon of sides n which satisfies the equation $3.{}^{n}P_{4} = {}^{n-1}P_{5}$.

17. Rajdhani express travelling from Delhi to Mumbai has 10 stations enroute. Number of ways in which a train can be stopped at 3 stations if no two of the stopping stations are consecutive, is

(a) 20 (b) 35
(c) 56 (d) 85

18. Number of quadrilaterals that can be made using the vertices of the polygon of sides 10 if exactly two adjacent sides of the quadrilateral are common to the sides of the n-gon, is

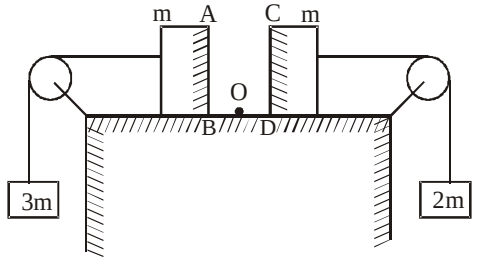
(a) 50 (b) 60
(c) 70 (d) None of these

Part - B : Physics

SECTION – I - Single Correct Choice Type

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.

19. Two blocks each of mass m lie on a smooth table. They are attached to two other masses as shown in the figure. The pulleys and strings are light. An object O is kept at rest on the table. The sides AB and CD of the two blocks are made reflecting. Find the acceleration of two images formed in those two reflecting surfaces w.r.t. each other.

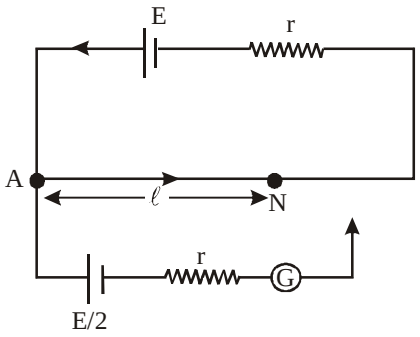


(a) 17g/6 (b) 7g/6
(c) 11g/6 (d) 5g/6

20. A small quantity of solution containing Na^{24} radionuclide (half life 15 hours) of activity 1.0 microcurie is injected into the blood of a person. A sample of the blood of volume $1cm^3$ taken after 5 hours shows an activity of 296 disintegrations per minute. Determine the total volume of blood in the body of the person. Assume that the radioactive solution mixes uniformly in the blood of the person.
(1 curie = 3.7×10^{10} disintegrations per second).

(a) 5.91 litres (b) 0.91 litres
(c) 3.21 litres (d) 4.12 litres

21. Consider the potentiometer circuit arranged as in figure. The potentiometer wire (resistance 15r) is 600 cm long. If the jockey touches the wire at a distance of 560 cm from A, what will be the current in the galvanometer ?



(a) 3E/11r (b) 5E/22r
(c) 3E/22r (d) 5E/11r

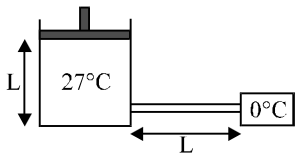
22. Three identical positive charges Q are arranged at the vertices of an equilateral triangle. The side of the triangle is a. Find the intensity of the field at the vertex of a regular tetrahedron of which the triangle is the base.

(a) $\sqrt{6}\frac{KQ}{a^2}$ (b) $\sqrt{2}\frac{KQ}{a^2}$
(c) $\sqrt{3}\frac{KQ}{a^2}$ (d) None of these

23. A point source is emitting sound in all directions. Find the ratio of distance of two points from the point source where the difference in loudness levels is 3 dB. ($\log_{10} 2 = 0.3$)

(a) 2 (b) 3
(c) 1/2 (d) $1/\sqrt{2}$

24. 0.5 mole of an ideal gas at constant temperature 27°C kept inside a cylinder of length L and cross-section area A closed by a massless piston.

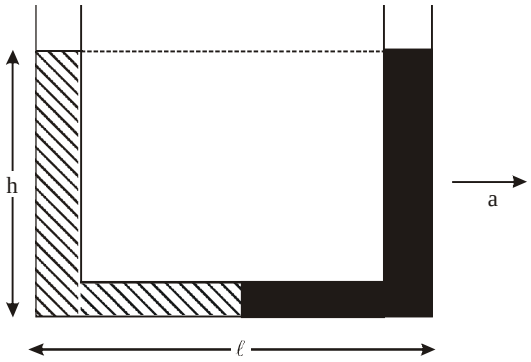


The cylinder is attached with a conducting rod of length L, cross-section area (1/9) m^2 and thermal conductivity K, whose other end is maintained at 0°C. If piston is moved such that rate of heat flow through the conducing rod is constant then velocity of piston when it is at height L/2 from the bottom of cylinder is :
[Neglect any kind of heat loss from system]

(a) $\left(\frac{K}{R}\right)$ m/sec (b) $\left(\frac{K}{10R}\right)$ m/sec

(c) $\left(\frac{K}{100R}\right)$ m/sec (d) $\left(\frac{K}{1000R}\right)$ m/sec

25. A U-tube of base length ℓ filled with same volume of two liquids of densities ρ and 2ρ is moving with an acceleration a on the horizontal plane. If the height difference between the two surfaces (open to atmosphere) becomes zero, then the height h is given by –



(a) $\frac{a}{2g}\ell$ (b) $\frac{3a}{2g}\ell$

(c) $\frac{a}{g}\ell$ (d) $\frac{2a}{3g}\ell$

SECTION – II - Multiple Correct Choice Type

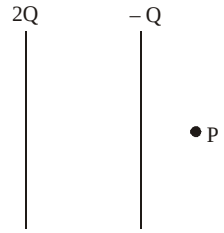
This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE OR MORE is/are correct.

26. A double star is a system of two stars of masses m and 2m, rotating about their centre of mass only under their mutual gravitational attraction. If r is the separation between these two stars then their time period of rotation about their centre of mass will be proportional to

(a) $r^{3/2}$ (b) r

(c) $m^{1/2}$ (d) $m^{-1/2}$

27. In the figure shown, the plates of a parallel plate capacitor have unequal charges. Its capacitance is C. P is a point outside the capacitor and close to the plate of charge –Q. The distance between the plates is 'd'.



(a) A point charge at point 'P' will experience electric force due to capacitor

(b) The potential difference between the plates will be 3Q/2C

(c) The energy stored in the electric field on the region between the plates is $9Q^2/8C$

(d) The force on one plate due to the other plate is $\frac{Q^2}{2\pi\varepsilon_0 d^2}$

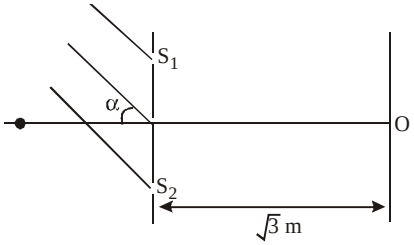
28. Suppose the potential energy between electron and proton at a distance r is given by $-\frac{Ke^2}{3r^3}$. Application of Bohr's theory to hydrogen atom in this case shows that

(a) energy in the nth orbit is proportional to n^6
(b) energy is proportional to m^{-3} (m : mass of electron)
(c) energy in the nth orbit is proportional to n^{-2}
(d) energy is proportional to m^3 (m = mass of electron)

29. During an experiment, an ideal gas is found to obey a condition $\frac{P^2}{\rho}$ = constant [ρ = density of the gas]. The gas is initially at temperature T, pressure P and density ρ. The gas expands such that density changes to ρ /2

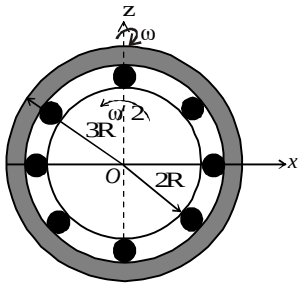
(a) The pressure of the gas changes to $\sqrt{2}$ P
(b) The temperature of the gas changes to $\sqrt{2}$ T
(c) The graph of the above process on the P-T diagram is parabola
(d) The graph of the above process on the P-T diagram is hyperbola

30. A parallel beam of light (λ = 5000 Å) is incident at an angle α = 30° with the normal to the slit plane in a Young's double slit experiment. Assume that the intensity due to each slit at any point on the screen is I_0. Point O is equidistant from S_1 and S_2. The distance between slits is 1mm.



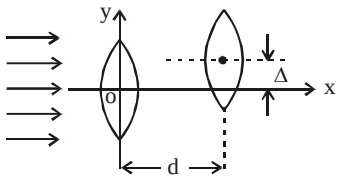
(a) the intensity at O is $4I_0$
(b) the intensity at O is zero
(c) the intensity at a point on the screen 1m below O is $4I_0$
(d) the intensity at a point on the screen 1m below O is zero

31. The figure shows a system consisting of (i) a ring of outer radius 3*R* rolling clockwise without slipping on a horizontal surface with angular speed ω and (ii) an inner disc of radius 2*R* rotating anti-clockwise with angular speed ω/2. The ring and disc are separated by frictionless ball bearings. The point *P* on the inner disc is at a distance *R* from the origin, where *OP* makes an angle of 30° with the horizontal. Then with respect to the horizontal surface,



(a) the point *O* has linear velocity $3R\omega\hat{i}$
(b) the point *P* has linear velocity $\frac{11}{4}R\omega\hat{i}+\frac{\sqrt{3}}{4}R\omega\hat{k}$.
(c) the point *P* has linear velocity $\frac{13}{4}R\omega\hat{i}-\frac{\sqrt{3}}{4}R\omega\hat{k}$
(d) the point *P* has linear velocity $\left(3-\frac{\sqrt{3}}{4}\right)R\omega\hat{i}+\frac{1}{4}R\omega\hat{k}$

32. Two thin convex lenses of focal lengths f_1 and f_2 are separated by a horizontal distance d (where $d < f_1$, $d < f_2$) and their centres are displaced by a vertical separation Δ as shown in the fig.



Taking the origin of coordinates *O*, at the centre of the first lens the x and y coordinates of the focal point of this lens system, for a parallel beam of rays coming from the left, are given by:

(a) $x = \frac{f_1 f_2}{f_1 + f_2}, y = \Delta$

(b) $x = \frac{f_1(f_2 + d)}{f_1 + f_2 - d}, y = \frac{\Delta}{f_1 + f_2}$

(c) $x = \frac{f_1 f_2 + d(f_1 - d)}{f_1 + f_2 - d}, y = \frac{\Delta(f_1 - d)}{f_1 + f_2 - d}$

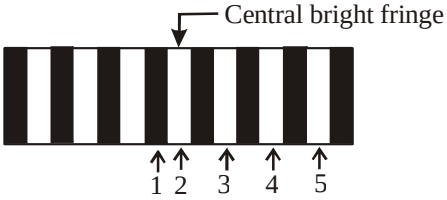
(d) $x = \frac{f_1 f_2 + d(f_1 - d)}{f_1 + f_2 - d}, y = 0$

SECTION – III - Comprehension Type

This section contains 2 paragraphs. Each paragraph has 2 multiple choice questions based on a paragraph. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.

PARAGRAPH - 1

The figure shows the interference pattern obtained in double-slit experiment using light of wavelength 600nm. 1, 2, 3, 4 and 5 are marked on the five fringes.



33. Which fringe results from a phase difference of 4π between the light waves emanating from two slits

(a) 2 (b) 3

(c) 5 (d) 4

34. Let ΔX_A and ΔX_C represent path differences between waves interfering at 1 and 3 respectively then $(|\Delta X_C| - |\Delta X_A|)$ is equal to

(a) 0 (b) 300nm

(c) 600 nm (d) 900nm

PARAGRAPH - 2

Superposition of waves results in maximum and minimum of intensities such as in case of standing waves. This phenomenon is called as interference. Another type of superposition result in interference in time which is called as beats. In this case waves are analyzed at a fixed point as a function of time. If the two waves are of nearby same frequency are superimposed, at a particular point, intensity of combined waves gives a periodic peak and fall. This phenomenon is beats. If ω_1 and ω_2 are the frequencies of two waves then by superimposed $y = y_1 + y_2$, we get at

$$x = 0,\ y = 2A\cos\left[\left(\frac{\omega_1 - \omega_2}{2}\right).t\right]\sin\left[\left(\frac{\omega_1 + \omega_2}{2}\right).t\right]$$

Thus amplitude frequency is small and fluctuates slowly. A beat i.e., a maximum of intensity occurs, also intensity depends on square of amplitude. The beat frequency is given by $\omega_{beat} = |\omega_1 - \omega_2|$.

Number of beats per second is called as beat frequency. A normal ear can detect only upto 15 Hz of frequency because of persistence of ear.

35. If two sound sources of frequency difference 25 Hz are sounded together. Then which of the following is correct ?

(a) A normal human ear will hear 25 Hz beat frequency

(b) A normal human ear will hear only 10 Hz beat frequency

(c) A normal human ear can hear this frequency

(d) A normal human ear cannot hear this beat frequency

36. The frequency of beats produced when two sources of sound are activated, one emitting wavelength 32 cm, other 32.2 cm is (Take $v_{sound} = 350$ m/s)

(a) 14 (b) 18

(c) 7 (d) 10

Part - C : Chemistry

SECTION – I - Single Correct Choice Type

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.

37. The bond dissociation enthalpies of $H_2(g)$ and $N_2(g)$ are + 435.95 kJ mol^{-1} and + 941.8 kJ mol^{-1} and enthalpy of formation of $NH_3(g)$ is – 46.024 kJ mol^{-1}. What is the enthalpy of atomization of $NH_3(g)$

(a) 0.170 MJ mol^{-1} (b) 1.70 MJ mol^{-1}
(c) 1.170 MJ mol^{-1} (d) 2.130 MJ mol^{-1}

38. In Ostwald's process for the manufacture of nitric acid, the first step involves the oxidation of ammonia gas by oxygen gas to give nitric oxide gas and steam. What is the maximum weight of nitric oxide that can be obtained starting only with 10.00 g of ammonia and 20.00 g of oxygen ?

(a) 15g (b) 20g
(c) 10g (d) 25g

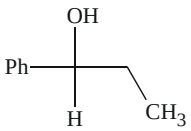
39. The molar volume of liquid benzene (density=0.877 g mL^{-1}) increases by a factor of 2750 as it vapourizes at 20°C. At 27°C when a non-volatile solute (that does not dissociate) is dissolved in 54.6 cm^3 of benzene, vapour pressure of this solution, is found to be 98.88 mm Hg. Calculate the freezing point of the solution.

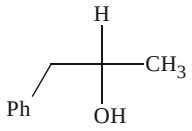
Given : Enthalpy of vapourization of benzene (ℓ) = 394.57 Jg^{-1}.
Enthalpy of fusion of benzene (ℓ) = 10.06 kJ mol^{-1}
Molal depression constant for benzene = 5.0 K kg mol^{-1}.
[Given : log 100.2 = 2.00086, log 74.63 = 1.8729]

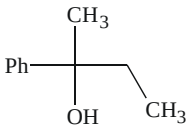
(a) 177.65 K (b) 277.65 K
(c) 517.65 K (d) 237.15 K

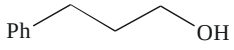
40. An unknown compound (A) with the M.F. $C_9H_{12}O$ does not decolorize Br_2 in CCl_4 and is oxidised by hot $KMnO_4$ to give $PhCO_2H$. The compound reacts with Na to give a colourless and odourless gas. From the following results deduce the correct structure for (A).

(i) he colour of $Cr_2O_7^{2-}$ changes from orange to blue-green.
(ii) The compound can be resolved.
(iii) No precipitate of CHI_3 is observed with I_2 / OH^-.
(iv) Oxidation with CrO_3 / pyridine gives a chiral compound.

(a) 

(b) 

(c) 

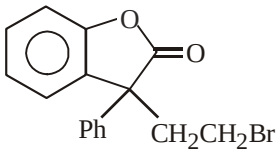
(d) 

41. Consider the cell Ag(s) | AgBr(s)|Br^- (aq)|| AgCl(s) | Cl^- (aq) | Ag(s) at 25°C. The solubility product constants of AgBr & AgCl are respectively 5×10^{-13} & 1×10^{-10}. For what ratio of the concentrations of Br^- & Cl^- ions would the emf of the cell be zero ? [Given : 0.059 log 5×10^{-13} = –0.7257]

(a) 1 : 200 (b) 1 : 100
(c) 1 : 500 (d) 200 : 1

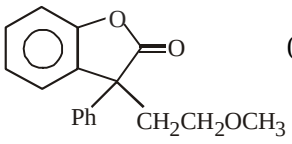
42. Which of the following complex will show geometrical as well as optical isomerism. [en = ethylene diamine]

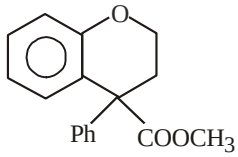
(a) $[Pt(NH_3)_2Cl_2]$ (b) $[Pt(NH_3)Cl_4]$
(c) $[Pt(en_3)]^{4+}$ (d) $[Pt(en)_2Cl_2]$

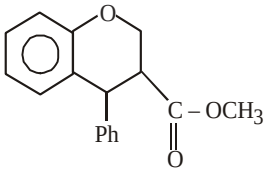
43. 

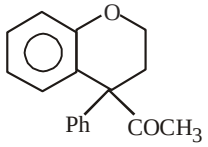
$\xrightarrow{NaOCH_3}$ Product

Product is/are

(a) 

(b) 

(c) 

(d) 

SECTION – II - Multiple Correct Choice Type

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE OR MORE is/are correct.

44. A solution of 0.2g of a compound containing Cu^{2+} and $C_2O_4^{2-}$ ions on titration with 0.02M $KMnO_4$ in presence of H_2SO_4 consumes 22.6 mL of the oxidant. The resultant solution is neutralized with Na_2CO_3, acidified with dil. acetic acid and treated with excess KI. The liberated iodine requires 11.3 mL of 0.05 M $Na_2S_2O_3$ solution for complete reduction. Then the correct options are

(a) Amount of $C_2O_4^{2-}$ in the solution = 1.13×10^{-3} mol

(b) Amount of Cu^{2+} in the solution = 0.56×10^{-3} mol

(c) Amount of $C_2O_4^{2-}$ in the solution = 0.56×10^{-3} mol

(d) Amount of Cu^{2+} in the solution = 1.13×10^{-3} mol

45. Choose the correct statements

(a) BeO is insoluble but $BeSO_4$ is soluble in water.

(b) The carbon hydride of the type C_nH_{2n+2} act as Lewis acid or base

(c) Due to its high bond enthalpy, dihydrogen is not particularly reactive at room temperature

(d) The s-block elements are very reactive

46. Which of the following is (are) correct statement(s) (assuming oxidation number of metal does not affect crystal field energy)

(a) Considering H_2O to be a weak ligand then on the basis of CFSE only, we can say that $[Co(H_2O)_6]^{2+}$ is more stable than $[Co(H_2O)_6]^{3+}$

(b) On the basis of CFSE only $[Fe(NH_3)_6]^{2+}$ is more stable than $[Fe(NH_3)_6]^{+3}$

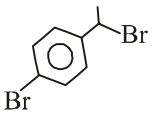
(c) All octahedral complexes of Ni(II) are bound to be outer d-complex

(d) The type of d-orbital involved in the hybridisation for a square planar complex (CN = 4) is d_{z^2}.

47. An aromatic chiral compound G ($C_8H_8Br_2$) on treatment with aqueous NaOH gives H (C_8H_9BrO). On heating 'G' with potassium tert-butoxide I (C_8H_7Br) is formed. With one equivalent of methyl magnesium bromide in ether *p*-bromoisopropylbenzene is formed which observation/s is/are correct about these reactions.

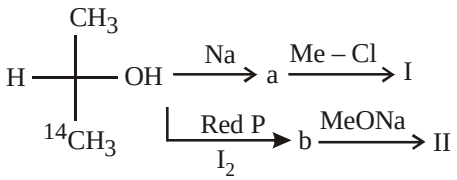
(a) (I) is an optically inactive aromatic alkene

(b) H is an optically active phenol

(c) G = 

(d) Benzylic halide gives nucleophilic substitution with faster rate than aryl halide

48. Choose the correct options for



(a) I and II are identical

(b) I and II are different

(c) Mechanism of formation of I and II are same

(d) Mechanism of formation of I and II are different

49. Identify the correct statement(s) –

(a) $|\psi|$ is the probability of finding the electron in an orbital

(b) *p*-orbital is directional in nature

(c) $d_{x^2-y^2}$ has dumb bell shape along *x* and *y*-axis

(d) d_{z^2} has dumb bell shape along *x* and *y*-axis

50. Buffer solution A of a weak monoprotic acid and its sodium salt in the concentration ratio $x : y$ has pH = $(pH)_1$. Buffer solution B of the same acid and its sodium salt in the concentration ratio $y : x$ has pH = $(pH)_2$.
If $(pH)_2 - (pH)_1 = 1$ unit and $(pH)_1 + (pH)_2 = 9.5$ units, then
(a) $pK_a = 4.75$ (b) $x/y = 2.36$
(c) $x/y = 3.162$ (d) $pK_a = 5.25$

SECTION – III - Comprehension Type

This section contains 2 paragraphs. Each paragraph has 2 multiple choice questions based on a paragraph. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONLY ONE is correct.

PARAGRAPH - 1

Paragraph for question nos. 51 to 52

The shapes of molecules can be predicted by VSEPR theory, hybridization and dipole moment. Total number of hybrid orbitals (H) on the central atom of a molecule can be calculated by using the following relation :

H = [Total no. of valence electron pairs (P)–3 × (no. of atoms surrounding the central atom, excluding Hydrogen atoms)]

One can also calculate total no. of bond pairs (n) around central atom as n = total number of atoms surrounding the central atom also, total no. of lone pairs (m) = H – n

Thus, VSEPR notation of a molecule can be written as AX_nE_m. Where, A denotes central atom of the molecule.

X denotes bond pairs on central atom of the molecule.

E denotes lone pairs on central atom of the molecule.

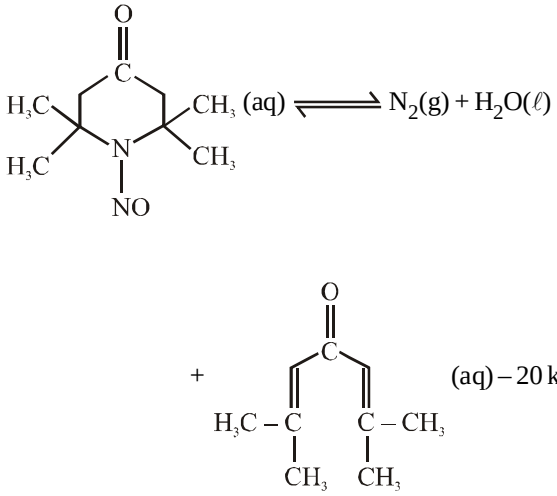
In a polar molecule, the net dipole moment of the molecule $\propto m$

51. VSEPR notation of chlorine trifluoride molecule is
(a) AX_5 (b) AX_3
(c) AX_2E_3 (d) AX_3E_2

52. Some molecules are given below
CO_2, SO_2, H_2O
I II III
The incorrect increasing order of dipole moment of given species is –
(a) I < II < III (b) II < I < III
(c) III < II < I (d) III < I < II

PARAGRAPH - 2

Consider the inter conversion of nitrosotriacetoamine into nitrogen phorone and water.



The reaction is 1st order in each direction, with an equilibrium constant of 10^4, the activation energy for the forward reaction is 57.45 kJ/ mol. Assuming arrhenius preexponetial factor of 10^{12} s^{-1}.

53. What is the expected forward rate constant at 300K , if we initiate this reaction starting with only reactant
(a) 10^2 (b) 10^6
(c) 10^8 (d) 10^4

54. If the change in entropy of the reaction is 0.07 kJ. K^{-1} mol^{-1} at 1 atm pressure. Calculate up to which temperature the reaction would not be spontaneous. (For forward reaction)
(a) T < 285.7 K (b) T > 250 K
(c) T < 340.2 K (d) T > 200 K

RESPONSE SHEET

MOCK TEST - 1

Name : ..... Date : .....

PAPER 1

1	(a)	(b)	(c)	(d)	28	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)
2	(a)	(b)	(c)	(d)	29	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)
3	(a)	(b)	(c)	(d)	30	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)
4	(a)	(b)	(c)	(d)	31	(a)	(b)	(c)	(d)
5	(a)	(b)	(c)	(d)	32	(a)	(b)	(c)	(d)
6	(a)	(b)	(c)	(d)	33	(a)	(b)	(c)	(d)
7	(a)	(b)	(c)	(d)	34	(a)	(b)	(c)	(d)
8	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)	35	(a)	(b)	(c)	(d)
9	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)	36	(a)	(b)	(c)	(d)
10	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)	37	(a)	(b)	(c)	(d)
11	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)	38	(a)	(b)	(c)	(d)
12	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)	39	(a)	(b)	(c)	(d)
13	(a)	(b)	(c)	(d)	40	(a)	(b)	(c)	(d)
14	(a)	(b)	(c)	(d)	41	(a)	(b)	(c)	(d)
15	(a)	(b)	(c)	(d)	42	(a)	(b)	(c)	(d)
16	(a)	(b)	(c)	(d)	43	(a)	(b)	(c)	(d)
17	(a)	(b)	(c)	(d)	44	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)
18	(a)	(b)	(c)	(d)	45	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)
19	(a)	(b)	(c)	(d)	46	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)
20	(a)	(b)	(c)	(d)	47	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)
21	(a)	(b)	(c)	(d)	48	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)
22	(a)	(b)	(c)	(d)	49	(a)	(b)	(c)	(d)
23	(a)	(b)	(c)	(d)	50	(a)	(b)	(c)	(d)
24	(a)	(b)	(c)	(d)	51	(a)	(b)	(c)	(d)
25	(a)	(b)	(c)	(d)	52	(a)	(b)	(c)	(d)
26	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)	53	(a)	(b)	(c)	(d)
27	(0)	(1)	(2)	(3) (4) (5) (6) (7) (8) (9)	54	(a)	(b)	(c)	(d)

PAPER 2

1	(a)	(b)	(c)	(d)	28	(a)	(b)	(c)	(d)
2	(a)	(b)	(c)	(d)	29	(a)	(b)	(c)	(d)
3	(a)	(b)	(c)	(d)	30	(a)	(b)	(c)	(d)
4	(a)	(b)	(c)	(d)	31	(a)	(b)	(c)	(d)
5	(a)	(b)	(c)	(d)	32	(a)	(b)	(c)	(d)
6	(a)	(b)	(c)	(d)	33	(a)	(b)	(c)	(d)
7	(a)	(b)	(c)	(d)	34	(a)	(b)	(c)	(d)
8	(a)	(b)	(c)	(d)	35	(a)	(b)	(c)	(d)
9	(a)	(b)	(c)	(d)	36	(a)	(b)	(c)	(d)
10	(a)	(b)	(c)	(d)	37	(a)	(b)	(c)	(d)
11	(a)	(b)	(c)	(d)	38	(a)	(b)	(c)	(d)
12	(a)	(b)	(c)	(d)	39	(a)	(b)	(c)	(d)
13	(a)	(b)	(c)	(d)	40	(a)	(b)	(c)	(d)
14	(a)	(b)	(c)	(d)	41	(a)	(b)	(c)	(d)
15	(a)	(b)	(c)	(d)	42	(a)	(b)	(c)	(d)
16	(a)	(b)	(c)	(d)	43	(a)	(b)	(c)	(d)
17	(a)	(b)	(c)	(d)	44	(a)	(b)	(c)	(d)
18	(a)	(b)	(c)	(d)	45	(a)	(b)	(c)	(d)
19	(a)	(b)	(c)	(d)	46	(a)	(b)	(c)	(d)
20	(a)	(b)	(c)	(d)	47	(a)	(b)	(c)	(d)
21	(a)	(b)	(c)	(d)	48	(a)	(b)	(c)	(d)
22	(a)	(b)	(c)	(d)	49	(a)	(b)	(c)	(d)
23	(a)	(b)	(c)	(d)	50	(a)	(b)	(c)	(d)
24	(a)	(b)	(c)	(d)	51	(a)	(b)	(c)	(d)
25	(a)	(b)	(c)	(d)	52	(a)	(b)	(c)	(d)
26	(a)	(b)	(c)	(d)	53	(a)	(b)	(c)	(d)
27	(a)	(b)	(c)	(d)	54	(a)	(b)	(c)	(d)

TEST ASSESSMENT AND ANALYSIS SHEET

Mock Test - 1

Name :…….....…. Test Code : .....…….. Date & Time of test:…….....

	Marks per questions	PAPER 1				PAPER 2			
		Total Qs.	Attempted	Correct	Net Score	Total Qs.	Attempted	Correct	Net Score
PHYSICS									
MCQ'S									
MCQ > 1 correct									
Passage Cum Matching									
Integer Answer									
Passage Based									
Physics Net Score									
Sectional % Score									
CHEMISTRY									
MCQ'S									
MCQ > 1 correct									
Passage Cum Matching									
Integer Answer									
Passage Based									
Chemistry Net Score									
Sectional % Score									
MATHEMATICS									
MCQ'S									
MCQ > 1 correct									
Passage Cum Matching									
Integer Answer									
Passage Based									
Maths Net Score									
Sectional % Score									
STRIKE RATE (Correct Answers/ Questions attempted):									
TOTAL NET SCORE									
COMBINED NET SCORE (Paper 1 + Paper 2)									

1) Analysis of wrong questions

Reasons for wrong questions (to be filled after you have attempted wrong questions on your own after the test)	**No. of ques.**
Knew the question and solved after test but did wrong because of calculation mistake (A)	
Knew the question and solved after test but did wrong because got confused and applied wrong concept (B)	
Did not knew the question and couldn't solve even after exam (C)	
Total Number of questions attempted wrong	

Note : If some of (A) & (B) is high then you need more practice and also read instructions more carefully whereas if (C) is very high it means the coverage of topic is not sufficient and you need to improve on it.

2) Analysis of not attempted questions : Divide the questions not attempted in 3 categories

Reasons for unattempted questions (fill after you have tried unattempted questions on your own after the test)	**No. of ques.**
Easy questions (A)	
Average questions (B)	
Difficult questions (C)	
Total Number of ques. not attempted	

SOLUTIONS - MOCK IITs

MOCK IIT - 1

ANSWER KEY - PAPER 1									
1	(a, b, c, d)	**13**	(d)	**25**	(a,d).	**37**	(a,b,d)	**49**	(d)
2	(a, b, c, d)	**14**	(b)	**26**	4	**38**	(a,b,c,d)	**50**	(b)
3	(a, b)	**15**	(c)	**27**	5	**39**	(a,b)	**51**	(a), (b)
4	(a, b, c, d)	**16**	(c)	**28**	7	**40**	(a,b,c)	**52**	(c)
5	(b)	**17**	(a)	**29**	7	**41**	(a, c)	**53**	(b)
6	(c, d)	**18**	(d)	**30**	4	**42**	(c, d)	**54**	(d)
7	(a, c)	**19**	(a,c)	**31**	(c)	**43**	(b, d)		
8	(0)	**20**	(a,b,c)	**32**	(b)	**44**	8		
9	(0)	**21**	(a,b,c,d)	**33**	(d)	**45**	7		
10	(2)	**22**	(a,d)	**34**	(c)	**46**	1		
11	(1)	**23**	(a,b,c)	**35**	(d)	**47**	3		
12	(2)	**24**	(c,d)	**36**	(a)	**48**	5		

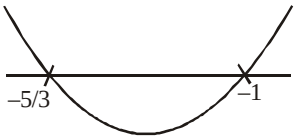
EXPLANATORY NOTES

PAPER - 1

1. (a, b, c, d)

$f'(x) = 3x^2 + 2px + q < 0,$

$x \in \left(-\frac{5}{3}, -1\right)$



$\Rightarrow 3x^2 + 2px + q = (3x + 5)(x + 1)$

$\Rightarrow 2p = 8 ; p = 4 \ \& \ q = 5 \Rightarrow p + q = 9$

2. (a, b, c, d)

(a) $T_n = \tan^{-1}\left(\frac{2}{n^2}\right) = \tan^{-1}\left(\frac{2}{1+(n^2-1)}\right)$

$= \tan^{-1}\left(\frac{2}{1+(n-1)(n+1)}\right)$

$= \tan^{-1}\left(\frac{(n+1)-(n-1)}{1+(n-1)(n+1)}\right)$

$= \tan^{-1}(n+1) - \tan^{-1}(n-1)$

$T_1 = \tan^{-1}(2) - \tan^{-1}(0)$

$T_2 = \tan^{-1}(3) - \tan^{-1}(1)$

$T_3 = \tan^{-1}(4) - \tan^{-1}(2)$

$\vdots \quad \vdots \quad \vdots$

$T_{n-1} = \tan^{-1}(n) - \tan^{-1}(n-2)$

$T_n = \tan^{-1}(n+1) - \tan^{-1}(n-1)$

$S = T_1 + T_2 + \ldots\ldots + T_n = \pi - \tan^{-1}(1) = \frac{3\pi}{4}$

(b) $\ell = \lim_{n\to\infty} n \sin\left(2\pi\sqrt{1+n^2} - 2n\pi\right)$

$= \lim_{n\to\infty} n \sin\left(\frac{2\pi(\sqrt{1+n^2}-n)}{\sqrt{1+n^2}+n)} \times (\sqrt{1+n^2}+n)\right)$

$= \lim_{n\to\infty} \left(\frac{n \sin\left(\frac{2\pi}{\sqrt{1+n^2}+n}\right)}{\left(\frac{2\pi}{\sqrt{1+n^2}+n}\right)} \left(\frac{2\pi}{\sqrt{1+n^2}+n}\right)\right)$

$= \lim_{n\to\infty} \frac{2n\pi}{n\left(\sqrt{1+\frac{1}{n^2}}+1\right)} = \frac{2\pi}{2} = \pi$

(c) $f(x) = \sin^2 2x + (1 - \sin^2 2x)^2 + 2$

$= \sin^2 2x + 1 + \sin^4 2x - 2\sin^2 2x + 2$

$= 3 + \sin^4 2x - \sin^2 2x = 3 - \sin^2 2x\,(1 - \sin^2 2x)$

$= 3 - \sin^2 2x \cdot \cos^2 2x = 3 - \frac{\sin^2 4x}{4}$

$\Rightarrow$ period of $f(x)$ is $\frac{\pi}{4}$

(d) $I = \int_{-1}^{1} (1+x)^{1/2}(1-x)^{3/2}dx$

$= \int_{-1}^{1} (1+x)^{1/2}(1-x)^{1/2}(1-x)dx$

$= \int_{-1}^{1} \sqrt{1-x^2}(1-x)dx$

Put $x = \sin\theta \Rightarrow dx = \cos\theta\, d\theta$

$\therefore I = \int_{-\pi/2}^{\pi/2} \cos\theta(1-\sin\theta)\cos\theta d\theta$

$= \int_{-\pi/2}^{\pi/2} \cos^2\theta\, d\theta - \int_{-\pi/2}^{\pi/2} \cos^2\theta \sin\theta\, d\theta$

$= \frac{\sin 2\theta}{4} + \left|\frac{\theta}{2}\right|_{-\pi/2}^{\pi/2} + \left|\frac{\cos^3\theta}{3}\right|_{-\pi/2}^{\pi/2}$

$= \frac{\pi}{4} + \frac{\pi}{4} + 0 = \frac{2\pi}{4} = \frac{\pi}{2}$

3. (a, b)

(a) $\vec{a}.(\vec{b}-\vec{c}) = 0$

$\Rightarrow$ Either $\vec{b} = \vec{c}$ or angle between $\vec{a}$ and $\vec{b}-\vec{c}$ is $90°$

$\Rightarrow$ (a) is not correct.

(b) $\vec{a}\times(\vec{b}-\vec{c}) = 0$

$\Rightarrow$ Either $\vec{b} = \vec{c}$ or $\vec{a}$ and $\vec{b}-\vec{c}$ are collinear

$\Rightarrow$ (b) is not correct.

(c) $\vec{a}.(\vec{b}-\vec{c}) = 0$ and $\vec{a}\times(\vec{b}-\vec{c}) = 0$

$\Rightarrow$ [Either $\vec{b} = \vec{c}$ or angle between $\vec{a}$ & $(\vec{b}-\vec{c})$ is $90°$] and

[Either $\vec{b} = \vec{c}$ or angle between $\vec{a}$ & $(\vec{b}-\vec{c})$ is 0]

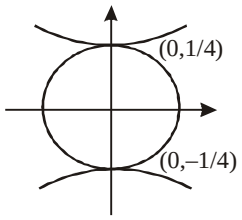
$\vec{a}$ and $\vec{b}-\vec{c}$ are collinear. Hence, $\vec{b} = \vec{c}$

(c) is correct.

(d) (d) is true, refer reciprocal system of vectors.

4. (a, b, c, d)

(a) $\frac{y^2}{1/16} - \frac{x^2}{1/9} = 1$



Locus will be the auxillary circle

$x^2 + y^2 = 1/16$

(b) The point with slope 2 and 3 are normal at $(4,-4)$; $(9,-6)$ where there is no curve, point of normal $(am^2, -2am)$

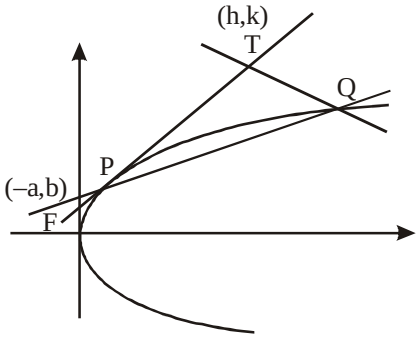
(c) $T: \frac{xx_1}{a^2} - \frac{yy_1}{b^2}$; $\frac{x.ae}{a^2} - \frac{y.b^2}{a.b^2} = 1$ or $\frac{ex}{a} - \frac{y}{a} = 1$

or $ex - y = a \Rightarrow m = e$

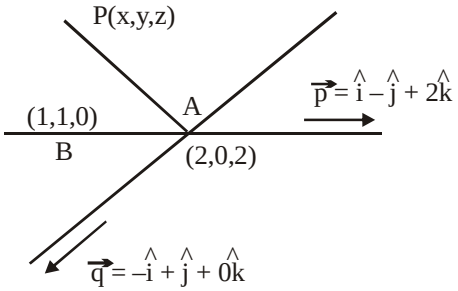
(d) Chord of contact of (h, k)

$ky = 2a(x + h)$. It passes through $(-a, b)$

$\Rightarrow bk = 2a(-a + h) \Rightarrow$ Locus is $y = 2a(x - a)$.



5. (b)



Lines intersect at (2, 0, 2). Equation of the plane is

$$\begin{vmatrix} x-2 & y & z-2 \\ -1 & 1 & 0 \\ 1 & -1 & 2 \end{vmatrix} = 0 \Rightarrow x + y - 2 = 0$$

6. **(c, d)** $g(x+2)=\int_0^{x+2} f(t)dt$

$$\int_0^2 f(t)\,dt+\int_2^{x+2} f(t)\,dt=g(2)+\int_0^x f(t)\,dt$$

$\therefore\ g(x+2)=g(2)+g(x)$

$\Rightarrow\ g(x)$ is periodic with period 2

Also, $g(2)=\int_0^2 f(t)dt=\int_0^1 f(t)dt+\int_1^2 f(t)dt$

$=\int_0^1 f(t)dt+\int_{-1}^0 f(t)dt$ [putting $t=u+2$]

$=\int_{-1}^1 f(t)\,dt=0$ [$\because$ $f(x)$ is odd]

$\therefore\ g(2n)=0$

[$\because$ $g(x)$ is periodic with period 2]

Also, $g(-x)=\int_0^{-x} f(t)\,dt=\int_0^u f(-u)(-du)$

$=\int_0^x f(u)\,du\ (\because\ f(x)$ is odd$)$

$=g(x)$

7. **(a, c)** $\frac{dy}{dx}+\frac{e^x}{1+e^x}y=\frac{1}{1+e^x}$

I.F. $=1+e^x$

$\therefore$ Sol^n: $y(1+e^x)=x+c$

$y(0)=2\Rightarrow c=4$

$\therefore\quad y=\frac{x+4}{e^x+1}$

$\therefore\quad y(-4)=0$

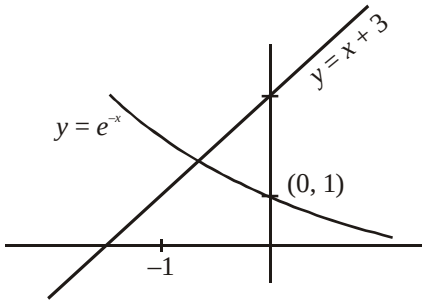
Also $\frac{dy}{dx}=\frac{(e^x+1)-e^x(x+4)}{(e^x+1)^2}$

For critical point $\frac{dy}{dx}=0$

$\Rightarrow\quad e^x(x+3)=1$

$\Rightarrow\quad x+3=e^{-x}$

Its solution will be intersection point of $y=x+3$ and $y=e^{-x}$



Clearly there is a critical point in (–1, 0).

8. **Ans : 0**

Here, $t_{r+1}={}^nC_r(a-r)(b-r)(c-r)(-1)^r$

Now, $\sum_{r=0}^n t_{r+1}=\sum_{r=0}^n {}^nC_r(-1)^r(a-r)(b-r)(c-r)$

$\Rightarrow\quad S=\sum_{r=0}^n {}^nC_r(-1)^r\{abc+(a+b+c)r^2-(ab+bc+ca)r-r^3\}$

$\Rightarrow\quad S=abc\left\{\sum_{r=0}^n(-1)^r\,{}^nC_r\right\}$

$+(a+b+c)\left\{\sum_{r=0}^n(-1)^r\,r^2\,{}^nC_r\right\}$

$-(ab+bc+ca)\left\{\sum_{r=0}^n(-1)^r\,r\,{}^nC_r\right\}-\sum_{r=0}^n(-1)^r\,r^3\,{}^nC_r$

Since, $\sum_{r=0}^n(-1)^r\,{}^nC_r=0$

Also, $\sum_{r=0}^{n}(-1)^r\, r\, {}^nC_r = \frac{d}{dx}(1-x)^n\,|_{x=1} = 0$

Similarly,

$\sum_{r=0}^{n}(-1)^r\, r^2\, {}^nC_r =$ value of $\frac{d}{dx}(nx(1-x)^{n-1}\,|_{x=1} = 0$

Hence, $S = abc\,(0) + (a+b+c)\,(0) - (ab+bc+ca)\,(0) - 0$

$\therefore \quad S = 0.$

9. Ans : 0

Let $z = i^{\,i}$

$\Rightarrow \ln z = i \ln i = -\frac{\pi}{2}$ or $z = e^{-\frac{\pi}{2}} > 0 \Rightarrow \arg(z) = 0$

10. Ans : 2

$$\text{Let D} = \begin{vmatrix} \cos p & -\sin p & 1 \\ \sin p & \cos p & 1 \\ \cos(p+q) & -\sin(p+q) & 1 \end{vmatrix}$$

Applying $R_3 : R_3 - \cos qR_1 + \sin qR_2$

$$\text{D} = \begin{vmatrix} \cos p & -\sin p & 1 \\ \sin p & \cos p & 1 \\ 0 & 0 & 1+\sin q-\cos q \end{vmatrix}$$

On expanding we get D = 1 + sin q – cos q $\left(\because \sin q \neq \cos q\right)$

To solve for x, y, z

$$D_x = \begin{vmatrix} \cos q+1 & -\sin p & 1 \\ -\sin q+1 & \cos p & 1 \\ 2 & -\sin(p+q) & 1 \end{vmatrix}$$

Apply $C_1 : C_1 - C_3$ first, then $R_3 : R_3 - \cos qR_1 + \sin R_2$ and expanding we get $D_x = (1+\sin q-\cos q)\cos(p+q)$

Similarly, $D_y = (1+\sin q-\cos q)\sin(p+q)$ and

$$D_z = \begin{vmatrix} \cos p & -\sin p & \cos q+1 \\ \sin p & \cos p & -\sin q+1 \\ \sin(p+q) & -\sin(p+q) & 2 \end{vmatrix}$$

Applying $R_3 : R_3 - \cos qR_1 + \sin qR_2$ and expanding we get

$D_z = 1+\sin q-\cos q$

$\therefore x = \frac{D_x}{x}; y = \frac{D_y}{D}; z = \frac{D_z}{D}$ x = cos (p + q); y = –sin (p + q);

z = 1 $\Rightarrow$ $x^2 + y^2 + z^2 = 2.$

11. Ans : 1

Let A_t, $t = 1, 2, \ldots\ldots 6$ be the set of days on which the friend is present at dinner and B_t be the set of days on which the friend is absent at dinner. Then $|A_t| = |B_t| = 7$

Also $|A_i \cap A_j| = 7, |A_i \cap A_j \cap A_k| = 4$

$|A_i \cap A_j \cap A_k \cap A_l| = 3, |A_i \cap A_j \cap A_k \cap A_l \cap A_m| = 2$

and $|A_1 \cap A_2 \cap A_3 \cap A_4 \cap A_5 \cap A_6| = 1$

where i, j, k, l, m, vary from 1 to 6 and are distinct. Now the number of dinners at which at least one friend was present

$= |A_1 \cup A_2 \cup \ldots\ldots \cup A_6|$

$= \sum|A_i| - \sum|A_i \cap A_j| + \sum|A_i \cap A_j \cap A_k|$

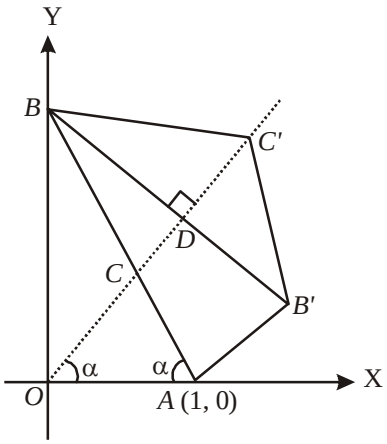
$- \sum|A_i \cap A_j \cap A_k \cap A_l| + \sum|A_i \cap A_j \cap A_k \cap A_l \cap A_m| - |A_1 \cap A_2 \cap \ldots\ldots \cap A_6|$

$= {}^6C_1 \times 7 - {}^6C_2 \times 5 + {}^6C_3 \times 4 - {}^6C_4 \times 3 + {}^6C_5 \times 2 - {}^6C_6 \times 1 = 13$

Total number of dinners is $|A_t| + |B_t| = 7 + 7 = 14$

$\therefore$ Number of dinners the person had alone = 14 – 13 = 1

12. Ans : 2



From figure $OB = \tan\alpha$ and $\angle COA = \alpha$

So, equation of line OC is $y = x \tan\alpha$ and $AB = \sec\alpha$

So, in ΔBDC angle $BCD = (180° - 2\alpha)\left(\because \angle COA = \alpha\right)$

$\Rightarrow \quad BD = BC \sin(180 - 2\alpha)$

$= BC \times \sin 2\alpha = \frac{1}{2} \times \sec\alpha \times 2\sin\alpha \times \cos\alpha = \sin\alpha$

$\Rightarrow \quad BD = B'D' = \sin\alpha$

Clearly ΔBDC and $\Delta BDC'$ are congruent

$BC' = BC = \frac{1}{2}\sec\alpha$ and $\angle ABB' = \angle B'BC'$ ...(2)

Now, $\frac{\text{area of } \Delta ABB'}{\text{area of } \Delta BB'C'} = \frac{AB \times BB' \times \sin\angle ABB'}{BB' \times BC' \times \sin\angle B'BC'}$

$= \frac{AB}{BC'} = \frac{\sec\alpha}{\frac{1}{2}\sec\alpha} = 2$ (Since $\angle ABB' = \angle B'BC'$)

ALTERNATE METHOD :

From figure $OB = \tan\alpha$. So, the coordinates of B are $(0, \tan\alpha)$ and the equation of OC is $y = x\tan\alpha$

The equation of BB' is

$y - \tan\alpha = -\cot\alpha(x - 0) \Rightarrow x\cot\alpha + y = \tan\alpha$

Now $B'(x_1, y_1)$ is given by

$\frac{x_1 - 0}{\tan\alpha} = \frac{y_1 - \tan\alpha}{-1} = \frac{-2(-\tan\alpha)}{1 + \tan^2\alpha}$

$\therefore x_1 = \frac{2\tan^2\alpha}{1 + \tan^2\alpha}, y_1 = \frac{\tan^3\alpha - \tan\alpha}{1 + \tan^2\alpha}$

Further C is $\left(\frac{1}{2}, \frac{1}{2}\tan\alpha\right)$, so $C'(x_2, y_2)$ is given by

$\frac{x_2 - \frac{1}{2}}{\cot\alpha} = \frac{y_2 - \frac{1}{2}\tan\alpha}{1} = \frac{-2\left(\frac{1}{2}\cot\alpha + \frac{1}{2}\tan\alpha - \tan\alpha\right)}{\cot^2\alpha + 1}$

$\therefore x_2 = \frac{3\tan^2\alpha - 1}{2(1 + \tan^2\alpha)}, y_2 = \frac{\tan\alpha(3\tan^2\alpha - 1)}{2(1 + \tan^2\alpha)}$

Now area of $\Delta ABB'$

$= \frac{1}{2}\begin{vmatrix} 1 & 0 & 1 \\ 0 & \tan\alpha & 1 \\ x_1 & y_1 & 1 \end{vmatrix} = \frac{1}{2}\begin{vmatrix} 1 & 0 & 0 \\ 0 & \tan\alpha & 1 \\ x_1 & y_1 & 1 - x_1 \end{vmatrix}$

$= \frac{1}{2}\left|\tan\alpha(1 - x_1) - y_1\right|$

$= \frac{1}{2}\left|\tan\alpha\left(1 - \frac{2\tan^2\alpha}{1 + \tan^2\alpha}\right) - \frac{\tan\alpha(\tan^2\alpha - 1)}{1 + \tan^2\alpha}\right|$

$= \left|\frac{\tan\alpha(1 - \tan^2\alpha)}{1 + \tan^2\alpha}\right|$

area of $\Delta BB'C'$

$= \frac{1}{2}\begin{vmatrix} 0 & \tan\alpha & 1 \\ x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \end{vmatrix} = \frac{1}{2}\begin{vmatrix} 0 & \tan\alpha & 1 \\ x_1 & y_1 - \tan\alpha & 0 \\ x_2 & y_2 - \tan\alpha & 0 \end{vmatrix}$

$= \frac{1}{2}\left|\left[x_1(y_2 - \tan\alpha) - x_2(y_1 - \tan\alpha)\right]\right|$

$= \frac{1}{2}\left|\frac{2\tan^2\alpha}{1 + \tan^2\alpha}\left\{\frac{3\tan^3\alpha - \tan\alpha}{2(1 + \tan^2\alpha)} - \tan\alpha\right\}\right.$

$\left. - \frac{3\tan^2\alpha - 1}{2(1 + \tan^2\alpha)}\left\{\frac{\tan^3\alpha - \tan\alpha}{1 + \tan^2\alpha} - \tan\alpha\right\}\right|$

$= \frac{1}{2}\left|\frac{\tan^3\alpha(\tan^2\alpha - 3)}{(1 + \tan^2\alpha)^2} + \frac{\tan\alpha(3\tan^2\alpha - 1)}{(1 + \tan^2\alpha)^2}\right|$

$= \frac{1}{2}\left|\frac{\tan\alpha(\tan^4\alpha - 1)}{(1 + \tan^2\alpha)^2}\right| = \frac{1}{2}\left|\frac{\tan\alpha(1 - \tan^2\alpha)}{1 + \tan^2\alpha}\right|$

$= \frac{1}{2}(\text{area of } \Delta ABB')$

$\therefore \frac{\text{area of } \Delta ABB'}{\text{area of } \Delta BB'C'} = 2$

13. (d) Since $R: \{(x, y) : 2x^2 + 3y^2 - 5xy = 0\}$

For $R \to R$

$x\,Rx \Leftrightarrow 2x^2 + 3x^2 - 5x^2 = 0$ (True) and so reflexive.

14. (b) Since $R : N \to N$; $R = \{(x, y) : y = x + 4 \text{ and } x < 4\}$

$\Rightarrow R = \{(1, 5), (2, 6), (3, 7)\}$

$\Rightarrow$ R is not reflexive, not symmetric, but transitive and anti-symmetric by default.

15. (c) Since, $R : Z \to Z$; $R = \{(x, y) : x - y \in Z\}$

$\because x - x = 0 \in Z$

$\Rightarrow$ R is reflexive and $x - y \in Z$

$\Rightarrow y - x \in Z \Rightarrow$ R is symmetric.

Also $x - y, y - z \in Z \Rightarrow (x - y) + (y - z) \in Z$

$\Rightarrow (x - z) \in Z \Rightarrow$ R is transitive.

$\because (2, 4), (4, 2) \in Z$, but $2 \neq 4$

$\Rightarrow$ R is not anti-symmetric.

16. (c) If $D = b^2 - 4ac = 0$, $a < 0$,

then $ax^2 + bx + c \leq 0 \ \forall \ x \in R$

$\Rightarrow f(x)$ is not defined at any real x.

$\Rightarrow$ Domain $= \phi$

17. (a) If $D = b^2 - 4ac > 0$, $a < 0$

then $ax^2 + bx + c > 0 \ \forall \ x \in (\alpha, \beta)$

$\Rightarrow$ Domain $= (\alpha, \beta)$

18. (d) If $D = b^2 - 4ac > 0$, $a > 0$

then $ax^2 + bx + c > 0 \ \forall \ x \in (-\infty, \alpha) \cup (\beta, \infty)$

$\Rightarrow$ Domain $= (-\infty, \alpha) \cup (\beta, \infty)$

19. **(a, c)** Path difference $= \sqrt{D^2 + d^2} - D = 1$ cm.

Also, $[\sqrt{D^2 + d^2} - D] = (2n - 1)\frac{\lambda}{2} \Rightarrow \lambda = \frac{2(1)}{2n - 1}$

For $n = 1, 2, 3$.....

$\lambda = 2\text{cm}, \frac{2}{3}\text{cm}, \frac{2}{5}\text{cm}, ...$

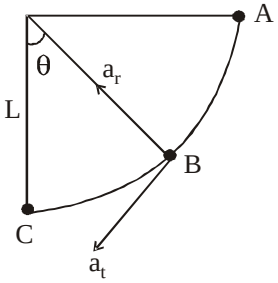
20. **(a, b, c)**

Between A and B, $mgL\cos\theta = \frac{1}{2}mv_B^2$

$\therefore \ v_B^2 = 2gL\cos\theta$

Now, $a_r = \frac{v_B^2}{L} = 2g\cos\theta$

and $a_t = g\sin\theta$



$\therefore \ a = \sqrt{a_t^2 + a_r^2} = g\sqrt{1 + 3\cos^2\theta}$

Now, at B : $T_B - mg\cos\theta = \frac{mv_B^2}{L}$

Put $V_B \Rightarrow T_B = 3mg\cos\theta$

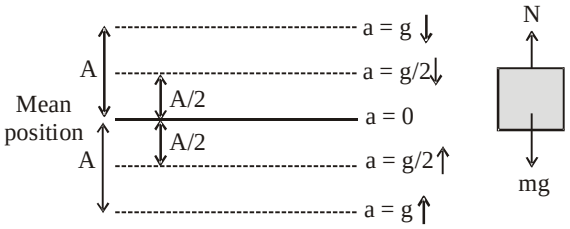
When total acceleration vector directed horizontally

$$\tan(90° - \theta) = \frac{a_t}{a_r} = \frac{g\sin\theta}{2g\cos\theta} = \frac{1}{2}\tan\theta$$

On solving, $\theta = \cos^{-1}\frac{1}{\sqrt{3}}$

21. **(a, b, c, d)**

As the block loses contact with the plank at extreme position



i.e. normal force becomes zero, it has to be the upper extreme, where acceleration of the block will be g downwards.

$\therefore \ \omega^2 A = g \ ; \quad \omega^2 = \frac{10}{0.4} = 25$

or $\omega = 5$ rad/s $\ \therefore \ T = \frac{2\pi}{\omega} = \frac{2\pi}{5}$s

Acceleration in SHM is given by, $a = \omega^2 x$

From the figure we can see that, at lower extreme, acceleration is g upwards

$\therefore \ N - mg = ma$ or $N = m(a + g) = 2mg$

At halfway up, acceleration is g/2 downwards

$\therefore \ mg - N = ma$ or $N = m(g - g/2) = \frac{1}{2}mg = 0.5\,mg$

At halfway down, acceleration is g/2 upwards

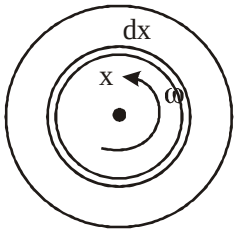
$\therefore \ N - mg = ma$ or $N = m(g + g/2) = \frac{3}{2}mg$

At mean position, velocity is maximum and acceleration is zero. $\therefore \ N = mg$

22. **(a, d)** Consider a ring of radius x and the thickness dx.

Equivalent current in the ring

$= \frac{\omega}{2\pi} \times$ charge on the ring



$= \frac{\omega}{2\pi} \times (2\pi x dx)\frac{Q}{\pi R^2}$

$dB \text{ (due to this ring)} = \frac{\mu_0}{2x}\left(\frac{\omega}{2\pi}\frac{2xQ}{R^2}dx\right)$

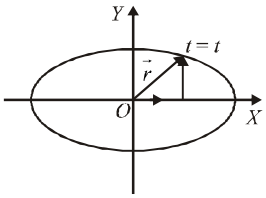
$\therefore\ B = \int_0^R \frac{\mu_0 \omega}{2\pi}\frac{Q}{R^2}dx = \frac{\mu_0 \omega Q}{2\pi R^2}.R = \frac{\mu_0 \omega Q}{2\pi R}$ (Outward)

23. **(a, b, c)** $x = a \cos pt \Rightarrow \cos(pt) = \frac{x}{a}$ ... (1)

$y = b \sin pt \Rightarrow \sin(pt) = \frac{y}{b}$ ... (2)

Squaring and adding (1) and (2), we get,

$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$



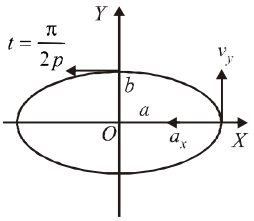
$\therefore$ The path of the particle is an ellipse.

From the given equations we can find,

$\frac{dx}{dt} = v_x = -ap \sin pt;\ \frac{d^2x}{dt^2} = a_x = -ap^2 \cos pt$

$\frac{dy}{dt} = v_y = pb \cos pt$

and $\frac{d^2y}{dt^2} = a_y = -bp^2 \sin pt$



At time $t = \frac{\pi}{2p}$ or $pt = \frac{\pi}{2}$

a_x and v_y become zero (because $\cos\frac{\pi}{2} = 0$). Only v_x and a_y are left,

or we can say that velocity is along negative x-axis and acceleration along negative y-axis.

Hence, at $t = \frac{\pi}{2p}$, velocity and acceleration of the particle are normal to each other.

At $t = t$, position of the particle $\vec{r}(t) = x\hat{i} + y\hat{j}$

$= a\cos pt\,\hat{i} + b \sin pt\,\hat{j}$ and acceleration of the particle is

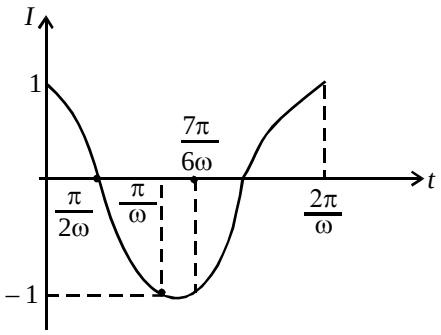
$\vec{a}(t) = a_x\hat{i} + a_y\hat{j} = -p^2[a\cos pt\,\hat{i} + b\sin pt\,\hat{j}]$

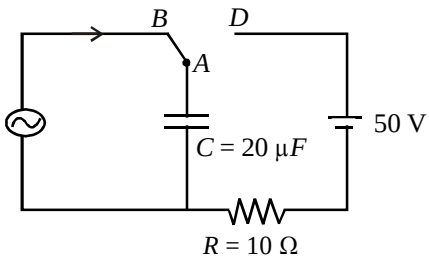
$= -p^2[x\hat{i} + y\hat{j}] = -p^2\vec{r}(t)$

Therefore, acceleration of the particle is always directed towards origin.

At $t = 0$, particle is at $(a, 0)$ and at $t = \frac{\pi}{2p}$, particle is at $(0, b)$. Therefore, the distance covered is one fourth of the elliptical path and not a.

24. **(c, d)** $I = \cos 500\,t$





Till $t = \frac{7\pi}{6\omega}$, the charge will be maximum at $\frac{\pi}{2\omega}$

$Q' = \int_0^{\pi/2\omega} \cos 500t\ dt = \left[\frac{\sin 500t}{500}\right]_0^{\pi/2\omega}$

$= \frac{1}{500}\sin\left(500 \times \frac{\pi}{2 \times 500}\right) = \frac{1}{500}C$

$\therefore$ (a) is incorrect

From the graph it is clear that just before $t = \frac{7\pi}{6\omega}$, the current is in anticlockwise direction.

$\therefore$ (b) is incorrect

At $t = \frac{7\pi}{6\omega}$, the charge on the upper plate of capacitor is

$$\int_0^{\frac{7\pi}{6\omega}} \cos 500t \, dt = \frac{1}{500}\sin\left(500 \times \frac{7\pi}{6\times 500}\right)$$

$$= -\frac{1}{500}\times\frac{1}{2} = -10^{-3}\text{C}$$

Now applying KVL (when A is just connected to D)

$$50 + \frac{10^{-3}}{20\times 10^{-6}} - i\times 10 = 0 \Rightarrow i = 10 \text{ A}$$

$\therefore$ (c) is the correct option.

The maximum charge on C is $Q = CV = 20 \times 10^{-6} \times 50 = 10^{-3}$C

Therefore, the total charge flown = 2×10^{-3} C

$\therefore$ (d) is the correct option.

25. **(a,d)** are correct options.

26. **4**

Force on 10 kg mass = $10 \times 12 = 120$ N

The mass of 10 kg will pull the mass of 20 kg in the backward direction with a force of 120 N.

$\therefore$ Net force on mass 20 kg $= 200 - 120 = 80$ N

Its acceleration $= \frac{80\text{ N}}{20\text{ kg}} = \mathbf{4\,m/s^2}$

27. **5**

$F = 20 - 10x = -10(x - 2)$

Hence, force constant is k = 10 ; $m = 0.1$ kg

Angular frequency, $\omega = \sqrt{\frac{k}{m}} = 10$ rad/s

$v_{max} = \omega A = 50$ m/s = **(5×10)** m/s

28. **7**

From the law of length of stretched string, we have $n_1\ell_1 = n_2\ell_2 = n_3\ell_3$

Here $n_1 : n_2 : n_3 = 1 : 3 : 15$

$$\therefore \frac{\ell_1}{\ell_2} = \frac{n_2}{n_1} = \frac{3}{1} \text{ and } \frac{\ell_1}{\ell_3} = \frac{n_3}{n_1} = \frac{15}{1}$$

$$\ell_2 = \frac{\ell_1}{3} \text{ and } \ell_3 = \frac{\ell_1}{15}$$

The total length of the wire is 105 cm

Therefore, $\ell_1 + \ell_2 + \ell_3 = 105$

$$\text{or } \ell_1 + \frac{\ell_1}{3} + \frac{\ell_1}{15} = 105 \text{ or } \frac{21\ell_1}{15} = 105$$

$$\ell_1 = \frac{105\times 15}{15} = 75 \text{ cm}$$

$$\therefore \ell_2 = \frac{\ell_1}{3} = \frac{75}{3} = 25 \text{ cm} \; ; \; \ell_3 = \frac{\ell_1}{15} = \frac{75}{15} = 5 \text{ cm}$$

Hence the bridge should be placed at 75 cm and (75 + 25) = 100 cm from one end.

$\therefore$ Required sum = (75 + 100) cm = 175 cm = (182 – 7) cm

$\therefore$ x = **7.**

29. **7**

Here $\ell_1 = 50\text{cm}, \alpha_1 = 2.10\times 10^{-5}$ / K

$\Delta t = (250 - 40) = 210°\text{C}$, $\alpha_2 = 1.2\times 10^{-5}$ / K

Change in length

$$\Delta L_1 = L_1\alpha_1\Delta t = 50\times 2.10\times 10^{-5}\times 210 = 0.22 \text{ cm.}$$

Similarly, $\Delta L_2 = L_2\alpha_2\Delta t = 50\times 1.2\times 10^{-5}\times 210 = 0.12$ cm.

$\therefore$ Total change in length

$$\Delta L = \Delta L_1 + \Delta L_2 = 0.22 + 0.12 = 0.34 \text{ cm.}$$

$$= 34\times 10^{-2} \text{ cm}$$

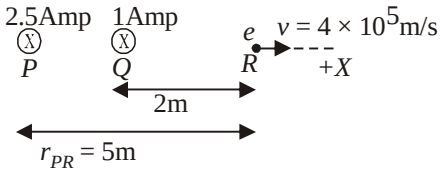
$\Rightarrow$ A = 34. Hence sum of digits of A = 3 + 4 = **7.**

30. **4**

The magnetic field (due to current in wire P) at R

$$= \frac{\mu_0}{4\pi}\times\frac{2I_p}{r_{PR}} = \frac{\mu_0}{4\pi}\times\frac{2\times 2.5}{5}$$

$= \frac{\mu_0}{4\pi}$ [in the plane of paper downwards]



Similarly the magnetic field (due to current in wire Q) at R

$= \frac{\mu_0}{4\pi} \times \frac{2 \times I}{2} = \frac{\mu_0}{4\pi} I$ [in the plane of paper downward]

The total magnetic field at R [due to P and Q]

$B = \frac{\mu_0}{4\pi} + \frac{\mu_0}{4\pi} I = \frac{\mu_0}{4\pi}(1 + I)$ [in the plane of paper downwards]

The force experienced by the electron

$F = qvB \sin\theta$

$= evB \sin 90° = 1.6 \times 10^{-19} \times 4 \times 10^5 \times \frac{\mu_0}{4\pi}(1 + I)$

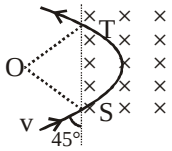
But $F = 3.2 \times 10^{-20}$ N (Given)

$\therefore \quad 3.2 \times 10^{-2} = 1.6 \times 10^{-19} \times 4 \times 10^5 \times 10^{-7}\,(1 + I)$

$\Rightarrow \quad I =$ **4 amp.**

31. (c) $\overrightarrow{ST} = 2\,OS \cos \angle OST$

$= 2 \times \frac{mv \cos 45°}{qB}$



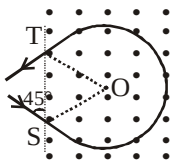
$= 2 \times \frac{mv}{qB} \times \frac{1}{\sqrt{2}}$

$= \sqrt{2} \times \frac{mv}{qB}$

32. (b) $\angle OST = \angle OTS = 45°$

So, $\angle SOT = 90°$

Arc length $\overset{\frown}{ST}$



$= \frac{3}{4} \times 2\pi OS$

$= \frac{3}{4} \times 2 \times \frac{22}{7} \times \frac{mv}{qB}$

$= \frac{33}{7} \cdot \frac{mv}{qB}$

33. (d) For the combination,

(a) III (i) R

$\overline{ST} = 2 \times r = 2 \times \frac{mv}{2qB} = \frac{mv}{qB}$

(b) IV (ii) Q

Arc $\overset{\frown}{ST} = \frac{1}{2} \times 2\pi r = \frac{1}{2} \times 2 \times \frac{22}{7} \times \frac{mv}{2qB}$

$= \frac{11\,mv}{7\,qB}$

(c) III (i) Q

Same as explained above.

34. (c) during the upward journey of projectile velocity of the body decreases and finally becomes zero at the top but then after the direction of velocity changes and goes on increasing while acceleration remains constant throughout the journey a = – g.

35. (d) When velocity-time graph is straight line the corresponding acceleration-time graph will be straight line parallel to time-axis i.e. constant acceleration.

36. (a) For case IV displacement time graph shows that body is in rest.

37. (a,b,d)

Recall that the —Cl group present in the *o*- and *p*- positions to the electron-withdrawing group is activated toward nucleophilic substitution, hence only —Cl present on the *o*- and/or *p*-position to the —NO_2 group will be replaced.

38. (a,b,c,d)

(a) Screening effect ↑, effective nuclear charge ↓ thus valence shell electron is loosely bound. Hence I.E ↓

(b) Be and Mg has ns^2 configuration (stable configuration)

(c) Due to lanthanide contraction

(d) $r_{metallic} > r_{covalent}$ (covalent bond formation involves the overlapping of orbitals)

39. (a,b)

Let a and b be the atomic masses of A and B respectively. Then

Molar mass of AB_2 = (a + 2b) g/mol

Molar mass of AB_4 = (a + 4b) g/mol

From the given data,

Molality of AB_2 in solution

$$= \frac{1g/(a+2b)g\,mol^{-1}}{(20g/1000g\ kg^{-1})} = \frac{1\times 50}{(a+2b)}\ mol\ kg^{-1}$$

and molality of AB_4 in solution

$$= \frac{1g/(a+4b)g\,mol^{-1}}{(20g/1000g\ kg^{-1})} = \frac{1\times 50}{(a+4b)}\ mol\ kg^{-1}$$

Then, $\Delta T_f(AB_2) = K_f \times \frac{50}{(a+2b)}\ mol\ kg^{-1}$

$$2.3\ K = 5.1\ K\ kg\ mol^{-1} \times \frac{50}{(a+2b)}\ mol\ kg^{-1} \quad .....(1)$$

and $\Delta T_f(AB_4) = K_f \times \frac{50}{(a+4b)}\ mol\ kg^{-1}$

$$1.3\ K = 5.1\ K\ kg\ mol^{-1} \times \frac{50}{(a+4b)}\ mol\ kg^{-1}$$

From the above equations, one can write,

$$\frac{2.3}{1.3} = \frac{(a+4b)}{(a+2b)}$$

This gives, a = 0.6 b,

Put in eq. (1), b = 42.64

Hence a = 0.6 × 42.64 = 25.58

Therefore, Atomic mass of A = 25.58 u

Atomic mass of B = 42.64 u

40. (a,b,c)

(a) $PO_4^{3-} + 3HNO_3 \xrightarrow{\Delta} H_3PO_4 + 3NO_3^-$

$$H_3PO_4 + 12(NH_4)_2MoO_4 + 21HNO_3 \xrightarrow[\text{Not exceeding } 40^\circ C]{\Delta}$$

$$(NH_4)_3PO_4.12MoO_3 \downarrow + 21NH_4NO_3 + 12H_2O$$

or $(NH_4)_3[P(Mo_3O_{10})_4]\downarrow$

Amm. Phospho molybdate

(Canary yellow ppt.

(b) $NO_2^- + \underset{(dil.)}{H^+} \xrightarrow{R.T.} HNO_2$

$$3HNO_2 \xrightarrow{R.T.} 2NO\uparrow + HNO_3 + H_2O$$

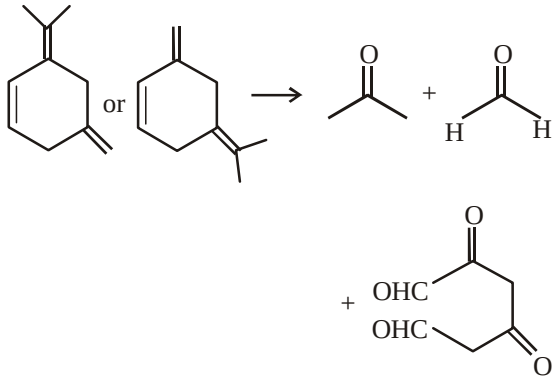
$$FeSO_4(aq) + NO\uparrow \xrightarrow{R.T.} [Fe(H_2O)_5(NO)]^{2+} + SO_4^{2-}$$

Brown ring complex

(c) $3HgCl_2 + SO_4^{2-} + 2H_2O \longrightarrow HgSO_4.2HgO\downarrow + 4H^+ + 6Cl^-$

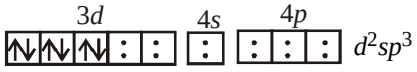
Yellow ppt.

41. (a, c)



42. (c, d)

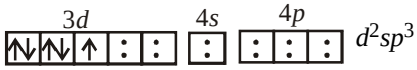
$[Fe(CN)_6]^{4-}$



d^2sp^3

No unpaired electron(s)

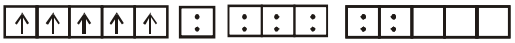
$[Fe(CN)_6]^{3-}$



d^2sp^3

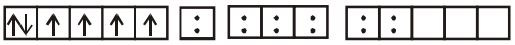
One unpaired electron

$[Fe(H_2O)_6]^{3+}$



sp^3d^2 hybridization

$[FeF_6]^{4-}$

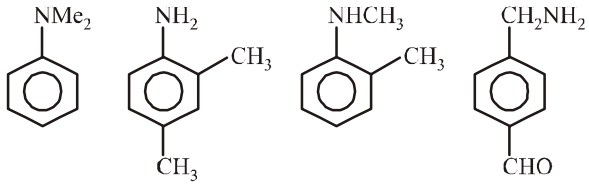


sp^3d^2 hybridization

43. (b, d)

NOTE : Only primary amines give carbylamine test.

Hence 2,4-dimethylaniline and *p*-methylbenzylamine both give this test.



44. Ans : 8

Dipole moment, μ = e × d coulombs metre

For KCl, $d = 2.6 \times 10^{-10}$ m

For complete separation of unit charge (electronic charge) (e) = 1.602×10^{-19} C

Hence $\mu = 1.602 \times 10^{-19} \times 2.6 \times 10^{-10} = 4.1652 \times 10^{-29}$ Cm

$\mu_{KCl} = 3.332 \times 10^{-29}$ Coulomb meter (given)

$$\therefore \%\ \text{Ionic character of KCl} = \frac{3.332 \times 10^{-29}}{4.1652 \times 10^{-29}} \times 100$$

$$= 80\%$$

Given % ionic character of KCl = $10x$

$\therefore 80 = 10x \Rightarrow x = \mathbf{8}$.

45. Ans : 7

Using gas equation; $PV = nRT$

Total no. of moles of gases in the mixture (n)

$$= \frac{PV}{RT} = \frac{6 \times 3}{0.0821 \times 300} = 0.7308 \text{ mol.}$$

Thus no. of moles of unknown gas = 0.7308 – 0.7

= 0.0308 mol.

Now we know that

$$\frac{r_1}{r_2} = \frac{\text{moles of hydrogen gas}}{\text{moles of unknown gas}} = \frac{0.7}{0.0308}$$

Also we know that $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

$$\therefore \quad M_2 = \left(\frac{r_1}{r_2}\right)^2 M_1 \quad \text{or} \quad M_2 = \left(\frac{0.7}{0.0308}\right)^2 \times 2 = 1033$$

Given 1033 = 1040 – A.

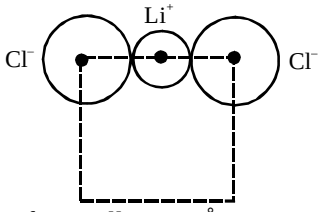
$\therefore$ A = **7.**

46. Ans : 1

Two molecules of an α-amino acid will form only one dipeptide, recall that four different dipeptides are formed when two α-amino acids are different.

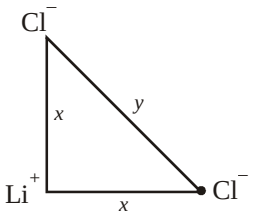
47. Ans : 3

Cl^- ions in LiCl similar to rock salt (NaCl) constitute *ccp* which has face centred cubic lattice. Li^+ ions fit exactly into the octahedral voids.



Edge length of unit cell = 5.14 Å

Distance between Li^+ and Cl^- ions (x) $= \frac{5.14}{2} = 2.57$ Å



Cl^- ions occupy the corners of the face of cube as well as the centre of the face.

y = distance between the centres of two Cl^- ions.

Hence, $y = \sqrt{x^2 + x^2} = x\sqrt{2} = 2.57 \times 1.414 = 3.634$ Å

= 363 pm

Given, 363 = 121x.

$$\therefore x = \frac{363}{121} = \mathbf{3}.$$

48. Ans : 5

Given : $\wedge_m^\infty (Ag^+) = 6 \times 10^{-3}$; $\wedge_m^\infty (Br^-) = 8 \times 10^{-3}$;

$\wedge_m^\infty (NO_3^-) = 7 \times 10^{-3}$ and $K_{sp}(AgBr) = 12 \times 10^{-14}$

To find the specific conductivity (κ) of the final solution of AgBr in which $AgNO_3$ (10^{-7} M) is mixed we must find the individual κ of the ions.

or $\kappa_{soln} = \kappa_{Ag^+} + \kappa_{Br^-} + \kappa_{NO_3^-}$

Again, $\kappa = \wedge_m^\infty \times$ molar concentration

<u>Calculation of molar concentration of ions :</u>

Concentration,

$[NO_3^-] = 10^{-7}$ moles / $l \equiv 10^{-4}$ moles / m^3

Let x be the molar concentration of Ag^+ from AgBr

$\Rightarrow (x + 10^{-7})x = 12 \times 10^{-14}$

or $x^2 + 10^{-7}x - 12 \times 10^{-14} = 0$

or, $(x + 4 \times 10^{-7})(x - 3 \times 10^{-7}) = 0 \Rightarrow x = 3 \times 10^{-7}$ M

$\Rightarrow [Br^-] = 3 \times 10^{-7}$ M $\equiv 3 \times 10^{-4}$ moles / m^3 and

$[Ag^+] = 3 \times 10^{-7} + 10^{-7} = 4 \times 10^{-7}$ M

$= 4\times10^{-4}$ moles / m^3

$\kappa_{Ag^+} = 6\times10^{-3}\times4\times10^{-4}$

$= 24\times10^{-7}$ $(Sm^2mol^{-1}\times mol/m^3) = 24\times10^{-7} S/m$

Similarly, $\kappa_{Br^-} = 8\times10^{-3}\times3\times10^{-4} = 24\times10^{-7}$ S/m and

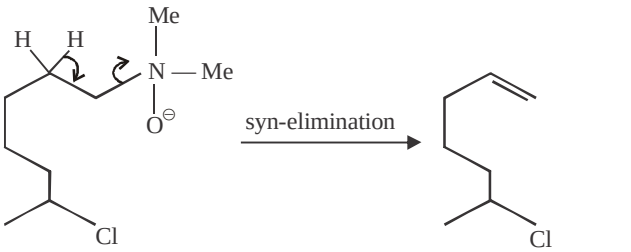
$\kappa_{NO_3^-} = 7\times10^{-3}\times10^{-4} = 7\times10^{-7}$ S/m

$\Rightarrow \kappa = (24+24+7)\times10^{-7}$ S/m $= 55\times10^{-7}$ S/m

Given $55\times10^{-7} = 11x\times10^{-7}$ $\therefore x = \mathbf{5}$.

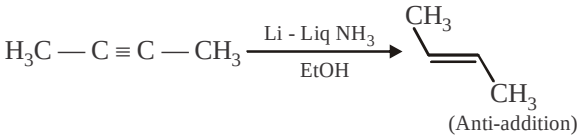
Passage 6

49. (d)

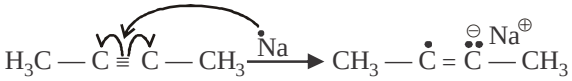


Less substituted product
(Hofmann's product)

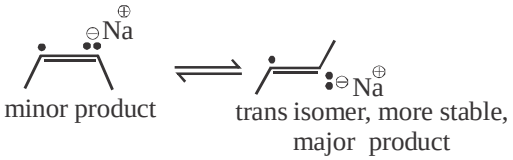
50. (b) Birch reduction (anti-addition)

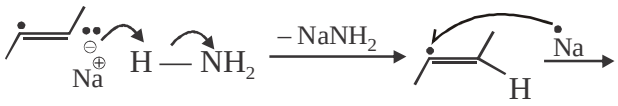


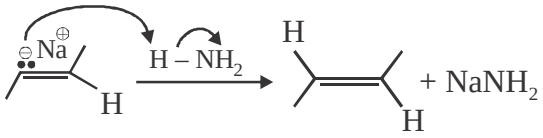
(Anti-addition)



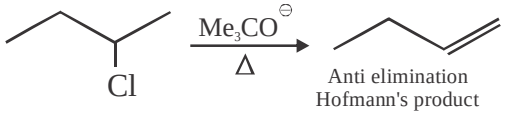
or



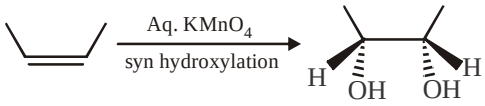




51. (a)



(b)



The option (a) is not matching, thus answer is (a)

Passage - 2

52. (c) radius $(r_n) = \dfrac{n^2h^2}{4\pi^2 mZe^2} = \dfrac{n^2}{Z} \times 0.529\text{Å}$

$= \dfrac{n^2}{Z} = 0.0529\,\text{nm}$

53. (b) $V_n = \dfrac{2\pi Ze^2}{nh} = \left[\dfrac{Ze^2}{rm}\right]^{1/2}$

54. (d) $E_n = -\dfrac{2\pi^2 mZ^2e^4}{n^2h^2} = -\dfrac{Z^2}{n^2} \times 313.6\,\text{kcal}$

ANSWER KEY PAPER - 2									
1	(a)	**14**	(b,c)	**27**	(a,b,c)	**40**	(c)	**53**	(b)
2	(c)	**15**	(d)	**28**	(a,b)	**41**	(a)	**54**	(a)
3	(c)	**16**	(a)	**29**	(b,d)	**42**	(d)		
4	(b)	**17**	(c)	**30**	(a,c)	**43**	(b)		
5	(c)	**18**	(a)	**31**	(a,b)	**44**	(a,b)		
6	(d)	**19**	(a)	**32**	(c)	**45**	(a,c,d)		
7	(b)	**20**	(a)	**33**	(d)	**46**	(a,b,c)		
8	(a, b)	**21**	(c)	**34**	(b)	**47**	(a,c,d)		
9	(b, c, d)	**22**	(a)	**35**	(d)	**48**	(a,c)		
10	(a, b, c, d)	**23**	(d)	**36**	(c)	**49**	(b, c)		
11	(a, b, c, d)	**24**	(c)	**37**	(c)	**50**	(a, c)		
12	(a, b, c, d)	**25**	(b)	**38**	(a)	**51**	(d)		
13	(b, d)	**26**	(a,d)	**39**	(b)	**52**	(a)		

PAPER - 2

1. (a) Obviously roots are $1+i, 1-i, 1+2i$ & $1-2i$ and r (say), where r is real

Now sum of the roots = 6 (from the given equation)

$\therefore\ 4 + r = 6 \Rightarrow r = 2$

Product of the roots $= (1-i^2)(1-4i^2)\cdot 2$

$\therefore\ -D = 2\cdot 5\cdot 2 \Rightarrow D = -20$

2. (c) **Case 1 :** If $0 \le x \le \frac{1}{2}$, then

$$\cos^{-1}\left(\frac{x}{2}+\frac{1}{2}\sqrt{3-3x^2}\right) = \cos^{-1}\left(x.\frac{1}{2}+\sqrt{1-x^2}.\frac{\sqrt{3}}{2}\right)$$

$$= \cos^{-1}x - \cos^{-1}\frac{1}{2}$$

$\therefore$ Equation is: $\cos^{-1}x + \cos^{-1}x - \cos^{-1}\frac{1}{2} = \frac{\pi}{3}$

$\Rightarrow x = \frac{1}{2}$

Case 2 : If $\frac{1}{2} \le x \le 1$, then

$$\cos^{-1}\left(\frac{x}{2}+\frac{1}{2}\sqrt{3-3x^2}\right) = \cos^{-1}\frac{1}{2} - \cos^{-1}x$$

$\therefore$ Equation is $\cos^{-1}x + \cos^{-1}\frac{1}{2} - \cos^{-1}x = \frac{\pi}{3}$,

which is identity

Hence the identity holds good for $x \in \left[\frac{1}{2}, 1\right]$.

3. (c) $$I = \int \frac{dx}{x\,(x^{2007}+1)} = \int \frac{x^{2007}+1-x^{2007}}{x\,(x^{2007}+1)}dx$$

$$= \int\left(\frac{1}{x} - \frac{x^{2006}}{1+x^{2007}}\right)dx = \ln x - \frac{1}{2007}\ln(1+x^{2007})$$

$$= \frac{\ln x^{2007} - \ln(1+x^{2007})}{2007} = \frac{1}{2007}\ln\left(\frac{x^{2007}}{1+x^{2007}}\right) + C$$

Comparing from the given, we get

$p = 2007, q = 2007, r = 2007$

$\therefore\ p + q + r = 6021$

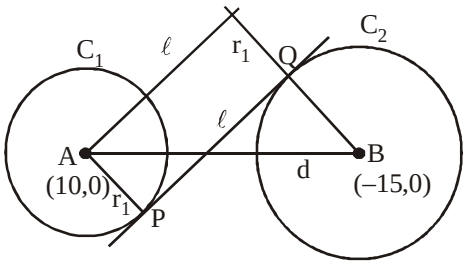
4. (b) Given $e^{\lim\limits_{x\to\infty} x\left(\frac{2\tan^{-1}x}{\pi}-1\right)} = e^L$

where $L = \lim\limits_{x\to\infty} x\left(\frac{2\tan^{-1}x - \pi}{\pi}\right)$

$$L = \lim_{x\to\infty} x\,\frac{2[(\pi/2) - \cot^{-1}x] - \pi}{\pi}$$

$$= \lim_{x\to\infty} -\frac{2.x.\cot^{-1}x}{\pi} = \lim_{x\to\infty} -\frac{2}{\pi}\frac{\tan^{-1}(1/x)}{(1/x)} = -\frac{2}{\pi}$$

5. (c)



Centres of C_1 and C_2 are (10, 0) and (–15, 0) respectively.

$r_1 = 6; r_2 = 9,\ d = 25$, where d is the distance between the centres.

Now, $r_1 + r_2 < d \Rightarrow$ Circles are separated.

$$PQ = \ell = \sqrt{d^2 - (r_1 + r_2)^2} = \sqrt{625 - 225} = 20$$

6. **(d)** $x = a - [x]^3 \Rightarrow x \in I$

$\therefore a = x^3 + x$

$$\sum a = \sum_{r=1}^{7} r^3 + \sum_{r=1}^{7} r = \left(\frac{7\times 8}{2}\right)^2 + \frac{7\times 8}{2} = 784 + 28 = 812$$

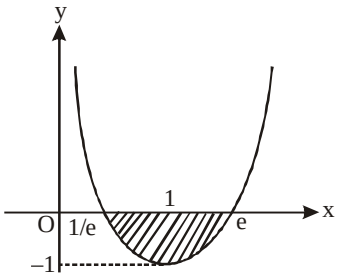
7. **(b)** $y = \ln^2 x - 1$

$$y' = \frac{2\ln x}{x} = 0$$

$\Rightarrow \; x = 1$

$x > 1, y \uparrow$

and $0 < x < 1$, y is $\downarrow$



$$A = \left|\int_{1/e}^{e} (\ln^2 x - 1)\, dx\right|$$

$$= \left|\left[x \ln^2 x\right]_{1/e}^{e} - 2\int_{1/e}^{e} \left(\frac{\ln x}{x}\right).x\, dx - \left(e - \frac{1}{e}\right)\right|$$

$$= \left|\left(e - \frac{1}{e}\right) - 2\int_{1/e}^{e} \left(\frac{\ln x}{x}\right).x\, dx - \left(e - \frac{1}{e}\right)\right|$$

$$= \left|-2\left[\left[x \ln x\right]_{1/e}^{e} - \int_{1/e}^{e} dx\right]\right|$$

$$= \left|-2\left[\left(e + \frac{1}{e}\right) - \left(e - \frac{1}{e}\right)\right]\right| = \left|\frac{-4}{e}\right| = \frac{4}{e}$$

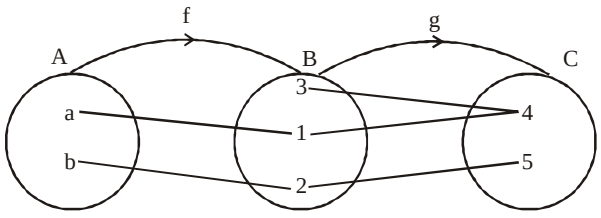
8. **(a, b)** We have $b_3 > 4b_2 - 3b_1 \Rightarrow b_1 r^2 > 4b_1 r - 3b_1$

$\Rightarrow r^2 > 4r - 3 \quad [\because b_1 > 0]$

$\Rightarrow r^2 - 4r + 3 > 0 \Rightarrow (r-3)(r-1) > 0 \Rightarrow r > 3$ or $r < 1$

9. **(b, c, d)**

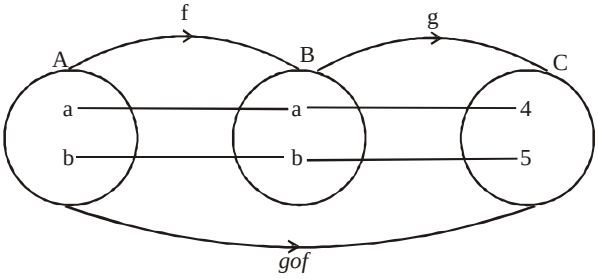
As shown *gof* is one-one but g is many-one



$\Rightarrow$ (a) is not correct.

(b) If *gof* is one-one then f is also one-one,

If f is many-one then *gof* can not be one-one



(c) and (d) are obviously true.

10. **(a, b, c, d)**

$7 + 8 + 7 = 22 \neq 20 \Rightarrow$ coefficient of $x^7 y^8 z^7$ is zero.

Total number of terms is ${}^{22}C_2 = 231$

General term $= \dfrac{20!}{p!q!k!}\, x^p y^q z^k$,

where $p + q + k = 20$

If we choose $p = 20 - r$ and $q = r - k$

then we obtain the required form.

For sum of coefficients, put $x = y = z = 1$

$\Rightarrow$ sum of coefficients $= 3^{20}$.

11. **(a, b, c, d)**

Any point on the parabola is $(at^2, 2at)$

$\therefore$ mid point of (a, 0) and $(at^2, 2at)$ is $\left(\dfrac{a + at^2}{2}, at\right)$

$\therefore$ locus is given by $x = \dfrac{a + at^2}{2}$, $y = at$

i.e., $2x = a\left(1 + \dfrac{y^2}{a^2}\right)$

i.e., $2ax = a^2 + y^2$ i.e., $y^2 = 2a(x - a/2)$

It is a parabola with vertex at (a/2, 0), latus rectum = 2a

directrix is $x - a/2 = -a/2$ i.e., $x = 0$

At focus, $x - a/2 = a/2$ i.e., $x = a$

Hence, focus = (a, 0).

12. (a, b, c, d)

Given hyperbola can be written as

$$\frac{(x-1)^2}{16}-\frac{(y-1)^2}{9}=1$$

$$\Rightarrow \frac{X^2}{16}-\frac{Y^2}{9}=1 \text{ {where } } X=x-1, Y=y-1\}$$

$$e=\sqrt{1+\frac{b^2}{a^2}}=\sqrt{1+\frac{9}{16}}=\frac{5}{4}$$

Directries are $X=\pm\frac{a}{e}$

$$\Rightarrow x-1=\pm\frac{16}{5} \Rightarrow x=\frac{21}{5} \text{ and } x=-\frac{11}{5}$$

Length of latus rectum $=\frac{2b^2}{a}=\frac{9}{2}$

At Focii, $X=\pm ae, Y=0$

$\therefore$ focii are $(6, 1)$ and $(-4, 1)$.

13. (b, d)

For $1\le x\le 33$, $\frac{1}{3}<\frac{1}{3}+\frac{x}{50}<1 \Rightarrow \left[\frac{1}{3}+\frac{x}{50}\right]=0$

For $34\le x\le 50$, $1<\frac{1}{3}+\frac{x}{50}<\frac{4}{3} \Rightarrow \left[\frac{1}{3}+\frac{x}{50}\right]=1$

$\therefore$ $E=17$

14. (b,c) $PQ=kI \Rightarrow \frac{P.Q}{k}=I \Rightarrow P^{-1}=\frac{Q}{k}$

Also $|P|=12\alpha+20$

Comparing the third elements of 2nd low on both sides, we get

$$-\left(\frac{3\alpha+4}{12\alpha+20}\right)=\frac{1}{k}\times\frac{-k}{8}$$

$\Rightarrow 24\alpha+32=12\alpha+20 \Rightarrow \alpha=-1$

$\therefore |P|=8$

Also $PQ=kI \Rightarrow |P|\,|Q|=k^3$

$$\Rightarrow 8\times\frac{k^2}{2}=k^3 \Rightarrow k=4 \Rightarrow |Q|=\frac{k^2}{2}=8$$

(b) $4\alpha-k+8=4\times(-1)-4+8=0$

(c) Now $\det(P \text{ adj } Q)=|P|\,|\text{adj } Q|$

$=|P|\,|Q|^2=8\times 8^2=2^9$

(d) $|Q \text{ adj } P|=|Q|\,|P|^2=2^9$

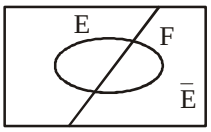
For Qs. 15-16.

$P(E)=p$

$P(F)=P(E\cap F)+P(\bar{E}\cap F)$

$P(F)=P(E)\,P(F/E)+P(\bar{E})\,P(F/\bar{E})$

$$=p.1+(1-p).\frac{1}{5}=\frac{4p}{5}+\frac{1}{5}$$



15. (d) If $p=0.75$

$$P(F)=\frac{1}{5}(4p+1)=\frac{1}{5}(4)=0.8$$

$$\therefore P(E/F)=\frac{P(E\cap F)}{P(F)}=\frac{0.75}{0.80}=\frac{15}{16}$$

16. (a) Now $P(E/F)=\frac{5p}{(4p+1)}\ge p$

Equality holds for $p=0$ or $p=1$

For all others value of $p\in(0,1)$, L.H.S. > R.H.S.

For Qs. 17-18

$$3.{}^nP_4={}^{n-1}P_5 \Rightarrow 3.\frac{n!}{(n-4)!}=\frac{(n-1)!}{(n-6)!}$$

$\Rightarrow 3n=(n-4)(n-5) \Rightarrow 3n=n^2-9n+20$

$\Rightarrow n^2-12n+20=0$

$\Rightarrow (n-10)(n-2)=0 \Rightarrow n=10$ as $n\ne 2$

17. (c) From 10 stations train to be stopped at 3.

$\therefore$ 7 remains. In between these 7 stations i.e. there are 8 gaps.

$\therefore$ out of 8 gaps select any 3 in ${}^8C_3$ i.e. 56 ways.

18. (a) Any 3 consecutive vertices can be selected in 10 ways

(1, 2, 3) or (2, 3, 4) or ..... or (10, 1, 2)

say e.g. (1, 2, 3)

Now 4 and 10 cannot be selected from the remaining five vertices from 5 to 9, any one vertex can be selected in ${}^5C_1$ ways.

$\therefore$ number of such quadrilaterals = $10 \,.\, {}^5C_1 = 50$

19. (a) Acceleration of block AB = $\dfrac{3mg}{3m+m} = \dfrac{3}{4}g$

Acceleration of block CD = $\dfrac{2mg}{2m+m} = \dfrac{2g}{3}$

Acceleration of image in mirror AB = 2 acceleration of mirror = $2\left(\dfrac{-3g}{4}\right) = \dfrac{-3}{2}g$

Acceleration of image in mirror CD = $2\left(\dfrac{2g}{3}\right) = \dfrac{4g}{3}$

$\therefore$ Acceleration of the two image w.r.t. each other

$$= \frac{4g}{3} - \left(\frac{-3g}{2}\right) = \frac{17g}{6}$$

20. (a) We know that $T_{1/2} = \dfrac{0.693}{\lambda}$

or $\lambda = \dfrac{0.693}{T_{1/2}} = \dfrac{0.693}{15\times 3600} = 1.283 \times 10^{-5}$ sec.

Now activity $A = \dfrac{dN}{dt} = \lambda N_0$ where A = 1 microcurie

$= 3.7 \times 10^4$ disintegrations/sec

$\therefore\ 3.7\times10^4 = 1.283\times10^{-5}\, N_0$

$\Rightarrow N_0 = \dfrac{3.7\times10^4}{1.283\times10^{-5}} = 2.883\times10^9$

Let the number of radioactive nuclei present after 5 hours be N_1 in 1cc sample of blood. Then

$$\frac{dN}{dt} = \lambda N_1 \quad \text{or} \quad \frac{296}{60} = \frac{0.693}{15\times3600} N_1$$

or $N_1 = \dfrac{296\times15\times3600}{60\times0.693} = 3.844\times10^5$

Let N_0' be the number of radioactive nuclei per cc of sample, then

$$\frac{N_1}{N_0'} = \left(\frac{1}{2}\right)^{t/T} \quad \text{or} \quad N_0' = (2)^{t/T}\times N_1$$

$\therefore\ N_0' = (2)^{5/15}\times N_1 = (2)^{1/3}\times 3.844\times10^5$

$= 1.269\times3.844\times10^5 = 4.878\times10^5$

$[\because\ (2)^{1/3} = 1.269]$

Volume of blood

$$V = \frac{N_0}{N_0'} = \frac{2.883\times10^9}{4.878\times10^5} = 0.5910\times10^4 \text{ cm}^3$$

$= 5.91$ litres.

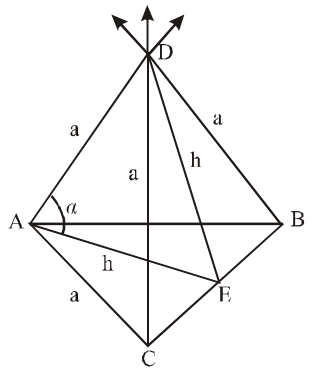
21. (c) Resistance of 560cm. wire = $\dfrac{15r}{600}\times560 = 14r$

Let potential at A is zero. Then apply Kirchoff's law,

$$\frac{x-0}{14r} + \frac{x-\frac{E}{2}-0}{r} + \frac{(x-E-0)}{2r} = 0 \Rightarrow x = \frac{14E}{22}$$

$$\Rightarrow I_0 = \frac{x-\frac{E}{2}}{r} = \frac{\left(\frac{14E}{22}\right)-\frac{E}{2}}{r} = \frac{3E}{22r}$$

22. (a) Each charge creates at point D a field intensity of $E_1 = \dfrac{KQ}{a^2}$. The total intensity will be the sum of three vectors (fig.). The sum of the horizontal components of these vectors will be zero, since they are equal in magnitude and form angles of 120° with each other. The vectors from angles of 90° – a with the vertical, where a is the angle between the edge of the tetrahedron and the altitude h of triangle ABC.



The vertical components are identical each being equal

to $\frac{KQ}{a^2}\sin\alpha$. It follows from triangle ADE that $\sin\alpha = \sqrt{\frac{2}{3}}$.

Therefore, the sought intensity of the field is $E = \sqrt{6}\frac{KQ}{a^2}$.

23. (d) $dB = 10\log\left(\frac{I}{I_0}\right) = 10\log\left(\frac{K/r^2}{I_0}\right)$

$= 10[\log(K') - 2\log r]$

$dB_1 = 10(\log K' - 2\log r_1)$, $dB_2 = 10(\log K' - 2\log r_2)$

$3 = dB_1 - dB_2$

$= 20\log\left(\frac{r_2}{r_1}\right) \Rightarrow \left(\frac{r_1}{r_2}\right) = \frac{1}{\sqrt{2}}$

24. (c) $\frac{DQ}{Dt} = \frac{DW}{Dt}$ = work done per unit time = $\frac{Ka\theta}{L}$

Power = F × velocity = $PAV' = \frac{nRT}{V}AV'$

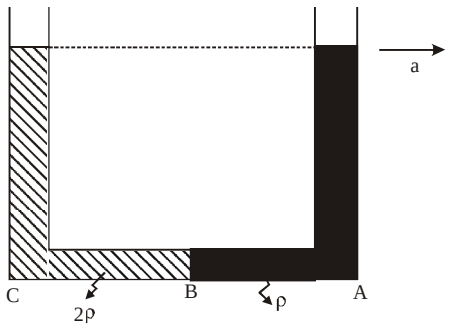
where V → volume, V' → velocity

$\Rightarrow \frac{0.5R(300)}{V}AV' = \frac{Ka\theta}{L}$

$\Rightarrow \frac{0.5R(300)}{A.\frac{L}{2}}AV' = \frac{Ka\theta}{L}$

$\Rightarrow V = \frac{K(1/9)}{R}\left(\frac{27}{300}\right) = \frac{K}{100R}$

25. (b) For the given situation, liquid of density 2ρ should be behind that of ρ.



From right limb :

$P_A = P_{atm} + \rho gh$

$P_B = P_A + \rho a\frac{\ell}{2} = P_{atm} + \rho gh + \rho a\frac{\ell}{2}$

$P_C = P_B + (2\rho)a\frac{\ell}{2} = P_{atm} + \rho gh + \frac{3}{2}\rho a\ell$ .... (1)

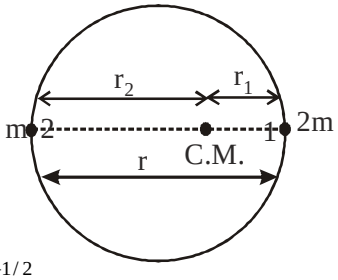
But from left limb :

$P_C = P_{atm} + (2\rho)gh$ .... (2)

From (1) and (2)

$P_{atm} + \rho gh + \frac{3}{2}\rho a\ell = P_{atm} + 2\rho gh \Rightarrow h = \frac{3a}{2g}\ell$

26. (a,d) $r_2 = \frac{2mr}{m+2m} = \frac{2r}{3}$



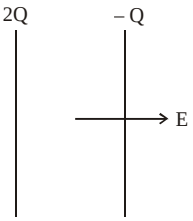
$T_2^2 = \frac{4\pi^2 r_2^3}{Gm}$

$T_2^2 = \frac{32\pi^2 r^3}{27Gm}$

$T_2 \propto r^{3/2}$; $T_2 \propto m^{-1/2}$

27. (a, b, c) (a) Due to net electric field at P produced by capacitor charge will experience force

(b) $E = \frac{2Q}{2A\varepsilon_0} + \frac{Q}{2A\varepsilon_0} \Rightarrow E = \frac{3Q}{2A\varepsilon_0}$



$E = \frac{3}{2}\frac{Q}{Cd} \Rightarrow Ed = \frac{3Q}{2C} = V$

(c) Energy = $\frac{1}{2}\varepsilon_0 E^2 Ad = \frac{1}{2}\varepsilon_0\left(\frac{3Q}{2Cd}\right)^2 Ad = \frac{9}{8}\frac{Q^2}{C}$

(d) Force on plate,

$F = \left(\frac{2Q}{2A\varepsilon_0}\right)\times\left(\frac{-Q}{1}\right) = -\frac{Q^2}{A\varepsilon_0}$; $F = \frac{Q^2}{A\varepsilon_0}$

28. (a, b) $|F| = \frac{dU}{dr} = \frac{Ke^2}{r^4}$ ..... (1)

$\frac{Ke^2}{r^4} = \frac{mv^2}{r}$ ..... (2)

and $mvr = \frac{nh}{2\pi}$ ..... (3)

By (2) and (3),

$r = \frac{Ke^2 4\pi^2}{h^2}\frac{m}{n^2} = K_1\frac{m}{n^2}$ ..... (4)

From (2) $KE = \frac{1}{2}mv^2 = \frac{1}{2}\frac{Ke^2}{r^3}$

Total energy = KE + PE = $\frac{Ke^2}{2r^3} - \frac{Ke^2}{3r^3}$

$= \frac{Ke^2}{6r^3} = \frac{Ke^2}{6\left(\frac{K_1 m}{n^2}\right)^3} = \frac{Ke^2 n^6}{6K_1^3 m^3}$

Total energy $\propto n^6$

Total energy $\propto m^{-3}$

29. (b, d)

$\frac{P^2}{\rho} = k \Rightarrow \frac{P^2 RT}{PM} = k \Rightarrow PT = \left(\frac{kM}{R}\right)$ ..... (1)

$\frac{P^2}{\rho} = \frac{P'^2}{\rho/2} \Rightarrow P' = \frac{P}{\sqrt{2}}$

Hence from (1), $T' = T\sqrt{2}$.

PT = constant, hence P-T curve is a hyperbola.

30. (a, c) Path difference at point O is d sin α = 0.5 mm, Corresponding phase difference,

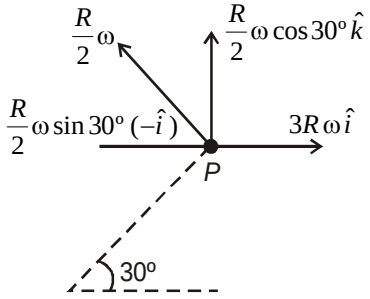
$\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x = \frac{2\pi\,(0.5\times10^{-3})}{5000\times10^{-10}} = 2000\pi = 2\pi\times1000$

$\Rightarrow$ O is a point corresponding to maxima.

The point at 1m below O corresponds to central maxima.

31. (a, b) For rolling motion, the velocity of the point of contact with respect to the surface should be zero. For this

$3R\omega(-\hat{i}) + \vec{v}_0 = 0 \qquad \therefore \quad \vec{v}_0 = 3R\omega\,\hat{i}$



A shown in the figure, the point *P* will have two velocities

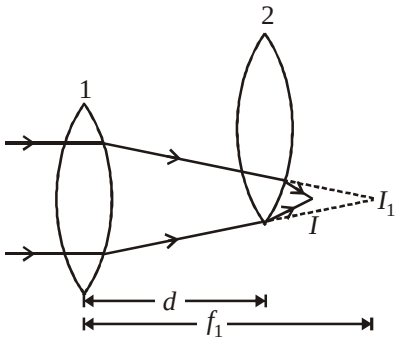
(i) $3R\omega\,\hat{i}$ (due to translational motion)

(ii) $\frac{R}{2}\omega$ making an angle of 30° with the vertical due to rotation

$\therefore \quad \overrightarrow{v_P} = \left[3R_\omega\,\hat{i} - \frac{R_\omega}{4}\hat{i}\right] + \frac{\sqrt{3}R_\omega}{4}\hat{k}$

$= \frac{11}{4}R_\omega\,\hat{i} + \frac{\sqrt{3}}{4}R_\omega\,\hat{k}$

32. (c) The image I_1 of parallel rays formed by lens 1 will act as virtual object.



Applying lens formula for lens 2

$\Rightarrow \quad \frac{1}{v_2} - \frac{1}{f_1 - d} = \frac{1}{f_2} \quad \Rightarrow \quad v_2 = \frac{f_2(f_1 - d)}{f_2 + f_1 - d}$

$\therefore$ The horizontal distance of the image *I* from *O* is

$x = d + \frac{f_2(f_1 - d)}{f_2 + f_1 - d} = \frac{f_1 f_2 + d(f_1 - d)}{f_1 + f_2 - d}$

To find the y-coordinate, we use magnification formula for lens 2

$m = \frac{v_2}{u_2} = \frac{\frac{f_2(f_1 - d)}{f_1 + f_2 - d}}{f_1 - d} = \frac{f_2}{f_1 + f_2 - d}$

Also $m = \frac{h_2}{\Delta} \Rightarrow h_2 = \frac{\Delta \times f_2}{f_1 + f_2 - d}$

$\therefore$ The y-coordinate $y = \Delta - h_2$

$= \Delta - \frac{\Delta f_2}{f_1 + f_2 - d} = \frac{\Delta(f_1 - d)}{f_1 + f_2 - d}$

33. (d) Phase difference of 4π is for second order bright fringe. i.e. fringe no. 4.

34. (b) $\Delta X_C = \lambda, \Delta X_A = \lambda/2$

$\Delta X_C - \Delta X_A = \lambda/2 = 300\text{nm}.$

35. (d) Normal human ear cannot hear beat frequency (25Hz) as it is greater than 15Hz.

36. (c) $f = \frac{v}{\lambda}$; $f_1 - f_2 = \frac{350}{(32/100)} - \frac{350}{(32.2/100)}$; 7

37. (c) The desired equation is

$NH_3(g) \rightarrow N(g) + 3H(g)$

we can consider the reaction as

$NH_3(g) \xrightarrow{\Delta H_1} N(g) + 3H(g)$

$\xrightarrow{\Delta H_2} \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$

$\therefore \quad \Delta H_1 + \Delta H_2 = +46.024\ \text{kJ mol}^{-1}$

Now, $\Delta H_2 = -\frac{3}{2}(435.95) - \frac{1}{2}(941.8)$

or $\Delta H_1 = 46.024 + 653.925 + 470.9$

or $\Delta H_1 = 1170.849\ \text{kJ mol}^{-1}$

or $\Delta H_1 = 1.170849\ \text{kJ mol}^{-1}$

38. (a) The reaction is

$4NH_3(g)$	+ $5O_2(g)$	$\rightarrow$ $4NO(g)$	+ $6H_2O(g)$
4×17 g	5×32 g	$4 \times (14+16)$g	
= 68 g	= 160 g	= 120 g	
10.0 g	20.0 g	?	

Inspection of the given data shows that in the given reaction, oxygen is the limiting reagent. Therefore, maximum mass of nitric oxide formed

$= \frac{120\text{g} \times 20\text{g}}{160\text{g}} = 15\text{g}$

39. (b) Let the moles of benzene vapourizes at 20°C = n_1

Volume of n_1 mole of benzene when it vaporises (ℓ)

$= \frac{78n_1}{0.877}$

Volume of n_1 mole of benzene (g) = $2750\left(\frac{78n_1}{0.877}\right)$

$PV = nRT$

$P\left(\frac{78n_1}{0.877}\right)\left(\frac{2750}{1000}\right) = n_1 \times 0.082 \times 293$

$P^o_{\text{Benzene}} = 0.0982$ atm. = 74.63 mm Hg

P^o_{Benzene} at 27°C can be calculated as

$\log\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{2.303\ R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$

$\log\left(\frac{P_2}{74.63}\right) = \frac{394.57 \times 78}{2.303 \times 8.314}\left[\frac{7}{300 \times 293}\right]$

P^o_{Benzene} (at 27°C) = 100.2 mm Hg

Molality of the solution = $\frac{X_{\text{solute}} \times 1000}{X_{\text{solvent}} \times 78}$

$= \frac{\left(\frac{100.2 - 98.88}{98.88}\right) \times 1000}{0.98 \times 78} = 0.17$

$\Delta T_f = K_f m = 5 \times 0.17 = 0.85$

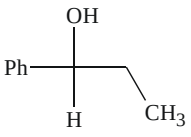
We know, that, $K_f = \left[\frac{RT_f^2}{1000\ \Delta H_f}\right] M$

$5 = \left(\frac{8.314 \times T_f^2}{1000 \times 10060}\right) 78$

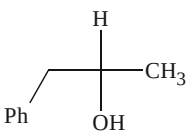
$T_f = 278.5\ \text{K}$

$\therefore$ Freezing point of solution = 278.5 – 0.85 = 277.65 K

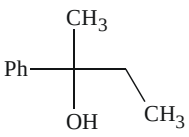
40. (c) Compound A is a monosubstituted Ph-derivative. It has an OH in the side chain, as indicated by the reaction of Na releasing H_2. The possible structures are



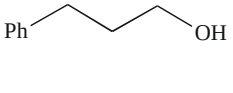
(1)



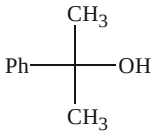
(2)



(3)



(4)



(5)

(i) Structure (5) is a 3° alcohol and is discounted on the basis of chromic acid test.

(ii) Structure (4) is eliminated; it is not chiral.

(iii) Structure (2) would give a precipitate with I_2/OH^- because of the -CH(OH)CH_3 group and is therefore eliminated. Only structure (1) and (3) are possible at this point.

(iv) The compound (A) is structure (3) because on oxidation it forms the chiral aldehyde, PhCH(CH_3)CH=O.

41. (a) $E^\circ_{Br^-/AgBr/Ag} = E^\circ_{Ag^+/Ag} + \frac{0.059}{1}\log K_{SP}$

$AgBr = E^\circ_{Ag^+/Ag} - 0.7257$

and $E^\circ_{Cl^-/AgCl/Ag} = E^\circ_{Ag^+/Ag} + \frac{0.059}{1}\log K_{SP}$

$AgCl = E^\circ_{Ag^+/Ag} - 0.59$

Now cell reaction is

$Ag + Br^- \longrightarrow AgBr + 1e^-$

$AgCl + e^- \longrightarrow Ag + Cl^-$

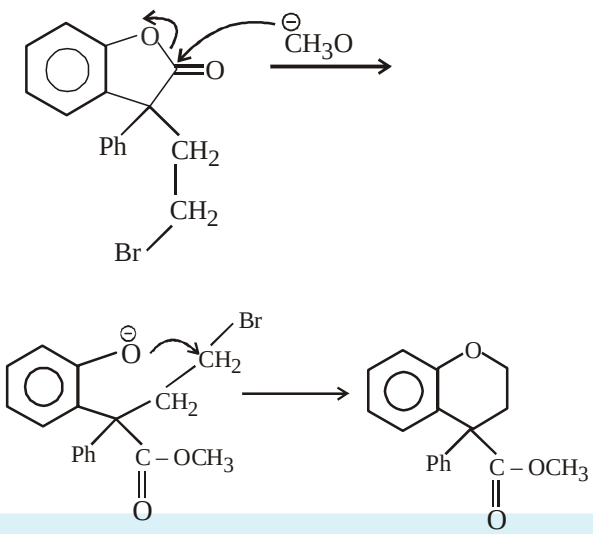
$Br^- + AgCl \xrightarrow{e^-} Cl^- + AgBr$

$0 = (0.7257 - 0.59) + \frac{0.059}{1}\log\frac{[Br^-]}{[Cl^-]}$

$\Rightarrow \frac{[Br^-]}{[Cl^-]} = 0.005 = 5:1000 = 1:200$

42. (d) $[Pt(en)_2Cl_2]$ will exhibit geometrical as well as optical isomerism. Geometrical isomerism is found in compounds having co-ordination number 4 (having square planar structure) and co-ordination number 6.

43. (b)



44. (a,b)

The chemical equation involving the titration of $C_2O_4^{2-}$ with MnO_4^- is

$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{+2} + 10CO_2 + 8H_2O$

The chemical equation involving Cu^{2+} ions are

$2Cu^{2+} + 4I^- \longrightarrow Cu_2I_2 + I_2$

$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$

The stoichiometry of the above reactions give

$2\text{mol } MnO_4^{2-} \equiv 5\text{ mol } C_2O_4^{2-}$

$2\text{mol } S_2O_3^{2-} \equiv 1\text{ mol of } I_2 \equiv 2\text{ mol } Cu^{2+}$

Therefore,

Amount of $C_2O_4^{2-}$ in the solution

$= \frac{0.02\text{ mol}}{1000\text{ mL}} \times 22.6\text{ mL} \times \frac{5}{2} = 1.13\times10^{-3}\text{mol}$

and amount of Cu^{2+} in the solution

$= \frac{0.05\text{ mol}}{1000\text{ mL}} \times 11.3\text{ mL} = 0.56\times10^{-3}\text{mol}$

45. (a,c,d)

(a) BeO is essentially covalent. Therefore, it does not dissolve in water. $BeSO_4$ in soluble in water due to its very high hydration enthalpy.

(b) The carbon hydrides of the type C_nH_{2n+2} are electron precise compounds. This compound will neither act as Lewis acid or Lewis base because all electrons are involved in bond formation.

(c) Due to its high bond enthalpy, dihydrogen is not particularly reactive at room temperature. It shows reactivity only at higher temperatures particularly in the presence of catalyst.

(d) The s-block elements are highly electropositive in nature. So, these are very reactive.

46. (a,b,c)

(a) $[Co(H_2O)_6]^{2+} \longrightarrow t_{2g}^{2,2,1}\, e_g^{1,1}$

$\therefore$ CFSE $= -0.8\,\Delta_0$

$[Co(H_2O)_6]^{3+} \longrightarrow t_{2g}^{2,1,1}\, e_g^{1,1}$

$\therefore$ CFSE $= -0.4\,\Delta_0$

(b) $[Fe(NH_3)_6]^{2+} \longrightarrow t_{2g}^{2,2,2}\, e_g^{0,0}$

$\therefore$ CFSE $= -2.4\,\Delta_0$

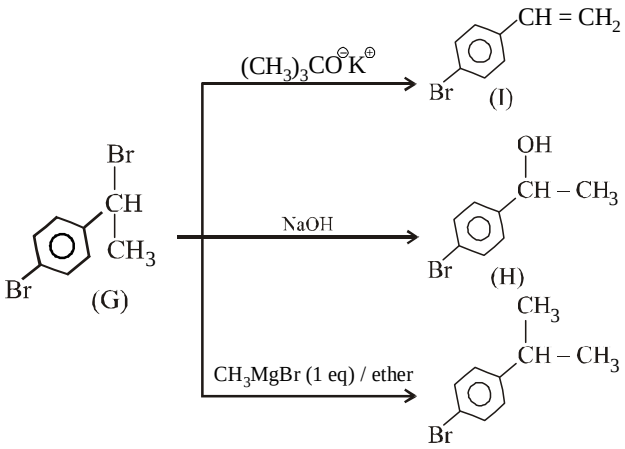
$[Fe(NH_3)_6]^{3+} \longrightarrow t_{2g}^{2,2,1}\, e_g^{0,0}$

$\therefore$ CFSE $= -2.0\,\Delta_0$

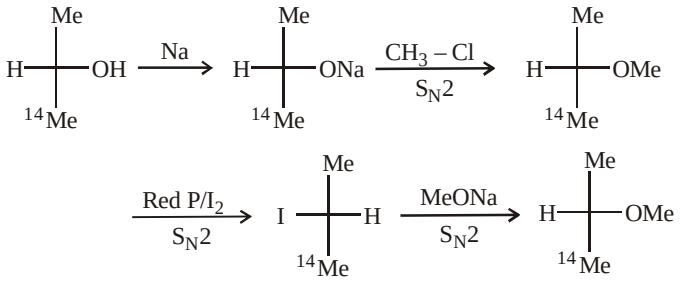
(c) For co-ordination no six, two empty d-orbitals are not available for d^2sp^3 as Ni(II) has $3d^8\ 4s^0$ configuration.

(d) d-orbital involved is $d_{x^2-y^2}$ not d_{z^2}.

47. (a,c,d)



48. (a,c)



49. (b, c)

$|\Psi|$ has no physical significance. However, $|\Psi|^2$ is the probability of finding the electron in an orbital, d_z2 orbital has dumb bell shape along z-axis and has a doughnut shaped electron cloud at the centre.

50. (a, c)

$(pH)_1 = pK_a + \log(y/x)$

$(pH)_2 = pK_a + \log(x/y)$

$$(pH)_2 - (pH)_1 = \log\left(\frac{x}{y}\right) - \log\left(\frac{y}{x}\right) = 1 \Rightarrow \log\left(\frac{x^2}{y^2}\right) = 1$$

$$\text{so } \frac{x^2}{y^2} = 10 \Rightarrow \frac{x}{y} = 3.162$$

$$(pH)_2 + (pH)_1 = 2pK_a + \log\left(\frac{y}{x}\right) + \log\left(\frac{x}{y}\right) = 2\ pK_a = 9.5$$

$$\text{so, } pK_a = \frac{9.5}{2} = 4.75$$

51. (d) Number of hybrid orbitals, H in ClF_3

$$= \frac{1}{2}(\text{valence electrons of Cl} + 3 \times \text{valence electron of F}) - 3 \times 3\ \text{F-atoms})$$

$$= \frac{1}{2}(7 + 3 \times 7) - 9 = 14 - 9 = 5$$

Number of bond pairs (n) = 3

Total number of lone pairs (m) = H – n = 5 – 3 = 2

Hence, VSEPR notation of ClF_3 is AX_3E_2.

52. (a) $CO_2 : H = \frac{1}{2}(4 + 2 \times 6) - 3 \times 2 = 2$;

Dipole moment (DM) = H – n

where n = no. of bond pairs

n = 2; d.m. = H – n = 2 – 2 = 0

$$SO_2 : H = \frac{1}{2}(6 + 2 \times 6) - 3 \times 2 = 3;\ n = 2;\ d.m. = 3 - 2 = 1$$

$$H_2O : H = \frac{1}{2}(2 \times 1 + 6) - 3 \times 0 = 4;\ n = 2;\ d.m. = 4 - 2 = 2$$

53. (b) $\log K_b = \log A - \frac{Ea}{2.303\,RT}$

$$\log K_b = 12 - \frac{57450}{2.303 \times 8.314 \times 300}$$

$\log K_b = 2$; $K_b = \text{Antilog } 2$; $K_b = 10^2$

$$K_c = \frac{K_F}{K_b} \Rightarrow 10^4 = \frac{K_F}{10^2}\ ;\ K_F = 10^6$$

54. (a) $\Delta G = \Delta H - T\Delta S$; $\Delta G = 20 - T \times 0.07$

For non-spontaneous process $\Delta G > 0$

hence $0 < 20 - T \times 0.07$

$$T < \frac{20}{0.07} \Rightarrow T < 285.7\ K$$