JEE ADVANCED 2017 MOCK TEST-2

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disha
Nurturing Ambitions

TARGET IIT

MOCK TEST - 2

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. The value of $\int_2^4 \left(\log_x 2 - \frac{(\log_x 2)^2}{\ln 2} \right) dx$ is not equal to:

(a) 0 (b) 1
(c) –2 (d) 8

2. If $C_0, C_1, \ldots\ldots\ldots, C_n$ all binomial coefficients in expansion of $(1+x)^n$ and $a_1, a_2, \ldots\ldots\ldots, a_n$ are in G.P. with common ratio $r(\neq 0)$, then $C_1a_1 + C_2a_2 + C_3a_3 + \ldots\ldots\ldots + C_na_n =$

(a) $\frac{a_1}{r}[(1+r)^n - 1]$

(b) $a_1 + a_1(1+r) + a_1(1+r)^2 + \ldots\ldots + a_1(1+r)^{n-1}$

(c) $\frac{a_1}{(r-1)}[r^n - 1]$

(d) $a_1[1 + r + r^2 + \ldots\ldots\ldots + r^n - 1]$

3. Let a, b > 0 then

(a) $|\sqrt{a} - \sqrt{b}| \le \sqrt{|a-b|}$ (b) $\frac{a}{b^2} + \frac{b}{a^2} \ge \frac{1}{a} + \frac{1}{b}$

(c) $\frac{a}{\sqrt{b}} + \frac{b}{\sqrt{a}} \ge \sqrt{a} + \sqrt{b}$ (d) $\frac{a^2}{1+a^4} + \frac{b^2}{1+b^4} \le 1$

4. Let x, y be real variable satisfying the $x^2 + y^2 + 8x - 10y - 40 = 0$. Let $a = \max\{(x+2)^2 + (y-3)^2\}$ and $b = \min\{(x+2)^2 + (y-3)^2\}$ then

(a) $a + b = 18$ (b) $a + b = 4\sqrt{2}$
(c) $a - b = 8\sqrt{2}$ (d) $a \cdot b = 73$

5. Which of the following is/are correct(s)

(a) If $\lim_{x\to 0} \frac{(\sin nx)[(a-n)nx - \tan x]}{x^2} = 0$, then the value of a is $n + \frac{1}{n}$

(b) If $f(x) = \begin{cases} x^2 + 2, & x \ge 1 \\ 2x + 1, & x < 1 \end{cases}$, then $\lim_{x\to 1} f(x) = 3$

(c) If $\lim_{x\to\infty} \left(1 + \frac{a}{x} + \frac{b}{x^2}\right)^{2x} = e^2$, then a = 1 and $b \in R$

(d) None of these

6. The rank of the matrix $\begin{bmatrix} -1 & 2 & 5 \\ 2 & -4 & a-4 \\ 1 & -2 & a+1 \end{bmatrix}$ is

(a) 1 if $a = 6$ (b) 2 if $a = 1$
(c) 3 if $a = 2$ (d) 1 if $a = -6$

7. $f(x)$ is defined for $x \ge 0$ and has a continuous derivative. It satisfies $f(0) = 1$, $f'(0) = 0$ and $(1 + f(x))f''(x) = 1 + x$. The values $f(1)$ can't take is (are)

(a) 2 (b) 1.75
(c) 1.50 (d) 1.35

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. Given

$$f(x)=\lim_{n\to\infty}2^{-(n+1)}\sum_{r=1}^{n}\left(2^{-r}\operatorname{cosec}\left(2^{-r}x\right)\cot\left(2^{-r}x\right)\right)$$ then find the value of $\lim_{x\to 0}x^2 f(x)$.

9. Let $p(x)$ be a real polynomial function given by $p(x)=ax^3+bx^2+cx+d$, such that if $|p(x)|\le 1$ for all x such that $|x|\le 1$ then find the greatest value of $|a|+|b|+|c|+|d|$.

10. The sum of the three positive numbers α,β,γ is equal to $\frac{\pi}{2}$ and if $\tan\alpha,\tan\beta,\tan\gamma$ form harmonic progression, find the value of $\cot\alpha\cot\gamma$.

11. Find the positive value of m, for which area of the region bounded by the curve $y=x-x^2$ and the line $y=mx$ is equal to $\frac{9}{2}$.

12. For a positive integer n, let $f(n)=\frac{n^2}{n^3+200}$.

Find the value of n for which $f(n)$ is the greatest.

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 option 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 and 2 give information about the equations of straight lines and column 3 gives information about the shortest distances between these straight lines.

Column 1		Column 2		Column 3	
(I)	$\frac{x-3}{1}=\frac{y-5}{-2}=\frac{z-7}{1}$	(i)	$\frac{3y-1}{3}=\frac{4z-1}{6}=\frac{2x-1}{1}$	(P)	$\sqrt{6}$
(II)	$\frac{x-\frac{1}{2}}{1}=\frac{y-\frac{1}{3}}{2}=\frac{z-\frac{1}{4}}{3}$	(ii)	$\frac{x+2}{-4}=\frac{y}{1}=\frac{z-7}{1}$	(Q)	9
(III)	$\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-3}{4}$	(iii)	$\frac{x+1}{7}=\frac{y+1}{-6}=\frac{z+1}{-1}$	(R)	0
(IV)	$\frac{x+3}{-4}=\frac{y-6}{3}=\frac{z}{2}$	(iv)	$\frac{x-2}{3}=\frac{y-4}{4}=\frac{z-5}{5}$	(S)	$6\sqrt{3}$

13. Which of the following options is the only correct combination?
(a) (I) (iii) (P) (b) (II) (i) (S) (c) (III) (iv) (R) (d) (IV) (ii) (Q)

14. Which of the following options is the only correct combination?
(a) (I) (iii) (P) (b) (II) (i) (R) (c) (III) (iv) (S) (d) (IV) (ii) (R)

15. Which of the following options is the only incorrect combination?
(a) (II) (i) (R) (b) (III) (iv) (P) (c) (IV) (ii) (Q) (d) (I) (iii) (R)

(Qs. 16-18) By appropriately matching the information given in the three columns of the following table, give the answer of the question that follows.
Column 1 gives information about the functions $f(x)$ and $g(x)$.
Column 2 gives information about the domain or range of $fog(x)$ or $gof(x)$
Column 3 gives information about the interval which is either domain or range of $fog(x)$ or $gof(x)$.

Column 1		Column 2		Column 3	
(I)	$f(x)=\cot^{-1}x$, $g(x)=e^{-x}$	(i)	Domain of $gof(x)$	(P)	$(0, \infty)$
(II)	$f(x)=1+x$, $g(x)=(\ln x)^2$	(ii)	Domain of $fog(x)$	(Q)	R
(III)	$f(x)=\sin x$, $g(x)=\cos^{-1}x$	(iii)	Range of $gof(x)$	(R)	$(e^{-\pi}, 1)$
(IV)	$f(x)=\cot^{-1}x$, $g(x)=\ln x$	(iv)	Range of $fog(x)$	(S)	$[0, 1]$

16. Which of the following options is the only correct combination?
(a) (I) (iii) (P) (b) (II) (i) (Q) (c) (III) (iv) (S) (d) (IV) (ii) (R)

17. Which of the following options is the only correct combination?
(a) (II) (iii) (R) (b) (I) (ii) (S) (c) (IV) (i) (Q) (d) (III) (iv) (P)

18. Which of the following options is the only incorrect combination?
(a) (II) (ii) (Q) (b) (III) (iv) (S) (c) (IV) (i) (Q) (d) (I) (iii) (R)

Part - B : Physics

SECTION – I - Multiple Correct Choice Type

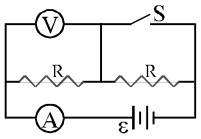
This section contains 7 multiple choice quesitons. Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE OR MORE is/are correct.

19. In displacement method, the distance between object and screen is 96 cm. The ratio of length of two images formed by a convex lens placed between them is 4.84.
(a) Ratio of the length of object to the length of shorter image is 11/5.
(b) Distance between the two positions of the lens is 36cm.
(c) Focal length of the lens is 22.5 cm.
(d) Distance of the lens from the shorter image is 30 cm.

20. A particle is projected vertically upwards with a velocity u from a point O. When it returns to the point of projection
(a) its average velocity is zero
(b) its average speed is u/2
(c) its displacement is zero
(d) its average speed is u.

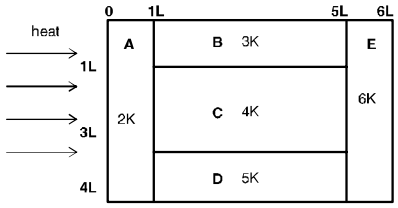
21. In a resonance tube experiment, a close organ pipe of length 120 cm. resonates when tune with a turning fork of frequency 340 Hz. If water is poured in the pipe then
(given v_{air} = 340 m/sec)
(a) minimum length of water column to have the resonance is 45 cm.
(b) the distance between two successive nodes is 50 cm.
(c) the maximum length of water column to create the resonance is 95 cm.
(d) None of these

22. The diagram shows a circuit with two identical resistors. The battery has a negligible internal resistance. When switch S is closed,



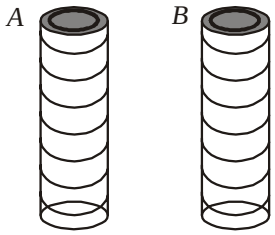
(a) equivalent resistance of the circuit decreases
(b) ammeter reading will increase
(c) voltmeter reading will increase
(d) power dissipated across R in right branch will become zero.

23. A composite block is made of slabs A, B, C, D and E of different thermal conductivities (given in terms of a constant K and sizes (given in terms of length, L) as shown in the figure. All slabs are of same width. Heat 'Q' flows only from left to right through the blocks. Then in steady state



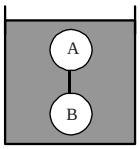
(a) heat flow through A and E slabs are same.
(b) heat flow through slab E is maximum.
(c) temperature difference across slab E is smallest.
(d) heat flow through C = heat flow through B + heat flow through D.

24. Two metallic rings *A* and *B*, identical in shape and size but having different resistivities ρ_A and ρ_B, are kept on top of two identical solenoids as shown in the figure. When current *I* is switched on in both the solenoids in identical manner, the rings *A* and *B* jump to heights h_A and h_B, respectively, with $h_A > h_B$. The possible relation(s) between their resistivities and their masses m_A and m_B is(are)



(a) $\rho_A > \rho_B$ and $m_A = m_B$ (b) $\rho_A < \rho_B$ and $m_A = m_B$
(c) $\rho_A > \rho_B$ and $m_A > m_B$ (d) $\rho_A < \rho_B$ and $m_A < m_B$

25. Two solid spheres A and B of equal volumes but of different densities d_A and d_B are connected by a string. They are fully immersed in a fluid of density d_F. They get arranged into an equilibrium state as shown in the figure with a tension in the string. The arrangement is possible only if



(a) $d_A < d_F$

(b) $d_B > d_F$

(c) $d_A > d_F$

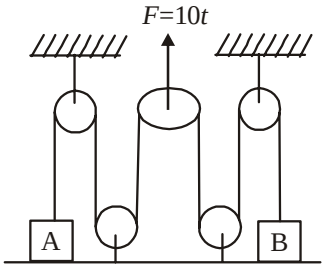
(d) $d_A + d_B = 2d_F$

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. In the arrangement shown in figure $m_A = 1$ kg and $m_B = 2$ kg, while all the pulleys and strings are massless and frictionless. At $t = 0$, a force $F = 10\,t$ starts acting over central pulley in vertically upward direction. If the velocity of A (in m/s) when B loses contact with floor is $2x$, find the value of x



27. A spring is stretched by 0.20 metre when a mass of 0.50 kg is suspended. The period of the spring when a mass of 0.25 kg is suspended and put to oscillation is given by $\frac{11x}{35}$, find the value of x ($g = 10$ m/sec^2).

28. An inductor of inductance 2.0 mH is connected across a charged capacitor of capacitance 5.0 mF, and the resulting LC circuit is set oscillating at its natural frequency. Let Q denote the instantaneous charge on the capacitor, and I the current in the circuit. It is found that the maximum value of Q is 200 mC. When $Q = 100$ mC, the value of $|dI/dt|$ is 10^y A/s. Find y ?

29. Two insulated metal spheres of radii 10 cm and 15 cm charged to a potential of 150 V and 100 V respectively, are connected by means of a metallic wire. What is the charge on the first sphere (in e.s.u.) ?

30. A whistling train approaches a junction. An observer standing at junction observes the frequency to be 2.2 kHz and 1.8 kHz of the approaching and the receding train respectively. If the speed (in ms^{-1}) of the train (speed of sound = 300 m/s) is 6 B, what is the value of B ?

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.

According to Bohr's model, electron revolves in circular orbits around the nucleus under the influence of coulombic force of attraction in defined stationary orbits, for which angular momentum, $mvr = \frac{nh}{2\pi}$. Column I, II & III give different relation between Z = atomic number, n = orbit number, and different physical quantities like angluar velocity, energy, current, ionization energy. (Here A_0, B_0, C_0 and D_0 are constants)

	Column I		Column II		Column III
I.	Ionisation energy of an electron in n^{th} Bohr's orbit	(i)	Inversely proportional to n	(P)	$A_0 \frac{Z^2}{n^3}(sec^{-1})$
II.	Current developed due to motion of an electron in n^{th} orbit	(ii)	Inversely proportional to n^3	(Q)	$B_0 \frac{Z}{n}$
III.	Velocity of an electron in n^{th} Bohr's orbit	(iii)	Directly proportional to Z^2	(R)	$C_0 \frac{Z^2}{n^3}$
IV.	Angular speed of an electron in n^{th} Bohr's orbit	(iv)	Directly proportional to Z	(S)	$D_0 \frac{Z^2}{n^2}$

31. If the value of current developed due to motion of an electron in 3rd Bohr's orbit (for Z = 3) is $C_0/3$ then correct matching satisfying the above condition will be:

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

32. Which of the following shows the correct matching?

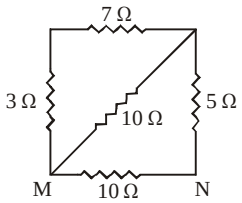
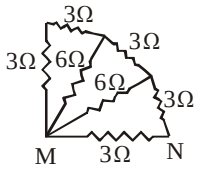
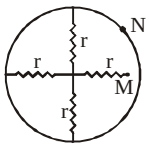
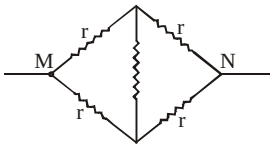
(a) II (ii) Q (b) III (i) Q (c) IV (ii) Q (d) I (i) R

33. Which of the following does not show the correct matching?

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

(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.

Two or more resistors are said to be connected in parallel if the same potential difference exists across all resistors. Column I shows different combination of resistances. Column II shows the equivalent resistance of the combination. A cell of emf 60 volts and internal resistance 1 Ω is connected across M and N.

Column I		Column II		Column III	
I.		(i)	2 Ω	(P)	20 A
II.		(ii)	5 Ω	(Q)	10 A
III.		(iii)	$\frac{4r}{3}$	(R)	$\frac{180}{4r+3}$ A
IV.		(iv)	r	(S)	$\frac{60}{r+1}$ A

34. If resistance r is 3 Ω, in the combination shown in Column I (III), then the equivalent resistance of the combination and current through the cell respectively are (4 Ω, 12 A); Which of the following is correct matching satisfying the condition?

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

35. Which of the following shows the correct matching?

(a) I (ii) Q (b) II (i) P (c) IV (ii) S (d) Both (a) and (b)

36. Which of the following shows the incorrect matching?

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

Part - C : Chemistry

SECTION – I - Multiple Correct Choice Type

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

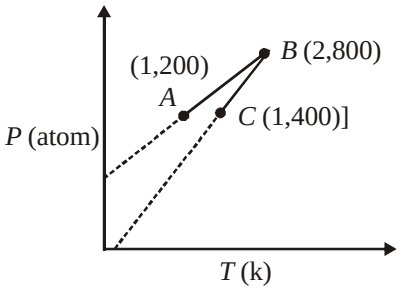
37. 0.2 mol of Na_3PO_4 and 0.5 mol of $Ba(NO_3)_2$ are mixed in 1L of solution. Which of the following is/are correct about this system ?

(a) 0.2 mol of barium phosphate precipitate is obtained
(b) 0.1 mol of barium phosphate precipitate is obtained
(c) Molarity of Ba^{2+} ions in the resulting solution is 0.2
(d) Molarities of Na^+ and NO_3^- ions are 0.6 and 1.0 respectively

38. Which of the following statement is/are correct

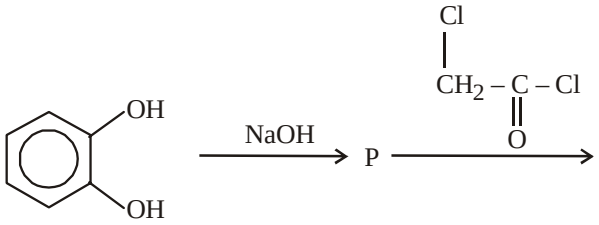
(a) The relative stability of carbocations follows
$(CH_3)_3\overset{+}{C} > (CH_3)_2\overset{+}{C}H > CH_3\overset{+}{C}H_2 > \overset{+}{C}H_3$
(b) The relative stability of carbocations follows
$(CH_3)_3\overset{+}{C} > CH_3\overset{+}{C}H_2 > \overset{+}{C}H_3 > (CH_3)_2\overset{+}{C}H$
(c) The stability of alkyl radical follows the order
$\dot{C}H_3 < CH_3\dot{C}H_2 < (CH_3)_2\dot{C}H < (CH_3)_3\dot{C}$
(d) The stability of alkyl radical follows the order
$\dot{C}H_3 < (CH_3)_3\dot{C} < CH_3\dot{C}H_2 < (CH_3)_2\dot{C}H$

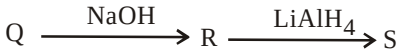
39. One mole of an ideal gas is subjected to a reversible process that involves two steps ($A \to B$ and $B \to C$). The pressure at A and C is same. Consider the graph and choose correct statements.

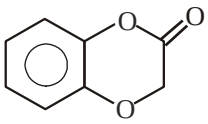


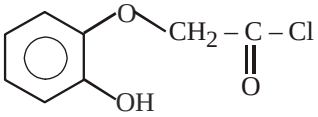
(a) Work done $A \to B$ is zero
(b) In path $A \to B$ work will be done on the gas by the surroundings
(c) Volume of gas at C = 2 × Volume of gas at A
(d) Volume of gas at B is 32.8

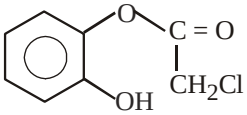
40.

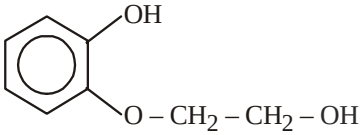




(a) R = 

(b) Q = 

(c) Q = 

(d) S = 

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

(a) B_2O_3 behaves as a base when reacted with strongly acidic oxides such as P_2O_5
(b) Orthoboric acid is a weak monobasic acid
(c) Orthoboric acid contains triangular BO_3^{3-} units, hydrogen bonded together into two dimensional sheets
(d) Orthoboric acid is a strong dibasic acid

42. Point out the correct statement(s) amongst the following

(a) $[Cu(CN)_4]^{3-}$ has square planar geometry and d^2sp hybridization

(b) $[Ni(CN)_6]^{4-}$ is octahedral and Ni has d^2sp^3 hybridization

(c) $[ZnBr_4]^{2-}$ is tetrahedral and diamagnetic

(d) $[Cr(NH_3)_6]^{3+}$ has octahedral geometry and sp^3d^2 hybridization

43. Aryl halides are less reactive towards nucleophilic substitution reaction as compared to alkyl halides due to

(a) the formation of less stable carbonium ion

(b) resonance stabilization

(c) longer carbon-halogen bond

(d) sp^2 hybridized carbon attached to the halogen.

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. Vapour pressure (in torr) of an ideal solution of two liquids A and B is given by : $P = 52X_A + 114$

where X_A is the mole fraction of A in the mixture. If the vapour pressure (in torr) of equimolar mixture of the two liquids is expressed as $7x + 126$, then find the value of x.

45. A metal (Atomic mass = 75 g mol $^{-1}$) crystallizes in cubic lattice, the edge length of unit cell being 5Å. The density of the metal is given 2g cm^{-3}. If the radius (pm) of the metal atom is expressed as $30\,x + 7$, then find the value of x.

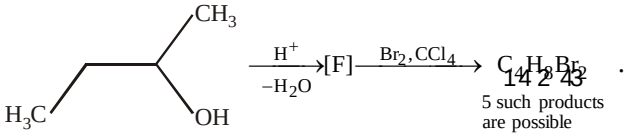
46. Electrolysis of NaCl solution with inert electrodes for certain period of time gave 600 cm^3 of 1.0 M NaOH in the electrolytic cell. During the same period 31.80 g of copper was deposited in a copper voltameter in series with the electrolytic cell. If the percent current efficiency in the electrolytic cell is expressed as 10 x then find the value of x (At. wt. of Cu = 63.6)

47. For the reaction $R - X + OH^- \rightarrow ROH + X^-$, the rate is given as :

$Rate = 5.0\times10^{-5}[R\text{–}X][OH^-] + 0.20 \times 10^{-5}[R\text{–}X]$.

If the percentage of R–X react by S_N2 mechanism when $[OH^-] = 1.0 \times 10^{-2}\,M$ is 10 x, then find the value of x.

48.



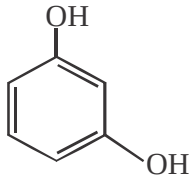
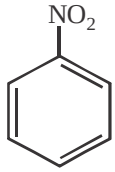
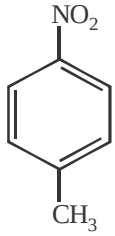
How many structures for F are possible?

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 Reactant and Column II & Column III contains condition required for reaction and product respectively.

Column I (Reactant)	Column II (Reaction condition)	Column III (Product)
(I) $HC \equiv CH$	(i) (i) $KMnO_4, \overset{\ominus}{O}H$, heat (ii) $H^{\oplus}$, H_2O (iii) $SOCl_2$ (iv) NH_3	(P) $C_6H_5NO_4$
(II) 	(ii) (i) Sn/HCl (ii) CH_3COCl (iii) Conc. H_2SO_4 (iv) HNO_3 (v) Dil H_2SO_4, heat (vi) $\overset{\ominus}{O}H$	(Q) $C_6H_5NO_3$
(III) 	(iii) (i) Red hot iron, 873K (ii) Fuming HNO_3, H_2SO_4, heat (iii) H_2S. NH_3 (iv) $NaNO_2$, H_2SO_4 (v) Hydrolysis	(R) $C_6H_6N_2O_2$
(IV) 	(iv) (i) Conc. H_2SO_4, 60°C (ii) Conc. HNO_3, Conc. H_2SO_4 (iii) Dil. H_2SO_4, heat	(S) $C_7H_6N_2O_3$

49. Find suitable combination which gives m-nitro phenol as a final product.
(a) (III) (i) (Q) (b) (II) (iv) (S) (c) (I) (iii) (Q) (d) (I) (ii) (P)

50. o-nitro aniline is given by which combination
(a) (IV) (iii) (S) (b) (III) (ii) (R) (c) (II) (iv) (Q) (d) (I) (iv) (S)

51. Find correct combination
(a) (IV) (iv) (S) (b) (II) (i) (P) (c) (I) (iv) (R) (d) (IV) (i) (S)

(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.

Column I, II & III contains, cell representation, type of reaction and electrode potential respectively.

Column I	Column II	Column III
(I) $Pt, H_2(1\ atm) \mid H^{\oplus}(10^{-3}\ M) \parallel H^{\oplus}(10^{-6}\ M) \mid H_2(1\ atm) \mid Pt$	(i) Spontaneous	(P) $E_{cell} = -0.13V$
(II) $Pt, F_2(g)(1\ atm) \mid F^{\ominus}(10^{-2}\ M) \parallel F^{\ominus}(10^{-3}\ M) \mid F_2(g)(2\ atm) \mid Pt$	(ii) Non-spontaneous	(Q) $E_{cell} = -0.177\ V$
(III) $Hg, Hg_2Cl_2(s) \mid KCl$ saturated solution $\parallel H^{\oplus}(pH = 10) \mid Q, QH_2 \mid Pt$ $\begin{pmatrix} E_{Q\mid H_2O} = 0.7V \\ E_{SCE} = 0.24V \end{pmatrix}$	(iii) Exergonic	(R) $E_{cell} = 0.582\ V$
(IV) $Q + 2H^{\oplus}(pH = 2) + 2e^- \longrightarrow H_2O(aq)$ $E^{o}_{cell} = 0.7$	(iv) Endergonic	(S) $E_{cell} = 0.069\ V$

52. For the cell given in column I, the only correct combination is

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

53. For the cell given in column I, the only correct combination is

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

54. For the cell given in column I, the only correct combination is

(a) (IV) (iii) (S) (b) (IV) (iii) (R) (c) (IV) (i) (Q) (d) (IV) (ii) (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 function $f : R \to R$, defined by $f(x) = [x]$, $\forall\, x \in R$, is
(a) one-one
(b) onto
(c) both one-one and onto
(d) neither one-one nor onto

2. If $x = a + b$, $y = a\omega + b\omega^2$ and $z = a\omega^2 + b\omega$, then $x^3 + y^3$ is equal to
(a) $6(a^3 + b^3)$ (b) $3(a^3 + b^3)$
(c) $a^3 + b^3$ (d) None of these

3. If $a_1, a_2, a_3, ..., a_n$ are in A.P. with S_n as the sum of first 'n' terms, then $\sum_{k=0}^{n} {}^nC_k S_k$ is equal to
(a) $2^{n-2}[na_1 + S_n]$ (b) $2^n[a_1 + S_n]$
(c) $2[na_1 + S_n]$ (d) $2^{n-1}[a_1 + S_n]$

4. Find the coefficient of x^{50} in the expression :
$(1 + x)^{1000} + 2x(1 + x)^{999} + 3x^2(1 + x)^{998} + ... + 1001.\, x^{1000}$.
(a) ${}^{1008}C_{55}$ (b) ${}^{1002}C_{52}$
(c) ${}^{1000}C_{40}$ (d) ${}^{1002}C_{50}$

5. If a, b and c are distinct positive real numbers and $a^2 + b^2 + c^2 = 1$, then $ab + bc + ca$ is
(a) less than 1 (b) equal to 1
(c) greater than 1 (d) any real number

6. Number of integers satisfying either $\log_3 |x| < 2$ or $|\log_3 x| < 2$ are
(a) 18 (b) 16
(c) 20 (d) 23

7. If the straight line $ax + by = 2$; $a, b \neq 0$ touches the circle $x^2 + y^2 - 2x = 3$ and is normal to the circle $x^2 + y^2 - 4y = 6$, then the values of a and b are respectively
(a) $1, -1$ (b) $1, 2$
(c) $-4/3, 1$ (d) $2, 1$

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. The values of x between 0 and 2π, which satisfy the equation $\sin x\sqrt{8\cos^2 x} = 1$ are in A.P. Choose the correct options
(a) common difference of A.P. is $\pi/4$
(b) $x = \pi/8$
(c) $x = 3\pi/8$
(d) $x = 5\pi/8$

9. The straight lines $x + y = 0$, $3x + y - 4 = 0$ and $x + 3y - 4 = 0$ from a triangle which is
(a) isosceles (b) right-angled
(c) obtuse-angled (d) equilateral

10. The function $f(x) = \dfrac{|x-1|}{x^2}$
(a) increases in $(-\infty, 0) \cup (1, 2)$
(b) increases in $(0, 1) \cup (2, \infty)$
(c) decreases in $(0, 1) \cup (2, \infty)$
(d) decreases in $(-\infty, \infty) \cup (1, 2)$

11. The differential equation $\dfrac{d^2x}{dy^2} + y + \cot^2 x = 0$ must be satisfied by
(a) $2 + c_1 \cos x + \sqrt{c_2} \sin x$
(b) $\cos x . \ell n\left(\tan\dfrac{x}{2}\right) + 2$
(c) $2 + c_1 \cos x + c_2 \sin x + \cos x\, \ell n\left(\tan\dfrac{x}{2}\right)$
(d) all of the above

12. If $I_n = \displaystyle\int_0^1 \frac{dx}{(1+x^2)^n}$, $n \in N$, then which of the following statements hold good
(a) $2n\, I_{n+1} = 2^{-n} + (2n-1) I_n$ (b) $I_2 = \dfrac{\pi}{8} + \dfrac{1}{4}$
(c) $I_2 = \dfrac{\pi}{8} - \dfrac{1}{4}$ (d) $I_3 = \dfrac{\pi}{16} - \dfrac{5}{48}$

13. If $2\vec{a}, -3\vec{b}, 2(\vec{a} \times \vec{b})$ are position vectors of the vertices A, B, C of ΔABC and $|\vec{a}| = 1, |\vec{b}| = 1, \overrightarrow{OA} \cdot \overrightarrow{OB} = -3$ (where O is the origin), then
(a) triangle ABC is right angled triangle
(b) angle B is $90°$
(c) $A = \cos^{-1}\left(\sqrt{\dfrac{7}{19}}\right)$
(d) The position vector of orthocentre is $2(\bar{a} \times \bar{b})$.

14. The quadratic expression $21 + 12x - 4x^2$ takes
(a) the least value 5 (b) the greatest value 30
(c) the greatest value 21 (d) none of these

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 sides of a triangle ABC satisfy the relations $a+b-c = 2$ and $2ab - c^2 = 4$ and $f(x) = ax^2 + bx + c$.

15. Area of the triangle ABC in square units, is
(a) $\sqrt{3}$ (b) $\dfrac{\sqrt{3}}{4}$
(c) $\dfrac{9\sqrt{3}}{4}$ (d) $4\sqrt{3}$

16. If $x \in [0, 1]$ then maximum value of $f(x)$ is
(a) 3/2 (b) 2
(c) 3 (d) 6

PARAGRAPH - 2

A jar contains 2n throughly mixed balls, n white and n black balls. n persons each of whom draw 2 balls simultaneously from the bag without replacement.

17. If the probability that each of the n person draw both balls of different colours is 8/35, then the value of n equals

(a) 3 (b) 4

(c) 5 (d) 6

18. If n = 4 the probability that each of the 4 persons draw both balls of the same colour is equal to

(a) 1/35 (b) 2/35

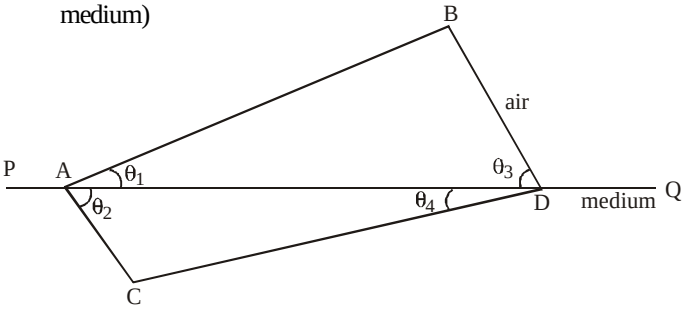
(c) 3/35 (d) 4/35

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. The following figure represents a wavefront AB which passes from air to another transparent medium and produces a new wavefront CD after refraction. The refractive index of the medium is (PQ is the boundary between air and the medium)



(a) $\frac{\cos\theta_1}{\cos\theta_4}$ (b) $\frac{\cos\theta_4}{\cos\theta_1}$

(c) $\frac{\sin\theta_1}{\sin\theta_4}$ (d) $\frac{\sin\theta_2}{\sin\theta_3}$

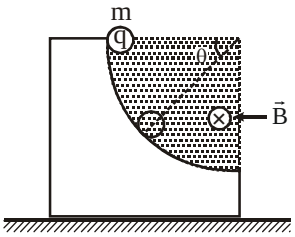
20. In the figure a charged sphere of mass m and charge q starts sliding from rest on a vertical fixed circular track of radius R from the position shown. There exists a uniform and constant horizontal magnetic field of induction B. The maximum force exerted by the track on the sphere.

(a) $3mg - qB\sqrt{2gR}$

(b) $2mg - qB\sqrt{2gR}$

(c) $mg - 2qB\sqrt{2gR}$

(d) $mg - qB\sqrt{3gR}$



21. The displacement of a particle is given at time t, by:

$x = A\sin(-2\omega t) + B\sin^2\omega t$. Then

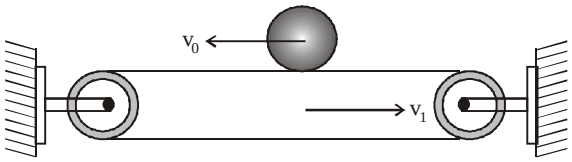
(a) the motion of the particle is SHM with an amplitude of $\sqrt{A^2 + \frac{B^2}{4}}$

(b) the motion of the particle is not SHM, but oscillatory with a time period of $T = \pi/\omega$

(c) the motion of the particle is oscillatory with a time period of $T = \pi/2\omega$

(d) the motion of the particle is a periodic.

22. A sphere of radius r and mass m has a linear velocity v_0 directed to the left and no angular velocity as it is placed on a belt moving to the right with a constant velocity v_1. If after sliding on the belt the sphere is to have no linear velocity relative to the ground as it starts rolling on the belt without sliding, in terms of v_1 and the coefficient of kinetic friction μ_k between the sphere and the belt, determine the required value of v_0



(a) $(1/5)\,v_1$ (b) $(3/5)\,v_1$

(c) $(2/5)\,v_1$ (d) $3v_1$

23. When 0.50 Å X-rays strike a material, the photoelectrons from the K- shell are observed to move in a circle of radius 23 mm in a magnetic field of 2×10^{-2} T. What is the binding energy of K-shell electrons?

(a) 6.2 keV (b) 0.2 keV
(c) 4.2 keV (d) 3.2 keV

24. A potentiometer wire of length L and resistance 10 Ω has a battery of 2.5V and a resistance in series in its primary circuit. The null point for a cell of emf 1 volt comes at L/2 distance from one end. If the series resistance in the primary circuit is doubled, then position of the new null point is

(a) 0.5 L (b) 0.6 L
(c) 1.0 L (d) None of the above

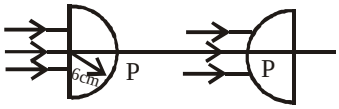
25. Two infinitely long straight parallel wires are joined at equal intervals of distance 2ℓ by cross wires of length ℓ each. The wires all have the same resistance per unit length equal to R/ℓ. A current enters and leaves the network at the ends of one of the cross wires. The equivalent resistance of the network is

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

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 parallel beam of light is incident normally on the flat surface of a hemisphere of radius 6 cm and refractive index 1.5, placed in air as shown in figure (i). Assume paraxial ray approximation.



figure(i) figure(ii)

(a) The rays are focussed at 12 cm from the point P to the right, in the situation as shown in figure (i).
(b) The rays are focussed at 16 cm from the point P to the right, in the situation as shown in figure (i).
(c) If the rays are incident at the curved surface (figure (ii)) then these are focussed at distance 18 cm from point P to the right.
(d) If the rays are incident at the curved surface (figure (ii)) then these are focussed at distance 14 cm from point P to the right.

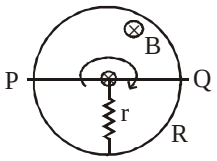
27. Let $\vec{v}$, v_{rms} and v_p respectively denote the mean speed, the root-mean-square speed, and the most probable speed of the molecules in an ideal monoatomic gas at absolute temperature T. The mass of a molecule is m.

(a) No molecule can have speed greater than v_{rms}.
(b) No molecule can have speed less than $\frac{v_p}{\sqrt{2}}$.
(c) $v_p < \vec{v} < v_{rms}$
(d) The average kinetic energy of a molecule is $\frac{3}{4}mv_p^2$

28. Two infinite, parallel, non-conducting sheets carry equal positive charge density σ. One is placed in the yz plane and the other at distance x = a. Take potential V = 0 at x = 0

(a) For $0 \le x \le a$, potential $V_x = 0$
(b) For $x \ge a$, potential $V_x = -\frac{\sigma}{\epsilon_0}(x-a)$
(c) For $x \ge a$, potential $V_x = \frac{\sigma}{\epsilon_0}(x-a)$
(d) For $x \le 0$ potential $V_x = \frac{\sigma}{\epsilon_0}x$

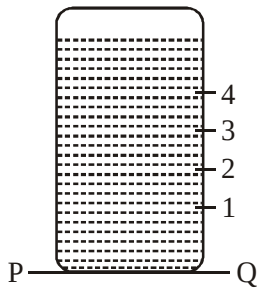
29. In the figure shown R is a fixed conducting ring of negligible resistance and radius 'a'. PQ is a uniform rod of resistance r.



It is hinged at the centre of the ring and rotated about this point in clockwise direction with a uniform angular velocity ω. B is a uniform magnetic field of strength B pointing inwards. 'r' is a stationary resistance.

(a) Current through r is zero
(b) Current through r is $2B\omega a^2/5r$
(c) Direction of current in external r is from centre to circumference
(d) Direction of current in external r is from circumference to centre.

30. A cylindrical vessel of 90 cm height is kept filled upto the brim. It has four holes 1, 2, 3, 4 which are respectively at heights of 20 cm, 30 cm, 40 cm and 50 cm from the horizontal floor PQ.



The water falling at the maximum horizontal distance from the vessel comes from

(a) hole number 4 (b) hole number 3
(c) hole number 2 (d) hole number 1

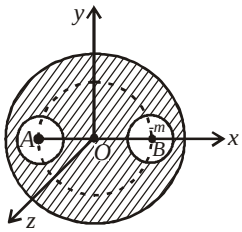
31. In an experiment to determine the acceleration due to gravity g, the formula used for the time period of a periodic motion is $T = 2\pi\sqrt{\frac{7(R-r)}{5g}}$. The values of R and r are measured to be (60 ± 1) mm and (10 ± 1) mm, respectively. In five successive measurements, the time period is found to be 0.52s, 0.56s, 0.57s, 0.54s and 0.59s. The least count of the watch used for the measurement of time period is 0.01s. Which of the following statement(s) is (are) true?

(a) The error in the measurement of r is 10%
(b) The error in the measurement of T is 3.75%
(c) The error in the measurement of T is 2%
(d) The error in the determined value of g is 11%

32. A solid sphere of uniform density and radius 4 units is located with its centre at the origin *O* of coordinates. Two spheres of equal radii 1 unit, with their centres at *A* (–2, 0 ,0) and B (2, 0, 0) respectively, are taken out of the solid leaving behind spherical cavities as shown in fig.

Then :

(a) The gravitational force due to this object at the origin is zero.
(b) the gravitational force at the point B (2, 0 ,0) is zero.



(c) the gravitational potential is the same at all points of circle $y^2 + z^2 = 36$.
(d) the gravitational potential is the same at all points on the circle $y^2 + z^2 = 4$.

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

If an object is placed at a distance u from the pole of a spherical mirror and its image is formed at a distance v (from the pole) then

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}=\frac{2}{R}$$

In this formula to calculate unknown, known quantities are substituted with proper sign.

If a thin object linear size O situated vertically on the axis of a mirror at a distance u from the pole and its image of size I is formed at a distance v (from the pole) magnification (transverse) is defined as the ratio of the size of image to the size of object

$$m = \left[\frac{I}{O}\right] = -\left[\frac{v}{u}\right]$$

- (+ve Erect image)
- (–ve inverted image)
- (|m| >1 large image)
- (|m| < 1 Small image)

Here -ve magnification implies that image is inverted with respect to object while +ve magnification means that image is erect with respect to object.

However, if the 1-D object is placed with its length along the principal axis, the so called longitudinal magnification becomes

$$m_L = \frac{I}{O} = -\frac{(v_2 - v_1)}{(u_2 - u_1)} = -\frac{dv}{du}$$

Relation between Object and Image Velocity :

Differentiating equation $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

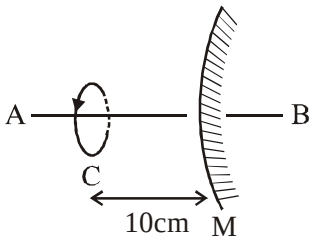
$$\Rightarrow -\frac{1}{v^2}\frac{dv}{dt} - \frac{1}{u^2}\frac{du}{dt} = 0 \Rightarrow -\frac{1}{v^2}V_{IM} - \frac{1}{u^2}V_{OM} = 0$$

$$\Rightarrow V_{IM} = -\frac{v^2}{u^2}V_{OM} \Rightarrow V_{IM} = -m^2 V_{OM}$$

where, V_{IM} = velocity of image w.r.t. mirror and
V_{OM} = velocity of object w.r.t. mirror

33. A particle revolves in clockwise direction (as seen from point A) in a circle C of radius 1 cm and completes one revolution in 2 sec. The axis of the circle and the principal axis of the mirror M coincide. Call it AB.

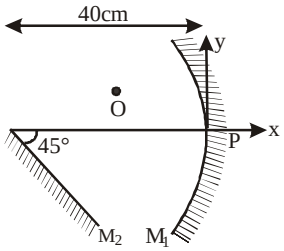
The radius of curvature of the mirror is 20 cm. Then the direction of revolution (as seen from A) of the image of the particle and its speed is –



(a) Clockwise, 3.14 m/s (b) Clockwise, 1.57 cm/s
(c) Anticlockwise, 1.57 m/s (d) Anticlockwise, 3.14 m/s

34. As shown in figure, an object O is at the position (–10, 2) with respect to the origin P. The concave mirror M_1 has radius of curvature 30 cm. A plane mirror M_2 is kept at a distance 40 cm infront of the concave mirror.

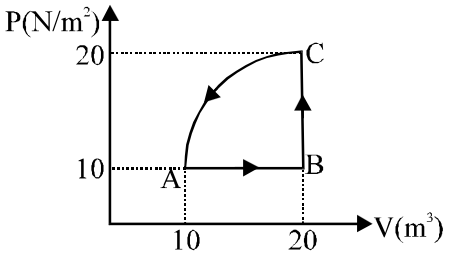
Considering first reflection on the concave mirror M_1 and second on the plane mirror M_2. Find the coordinates of the second image w.r.t. the origin P.



(a) (–46, –70) (b) (–30, –60)
(c) (–20, –50) (d) (–35, –65)

PARAGRAPH - 2

The PV diagram for a cyclic process performed on an ideal monoatomic gas is shown in figure. The curve AC is one fourth of circle .



35. Work done by the gas in process A to B is :
(a) –100 J (b) +100 J
(c) – 200 J (d) + 200 J

36. Heat absorbed by gas in cyclic process is :
(a) –25π J (b) 25π J
(c) 100π J (d) –100π J

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. A gas bulb of 1 litre capacity contains 2.0×10^{21} molecules of nitrogen exerting a pressure of 7.57×10^3 Nm^{-2}. If the ratio of most probable speed to the root mean square speed is 0.84, calculate the most probable speed for these molecules at this temperature.

(a) 425.14 m s^{-1} (b) 405.14 m s^{-1}

(c) 415.14 m s^{-1} (d) 515.14 m s^{-1}

38. What happens when 2-butyne reacts with H_2 in presence of Nickle Boride or lindlar's catalyst (Pd/$CaCO_3$—PbO)-

(a) $CH_3 - C \equiv C - H$ / $CH_3 - C \equiv C - H$

(b) $CH_3 - C \equiv C - H$ / $H - C \equiv C - CH_3$

(c) $CH_3—CH_2—CH_2—CH_3$

(d) $CH_2 = CH$ / $CH = CH_2$

39. The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at a constant volume.

$SO_2Cl_2(g) \rightarrow SO_2(g) + Cl_2(g)$

Experiment	Time/s	Total pressure/atm
1	0	0.5
2	100	0.6

Calculate the rate of the reaction when total pressure is 0.65 atm. [Given : log 5 = 0.699. log 4 = 0.602]

(a) 7.8×10^{-4} s^{-1} atm. (b) 0.8×10^{-4} s^{-1} atm.

(c) 2.4×10^{-2} s^{-1} atm. (d) 6.1×10^{-8} s^{-1} atm.

40. Calculate the overall complex dissociation equilibrium constant for the $[Cu(NH_3)_4]^{2+}$ ion, given that β_4 for this complex is 2.1×10^{13}

(a) 4.7×10^{-14} (b) 1.7×10^{-16}

(c) 0.7×10^{-11} (d) 8.7×10^{-14}

41. An excess of granular zinc was added to 500 mL of 1M nickel nitrate till equilibrium was established. Find out the concentration of nickel at the equilibrium, if the standard electrode potential of Zn^{2+} / Zn and Ni^{2+}/Ni are – 0.75 and – 0.24 V, respectively. [Given : log 1.8 = 0.25]

(a) 5.56×10^{-18} M (b) 0.56×10^{-18} M

(c) 2.16×10^{-18} M (d) 4.12×10^{-18} M

42. When metal X is treated with sodium hydroxide, a white precipitate (A) is obtained, which is soluble in excess of NaOH to give soluble complex (B). Compound (A) is soluble in dilute HCl to form compound (C). The compound (A) when heated strongly gives (D), which is used to extract metal. Identify (X).

(a) Aluminium (b) Gallium

(c) Indium (d) Thallium

43. It has been observed that writing on paper with an invisible ink containing ammonium thiocyanate becomes visible as red colour when the paper is brushed with an aqueous $FeCl_3$. If ammonium thiocyanate is first made alkaline instead of red colour, you get an orange colour which is less clear.

The above observation can be explained best by which of the following combinations

(a) Fe – CNS complex is formed in case of ammonium thiocyanate and $Fe(OH)_3$ is formed in case of alkaline ammonium thiocyanate

(b) Fe – CNS complex is formed in case of ammonium thiocyanate and $Fe(OH)_2$ is formed in case of alkaline ammonium thiocyanate

(c) In both cases same complex is formed but some of it gets dissolved in case of alkaline ammonium thiocyanate

(d) None of the above is correct

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. Given following series of reactions (unbalanced) :

(I) $NH_3 + O_2 \longrightarrow NO + H_2O$

(II) $NO + O_2 \longrightarrow NO_2$

(III) $NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$

(IV) $HNO_2 \longrightarrow HNO_3 + NO + H_2O$

Select the correct option (s) –

(a) Moles of HNO_3 obtained is half of moles of Ammonia used if HNO_2 is not used to produce HNO_3 by reaction (IV)

(b) $\frac{100}{6}\%$ more HNO_3 will be produced if HNO_2 is used to produce HNO_3 by reaction (IV) than if HNO_2 is not used to produce HNO_3 by reaction (IV)

(c) If HNO_2 is used to produce HNO_3 then (1/4)th of total HNO_3 is produced by reaction (IV)

(d) Moles of NO produced in reaction (IV) is 50% of moles of total HNO_3 produced

45. Anhydrous barium nitrate when heated decomposes and oxygen and NO_2 gas is evolved. Similarly magnesium nitrate when heated decomposes to give out NO_2 gas and oxygen. In both cases corresponding oxides are also formed. Select the correct answer(s) :

(a) The lattice energy value is higher for magnesium nitrate than that of barium nitrate

(b) NO_2 will be evolved at a lower temperature in case of $Mg(NO_3)_2$ as compared to that $Ba(NO_3)_2$

(c) NO_2 will be evolved at a lower temperature in case of Ba $(NO_3)_2$ as compared to that of $Mg(NO_3)_2$

(d) In both cases [i.e., heating of $Mg(NO_3)_2$] the ratio of volume of NO_2 and O_2 evolved is 4 : 1

46. The following statement is/are true for Cannizzaro reaction

(a) The aldehyde is oxidised as well as reduced

(b) The aldehydes not containing α-Hydrogen atoms give the reaction

(c) The reaction is not given by aldehydes containing α-Hydrogen atoms.

(d) In crossed Cannizzaro reaction of H_2CO and PhCHO, H_2CO does not oxidized.

47. An aromatic compound 'A' on treatment with aqueous ammonia and heating forms compound 'B' which on heating with Br_2 and KOH forms a compound 'C' of molecular formula C_6H_7N. Then choose the correct options

(a) A is Benzoic acid (b) B is Benzamide

(c) C is aromatic amine (d) C is aniline

48. Choose the correct statements

(a) In Lassaigne's method the appearance of a bluish green or a blue colouration, confirms the presence of nitrogen in the organic compound.

(b) In Beilstein test appearance of green or bluish green colour of the flame indicates the presence of halogens.

(c) If organic compound is fused with sodium peroxide (Na_2O_2) and the mass is extracted with water and extract is boiled with conc. HNO_3 and then ammonium molybedate solution is added. The appearance of yellow precipitate or colouration shows the presence of phosphorus.

(d) In sodium nitroprusside test the appearance of violet colouration indicates nitrogen.

49. Which of the following trends of ionisation energy are correct?

(a) O > N > F (b) F > N > O

(c) Na < Al < Mg (d) P > S > Si

50. Amongst the following, the correct statement(s) is/are:

(a) NO has one unpaired electron in the antibonding molecular orbital

(b) NO^+ is more stable than O_2^+

(c) OF^+ is more paramagnetic than Ne_2^+

(d) A pi bond is concentrated along the bond axis.

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

There are set of 4 quantum numbers :

(i) Principal quantum number is denoted by n. The values of n ranges from 1 to n. It gives information about the size and energy level of major energy shells.
For one electron species, the mathematical expression of energy is $E_n = \frac{-2\pi^2 me^4 z^2}{n^2 h^2}$

(ii) Azimuthal or angular quantum number is denoted by ℓ. Its value ranges from 0 to (n – 1) for s, p, d, f sub-shells respectively. It gives information about shape, energy level of sub-shell and orbital angular momentum of the electron, $\left[\sqrt{\ell(\ell+1)}\frac{h}{2\pi}\right]$.

(iii) Magnetic quantum number is denoted by m. The values of m ranges from $-\ell$ to $+\ell$. It gives information about possible number of orientations of sub-shells.

(iv) Spin quantum number is denoted by s. The values of s are $\frac{1}{2}$ and $-\frac{1}{2}$. It signifies the direction of spin of electrons in an orbital.

51. For an electron in *f* sub-shell, the orbital angular momentum is

(a) $\sqrt{2}\,h/2\pi$ (b) $\sqrt{3}\,h/2\pi$
(c) $\sqrt{12}\,h/2\pi$ (d) $2h/2\pi$

52. The angular momentum ℓ of an electron in a Bohr's orbital is given as

(a) $L = \frac{nh}{2\pi}$ (b) $L = \sqrt{\ell(\ell+1)}\frac{h}{2\pi}$
(c) $L = \sqrt{\ell(\ell+2)}\frac{h}{2\pi}$ (d) $L = \frac{h}{4\pi}$

PARAGRAPH - 2

Alkyl derivatives of aceto acetic ester can undergo two types of hydrolysis, ketonic and acid hydrolysis. The scheme of these hydrolysis reactions are as follows :

Ketonic hydrolysis

$$CH_3COCHRCOOC_2H_5 \xrightarrow[(2)\ H_2SO_4]{(1)\ KOH\ (dil.)} CH_3-\underset{\underset{O}{\|}}{C}-CH_2-R + CO_2 + EtOH$$

Acid hydrolysis

$$CH_3COCHRCOOC_2H_5 \xrightarrow{conc.\ KOH} CH_3COOK + RCHCOOK + EtOH$$

The above names are in agreement to the type of products obtained.

53. What is the final product S in the given reaction

$$CH_3COCH_2COOC_2H_5 \xrightarrow{EtONa\ (1mole)} P \xrightarrow{EtI} Q \xrightarrow[(2)\ H_3PO_4]{(1)\ KOH} S$$

(a) CH_3COOH
(b) $CH_3-\underset{\underset{O}{\|}}{C}-CH_2-CH_2-CH_3$
(c) $CH_3-\underset{\underset{O}{\|}}{C}-\underset{\underset{CH_3}{|}}{CH}-CH_3$
(d) $CH_3-\underset{\underset{O}{\|}}{C}-Et$

54. Which reaction sequence can prepare succinic acid as final product

(a) $CH_3COCH_2COOEt \xrightarrow{EtONa\ (1eq)} \xrightarrow{Cl-CH_2COOEt} \xrightarrow[H^{\oplus}]{KOH}$
(b) $CH_3COCH_2COOEt \xrightarrow{EtONa\ (1eq)} \xrightarrow{Cl-CH_2COOH} \xrightarrow[H^{\oplus}]{KOH}$
(c) $CH_3COCH_2COOEt \xrightarrow{EtONa\ (1eq)} \xrightarrow{Cl-CH_2COOMe} \xrightarrow{Conc.\ KOH}$
(d) $CH_3COCH_2COOEt \xrightarrow{EtONa\ (1eq)} CH_3-\underset{\underset{O}{\|}}{C}-Cl \xrightarrow{Conc.\ KOH}$

RESPONSE SHEET

MOCK TEST - 2

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 - 2

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 - 2

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

EXPLANATORY NOTES

PAPER - 1

1. (b, c, d)

$$I = \int_2^4 \left[\frac{ln2}{ln\,x} - \frac{(ln\,2)^2}{(ln\,2)(ln\,x)^2}\right] dx$$

$$= (ln\ 2)\int_2^4 \left[\frac{1}{ln\,x} - \frac{1}{(ln\,x)^2}\right] dx$$

Put $ln\ x = t \Rightarrow x = e^t \Rightarrow dx = e^t dt$ for $x = 2,\ t = ln\ 2$

$x = 4,\ t = ln\ 4 = 2\,ln\,2$

$$= (ln\ 2)\int_{ln2}^{2ln2} \left[\frac{1}{t} - \frac{1}{t^2}\right] e^t dt = (ln\,2)\left[\frac{e^t}{t}\right]_{n2}^{2ln2}$$

$$= (ln\ 2)\left[\frac{4}{2\ ln\,2} - \frac{2}{ln\,2}\right] = 0.$$

2. (a, b)

$a_2 = a_1 r,\ a_3 = a_1 r^2, \ldots\ldots\ldots\ldots, a_n = a_1\, r^{n-1}.$

Given expression $= \frac{a_1}{r}[C_1 r + C_2 r^2 + \ldots\ldots + C_n r^n]$

$$= \frac{a_1}{r}[(1+r)^n - 1] = a_1\left(\frac{(1+r)^n - 1}{(1+r) - 1}\right)$$

$= a_1\,[1 + (1 + r) + (1 + r)^2 + \ldots\ldots\ldots + (1 + r)^{n-1}]$

3. (a, b, c, d)

Assume a = b, we have nothing to prove.

(a) for a > b

$$\sqrt{a} - \sqrt{b} = \frac{a-b}{\sqrt{a} + \sqrt{b}} \le \frac{a-b}{\sqrt{a}} < \frac{a-b}{\sqrt{a-b}}$$

Hence option (a) is correct

(b) The given inequality is equivalent to

$a^3 + b^3 \ge ab(a + b)$

For a < b or a > b

$\Rightarrow a^2 + b^2 - ab \ge ab$

$\Rightarrow (a - b)^2 \ge 0$ for all $a > 0, b > 0$

Hence option (b) is also correct.

(c) The given inequality is equivalent to

$a^{3/2} + b^{3/2} \ge \sqrt{ab}(\sqrt{a} + \sqrt{b})$

For a < b or a > b

$\Rightarrow (a^{1/2})^2 + (b^{1/2})^2 - a^{1/2}b^{1/2} \geq \sqrt{ab}$

$\Rightarrow \left(\sqrt{a} - \sqrt{b}\right)^2 \geq 0$

Hence option (c) is also correct.

(d) Given expression is equivalent to

$$\frac{2a^2}{1+a^4} + \frac{2b^2}{1+b^4} \leq 2$$

$$\Rightarrow \frac{2a^2}{1+a^4} - 1 + \frac{2b^2}{1+b^4} - 1 \leq 0$$

$$\Rightarrow \frac{\left(1-a^2\right)^2}{1+a^4} + \frac{\left(1-b^2\right)^2}{1+b^4} \geq 0$$

As $\left(1-a^2\right)^2 \geq 0$ for all $a > 0$

So $\dfrac{(1-a^2)^2}{1+a^4} \geq 0$ for all $a > 0$

Similarly $\dfrac{(1-b^2)^2}{1+b^4} \geq 0$ for all $b > 0$

Hence option (d) is also correct.

4. (a, d)

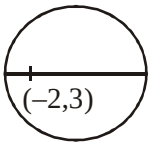
$x^2 + y^2 + 8x - 10y - 40 = 0$

centre of the circle is $(-4, 5)$

its radius $= 9$

Distance of the centre $(-4, 5)$

from the point $(-2, 3)$ is $\sqrt{4+4} = 2\sqrt{2}$



$\therefore \quad a = 2\sqrt{2} + 9$ and $b = -2\sqrt{2} + 9$

$\therefore \quad a + b = 18,\ a - b = 4\sqrt{2}\ ,\ a.b = 81 - 8 = 73$

5. (a, b, c)

(a) $\lim\limits_{x\to 0} \dfrac{(\sin nx)\,[(a-n)nx - \tan x]}{x^2} = 0$

$$\Rightarrow \lim_{x\to 0} \frac{\left(nx - \frac{n^3x^3}{3!} + \ldots\right)\left[n(a-n)x - \left\{x + \frac{x^3}{3} + \ldots\right\}\right]}{x^2} = 0$$

$\Rightarrow n^2(a-n) - n = 0 \Rightarrow an - n^2 - 1 = 0$

$\Rightarrow a = \dfrac{n^2+1}{n} = n + \dfrac{1}{n}$

(b) $\lim\limits_{x\to 1^-} f(x) = \lim\limits_{h\to 0} [2(1-h) + 1] = 3$

$\lim\limits_{x\to 1^+} f(x) = \lim\limits_{h\to 0} [(1+h)^2 + 2] = 3$

$\therefore$ LHL = RHL, so $\lim\limits_{x\to 1} f(x) = 3$

(c) $e^2 = \lim\limits_{x\to\infty} \left(1 + \dfrac{a}{x} + \dfrac{b}{x^2}\right)^{2x}$ [1^∞ form]

$= e^{\lim\limits_{x\to\infty} 2x\left[1+\frac{a}{x}+\frac{b}{x^2}-1\right]} = e^{\lim\limits_{x\to\infty} 2\left(a+\frac{b}{x}\right)} = e^{2a}$

$\therefore a = 1$ and $b \in R$

6. (b, d) Let $A = \begin{bmatrix} -1 & 2 & 5 \\ 2 & -4 & a-4 \\ 1 & -2 & a+1 \end{bmatrix} \sim \begin{bmatrix} -1 & 2 & 5 \\ 0 & 0 & a+6 \\ 0 & 0 & a+6 \end{bmatrix}$

$(R_2 \to R_2 + 2R_1,\ R_3 \to R_3 + R_1)$

Clearly rank of A is 1, if $a = -6$

Also, for $a = 1$, $|A| = \begin{vmatrix} -1 & 2 & 5 \\ 2 & -4 & -3 \\ 1 & -2 & 2 \end{vmatrix} = 0$

and $\begin{vmatrix} 2 & 5 \\ -4 & -3 \end{vmatrix} = -6 + 20 = 14 \neq 0$

$\therefore$ Rank of A is 2, if $a = 1$.

7. (a,b,c,d) $1 + x$ is never zero, so $1 + f(x)$ is never zero. It is 1 for $x = 0$, so it is always positive.

Hence $f''(x)$ is always positive. $f'(0) = 0$, so $f'(0) > 0$ for all $x > 0$ and hence f is strictly increasing.

So, in particular, $1 + f(x) \geq 2$ for all x.

We have $f''(x) \leq \dfrac{(1+x)}{2}$.

Integrating, $f'(x) \leq f'(0) + \dfrac{x}{2} + \dfrac{x^2}{4} = \dfrac{x}{2} + \dfrac{x^2}{4}$.

Integrating , again, $f(x) \le f(0) + \frac{x^2}{4} + \frac{x^3}{12}$. Hence

$$f(1) \le 1 + \frac{1}{4} + \frac{1}{12} = \frac{4}{3}.$$

8. Ans : 1

$$f(x) = \lim_{n\to\infty} 2^{-(n+1)} \sum_{r=1}^{n} 2^{-r} \operatorname{cosec}\left(\frac{x}{2^r}\right) \cot\left(\frac{x}{2^r}\right)$$

Consider

$$\sum_{r=1}^{n} 2^{-r} \frac{\cos\left(\frac{x}{2^r}\right)}{\sin^2\left(\frac{x}{2^r}\right)} = \sum_{r=1}^{n} 2^{-r} \left(\frac{2\cos^2\left(\frac{x}{2^{(r+1)}}\right) - 1}{4\sin^2\left(\frac{x}{2^{(r+1)}}\right)\cos^2\left(\frac{x}{2^{(r+1)}}\right)} \right)$$

$$\sum_{r=1}^{n} \left(2^{-(r+1)} \operatorname{cosec}^2\left(\frac{x}{2^{n+1}}\right) - 2^{-r} \operatorname{cosec}^2\left(\frac{x}{2^2}\right) \right)$$

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

$$\Rightarrow f(x) = \lim_{x\to\infty} \left(\frac{\left(\frac{x}{2^{(n+1)}}\right)}{\sin\left(\frac{x}{2^{(n+1)}}\right)} \right)^2 \cdot \frac{1}{x^2} - \lim_{n\to\infty} \frac{\frac{1}{2}\operatorname{cosec}^2\left(\frac{x}{2}\right)}{(2^{(n+2)})}$$

$$\therefore \lim_{x\to 0} x^2 f(x) = 1$$

9. Ans : 7

Without loss of generality we can assume that $a, b \ge 0$. Now

If $c, d \ge 0$ then $p(1) = a + b + c + d \le 1$

$\Rightarrow |a| + |b| + |c| + |d| \le 1$

If $c \ge 0, d < 0$ then $|a| + |b| + |c| + |d|$

$= a + b + c - d = (a + b + c + d) - 2d$

$= p(1) - 2p(0) \le 1 + 2 = 3$

If $c < 0, d \ge 0$ then $|a| + |b| + |c| + |d| = a + b - c + d$

$$= \frac{4}{3}p(1) - \frac{1}{3}p(-1) - \frac{8}{3}p\left(\frac{1}{2}\right) + \frac{8}{3}p\left(-\frac{1}{2}\right) \le \frac{4}{3} + \frac{1}{3} + \frac{8}{3} + \frac{8}{3} = 7$$

Finally : $d < 0, c < 0$ then

$|a| + |b| + |c| + |d| = a + b - c - d$

$$= \frac{5}{3}p(1) - 4p\left(\frac{1}{2}\right) + \frac{4}{3}p\left(-\frac{1}{2}\right) \le \frac{5}{3} + 4 + \frac{4}{3} = 7$$

$\therefore |a| + |b| + |c| + |d| \le 7$

10. Ans : 3

The sum of the three positive numbers α, β, γ is equal to $\frac{\pi}{2}$ i.e., $\alpha + \beta + \gamma = \frac{\pi}{2}$ ...(1)

cot α, cot β, cot γ form an A. P.

2 cot β = cot α + cot γ ... (2)

From (1),

$$\cot(\alpha + \gamma) = \frac{1}{\cot\beta} \Rightarrow \frac{\cot\beta\cot\alpha\cot\gamma - \cot\beta}{\cot\alpha + \cot\gamma} = 1$$

i.e. cot β cot α cot γ = cot β + 2 cot β, using (2)

⇒cot α cot γ = 3.

11. Ans : 4

Solving $y = x - x^2$ with $y = mx$, we get $x = 0$ or $1 - m$

$$\therefore \pm\frac{9}{2} = \int_0^{1-m} \left(x - x^2 - xm\right) dx = \left[\frac{x^2}{2} - \frac{x^3}{3} - \frac{mx^2}{2}\right]_0^{1-m}$$

$$= \frac{(1-m)^2}{2} - \frac{(1-m)^3}{3} - \frac{m(1-m)^2}{2}$$

$$\therefore \pm\frac{9}{2} = \frac{(1-m)^3}{6}$$

$\Rightarrow 1 - m = \pm 3 \Rightarrow m = -2$ or 4

Hence positive value of m = 4.

12. Ans : 7

Consider the function ,

$$f(x) = \frac{x^2}{x^3 + 200} \text{ on } [1, \infty)$$

$$f'(x) = \frac{x\left(400 - x^3\right)}{\left(x^3 + 200\right)^2}$$

$f'(x) > 0$ for $0 < x < \sqrt[3]{400}$

$f'(x) < 0$ for $x > \sqrt[3]{400}$

$f(x)$ increases in $0 < x < \sqrt[3]{400}$ and $f(x)$ decreases in neighbourhood of $x > \sqrt[3]{400}$

Now $7 < \sqrt[3]{400} < 8$, which follows that the largest term for $f(x)$ can be either $f(7)$ or $f(8)$

$$f(7) = \frac{49}{543} > f(8) = \frac{8}{89}$$

$f(7)$ is the greatest.

13. (d) Since, $\frac{x+3}{-4} = \frac{y-6}{3} = \frac{z}{2}$

and $\frac{x+2}{-4} = \frac{y}{1} = \frac{z-7}{1}$

Let l, m, n be the direction cosines of the line MN which is perpendicular to each of the given lines.

$\therefore \quad -4l + 3m + 2n = 0$ and $-4l + m + n = 0$

Solving, $\frac{l}{3-2} = \frac{m}{-8+4} = \frac{n}{-4+12}$

$$\Rightarrow \quad \frac{l}{1} = \frac{m}{-4} = \frac{n}{8} = \frac{\sqrt{l^2+m^2+n^2}}{\sqrt{1+16+64}} = \frac{1}{9}$$

$$\Rightarrow \quad l = \frac{1}{9}, m = \frac{-4}{9}, n = \frac{8}{9}$$

It is obvious that the points P (– 3, 6, 0) and Q (– 2, 0, 7) are situated on the given lines.

$\therefore$ Length of shortest distance = Projection of PQ on the common perpendicular MN

$$= \frac{1}{9}[(-2) - (-3)] + \left(-\frac{4}{9}\right)[0-6] + \frac{8}{9}[7-0] = 9$$

14. (b) Since, $\frac{3y-1}{3} = \frac{4z-1}{6} = \frac{2x-1}{1}$ and

$\frac{x-\frac{1}{2}}{1} = \frac{y-\frac{1}{3}}{2} = \frac{z-\frac{1}{4}}{3}$ are equations of same straight line. So, shortest distance will be zero.

15. (d) Since, $\frac{x-3}{1} = \frac{y-5}{-2} = \frac{z-7}{1}$ ... (1)

and $\frac{x+1}{7} = \frac{y+1}{-6} = \frac{z+1}{-1}$ ... (2)

Point A (3, 5, 7) is a point on line (1) and B (– 1, – 1, – 1) is a point on line (2). Also direction ratios of line (1) are 1, – 2, 1 and those of line (2) are 7, – 6, – 1.

We use the cartesian formula for the shortest distance.

S.D.

$$= \frac{\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ l_1 & m_1 & n_1 \\ l_2 & m_2 & n_2 \end{vmatrix}}{\sqrt{(m_1n_2 - m_2n_1)^2 + (n_1l_2 - n_2l_1)^2 + (l_1m_2 - l_2m_1)^2}}$$

Here, $(x_1, y_1, z_1) = (3, 5, 7)$

$(x_2, y_2, z_2) = (-1, -1, -1)$

$l_1 : m_1 : n_1 = 1 : -2 : 1$

$l_2 : m_2 : n_2 = 7 : -6 : -1$

$$\therefore \quad \sqrt{(m_1n_2 - m_2n_1)^2 + (n_1l_2 - n_2l_1)^2 + (l_1m_2 - l_2m_1)^2}$$

$$= \sqrt{(2+6)^2 + (7+1)^2 + (-6+14)^2} = 8\sqrt{3}$$

Also, $\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ l_1 & m_1 & n_1 \\ l_2 & m_2 & n_2 \end{vmatrix}$

$$= \begin{vmatrix} -1-3 & -1-5 & -1-7 \\ 1 & -2 & 1 \\ 7 & -6 & -1 \end{vmatrix}$$

$$= \begin{vmatrix} -4 & -6 & -8 \\ 1 & -2 & 1 \\ 7 & -6 & -1 \end{vmatrix} = 144$$

Hence, the shortest distance = $\frac{144}{8\sqrt{3}} = \frac{18}{\sqrt{3}} = 6\sqrt{3}$

16. **(c)** Since, $f(x) = \sin x$ and $g(x) = \cos^{-1} x$

Here, range of $g(x)$ is $[0, \pi]$ where $\sin x$ is non-monotonic but continuous.

If we divide $[0, \pi]$ into two subintervals $\left[0, \frac{\pi}{2}\right]$ and $\left[\frac{\pi}{2}, \pi\right]$.

In the interval $\left[0, \frac{\pi}{2}\right]$.

$\sin x$ increases and belongs to $[0, 1]$ whereas in the interval $\left[\frac{\pi}{2}, \pi\right]$. $\sin x$ decreases from 1 to 0 and so, $\sin x$ belongs to $[0, 1]$.

Hence, the range of fog is $[0, 1]$.

17. **(c)** Since $f(x) = \cot^{-1} x$, $g(x) = \ln x$

Domain of $f(x)$ is $(-\infty, \infty)$ and its range is $(0, \pi)$ whereas domain of $g(x)$ is $(0, \infty)$ and its range is R

Range of $f(x)$ should be in domain of $g(x)$ for $gof(x)$ to be defined.

Therefore, $(0, \pi)$ should be in domain of $g(x)$ and so $(0, \infty)$

Hence, domain of $gof(x)$ is R.

18. **(a)** Here $f(x) = 1 + x$, $g(x) = (\ln x)^2$

Since, domain of $f(x)$ = R,

range of $f(x)$ = R

Domain of $g(x) = (0, \infty)$: range of $g(x) = [0, \infty)$

Domain of $fog(x) = \{x \in (0, \infty) : g(x) \in R\}$

$= \{x \in (0, \infty) : (\ln x)^2 \in R\}$

$= (0, \infty)$

19. **(a, b, d)**

Given, D = 96, $\frac{I_2}{I_1} = 4.84$

Let $I_2 = 4.84\,a$ & $I_1 = a$; $O = \sqrt{I_1 I_2} = 2.2\,a$

(a) Required ratio $= \frac{2.2\,a}{a} = \frac{11}{5}$

(b) $\frac{v}{u} = \frac{11}{5}$ ..... (1)

$v + u = 96$ ..... (2)

$\therefore\ v + \frac{5v}{11} = 96 \Rightarrow \frac{16v}{11} = 96 \Rightarrow v = 66\ \&\ u = 30$

Distance between two position = v – u = 66 – 30

= 36 cm

(c) $\frac{1}{f} = \frac{1}{66} + \frac{1}{30} = \frac{30 + 66}{30 \times 66}$

$\Rightarrow\ f = \frac{30 \times 66}{96} = \frac{330}{16} = 20.625$ cm

(d) u = 30 cm

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

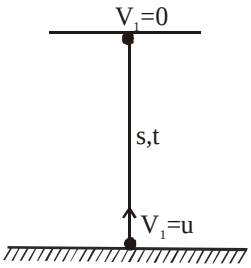
(a) Total displacement is zero hence its average velocity is zero.

(b) Total distance travelled is

2s and total time taken is 2t.

$0^2 = u^2 - 2gs$

$\therefore\ s = \frac{u^2}{2g} \Rightarrow 2s = \frac{u^2}{g}$



Also, $0 = u - gt \Rightarrow t = u/g$

$\therefore\ 2t = \frac{2u}{g}$ $\quad <\text{speed}> = \frac{u^2/g}{2u/g} = \frac{u}{2}$

(c) Displacement is zero

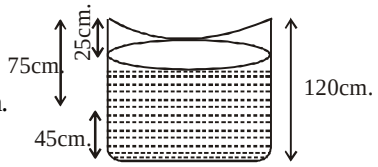
21. **(a, b, c)**

As $V = \nu\lambda$

$\lambda = \frac{V}{\nu} = \frac{340}{340} = 1$m

first resonance light

$R_1 = \frac{\lambda}{4} = \frac{1}{4}$m = 25 cm.



$\therefore R_2 = \frac{3\lambda}{4} = \frac{3}{4}$m = 75 cm.

$\therefore\ R_3 = \frac{5\lambda}{4} = \frac{5}{4}$m = 125 cm.

i.e., third resonance does not establish.

Now H_2O is poured, $\therefore$ Minimum length of H_2O column to have the resonance = 120 – 75 = 45 cm.

$\therefore$ Distance between two successive nodes

$$= \frac{\lambda}{2} = \frac{1}{2}\text{m} = 50\text{cm}$$

and maximum length of H_2O column to create resonance i.e., 120 – 25 = 95 cm.

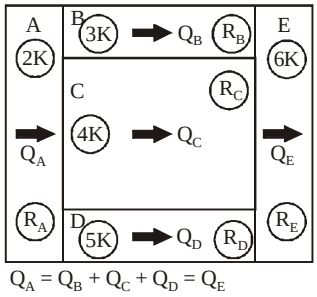
22. (a, b, c, d)

When S is closed resistance parallel to S become ineffective (no current, no power) hence equivalent resistance of the circuit decreases, ammeter and voltmeter reading increases.

23. (a, c, d)

It is given that heat Q flows only from left to right through the blocks. Therefore heat flow through A and E slabs are the same.

∴ [a] is correct option



Since heat flow through slabs A and E is same,

[b] is not correct.

We know that resistance to heat flow is $R = \frac{\ell}{KA}$

Let the width of slabs be Z. Then

$$R_A = \frac{L}{2K(4L)Z} = \frac{1}{8KZ},\ R_B = \frac{4L}{3K(LZ)} = \frac{4}{3KZ}$$

$$R_C = \frac{4L}{4K(2LZ)} = \frac{1}{2KZ},\ R_D = \frac{4L}{5K(LZ)} = \frac{4}{5KZ}$$

$$R_E = \frac{L}{6K(4LZ)} = \frac{1}{24KZ}$$

Now, $\Delta T = QR$

As R_E is least, ΔT_E is also smallest ie since the resistance to heat flow is least for slab *E*, the temperature difference across is smallest.

∴ Option (c) is the correct answer.

Also

$$Q_C = \frac{\Delta T_C}{R_C} = \frac{\Delta T_C}{1/2\,KZ} = 2KZ(\Delta T_C)$$

$$Q_B = \frac{\Delta T_B}{R_B} = \frac{\Delta T_C}{4/3KZ} = \frac{3KZ(\Delta T_C)}{4} \qquad [\because\ \Delta T_B = \Delta T_C]$$

$$Q_D = \frac{\Delta T_D}{R_D} = \frac{\Delta T_C}{4/5KZ} = \frac{5KZ(\Delta T_c)}{4} \qquad [\because \Delta T_D = \Delta T_C\ ]$$

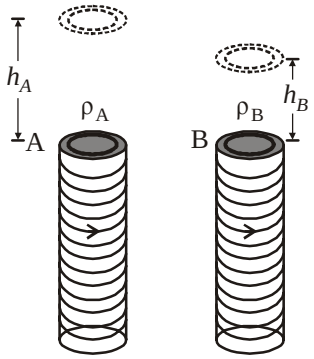
$$Q_B + Q_D = \frac{3KZ(\Delta T_C)}{4} + \frac{5KZ(\Delta T_C)}{4}$$

$$= \frac{8KZ(\Delta T_C)}{4} = 2KZ(\Delta T_C) = Q_C$$

∴ (d) is the correct option.

24. (b, d)

When current *I* is switched on in both the solenoids in identical manner, eddy currents are setup in metallic rings *A* and *B* in such a way that rings *A* and *B* are repelled.



Given $h_A > h_B$. This shows that eddy currents produced in A are greater than in *B*. This is possible when $\rho_A < \rho_B$ (the rate of change of flux is same in both the rings, therefore induced emf is same).

25. (a, b, d)

Let V be the volume of spheres.

For equilibrium of A :

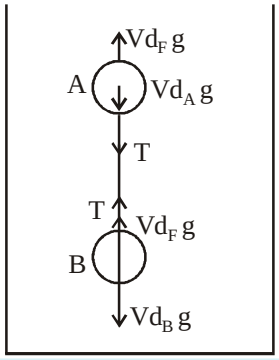
$$T + Vd_Ag = Vd_fg$$

$$\therefore \quad T = V_g(d_f - d_A) \qquad ...(1)$$

For $T > 0$, $d_f > d_A$ or $d_A < d_f$

(a) is the correct option

For equilibrium of B :



$T + Vd_fg = Vd_Bg$

$\therefore\ T = Vg(d_B - d_f)$ ...(2)

For $T > 0$, $d_B > d_f$

(b) is the correct option

From (1) & (2) $Vg(d_f - d_A) = Vg(d_B - d_f)$

$\therefore\quad d_f - d_A = d_B - d_f$

$\therefore\ 2d_f = d_A + d_B$

(d) is the correct option.

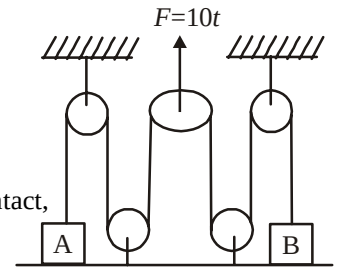
26. 5

$10\,t = 2T \Rightarrow T = 5t$

Block A will lose contact when

$T = m_Ag;\ \ 5t = m_Ag$

$\Rightarrow t_1 = \frac{m}{5}\text{sec} = 2\text{sec}$



While block B will lose contact, then

$T' = m_Bg \ \Rightarrow 5t = 2m_Bg$

or $\quad t_2 = \frac{2g}{5}$ sec = 4 sec

At $t_1 \le t$ for block A

$T - mg = ma$

$$5t - mg = \frac{mdv}{dt} \ \Rightarrow m\int_0^v dv = \int_{t_1}^{t_2}(5t - mg)dt$$

$v = 10$ m/s $= (2 \times 5)$ m/s $\qquad \therefore\ \ \boldsymbol{x = 5}$

27. 2

The force constant k of the spring is given by

$$k = \frac{F}{y} = \frac{0.5\text{ kg }Wt}{0.20\,m} = \frac{0.5 \times 10\text{ Newton}}{0.20\ m} = 25\text{ Newton/metre}$$

$$Now\ T = 2\pi\sqrt{\left(\frac{m}{k}\right)} = 2 \times \pi\sqrt{\left(\frac{0.25}{25}\right)} = \left(2 \times \frac{22}{7} \times \frac{1}{10}\right)\text{sec}$$

$$= 2 \times \frac{11}{35}\text{sec} \qquad \therefore\ \ \boldsymbol{x = 2}$$

28. 4

This is a problem of L-C oscillations.

Here Q_0 = maximum value of

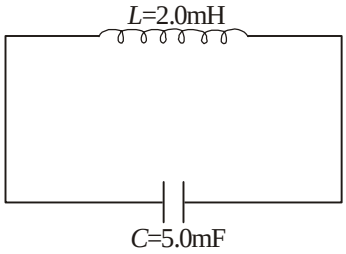
$Q = 200\ \mu\text{C} = 2 \times 10^{-4}\text{ C}$

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(2 \times 10^{-3}H)(5.0 \times 10^{-6}F)}} = 10^{+4}\text{s}^{-1}$$

Let at $t = 0$, $Q = Q_0$ then

$Q(t) = Q_0 \cos \omega t$ ...(1)

$$I(t) = \frac{dQ}{dt} = -Q_0\omega \sin \omega t \qquad \ldots(2)$$



$$\frac{dI(t)}{dt} = -Q_0\omega^2 \cos(\omega t) \qquad \ldots(3)$$

For $Q = 100\ \mu\text{C}\left(or\ \frac{Q_0}{2}\right)$

From (1), $100 = 200 \cos \omega t$

or $\cos(\omega t) = \frac{1}{2}$,

From eqution (3) :

$$\left|\frac{dI}{dt}\right| = (2.0 \times 10^{-4}C)(10^{+4}\text{s}^{-1})^2\left(\frac{1}{2}\right)$$

$$\left|\frac{dI}{dt}\right| = 10^4\text{ A/s} \qquad \therefore\ \ \boldsymbol{y = 4}$$

29. 4

Here, $r_1 = 10$ cm, $r_2 = 15$cm

$V_1 = 150$ V, $V_2 = 100$ V

Common potential

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2} = \frac{4\pi\epsilon_0(r_1V_1 + r_2V_2)}{4\pi\epsilon_0(r_1 + r_2)} = 120\text{ volt.}$$

$$q_1 = C_1V = 4\pi \in_0 r_1 V = \frac{10^{-1}}{9\times10^9}\times 12\,C$$

$$= \frac{12}{9\times10^9}\times 3\times10^9 \text{ esu} = \mathbf{4\,esu}$$

30. **5**

Let v be the actual frequency of the whistle. By Doppler's effect

$$v' = v\,\frac{v_S}{v_S - v_t}$$

where v_s = speed of sound = 300 m/s (given)

v' = 2.2 k Hz = 220 Hz (given)

$$\therefore \quad 2200 = v\,\frac{300}{300 - v_t} \qquad \text{...(i)}$$

While the train is receding

$$v'' = v\,\frac{v_s}{v_s + v_t}$$

Here, v' = 1.8 kHz = 1800 Hz (given)

$$\therefore\ 1800 = v\,\frac{300}{300 + v_t} \qquad \text{...(ii)}$$

Dividing (i) and (ii)

$$\frac{2200}{1800} = \frac{300}{300 - v_t}\times\frac{300 + v_t}{300}$$

$$\Rightarrow \quad \frac{11}{9} = \frac{300 + v_t}{300 - v_t}$$

$$\Rightarrow\ 3300 - 11v_t = 2700 = 9v_t$$

$$\Rightarrow\ 600 = 20\,v_t$$

$$\Rightarrow\ v_t = 30 \text{ m/s} = (6\times5) \text{ m/s} \qquad \therefore\ \mathbf{B = 5}$$

31. **(a)** Current developed due to motion of an electron in n^{th} Bohr's orbit = $I_0\frac{Z^2}{n^3}$ (unit ampere) here in column III

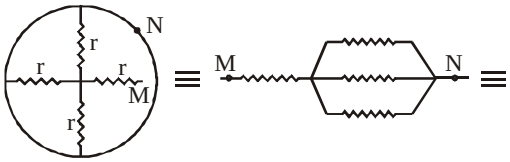
option (r) $C_0\frac{Z^2}{n^3}$, for z = 3 and n = 3 $I = C_0\times\frac{3^2}{3^3} = \frac{C_0}{3}$

32. **(b)** $\omega_n = \omega_0\frac{z^2}{n^3}\sec^{-1}$, $I_n = I_0\frac{Z^2}{n^3}$ A,

$$V_n = V_0\frac{Z}{n} \text{ m/s}, \quad E_n = E_0\frac{Z^2}{n^2} \text{ J}$$

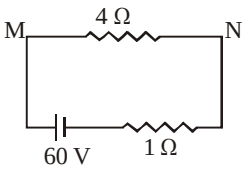
33. **(d)** Ionization energy, $E_n = E_0\frac{Z^2}{n^2}$

34. **(b)**



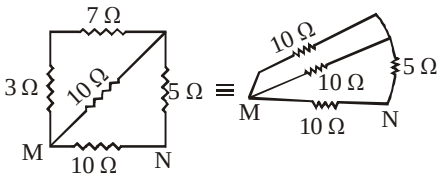
$$r + \frac{r}{3} = \frac{4r}{3} = \frac{4\times3}{3} = 4\Omega$$

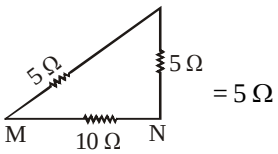
Now if battery of emf 60 V and resistance 1 Ω is connected



$$I = \frac{60}{4+1} = 12 \text{ A}$$

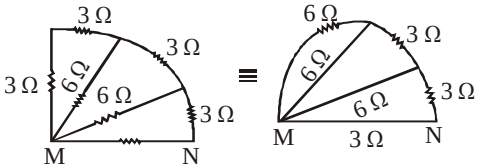
35. **(d)**

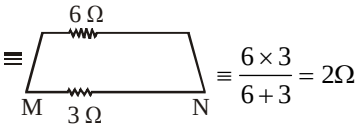




$= 5\ \Omega$

So current $I = \frac{60}{5+1} = 10\text{A}$

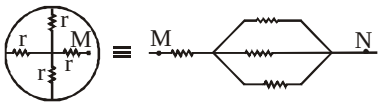




$$\equiv \frac{6\times3}{6+3} = 2\Omega$$

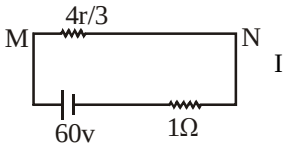
So current $I = \frac{60}{2+1} = 20\text{A}$

36. (d)

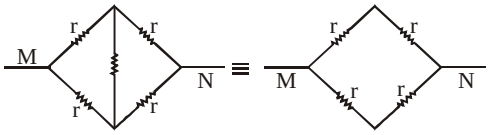


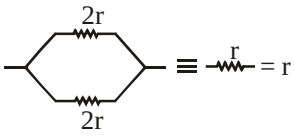
$$\equiv r + \frac{r}{3} = \frac{4r}{3}$$

Now if battery of emf 60v and resistance 1Ω is connected across M and N. Then



$$I = \frac{60}{\frac{4r}{3}+1} = \frac{180}{4r+3}$$





Now if battery is connected then $I = \frac{60}{r+1}$

37. (b, c, d)

$$2Na_3PO_4(aq) + 3Ba(NO_3)_{2(aq)} \rightarrow Ba_3(PO_4)_2(s) + 6NaNO_3(aq)$$

Na_3PO_4 is the limiting reactant and is completely consumed.

Mol. of $Ba_3(PO_4)_2$ formed $= \frac{0.2}{2} = 0.1$.

Mol. of $Ba(NO_3)_2$ reacted $= \frac{3}{2} \times 0.2 = 0.3$

Mol. of unreacted $Ba(NO_3)_2$ $= 0.5 - 0.3 = 0.2$

$=$ mol of Ba^{2+} ion.

Mol. of Na^+ in solution $= 0.2 \times 3 = 0.6$

Mol. of NO_3^- in solution $= 0.5 \times 2 = 1$

38. (a, c) The stability of a carbocation increases as the number of alkyl substituents bonded to the positively charged carbon increases hence the correct order of the stability of carbocations is 3° > 2° > 1°. Further ethyl carbocation is more stable then methyl carbocation. Due to + I effect stability of free radicals depends upon the presence of electron donating group. More the number of electron donating group attached to free radicals more is the stability i.e. 3° > 2° > 1°.

39. (c, d)

Volume of *A*,

$$V_A = \frac{1 \times R \times 200}{1} = 200R \quad [\because PV = nRT]$$

$$= 200 \times 0.082 = 16.4\ \text{L}$$

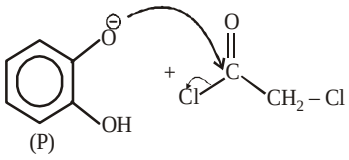
gives work in isothermal and reversible expansion of an ideal gas

$$V_B = \frac{0.082 \times 800}{2} = 32.8\text{L}$$

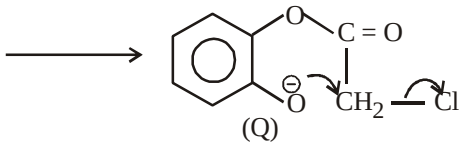
$$V_C = \frac{6.082 \times 400}{1} = 32.8\text{L}$$

Since $V_B > V_A$, expansion of gas occurs along *A* and *B* and work is done by the gas.

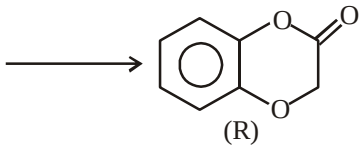
40. (a,c,d)



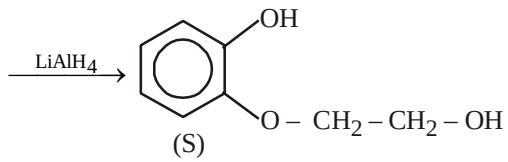
(P)



(Q)



(R)



(S)

41. (a, b, c)

(a) $B_2O_3 + P_2O_5 \rightarrow 2BPO_4$

(b) $H_3BO_3 \rightleftharpoons H^+ + H_2BO_3^-$

$H_2BO_3^- \rightleftharpoons H_2O + BO_2^-$

(c) In borates, each B atom is bonded to three oxygen atoms, arranged at the corners of an equilateral triangle

(sp^2-hybridisation)

42. **(a, c)** $[Cu(CN)_4]^{3-}$: $3d^{10}$ $4s$ $4p$ dsp^2 hybridization

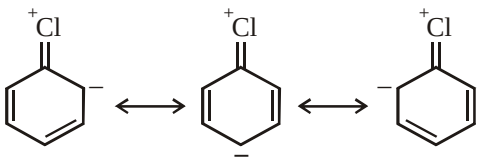
$[Ni(CN)_6]^{2-}$: sp^3d^2 hybridization

$[Zn\,Br_4]^{2-}$: sp^3 hybridization

$[Cr(NH_3)_6]^{3+}$: d^2sp^3 hybridization (always)

43. **(b, d)** Aryl halides are stable due to resonance stabilization.

The resonating structures



stabilise the aryl halide. These structures include a double bond between C and Cl which is shorter and thus stronger than the usual C – Cl single bond. The sp^2 hybridised carbon, being electronegative, makes the C – Cl bond shorter and stronger.

44. **Ans : 2**

Total V.P., $P = P_A^o X_A + P_B^o X_B = P_A^o X_A + P_B^o(1 - X_A)$

$= (P_A^o - P_B^o)X_A + P_B^o$

Thus, $P_B^o = 114$ torr ; $P_A^o - P_B^o = 52$

or $P_A^o = 166$ torr

Hence $P = 166 \times \frac{1}{2} + 114 \times \frac{1}{2} = 140$ torr

Given $140 = 7x + 126$

$7x = 14$

$x = \mathbf{2}$

45. **Ans : 7**

Density of the crystal d (g cm^{-3}) $= \frac{ZM}{N_A \times a^3}$

$$Z = \frac{d \times N_A \times a^3}{M} = \frac{2 \times 6 \times 10^{23} \times \left(5 \times 10^{-8}\right)^3}{75} = 2$$

Thus, the unit cell of cubic lattice will be body centred.

For *bcc* lattice, $4r$ (radius of atom) = Diagonal of cube

$= \sqrt{3}a$

$$r = \frac{\sqrt{3}}{4} \times a \times 10^2 = \frac{1.732 \times 5 \times 10^2}{4} = 216.5 = \mathbf{217\ pm}$$

($1\text{Å} = 10^{-8}$ cm $= 10^2$ pm)

Given 217 pm $= 30x + 7$

$30x = 210$

$\boldsymbol{x = 7}$

46. **Ans : 6**

$NaCl_{(aq)}$ (cathode) : $2H_2O + 2e^- \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$

$CuSO_{4(aq)}$ (cathode) : $Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$

Equivalents of OH^- = mole of OH^- formed $= \frac{600 \times 1}{1000} = 0.6$

Equivalents of Cu deposited $= \frac{31.8}{63.6/2} = 1.0$;

Current efficiency $= \frac{0.6 \times 100}{1}\% = \mathbf{60\%}$

Given $10x = 60$

$\boldsymbol{x = 6}$

47. Ans : 2

Rate $(S_{N^2}) = 5.0 \times 10^{-5} \times 10^{-2}[R-X]$

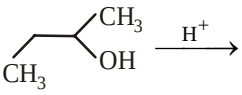
$= 5.0 \times 10^{-7}[R-X]$

Rate $(S_{N^1}) = 0.20 \times 10^{-5}[R-X]$

$$\% \text{ of } S_{N^2} = \frac{5 \times 10^{-7}[R-X] \times 100}{5 \times 10^{-7}[R-X] + 0.20 \times 10^{-5}[R-X]} = \mathbf{20}$$

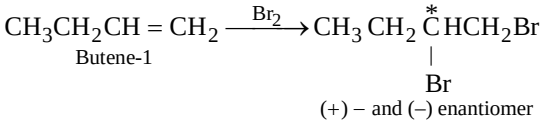
Given $20 = 10x$ $\quad\quad$ $\therefore$ $\boldsymbol{x = 2}$

48. Ans : 3

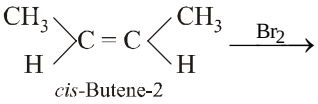


$CH_3CH_2CH = CH_2$ (Butene-1) + $CH_3CH = CHCH_3$ (Butene-2 (*cis*- and *trans*))

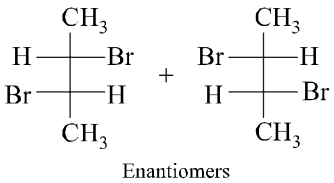
F



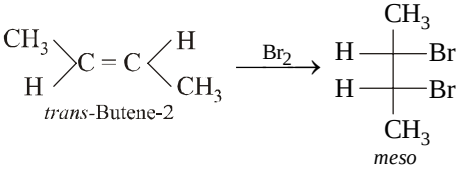
(+) – and (–) enantiomer



cis-Butene-2



Enantiomers

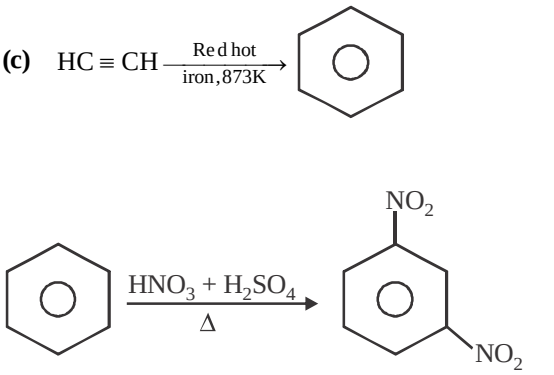


trans-Butene-2

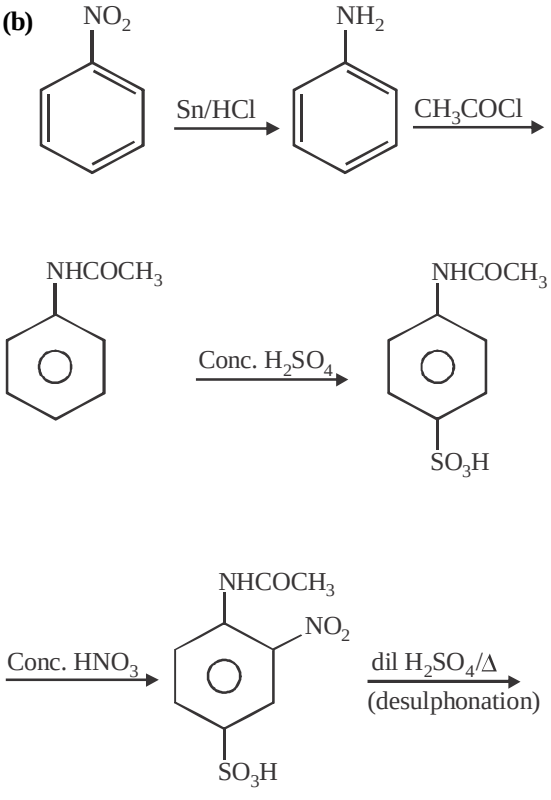
meso

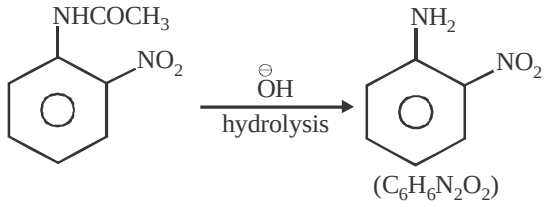
So F can have three possible structures.

49. (c)

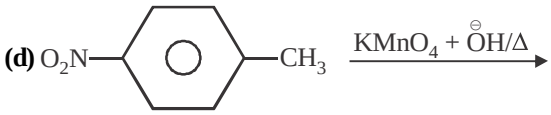


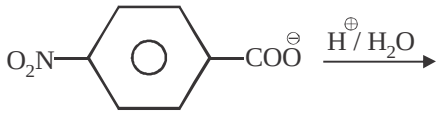
50. (b)

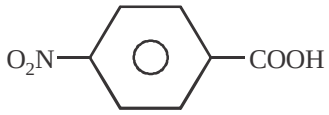


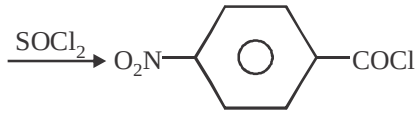


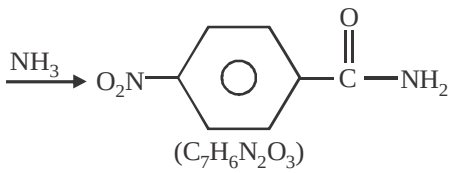
51. (d)











52. (b) $E_{cell} = -\frac{0.059}{1}\log\frac{[H^+]_a}{[H^+]_c}$

$= -0.059(pH_c - pH_a)$

$= -0.059(6-3) = -0.177V$

$\because E_{cell}$ is – ve, so reaction is Non-spontaneous.

53. (a) $E_{cell} = E_{(Q,2H^{\oplus}|H_2O)} - E_{SCE}$

Where,

$E_{(Q,2H^+/H_2O)} = E^{\circ}_{(Q,2H^+/H_2O)} - 0.059\ pH$

$\therefore \quad E_{cell} = \left[(E^{\circ}_{(Q,2H^+/H_2O)} - 0.059\ pH) - E_{SCE} \right]$

$= (0.7 - 0.059\ pH) - (0.24V)$

$= (0.7 - 0.059 \times 10) - (0.24V) = -0.13\ V$

$\because E_{cell}$ is – ve, so reaction is endergonic (i.e ΔG = +ve)

54. (b) $E_{cell} = E° - 0.059\ pH$

$= 0.7 - 0.059 \times 2 = 0.582\ V$

Since E_{cell} is + ve, so reaction is exergonic

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

PAPER - 2

1. (d) Let $f(x_1) = f(x_2) \Rightarrow [x_1] = [x_2]$ this not implies that $x_1 = x_2$

[For example, if $x_1 = 1.4$ and $x_2 = 1.5$,

then $[1.4] = [1.5] = 1$]

$\therefore$ f is not one-one.

Also, f is not onto as its range I (set of integers) is a proper subset of its co-domain R.

2. (b) $\because x + y + z = a(1 + \omega + \omega^2) + b(1 + \omega + \omega^2) = 0$

$(\because 1 + \omega + \omega^2 = 0)$

$\Rightarrow x^3 + y^3 + z^3 = 3xyz$

$= 3(a + b)(a\omega + b\omega^2)(a\omega^2 + b\omega)$

$= 3(a + b)[a^2\omega^3 + b^2\omega^3 + ab(\omega^2 + \omega^4)]$

$= 3(a + b)[a^2 + b^2 + ab(\omega^2 + \omega)]$

$= 3(a + b)(a^2 + b^2 - ab) = 3(a^3 + b^3)$

3. (a) $\sum_{k=0}^{n} {}^nC_k S_k = \sum_{k=0}^{n} {}^nC_k \frac{k}{2}[2a + (k-1)d]$

$= \left[\left(a_1 - \frac{d}{2}\right)\sum_{k=0}^{n} k\,{}^nC_k + \frac{d}{2}\sum_{k=0}^{n} k^2\,{}^nC_k\right]$

$= \left(a_1 - \frac{d}{2}\right) n.2^{n-1} + \frac{d}{2}[n.2^{n-1} + n(n-1)2^{n-2}]$

$= a_1.n.2^{n-1} + dn(n-1)2^{n-3}.$

$= n.2^{n-3}[4a_1 + a_n - a_1] = n.2^{n-3}[3a_1 + a_n]$

$= 2^{n-3}\left[2na_1 + 2n\left(\frac{a_1 + a_n}{2}\right)\right]$

$= 2^{n-2}[na_1 + S_n].$

4. (d) Let $S = (1 + x)^{1000} + 2x(1 + x)^{999} + 3x^2(1 + x)^{998}$

$+ \ldots\ 1000.x^{999}(1 + x) + 1001.x^{1000}$ ... (i)

Above series is a arithmetic-geometric series with common ratio of G.P. equal to $\frac{x}{(1+x)}$

So multiplying both sides by $\frac{x}{(1+x)}$, we get

$$\frac{xS}{(1+x)} = x(1+x)^{999} + 2x^2(1+x)^{998} + \ldots + \frac{1001.x^{1001}}{(1+x)}$$

$\ldots$(ii)

From (i) – (ii), we get

$$\left(1 - \frac{x}{1+x}\right)S = (1+x)^{1000} + x(1+x)^{999} + x^2(1+x)^{998}$$

$$+ \ldots + x^{1000} - \frac{1001.x^{1001}}{(1+x)}$$

$$\Rightarrow \frac{S}{(1+x)} = (1+x)^{1000}\left[\frac{1 - \left(\frac{x}{1+x}\right)^{1001}}{1 - \left(\frac{x}{1+x}\right)}\right] - 1001.\frac{x^{1001}}{(1+x)}$$

$$\Rightarrow \frac{S}{(1+x)} = (1+x)^{1000}\left[1-\frac{x^{1001}}{(1+x)^{1001}}\right].(1+x)$$

$$-1001.\frac{x^{1001}}{(1+x)}$$

$\Rightarrow S = (1+x)^{1002} - x^{1001}(1+x) - 1001.\,x^{1001}$

$\therefore$ coefficient of x^{50} in above expression $= {}^{1002}C_{50}$

5. (a) Since a and b are unequal,

$\frac{a^2+b^2}{2} > \sqrt{a^2 b^2}$ (A.M. > G.M. for unequal numbers)

$\Rightarrow a^2 + b^2 > 2ab$

Similarly $b^2 + c^2 > 2bc$ and $c^2 + a^2 > 2ca$

Hence $2(a^2 + b^2 + c^2) > 2(ab + bc + ca)$

$\Rightarrow ab + bc + ca < 1$

6. (b) $\log_3 |x| < 2 \Rightarrow |x| < 3^2 = 9,\ x \neq 0$

$\therefore -9 < x < 9, \qquad x \neq 0$

$\therefore$ set of integral values of x

$= \{-8, -7, ...-1, 1, 2, 3, ...8\}$

$\Rightarrow -2 < \log_3 x < 2\ ,\ x \neq 0 \Rightarrow 3^{-2} < x < 3^2,\ x \neq 0$

$\Rightarrow 1/9 < x < 9,\ x \neq 0$

$\therefore$ set of integral values of $x = \{1, 2, 3, ..., 8\}$

$\Rightarrow$ set of integral values of x satisfying either

$\log_3 |x| < 2$ or $|\log_3 x| < 2$ is

$\{-8, -7, ...-1, 1, 2, ..., 8\}$

$\therefore$ number of values of x is 16.

7. (c) Given $x^2 + y^2 - 2x = 3$

$\therefore$ centre is (1, 0) and radius is 2 and $x^2 + y^2 - 4y = 6$

$\therefore$ centre is (0, 2) and radius is $\sqrt{10}$.

Since line $ax + by = 2$ touches the first circle.

$$\therefore \frac{a(1)+b(0)-2}{\sqrt{a^2+b^2}} = 2 \text{ or } (a-2) = [2\sqrt{a^2+b^2}\ ] \quad ...(i)$$

Also the given line is normal to the second circle. Hence it will pass through the centre of the second circle.

$\therefore a(0) + b(2) = 2$ or $2b = 2 \Rightarrow b = 1$

Putting this value in equation (i) we get

$a - 2 = 2\sqrt{a^2+1}$ or $(a-2)^2 = 4(a^2+1)$

or $a^2 + 4 - 4a = 4a^2 + 4$ or $3a^2 + 4a = 0$

or $a(3a + 4) = 0$ or $a = 0, -4/3$

$\therefore$ values of a and b are $-4/3$, 1 respectively according to the given choices.

8. (a, b, c, d)

We have $\sin x\sqrt{8\cos^2 x} = 1$

$$\Rightarrow \sin x\,|\cos x| = \frac{1}{2\sqrt{2}}$$

Case –I : When $\cos x > 0$

In this case $\sin x \cos x = \frac{1}{2\sqrt{2}}$

$$\Rightarrow \sin 2x = +\frac{1}{\sqrt{2}} \Rightarrow 2x = \frac{\pi}{4}, \frac{3\pi}{4}, \frac{9\pi}{4}, \frac{13\pi}{4}$$

$$\Rightarrow x = \frac{\pi}{8}, \frac{3\pi}{8}, \frac{9\pi}{8}, \frac{13\pi}{8}$$

As x lies between 0 and 2π and $\cos x > 0$

$$\therefore x = \frac{\pi}{8}, \frac{3\pi}{8}$$

Case–II : When $\cos x < 0$.

In this case $\sin x\,|\cos x| = \frac{1}{2\sqrt{2}}$

$$\Rightarrow \sin x \cos x = -\frac{1}{2\sqrt{2}} \text{ of } \sin 2x = -\frac{1}{\sqrt{2}}$$

$$\Rightarrow x = \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}$$

$$\Rightarrow x = \frac{5\pi}{8}, \frac{7\pi}{8} \text{ as } \cos x < 0$$

Thus the values of x satisfying the given equation which lie between 0 and 2π are $\frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}$

These are in A.P. with common difference $\frac{\pi}{4}$

9. (a, c)

Let the given lines be represented by AB, BC and CA, respectively. Then A (–2, 2), B (2, – 2) and C (1, 1) are the vertices of the triangle ABC. Also, note that $AB = 4\sqrt{2}$, $AC = \sqrt{10}$ and $BC = \sqrt{10}$. This shows that Δ ABC is isosceles, it is clearly not right-angled or equilateral.

$$\text{Since } \cos C = \frac{BC^2 + AC^2 - AB^2}{2\,(BC)\,(AC)} = \frac{10+10-32}{2\sqrt{10}\sqrt{10}} < 0$$

$\Rightarrow \Delta$ ABC is obtuse-angled

10. (a, c)

$$f(x) = \frac{|x-1|}{x^2} = \begin{cases} \dfrac{x-1}{x^2}, & x \geq 1 \\ \dfrac{1-x}{x^2}, & x < 1, x \neq 0 \end{cases}$$

$$\therefore\ f'(x) = \begin{cases} \dfrac{x-2}{x^3}, & x < 1,\ x \neq 0 \\ \text{does not exist}, & x = 1 \\ \dfrac{2-x}{x^3}, & x > 1 \end{cases}$$

Clearly, $f'(x) > 0$ for $x < 0$ or $1 < x < 2$

and $f'(x) < 0$ for $0 < x < 1$ or $x > 2$

Thus, f(x) is increasing for $(-\infty, 0) \cup (1, 2)$

and decreasing for $(0,1) \cup (2, \infty)$.

11. (b, c)

(a) $y = 2 + c_1 \cos x + \sqrt{c_2} \sin x$

$$\frac{dy}{dx} = -c_1 \sin x + \sqrt{c_2} \cos x$$

$$\frac{d^2y}{dx^2} = -c_1 \cos x - \sqrt{c_2} \sin x = 2 - y$$

$$\frac{d^2y}{dx^2} + y - 2 = 0$$

(b) $y = \cos x\, \ell n \left(\tan \frac{x}{2}\right) + 2$

$$\frac{dy}{dx} = \cos x \frac{\sec^2 (x/2)}{2\tan (x/2)} - \sin x\, \ell n \left(\tan \frac{x}{2}\right)$$

$$\frac{dy}{dx} = \cot x - \sin x\, \ell n \left(\tan \frac{x}{2}\right)$$

$$\frac{d^2y}{dx^2} = -\cot^2 x - 2 - \cos x\, \ell n \left(\tan \frac{x}{2}\right)$$

$$\frac{d^2y}{dx^2} + y + \cot^2 x = 0$$

(c) $y = 2 + c_1 \cos x + c_2 \sin x + \cos x\, \ell n \tan \frac{x}{2}$

$$\frac{dy}{dx} = -c_1 \sin x + c_2 \cos x + \frac{d}{dx}\left(\cos x\, \ell n \left(\tan \frac{x}{2}\right)\right)$$

$$\frac{d^2y}{dx^2} = -(c_1 \cos x + c_2 \sin x) + \frac{d^2}{dx^2}\left(\cos x\, \ell n \left(\tan \frac{x}{2}\right)\right)$$

$$\Rightarrow \frac{d^2y}{dx^2} = -c_1 \cos x - c_2 \sin x - \cot^2 x - 2 - \cos x \ell n \left(\tan \frac{x}{2}\right)$$

$$\Rightarrow \frac{d^2y}{dx^2} + y + \cot^2 x = 0$$

12. (a, b)

$$I_n = \int_0^1 \frac{dx}{(1+x^2)^n} = \int_0^1 (1+x^2)^{-n}\, dx$$

$$= \frac{x}{(1+x^2)^n}\Big|_0^1 - \int_0^1 (-n)(1+x^2)^{-n-1}.2x.x\, dx$$

$$= \frac{1}{2^n} + 2n\int_0^1 (1+x^2)^{-n-1}.x.x\, dx$$

$$= \frac{1}{2^n} + 2n\int_0^1 \frac{x^2 dx}{(1+x^2)^{n+1}} = \frac{1}{2^n} + 2n\int_0^1 \frac{1+x^2-1}{(1+x^2)^{n+1}} dx$$

$$= \frac{1}{2^n} + 2nI_n - 2nI_{n+1}$$

$\therefore\ 2n\ I_{n+1} = 2^{-n} + (2n-1)\ I_n$

$\therefore\ 2I_2 = \frac{1}{2} + I_1 = \frac{1}{2} + \tan^{-1} x\,|_0^1 \qquad \therefore\ I_2 = \frac{1}{4} + \frac{\pi}{8}$

13. (a, c, d) $\overrightarrow{OA}.\overrightarrow{OB} = -3$

$2.3\cos\theta = -3$

$\cos\theta = -\frac{1}{2} \Rightarrow \theta = \frac{2\pi}{3}$

$(2(\vec{a}\times\vec{b}) - 2\vec{a}).(2(\vec{a}\times\vec{b}) - 3\vec{b})$

$= 4\,|\,\vec{a}\,|^2\,|\,\vec{b}\,|^2 \sin^2\theta + 6\,\vec{a}.\vec{b} = 4.\frac{3}{4} - 6.\frac{1}{2} = 0.$

Angle C is 90°.

14. (b) Since it is downward parabola

$\Rightarrow -\frac{D}{4a}$ is greatest value

$= -\frac{[(12)^2 - 4\,(21)(-4)]}{4(-4)} = 30$

For Qs. 15 to 16

Given $a + b - c = 2$ ....(1)

and $2ab - c^2 = 4$ ....(2)

$a^2 + b^2 + c^2 + 2ab - 2bc - 2ca = 4 = 2ab - c^2$

$(b-c)^2 + (a-c)^2 = 0 \Rightarrow a = b = c$

$\Rightarrow$ triangle is equilateral

Also $a = 2$ from (1) $\Rightarrow$ area of Δ ABC $= \frac{\sqrt{3}}{4}.4 = \sqrt{3}$

Also $f(x) = 2(x^2 + x + 1)$

$\Rightarrow$ f is increasing in [0, 1] $\Rightarrow f(x)|_{max} = 6$

and $r_1 = \frac{\Delta}{s-a} = \sqrt{3}$

15. (a) **16. (d)**

17. (b) $2n$ < n white / n black

$\underbrace{P_1\ P_2\ P_3 \cdots P_n}_{\text{n persons}}$

$n(S) = \frac{(2n)!\,n!}{(2!)^n.n!} = \frac{(2n)!}{2^n}$,

where S denotes the sample space

[n equal groups each of 2, distributed in n persons]

$n(E) = ({}^nC_1)^2 . ({}^{n-1}C_1)^2 . ({}^{n-2}C_1)^2 ..... ({}^1C_1)^2 = (n!)^2$,

where E: denotes the event that each of the n persons draw balls of different colour.

$P(E) = \frac{(n!)^2.2^n}{(2n)!} = \frac{8}{35} = \frac{(n!)^2.2^n}{2^n.n![1.3.5....(2n-1)]} = \frac{8}{35}$

$= \frac{n!}{[1.3.5....(2n-1)]} = \frac{8}{35}$ which hold true for n = 4.

18. (c) If n = 4 we have 8 < W W W W / B B B B ;

$P_1\ P_2\ P_3\ P_4$ 4 persons

$n(S) = \frac{8!.4!}{(2!)^4.4!} = \frac{7!}{2}$

Now 4 white can be grouped, 2 in each in $\frac{4!}{2!2!2!2!}$ ways and similarly 4 black can also be grouped in $\frac{4!}{2!2!2!2!}$ ways. Hence number of ways in which we have 4 groups each of two balls of same colour, is $\frac{4!}{8}.\frac{4!}{8}$.

These groups can be distributed in 4 person in 4! ways.

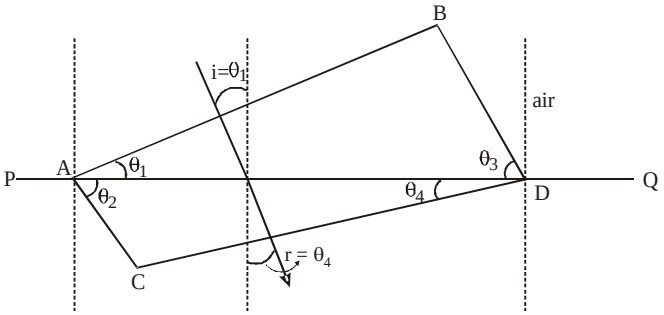
Hence $n(A) = \frac{4!}{8}.\frac{4!}{8}.4! = 6.6.6$

Where A denotes the event that 4 persons have draw both balls of same colour.

$\therefore\ P(A) = \frac{6.36.2}{7!} = \frac{72.6}{7.720} = \frac{3}{35}$

19. (c) By Snell's law

$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$



For $i = \theta_1, r = \theta_4$ and $\mu_1 = 1$

$$\mu_2 = \frac{\sin\theta_1}{\sin\theta_4}$$

20. (a) $F_m = qvB$, and directed radially inward.

$$\therefore N - mg\sin\theta + qvB = \frac{mv^2}{R}$$

$$\Rightarrow N = \frac{mv^2}{R} + mg\sin\theta - qvB$$

Hence at $\theta = \pi/2$

$$\Rightarrow N_{max} = \frac{2mgR}{R} + mg - qB\sqrt{2gR} = 3mg - qB\sqrt{2gR}$$

21. (a) The displacement of the particle is given by

$$x = A\sin(-2\omega t) + B\sin^2\omega t$$

$$= -A\sin 2\omega t + \frac{B}{2}(1 - \cos 2\omega t)$$

$$= -(A\sin 2\omega t + \frac{B}{2}\cos 2\omega t) + \frac{B}{2}$$

This motion represents SHM with an amplitude

$$\sqrt{A^2 + \frac{B^2}{4}}$$

22. (c) In ground reference frame the sphere has no relative velocity, but relative to belt it performs pure rolling motion, i.e., it has only angular velocity ω when pure rolling starts. No slipping condition yields

$$\omega r = v_1 \quad \text{or} \quad \omega = \frac{v_1}{r}$$

Now we apply angular momentum conservation about the bottom-most point.

$L_i = L_f$ (L = angular momentum)

$$\text{or} \quad mrv_0 = I\omega = \frac{2}{5}(mr^2)\frac{v_1}{r} \quad \Rightarrow v_0 = \frac{2}{5}v_1$$

23. (a) The velocity of the photoelectrons is found from

$F = ma$

$$evB = m\frac{v^2}{R} \qquad \text{or} \qquad v = \frac{e}{m}BR$$

The kinetic energy of the photoelectrons is then

$$K = \frac{1}{2}mv^2 = \frac{1}{2}\frac{e^2B^2R^2}{m}$$

$$= \frac{1}{2}\frac{(1.6\times10^{-19}\text{C})^2(2\times10^{-2}\text{T})^2(23\times10^{-3}\text{m})^2}{(9.1\times10^{-31}\text{kg})}$$

$$= 2.97\times10^{-15}\text{J}$$

$$\text{or } K = (2.97\times10^{-15}\text{J})\frac{1\text{keV}}{1.6\times10^{-16}\text{J}} = 18.6\text{keV}$$

The energy of the incident photon is

$$E_v = \frac{hc}{\lambda} = \frac{12.4\,\text{keV}}{0.50} = 24.8\,\text{keV}$$

The binding energy is the difference between these two values:

$$BE = E_v - K = 24.8\,\text{keV} - 18.6\,\text{eV} = 6.2\,\text{keV}$$

24. (b) For the first case $x = \frac{E_p}{L}\times\frac{R_W}{R_W + R}$

where R is the series resistance. Thus for the cell of 1 volt emf with balancing length L/2,

$$1 = xL/2 \qquad \text{or} \qquad 1 = \frac{2.5}{L}\times\frac{10}{10+R}\times\frac{L}{2}$$

$$\text{or } 20 + 2R = 25 \qquad \text{or} \qquad R = 2.5\Omega$$

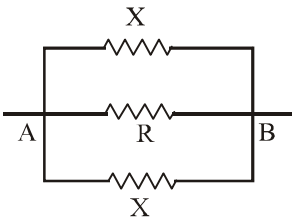
For second case series resistance

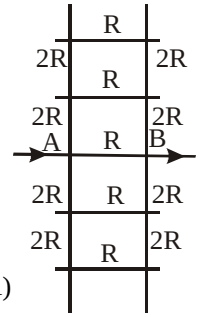
$$R' = 2R = 5\,\Omega \qquad \therefore x' = \frac{2.5}{L}\times\frac{10}{10+5}$$

$1 = x'\ell'$ where the new balancing length ℓ' is

$$\ell' = 1\times\frac{15L}{25} = 0.6\,L$$

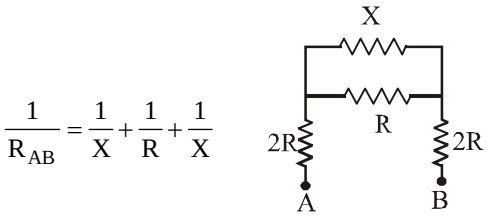
25. (b) The network is simplified as follws :





where $X = 2R + \frac{RX}{R+X} + 2R$ .....(1)

For the upper half,



$$\frac{1}{R_{AB}} = \frac{1}{X} + \frac{1}{R} + \frac{1}{X}$$

where R_{AB} is the equivalent resistance between A and B

From eq. (1)

$4R(R+X) + RX = (R+X)X$

$4R(R+X) = X^2$

$X^2 - 4RX - 4R^2 = 0$

$$X = \frac{4R \pm \sqrt{16R^2 + 16R^2}}{2} = 2R(1+\sqrt{2})$$

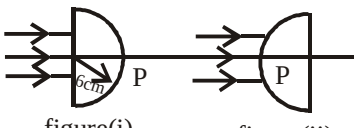
(negative sign is not possible)

$$\frac{1}{R_{AB}} = \frac{2}{X} + \frac{1}{R} = \frac{2}{2R(1+\sqrt{2})} + \frac{1}{R} = \frac{\sqrt{2}}{R} ;$$

$$R_{AB} = \frac{R}{\sqrt{2}}$$

26. (a, c)

As in figure (i), rays are parallel incident on curved part.



figure(i) figure(ii)

Therefore $\frac{1}{v} - \frac{3/2}{\infty} = \frac{1-3/2}{-6} \Rightarrow v = 12$ cm

For figure (ii), image created by curved part acts as object for the flat part.

For curved part , $\frac{1.5}{v} - \frac{1}{\infty} = \frac{0.5}{6} \Rightarrow v = 18$ cm

From flat surface, object is at 12 cm to the right.

For flat part, $\frac{1}{v} - \frac{3/2}{12} = 0 \Rightarrow \frac{1}{v} - \frac{1}{8} = 0 \Rightarrow v = 8$

27. (c, d)

$$v_{rms} = \sqrt{\frac{3RT}{M}} \; ; \; \bar{v} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{2.55\frac{RT}{M}}$$

$$v_p = \sqrt{\frac{2RT}{M}}$$

$$\text{Average KE} = \frac{1}{2}mv_{rms}^2 = \frac{1}{2}m\left(\frac{3}{2}v_p^2\right) = \frac{3}{4}mv_p^2$$

28. (a, b, d)

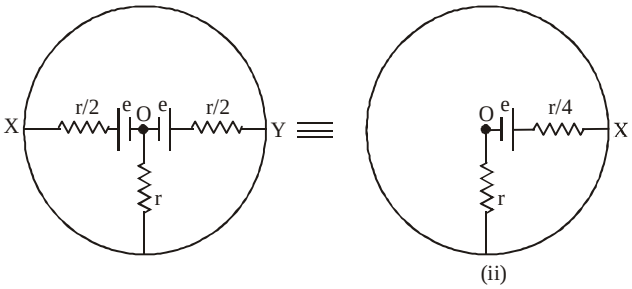
$$0 \le x \le a \; ; \left[-\int_0^x E_x dx\right] + V_{(0)} = 0 \;\; \text{as} \;\; (E_x = 0)$$

$$x \ge a \; ; \left[-\int_0^x E_x dx\right] + V_{(a)} = \left[-\int_a^x \frac{\sigma}{\epsilon_0} dx\right] + V_{(a)} = -\frac{\sigma}{\epsilon_0}(x-a)$$

$$x \le 0 \; ; \; -\int_0^x E_x dx + V_{(0)} = -\left(-\frac{\sigma}{\epsilon_0}x\right) + V_{(0)} = \frac{\sigma}{\epsilon_0}x$$

29. (b, d)

Equivalent circuit,



(ii)

$$\text{Induced emf } e = \left(\frac{B\omega a^2}{2}\right)$$

By nodal equation : $4\left(\frac{X-e}{r}\right)+\left(\frac{X-0}{r}\right)=0$

$\Rightarrow 5X=4e \Rightarrow X=\frac{4e}{5}=\frac{2B\omega a^2}{5}$ and $I=\frac{X}{r}=\frac{2B\omega a^2}{5r}$

also direction of current in r will be towards negative terminal i.e. from rim to origin.

Alternatively by equivalent of cells (figure (ii)) :

$$I=\frac{e}{r+\frac{r}{4}}=\frac{4e}{5r}$$

30. (a, b)

The maximum horizontal distance from the vessel comes from hole number 3 and 4.

$v=\sqrt{2gh} \rightarrow$ h is height of hole from top.

Horizontal distance

$$x=vt=\sqrt{2gh}\sqrt{\frac{2(H-h)}{g}}=2\sqrt{h(H-h)}$$

31. (a, b, d) % error in measurement of 'r' $=\frac{1}{10}\times 100=10\%$

$$T_{mean}=\frac{0.52+0.56+0.57+0.54+0.59}{6}=0.556\approx 0.56\ S$$

$$\Delta_T=\frac{0.04+0+0.01+0.02+0.03}{6}=0.016\approx 0.02 S$$

$\therefore$ % error in the measurement of 'T'

$$=\frac{0.02}{0.56}\times 100=3.57\%$$

% error in the value of g

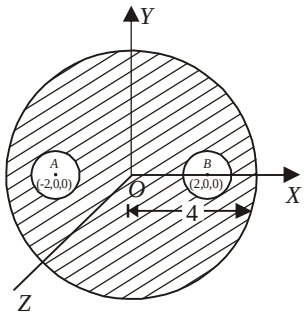
$$=2\frac{\Delta T}{T}\times 100+\left(\frac{\Delta R+\Delta r}{R-r}\right)\times 100$$

$$=2(3.57)+\left(\frac{1+1}{60-10}\right)\times 100 \approx 11\%$$

32. (a,c,d) The gravitational field intensity at the point *O* is zero (as the cavities are symmetrical with respect to *O*). Now the force acting on a test mass m_0 placed at *O* is given by

$$F=m_0E=m_0\times 0=0$$

Now, $y^2+z^2=36$ represents the equation of a circle with centre (0, 0, 0) and radius 6 units the plane of the circle is perpendicular to *x*-axis.



Note : Since the spherical mass distribution behaves as if the whole mass is at its centre (for a point outside on the sphere) and since all the points on the circle is equidistant from the centre of the sphere, the circle is a gravitational equipotential.

The same logic holds good for option (d).

33. (b) By mirror formula :

$$\frac{1}{v}+\frac{1}{-10}=\frac{1}{10} \Rightarrow v=+5\ cm \ \therefore m=+\frac{1}{2}$$

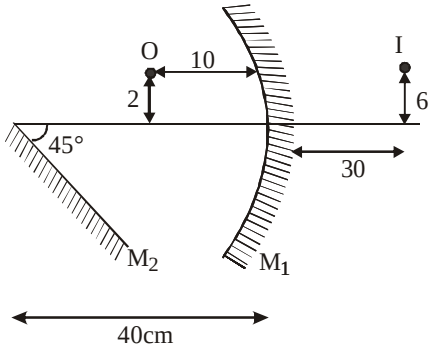
the image revolves in circle of radius $\frac{1}{2}$ cm .

Image of a radius erect $\Rightarrow$ particle will revolve in the same direction as the particle. The image will complete one revolution in the same time 2s.

Velocity of image,

$$v=\omega r=\frac{2\pi}{2}\times\frac{1}{2}=\frac{\pi}{2}cm/s=1.57\ cm/s$$

34. (a) For M_1, u = – 10, f = – 15, h = 2.



Using mirror formula

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}\Rightarrow\frac{1}{v}+\frac{1}{-10}=\frac{1}{-15}$$

$$\Rightarrow \frac{1}{v}=\frac{1}{10}-\frac{1}{15}=\frac{3-2}{30}\Rightarrow v=30\text{cm}.$$

and $\frac{h_2}{h_1}=-\frac{v}{u}\Rightarrow h_2=6$ cm.

The image formed by the plane mirror is at 70 below the principal axis and 70 + 6 – 30 = 46 of the concave mirror.

$\therefore$ coordinates of I_2 w.r.t. P = (– 46, – 70)

35. (b) $W_{AB}=P\Delta V=10\times10=100$ J

36. (a) $\Delta Q=\Delta U+\Delta W$

For cyclic process $\Delta U=0$

$$\Delta Q=\Delta W=-\frac{1}{4}\pi r_1r_2=-\frac{1}{4}\pi(10)(10)=-25\pi J$$

$\Delta W\rightarrow$ –ve for anticlockwise cycle

37. (c) We are given that

$V=1\text{ L}\equiv1\text{ dm}^3\equiv10^{-3}\text{ m}^3$; $N=2.0\times10^{21}$

$p=7.57\times10^3\text{ N m}^{-2}$

$c_{mp}/C_{rms}=0.84$; $c_{mp}=?$

Now, amount of gas $=\frac{2.0\times10^{21}}{6.023\times10^{23}\text{ mol}^{-1}}$

Using ideal gas equation, we get $T=\frac{pV}{nR}$

$$=\frac{(7.57\times10^3\text{ N m}^{-2})(10^{-3}\text{ m}^3)}{(2.0\times10^{21}/6.023\times10^{23}\text{mol}^{-1})(8.314\text{ J K}^{-1}\text{ mol}^{-1})}$$

$=274.2$ K

Now, $c_{rms}=\sqrt{\frac{3RT}{M}}$

$$=\left[\frac{3(8.314\text{ J K}^{-1}\text{ mol})(274.2\text{ K})}{(28\times10^{-3}\text{ kg mol}^{-1})}\right]^{1/2}=494.22\text{ m s}^{-1}$$

$c_{mp}=(0.84)(494.22\text{ ms}^{-1})=415.14\text{ m s}^{-1}$.

38. (a) 2-butyne forms cis-2-butene with Lindlar's catalyst.

39. (a) If the reaction is assumed to proceed to completion, the final pressure will be doubled the initial pressure. Then for a first order reaction, one can write.

$$k=\frac{2.303}{t}\log\frac{p_f-p_i}{p_f-p_i}=\frac{2.303}{t}\log\frac{(1-0.5)\text{ atm}}{(1-0.6)\text{ atm}}$$

For $t=100$ s

$$k=\frac{2.303}{100\text{s}}\log\frac{0.5\text{ atm}}{0.4\text{ atm}}=2.23\times10^{-3}\text{ s}^{-1}$$

For total pressure of 0.65 atm,

$\text{Rate the reaction}=k\times p(SO_2Cl_2)$

From the reaction stoichiometry,

$p(SO_2Cl_2)=2p_i-p_t=1\text{ atm}-0.65\text{ atm}=0.35\text{ atm}$

So, Rate of reaction $=2.23\times10^{-3}\text{ s}^{-1}\times0.35\text{ atm}$

$=7.8\times10^{-4}\text{ s}^{-1}$ atm.

40. (a) The overall dissociation constant is the reciprocal of overall stability constant i.e. $1/\beta_4=4.7\times10^{-14}$

41. (a) The equation for cell reaction is :

$Zn(s)+Ni(NO_3)_2\rightarrow Zn(NO_3)_2+Ni(s)$

or $Zn(s)+Ni^{2+}(aq)\rightarrow Zn^{2+}(aq)+Ni(s)$

In this cell zinc acts as anode while nickel acts as cathode so $E_{cell}=E_{cathode}-E_{anode}$

(on the basis of SRP)

$\therefore E_{cell}=-0.24-(-0.75)=+0.51$ V

Nernst equation for above reaction

$$E_{cell}=E^\circ_{cell}-\frac{0.0591}{n}\log\frac{[Zn^{2+}]}{[Ni^{2+}]}$$

At equilibrium $E_{cell}=0$ and $n=2$

$$\text{So, }0=0.51-\frac{0.0591}{2}\log\frac{[Zn^{2+}]}{[Ni^{2+}]}$$

$$\text{or }\log\frac{[Zn^{2+}]}{[Ni^{2+}]}=\frac{0.51\times2}{0.0591}=17.25$$

$$\text{or }\frac{[Zn^{2+}]}{[Ni^{2+}]}=1.8\times10^{17}$$

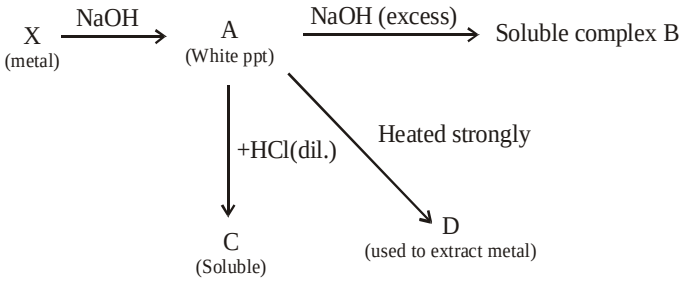
Let x mol L^{-1} be the concentration of $Ni^{2+}(aq)$ at equilibrium.

So Zn^{2+} (aq) ion conc. = $(1 - x)$ mol $L^{-1} \approx 1$ mol L^{-1}

So $\frac{1}{x} = 1.8 \times 10^{17}$ or $x = \frac{1}{1.8 \times 10^{17}} = 5.56 \times 10^{-18}$ M

Hence, $[Ni^{2+}] = 5.56 \times 10^{-18}$ M

42. (a) The scheme of reaction is



From the given information, it can be concluded that,

X is aluminium

A is $Al(OH)_3$

B is $Na^+[Al(OH)_4]^-$

C is $AlCl_3$ (aq)

D is Al_2O_3

The reactions are given below.

$$\underset{\text{limited}}{Al} + 3NaOH \longrightarrow \underset{\text{(A) white ppt}}{Al(OH)_3} + 3Na^+$$

$$Al(OH)_3 + \underset{\text{(excess)}}{NaOH} \longrightarrow \underset{\text{Sodium tetrahydroxoaluminate (soluble) (B)}}{Na^+[Al(OH)_4]^-}$$

$$Al(OH)_3 \xrightarrow{\text{heat}} \underset{\text{(O)}}{Al_2O_3(s)} + 3H_2O$$

$$Al(OH)_3 + 3HCl(dil.) \longrightarrow \underset{\text{(C) (soluble)}}{AlCl_3(aq)} + 3H_2O$$

43. (a) $Fe^{3+}(aq) + SCN^-(aq) \longrightarrow \underset{\text{Red}}{[Fe(SCN)]^{2+}(aq)}$

$$Fe^{3+}(aq) + 3OH^-(aq) \longrightarrow \underset{\text{Brown}}{[Fe(OH)_3](s)}$$

44. (a, c, d)

(I) $4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

(II) $2NO + O_2 \longrightarrow 2NO_2$

(III) $2NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$

(IV) $3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$

Let the moles of NH_3 = x moles

$$\therefore\ n_{HNO_3} = (\text{III reaction}) = x \times \frac{4}{4} \times \frac{2}{2} \times \frac{1}{2} = \frac{x}{2}$$

$$n_{HNO_3} = (\text{IV reaction}) = x \times \frac{4}{4} \times \frac{2}{2} \times \frac{1}{2} \times \frac{1}{3} = \frac{x}{6}$$

$$n_{NO} = x \times \frac{4}{4} \times \frac{2}{2} \times \frac{1}{2} \times \frac{2}{3} = \frac{x}{3}$$

Total $n_{HNO_3} = \frac{x}{2} + \frac{x}{6} = \frac{2x}{3}$ moles

$\therefore$ Moles of HNO_3 obtained in III reaction (if HNO_3 is not used to produce HNO_3) = $\frac{x}{2} = \frac{n_{NH_3}}{2}$

$$\therefore\ \underset{\text{of } n_{HNO_3} \text{ in III reaction}}{n_{HNO_3} = (\text{IV reaction})} = \frac{x/6}{2x/3} \times 100 = \frac{100}{3}\%$$

$$n_{HNO_3} = (\text{IV reaction}) = \frac{x/6}{2x/3} = \frac{1}{4}(\text{Total } n_{HNO_3})$$

$$\frac{n_{NO}}{\text{Total } n_{HNO_3}} \times 100 = \frac{x/3}{2x/3} \times 100 = 50\%$$

45. (a, b, d)

The nitrates of Mg and Ba decompose as follows

$2M(NO_3)_2 \xrightarrow{\text{heat}} 2MO + 4NO_2(g) + O_2(g)$ [M = Mg or Ba]

The option (c) is incorrect because of the fact that $Mg(NO_3)_2$ is more covalent than $Ba(NO_3)_2$. Due to this $Mg(NO_3)_2$ decomposes more readily.

46. (a, b, c)

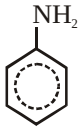
All aldehydes, not containing α-Hydrogen atoms, react with cold concentrated. alkali to form a corresponding alcohol and a salt of the corresponding acid. The aldehyde gets oxidised as well as reduced.

$$\underset{\text{Methanal}}{HCHO} + NaOH \longrightarrow \underset{\text{(sodium methanoate)}}{HCOO^-Na^+} + \underset{\text{(methanol)}}{CH_3OH}$$

H_2CO always oxidized in crossed-Cannizzaro reaction.

47. (a, b, c, d)

$A \xrightarrow{NH_3(aq),\ \Delta} B \xrightarrow{Br_2+KOH} C\ (C_6H_7N)$

C is an aromatic amine. So its structure is  (Aniline)

Based on the reactions,

B is an amide. So its structure is  (Benzamide)

and A is an acid. So its structure is  (Benzoic acid)

48. (a, b, c)

In Lassaigne's method, the appearance of a bluish green or a blue colouration, confirms the presence of nitrogen in the organic compound. In Beilstein test appearance of green or bluish green colour of the flame indicates the presence of halogens. If organic compound is fused with sodium peroxide (Na_2O_2) and the mass is extracted with water and extract is boiled with conc. HNO_3 and then ammonium molybedate solution is added. The appearance of yellow precipitate or colouration shows the presence of phosphorus. In sodium nitroprusside test the appearance of violet colouration indicates sulphur.

49. (b, c, d)

I. E, of O (Z = 8) is less than that of N (Z = 7) because of presence of half-filled orbitals in case of N ($1s^2\ 2s^2\ 2p_x^1 2p_y^1 2p_z^1$). It is an exception. In general I.E. increases on moving from left to right in a period.

50. (a, b, c)

$NO\ (11) : (\sigma 2s)^2 (\sigma^* 2s)^2 (\sigma 2p_z)^2 (\pi 2p_x)^2 (\pi 2p_y)^2 (\pi^* 2p_x)^1$

$NO^+\ (10) : (\sigma 2s)^2 (\sigma^* 2s)^2 (\sigma 2p_z)^2 (\pi 2p_x)^2 (\pi 2p_y)^2$; B.O. = 3

$O_2^+\ (11)$: B.O. = 2.5

Higher the bond order, higher is the stability

$OF^+\ (12) : (\sigma 2s)^2 (\sigma^* 2s)^2 (\sigma 2p_z)^2 (\pi 2p_x)^2 (\pi 2p_y)^2 (\pi^* 2p_x)^1 (\pi^* 2p_y)^1$;

2 unpaired electrons

$Ne^+_2\ (15) : (\sigma 2s)^2 (\sigma^* 2s)^2 (\sigma 2p_z)^2 (\pi 2p_x)^2 (\pi 2p_y)^2 (\pi^* 2p_x)^2 (\pi^* 2p_y)^2 (\sigma^* 2p_z)^1$

1 unpaired electron

51. (c) Orbital angular momentum for f orbital (ℓ = 3)

$$\sqrt{3(3+1)}\,\frac{h}{2\pi} = \sqrt{12}\,\frac{h}{2\pi}$$

52. (a) The angular momentum must be a multiple of $\frac{h}{2\pi}$.

$L = \frac{nh}{2\pi}$ [where n = 1, 2, 3, 4, ... for K, L, M, N shell respectively]

53. (b)

$$CH_3-\underset{\underset{O}{\|}}{C}-\underset{\underset{H}{|}}{CH}-COOEt \xrightarrow{EtO^{\ominus}}$$

$$CH_3-\underset{\underset{O}{\|}}{C}-\overset{\ominus}{\underset{\underset{H}{|}}{C}}-COOEt \xrightarrow{CH_3-CH_2-I}$$

$$CH_3-\underset{\underset{O}{\|}}{C}-\underset{\underset{CH_2-CH_3}{|}}{CH}-COOEt \xrightarrow{\text{Ketonic hydrolysis}}$$

$$CH_3-\underset{\underset{O}{\|}}{C}-CH_2-CH_2-CH_3$$

54. (c)

$$CH_3-\underset{\underset{O}{\|}}{C}-CH_2-COOEt \xrightarrow{EtO^{\ominus}}$$

$$CH_3-\underset{\underset{O}{\|}}{C}-\overset{\ominus}{CH}-COOEt \xrightarrow{Cl-CH_2-COOMe}$$

$$CH_3-\underset{\underset{O}{\|}}{C}-\underset{\underset{CH_2-COOMe}{|}}{CH}-COOEt \xrightarrow{\text{Acidic hydrolysis}}$$

$$\begin{matrix} CH_2-COOH \\ | \\ CH_2-COOH \end{matrix}$$

CH_3COOH + succinic acid