JEE MAIN 2026

Sample Paper - 15

Time Allowed: 3 hours **Maximum Marks:** 300

General Instructions:

1. The test consists of total 75 questions.

2. Each subject (PCM) has 25 questions.

3. Each subject divided into two sections. Section A consists of 20 multiple-choice questions & Section B consists of 5 numerical value-type questions.

4. Marking Scheme:

- Section A (MCQs): +4 marks for each correct answer, -1 mark for each incorrect answer, 0 marks for unattempted.
- Section B (Numerical): +4 marks for each correct answer, 0 marks for incorrect or unattempted.

5. Any textual, printed, or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.

6. All calculations/written work should be done in the rough sheet is provided with the Question Paper.

MATHEMATICS

Max Marks: 100

SECTION-I (SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

1. Let f(x) be a real function

Number of correct statements among the following.

Statement I: If f(x) is an odd function on R and is known to be an increasing function for x > 0 then it is also decreasing function for x < 0

Statement II: If f(x) is an odd function and $\lim_{x\to 0} f(x)$ exists then $\lim_{x\to 0} f(x) = 0$

Statement III: If f(x) is an even function on R and is known to be increasing for x > 0, then it is decreasing function for x <0

Statement IV: If f(x) is an even function and $f(0)$ exists then $\lim_{x\to 0^+} f(x) = \lim_{x\to 0^-} f(x)$

1)1 **2)**2 **3)**0 **4)**3

2. Let f(x) be continuous on [a, b] and differentiable on (a, b)

Number of correct statements among the following.

Statement I: If f(x) is strictly increasing on (a, b) then $f'(x) \geq 0$ for all $x \in (a,b)$

Statement II: If f(x) is strictly decreasing on (a, b) then $f'(x) < 0$ for all $x \in (a,b)$

Statement III: f(x) and $f'(x)$ have opposite sign, for all x, then $f^2(x)$ is a decreasing function

Statement IV: f(x) and $f'(x)$ have opposite sign, for all x, then $|f(x)|$ is an increasing function

1)1 **2)**2 **3)**3 **4)**4

3. Which of the following must be the true value of the statements below in that order.

Statement I: $\arg(\bar{z}) = -\arg(z)$ for any complex number z

Statement II: If $|z-z_1|-|z-z_2| = k$ where $k < |z_1 - z_2|$, Then the locus of z is a hyperbola

Statement III: $z_1, z_2 \ldots . z_n$ be the complex numbers representing the vertices of n – sided regular polygon, and "z_o" is its centre, then $\sum_{i=1}^{n} z_i^2 = nz_0^2$

Statement IV: If $z_1^2 + z_2^2 + z_1 z_2 = 0$, then z_1, z_2 and origin form an equilateral triangle.

1) TFFT **2)** FFTF **3)** FFTT **4)** TTTT

4. Let the function $f:R\to R$ be defined by $f(x)=x^3-x^2+(x-1)\sin x$ *and let* $g:R\to R$ be an arbitrary function.

Let $fg:R\to R$ be the product function defined by $(fg)(x)=f(x)g(x)$.

Then Number of correct statements among the following.

A) If g is discontinuous at x = 1, then fg can never be differentiable at x = 1

B) If fg is differentiable at x = 1, then g is continuous at x = 1

C) If fg is differentiable at x = 1, then g must be differentiable at x = 1

1)3 **2)**2 **3)**1 **4)**0

5. Which of the following must be the true value of the statements below in that order.

Statement I: $\int e^{ax}.\sin bx\,dx=\frac{e^{ax}}{a^2+b^2}(a\sin bx-b\cos bx)+c$, where $a,b\in R-\{0\}$ and c is arbitrary real number

Statement II: $\int\frac{f'(x)}{(f(x))^n}dx=\frac{(f(x))^{-n+1}}{-n+1}$ where $n\neq 1$ and $f(x)$ is a positive differentiable function

Statement III: $\int e^{kx}\frac{(f(kx)+f'(kx))}{k}dx=e^{kx}f(kx)+c$ where $k,c\in R$

Statement IV: Let $F(x)$ be an indefinite integral of $\sin^2 x$, then the function $F(x)$ satisfies $F(x+\pi)=F(x)$ for all real x.

1) TFFT **2)** TFTF **3)** TFTT **4)** TFFF

6. Which of the following must be the true value of the statements below in that order.

Statement I: For $x\in R$, let $\tan^{-1}(x)\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$. Then the minimum value of the function $f:R\to R$, defined by $f(x)=\int_0^{x\tan^{-1}x}\frac{e^{(t-\cos t)}}{1+t^{2023}}dt$ is zero

Statement II: If f(x) is a periodic function with period T, then

$$\int_{a+nT}^{b+nT} f(x)dx = \int_{a}^{b} f(x)dx, n \in Z, a, b \in R$$

Statement III: If $\psi(x) \le \phi(x)$ for $a \le x \le b$, then $\int_a^b |\psi(x)|dx \le \int_a^b |\phi(x)|dx$

1) TTF **2)** FTF **3)** FTT **4)** TTT

7. Consider the given statements

Statement I: If f(x) is bounded for $x \in [a,b]$, then area bounded by curve y = f(x), x – axis, x = a and x = b is $\int_a^b f(x)dx$

Statement II: If f(x) is bounded and differentiable for $x \in [a,b]$, then the area between $y = f(x) and\ y = f^{-1}(x)$ is equal to the double the value of $\int_a^b |f(x) - x|dx$

1) Only **Statement I** is true **2)** Only **Statement II** is true
3) Both **Statement I** and **II** are True **4)** Both **Statement I** and **II** are false

8. Let $y = y(x)$ be the solution of the differential equation $\frac{dy}{dx} + 2y = f(x)$, where

$$f(x) = \begin{cases} 1, & x \in [0,1] \\ 0, & \text{otherwise} \end{cases}$$

If $y(0) = 0$, then $y(\ln 2)$ is

1) $\frac{e^2-1}{4e^2}$ **2)** $\frac{e^2-1}{2e^2}$ **3)** $\frac{1}{4}$ **4)** $\frac{3}{8}$

9. Let $\bar{x}$, M and σ^2 be respectively the mean, mode and variance of n observations $x_1, x_2, ...x_n$ and $d_i = -x_i - a$, $i = 1, 2, \ldots, n$ where a is any number

Statement 1: variance of $d_1, d_2, ...d_n$ is σ^2

Statement 2: Mean and mode of $d_1, d_2, ...d_n$ are $-\bar{x} - a$ and $-M - a$ respectively

1)Statement 1 and Statement 2 are both false

2) Statement 1 and Statement 2 are both true

3)Statement 1 is true and Statement 2 is false

4)Statement 1 is false and Statement 2 is true

10. Number of correct statements among the following.

Statement I: If f, g: $R \to R$ defined as $f(x)=\begin{cases} x, & if\ x\ is\ rational \\ 0, & if\ x\ is\ irrational \end{cases}$ and

$g(x)=\begin{cases} 0, & if\ x\ is\ rational \\ x, & if\ x\ is\ irrational \end{cases}$, then, f –g is one-one and onto

Statement II: $f(x)=\sin x+\cos ax$ is periodic function then a must be rational

Statement III: If f : A $\to$ B and g : B $\to$ C are functions such that $gof : A \to C$ is one -one then f must be one -one

1)1 **2)**2 **3)**0 **4)**3

11. Which of the following is true?

1) $\frac{dy}{dx}$ for $y=\sin^{-1}(\cos x)$, where $x \in (0,\pi)$, is -1

2) $\frac{dy}{dx}$ for $y=\sin^{-1}(\cos x)$, where $x \in (0,2\pi)$, is 1

3) $\frac{dy}{dx}$ for $y=\cos^{-1}(\sin x)$, where $x \in \left(-\pi,\frac{\pi}{2}\right)$, is -1

4) $\frac{dy}{dx}$ for $y=\cos^{-1}(\sin x)$, where $x \in \left(-\frac{\pi}{2},\frac{3\pi}{2}\right)$, is -1

12. Consider the following Statements

Statement-I: If both functions $f(x)$ *and* $g(x)$ have limits at $x=a$, then

$\underset{x\to a}{Lt}\left[f\left(g(x)\right)\right]=\left[\underset{x\to a}{Lt}f\left(g(x)\right)\right]$ [ ] denotes G.I.F

Statement-2: A function may fail to have a limit at a point in its domain but functional value at x = a exists (i.e. f(a) exists)

1) Only **Statement I** is true **2)** Only **Statement II** is true

3) Both **Statement I** and **II** are True **4)** Both **Statement I** and **II** are false

13. Which of the following is always true

1) One root of the equation $ax^2+bx+c=0,$ in the form of $p+\sqrt{q}$ then other root is $p-\sqrt{q}\ \left(p\in z, q\in z^+\right)$

2) If the equation $ax^2+bx+c=0$ is satisfied by more than two distinct numbers (real or complex), then it becomes an identity.

3) If a = 2 and b, c are integers and the roots of the quadratic equation $ax^2+bx+c=0$ are rational, then the roots must be integers

4) a, b, c are in A.P and G.P then (a, b, c) can be (k, k, k) for all $k\in R$

14. Two players, P_1 and P_2, play a game against each other. In every round of the game, each player rolls a fair die once, where the six faces of the die have six distinct numbers. Let x and y denote the readings on the die rolled by P_1 *and* P_2, respectively. If $x>y$, then P_1 scores 5 points and P_2 scores 0 point. If $x=y$, then each player scores 2 points. If $x<y$, then P_1 scores 0 point and P_2 scores 5 points. Let X_i *and* Y_i be the total scores of P_1 *and* P_2, respectively, after playing the i^{th} round.

List – I	List – II
I) Probability of $(X_2 \geq Y_2)$ is	P) $\frac{3}{8}$
II) Probability of $(X_2 > Y_2)$ is	Q) $\frac{11}{16}$
III) Probability of $(X_3 = Y_3)$	R) $\frac{5}{16}$
IV) Probability of $(X_3 > Y_3)$	S) $\frac{355}{864}$
	T) $\frac{77}{432}$

1) $I \to Q; II \to R; III \to T; IV \to S$ **2)** $I \to Q; II \to R; III \to T; IV \to T$

3) $I \to P; II \to R; III \to Q; IV \to S$ **4)** $I \to P; II \to R; III \to Q; IV \to T$

15. Which of the following is/are true

Statement I: A variable circle cuts two fixed perpendicular lines so that each intercept is of different length, then locus of the centre of the circle is hyperbola.

Statement II: If the eccentric angles of the extremities of a focal chord of a Hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ are $\theta_1 \& \theta_2$ Then eccentricity of the Hyperbola $e=\frac{\cos\left(\frac{\theta_1+\theta_2}{2}\right)}{\cos\left(\frac{\theta_1-\theta_2}{2}\right)}=\frac{\sin(\theta_1+\theta_2)}{\sin(\theta_1)+\sin(\theta_2)}$

1) Only **Statement I** is true **2)** Only **Statement II** is true

3) Both **Statement I** and **II** are True **4)** Both **Statement I** and **II** are false

16. Consider the following Statements

Statement I: General form $ax+by+c=0$ (here a, b and c are the parameters and $a,b,c \in R$) always represents a straight line

Statement II: A line $ax+by+1=0,$ is such that the algebraic sum of theperpendiculars on it, from a number of points $(x_i,y_i),\ (i=1,2,.....,n).$ is zero, then the line always passes through a fixed point is $(\bar{x},\bar{y})$ *Where* $\bar{x}=\frac{\sum x_i}{n}$ *and* $\bar{y}=\frac{\sum y_i}{n}$

1) Only **Statement I** is true **2)** Only **Statement II** is true

3) Both **Statement I** and **II** are True **4)** Both **Statement I** and **II** are false

17. Which of the following must be the true value of the statements below in that order.

Statement I: If $\vec{a}=2\hat{i}+\hat{j}+k$, and $\vec{b}$ and $\vec{c}$ be two nonzero vectors such that $|\vec{a}+\vec{b}+\vec{c}|=|\vec{a}+\vec{b}-\vec{c}|$ and $\vec{b}.\vec{c}=0$ then $|\vec{a}+\lambda\vec{c}|\geq|\vec{a}|$ for all $\lambda\in R$

Statement II: If the vectors $\overrightarrow{PQ},\overrightarrow{QR},\overrightarrow{RS},\overrightarrow{ST},\overrightarrow{TU}$ and $\overrightarrow{UP}$ represent the sides of regular hexagon then $\overrightarrow{PQ}\times\left(\overrightarrow{RS}+\overrightarrow{ST}\right)\neq\vec{0}$

Statement III: Four points A,B,C & D with position vectors $\vec{a},\vec{b},\vec{c}\ \&\ \vec{d}$ respectively, are coplanar, then there exists constants x, y, z and w such that $x\vec{a}+y\vec{b}+z\vec{c}+w\vec{d}=\vec{0}$ where x + y + z + w = 0 but not all x, y, z and w are zero

1) TFF **2)** TFT **3)** FFT **4)** TTT

18. Which of the following must be the true value of the statements below in that order.

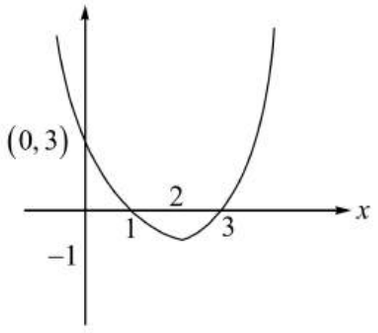
Statement I: For square matrices A and B of same order. (with real entries) (O is null matrix and I is Identity matrix of same order as A and B). If AB = O then $(\det A)^2+(\det B)^2=0$

Statement II: If $l_i,m_i,n_i\ (i=1,2,3)$ denote the direction cosines of 3 mutual perpendicular vectors then $A=\begin{pmatrix} l_1 & m_1 & n_1 \\ l_2 & m_2 & n_2 \\ l_3 & m_3 & n_3 \end{pmatrix}$ is an orthogonal matrix

Statement III: For two distinct Lines with shortest distance $d\neq0$ we can have a point A on line one and point B on line two such that AB=d then A and B be unique points on them in all possible cases

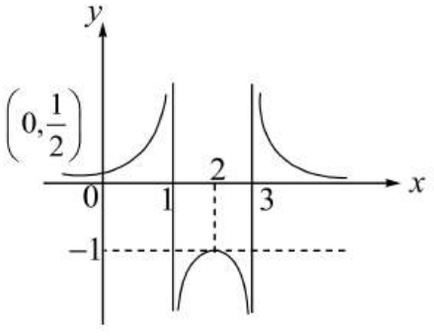
1) FFT **2)** FFF **3)** FTF **4)** FTT

19. Graph of $y = f(x)$ is given below

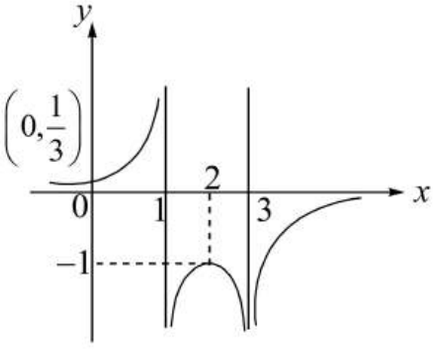


Then graph of $y = \dfrac{-1}{|f(x)|}$ is best represented by

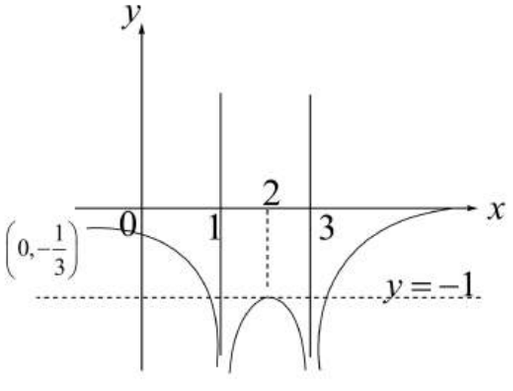
1)



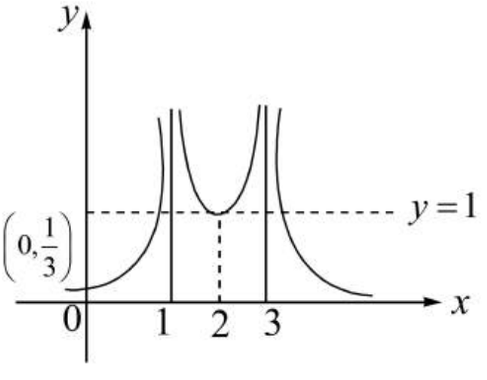
2)



3)



4)



20. Which of the following must be the true value of the statements below in that order.

Statement I: There are "n", $(n \geq 3)$ straight lines, drawn in a plane, no two of which are parallel and no three pass through the same point, and the points of intersection of these lines are joined. Then the number of fresh lines, hence made is $\frac{n(n-1)(n-2)(n-3)}{8}$

Statement II: Vertices of n-sided regular polygon, joined to form a triangle then number of obtuse angled triangle, is $= n.^{\frac{n}{2}-1}C_2$, if n is even $(n > 4)$

1) TT **2)** TF **3)** FT **4)** FF

SECTION-II (NUMERICAL VALUE TYPE)

This section contains **5 Numerical Value Type Questions.** The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **Nearest Integer** value (Example i,e. If answer is above **10** and less than **10.5** round off is **10** and If answer is from **10.5** and less than **11** round off is **11**).

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases

21. Let $P(a_1,b_1)$ and $Q(a_2,b_2)$ be two distinct points on a circle with center $C(\sqrt{2},\sqrt{3})$. Let O be the origin and OC be perpendicular to both CP and CQ. If the area of the triangle OCP is $\sqrt{35}$, then $a_1^2+a_2^2+b_1^2+b_2^2$ is equal to_____.

22. Let Q be the cube with the set of vertices $\{(x_1,x_2,x_3) \in R^3 : x_1,x_2\,x_3 \in \{0,1\}\}$. Let F be the set of all twelve lines containing the diagonals of the six faces of the cube Q. Let S be the set all four lines containing the main diagonals of the cube Q; for instance, the line passing through the vertices $(0,0,0)$ and $(1,1,1)$ is in S. For lines l_1 and l_2, let $d(l_1, l_2)$ denote the shortest distance between them. Then the maximum value of $d(l_1, l_2)$, as l_1 varies over F and l_2 varies over S, is λ. Find the value of λ^{-2}

23. Number of correct statements among the following is k. Then 2k is _____

Statement I: Chord joining the points $P\left(at_1^2, 2at_1\right) \& Q\left(at_2^2, 2at_2\right)$ of the parabola $y^2 = 4ax$ passes through focus of the parabola, length of the focal chord $PQ = |a|\left(t_1 + \frac{1}{t_1}\right)^2 \geq 4a$

Statement II: Let $P = \{\theta : \sin\theta - \cos\theta = \sqrt{2}\cos\theta\}$ and $Q = \{\theta : \sin\theta + \cos\theta = \sqrt{2}\sin\theta\}$ be two sets. Then P=Q

Statement III: If a,b,c,d and p are distinct non zero real numbers such that $\left(a^2 + b^2 + c^2\right)p^2 - 2(ab + bc + cd)p + \left(b^2 + c^2 + d^2\right) \leq 0$ then a,b,c,d are in G.P

24. Number of correct statements among the following is k. Then 3k is _____

Statement I: For two given events A and B, $P(A \cap B)$ is not less than P (A) +P (B) -1

Statement II: The number of symmetric relations defined on the set $\{1,2,3,4\}$ which are not reflexive is 20

Statement III: $\lim_{n\to\infty}\left\{\left(a^{\frac{1}{2}} - a^{\frac{1}{3}}\right)\left(a^{\frac{1}{2}} - a^{\frac{1}{5}}\right).....\left(a^{\frac{1}{2}} - a^{\frac{1}{2n+1}}\right)\right\} = o$, if a>1

25. Number of correct statements among the following is k. then 2k is _____

Statement I: Let $A = \{1, 2, 3, 4, 5, 6, 7\}$. Define $B = \{T \subseteq A : \text{either } 1 \notin T \text{ or } 2 \in T\}$ and C={T $\subseteq$ A : the sum of all the elements of 'T' is a prime number}. Then the number of elements in the set $B \cup C$ is 107

Statement II: If sum of n terms of any sequence is a quadratic in 'n', then the sequence is an AP

Statement III: Let $x = (8\sqrt{3} + 13)^{13}$ and $y = (7\sqrt{2} + 9)^9$. If [t] denotes the greatest integer $\leq t$, then $[x] + [y]$ is even

Statement IV: The expression $\left(x + \left(x^3 - 1\right)^{\frac{1}{2}}\right)^5 + \left(x - \left(x^3 - 1\right)^{\frac{1}{2}}\right)^5$ is a polynomial of degree 7

PHYSICS **Max Marks: 100**

SECTION-I (SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

26. A potential difference is applied across the ends of a metallic wire. If the potential difference is doubled, then the drift velocity:

1) will be doubled **2)** will be halfed

3) will be quadrupled **4)** will remain unchanged

27. Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then:

1) negative and distributed uniformly over its surface.

2) negative and appears only at the point on the sphere closest to the point charge

3) negative and distributed non-uniformly over its entire surface of the sphere

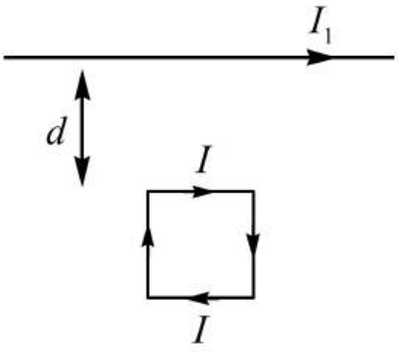
4) zero

28. When a proton is released from rest in a room, it starts with an initial acceleration a_0 towards west. When it is projected towards north with a speed v_0 it moves with an initial acceleration $3a_0$ towards west. The electric and magnetic fields in the room are

1) $\frac{ma_0}{e}\,east, \frac{3ma_0}{ev_0}\,down$ **2)** $\frac{ma_0}{e}\,west, \frac{2ma_0}{ev_0}\,up$

3) $\frac{ma_0}{e}\,west, \frac{2ma_0}{ev_0}\,down$ **4)** $\frac{ma_0}{e}\,east, \frac{3ma_0}{ev_0}\,up$

29. A square loop, carrying a steady current I, is placed in a horizontal plane near a long straight conductor carrying a steady current I_1 at a distance d from the conductor as shown in figure. The loop will experience:



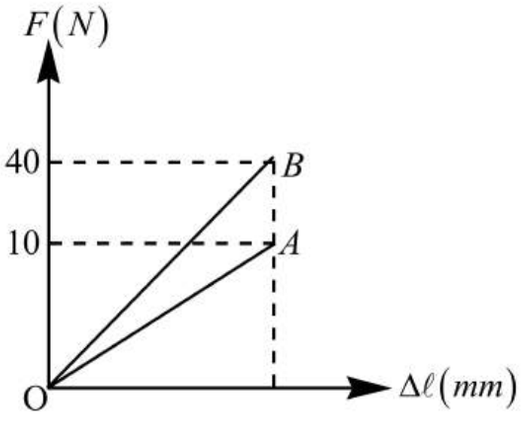
1) A net attractive force towards the conductor

2) A net repulsive force away from the conductor

3) A net torque acting upward perpendicular to the horizontal plane

4) A net torque acting downward normal to the horizontal plane

30. Two wires A and B of same length and made of same material are hanging from the same roof. The figure shows the load F versus extension $\Delta\ell$ graph for the two wires then:



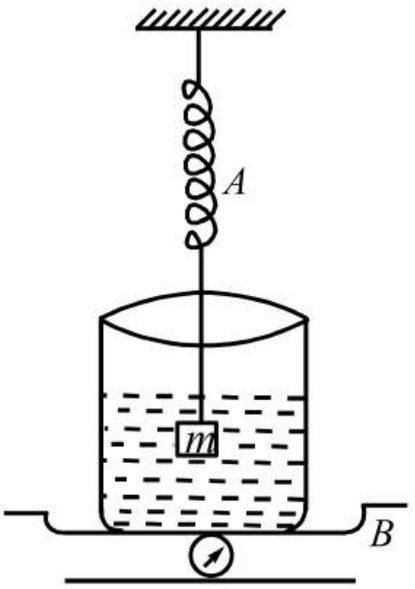
1) The elasticity of wire A is greater than that of B

2) The cross-sectional area of wire A is equal to that of B

3) The ratio of radii of wires A to B is 1:2

4) The ratio of area of cross-section of wires A to B 4:1

31. The spring balance A reads 2kg with a block m suspended from it. A balance B reads 5kg when a beaker with liquid is put on the pan of the balance. The two balances are now so arranged that the hanging mass is inside the liquid in the beaker as shown in the figure in this situation:



1) the balance A will read more than 2kg

2) the balance B will read more than 5kg

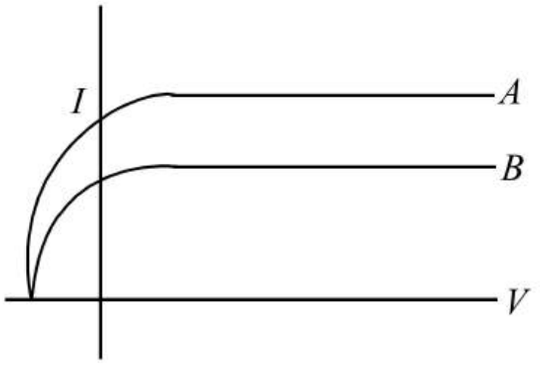
3) the balance A will read less than 2kg and B will read less than 5kg

4) the balances A and B will read 2kg and 5kg respectively

32. A spherical ball falls through viscous medium with terminal velocity v. If this ball is replaced by another ball of the same mass but half the radius, then the terminal velocity will be (neglect the effect of buoyancy):

1) v **2)** 2v **3)** 4v **4)** 8v

33. The graphs show the variation of current I (y-axis) in two photocells A & B as a function of the applied voltage V(x-axis) when light of same frequency is incident on the cell. Which of the following is the correct conclusion drawn from the data?



1) Cathodes of the two cells are made from the same substance, the intensity of light used are different

2) Cathodes are made from different substances and the intensity of light is the same

3) Cathode substances as well as intensity of light are different

4) no conclusion can be drawn

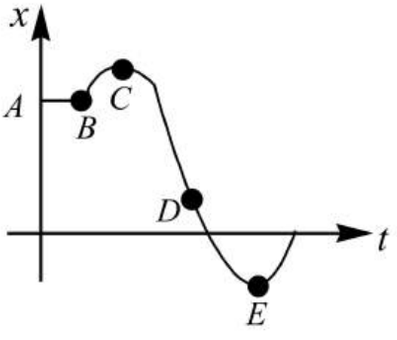
34. For the position (x) -time (t) graph shown of a particle in one dimensional motion. Choose the correct alternatives from below

a) Particle was released from rest at $t = 0$

b) At C particle will reverse its direction of motion

c) Average velocity for motion between B and D is positive

d) At E, velocity = 0 and acceleration > 0



1) a, b **2)** a, b, d **3)** a, d **4)** b, c, d

35. Assertion: The direction of the frictional force on an object is opposite to the actual motion (Kinetic friction) or the impending motion (static friction) of the object relative to the surface with which it is in contact.

Reason: Friction force always opposes the motion

1) Both A and R are true and R is the correct explanation of A

2) Both A and R are true and R is NOT the correct explanation of A

3) A is true but R is false

4) A is false but R is true

36. A plane glass sheet is kept over various coloured pictures. The least raised picture is

1) Green **2)** Yellow **3)** Violet **4)** Red

37. In a reflecting telescope, a secondary mirror is used to

1) remove spherical aberration

2) reduce the problem of mechanical support

3) make chromatic aberration zero

4) move the eyepiece outside the telescope tube

38. One cannot see through fog, more appropriate answer is

1) Fog absorbs all the incident light falling on it

2) Light suffers total reflection at droplets

3) Refractive index of the fog is infinity

4) Light is scattered by the droplets

39. When a body is under pure rolling, the fraction of its total kinetic energy which is purely rotational is $\frac{2}{5}$. Identify the body.

1) Hollow sphere **2)** Sphere **3)** Ring **4)** Disc

40. Two springs have their force constant as k_1 and k_2 $(k_1 > k_2)$. When they are stretched by the same force up to equilibrium

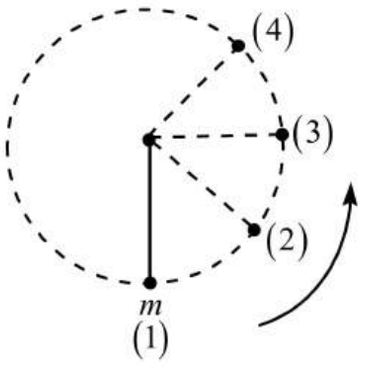
1) No work is done by this force in case of both the springs

2) Equal work is done by this force in case of both the springs

3) More work is done by this force in case of second spring

4) More work is done by this force in case of first spring

41. A particle (bob) of mass 1kg is performing vertical circular motion. Then:



1) Power delivered by tension at point (4) is negative.

2) Power delivered by tension at point (2) is positive.

3) Power delivered by gravitational force at point (3) is zero

4) Power delivered by gravitational force at point (4) is negative

42. Which of the following statements is true about the magnetic susceptibility x_m of paramagnetic substance?

1) Value of x_m is inversely proportional to the absolute temperature of the sample

2) Value of x_m is directly proportional to the absolute temperature of the sample

3) x_m is negative at all temperatures

4) x_m does not depend on the temperature of the sample

43. **Assertion (A):** A small metal ball is charged to a potential of +1 V. It is introduced into a large hollow metal sphere charged to a potential of +10,000V and comes into contact with the inside surface of the sphere. The ball's charge passes to the sphere completely.
Reason (R): Positive charge flows from a body at lower potential to another body at higher potential
1) If both A and R are true and R is correct explanation of A
2) If both A and R are true but R is not the correct explanation of A
3) If A is true but R is false
4) If both A and R are false

44. **Statement-I:** The fundamental frequency of an open organ pipe increases as the temperature is increased.
Statement-II: As the temperature increases, the velocity of sound increases more rapidly than length of the pipe.
1) Statement-I is true, Statement-II is true; Statement-II is correct explanation for Statement-I.
2) Statement-I is true, Statement-II is true; Statement-II is not a correct explanation for Statement-I
3) Statement-I is true, Statement-II is false
4) Statement-I is false, Statement-II is true.

45. The potential of electrostatic field is given by $\phi = xy$, where x & y are coordinate. Which of the following is correct?
1) Electric field at all points on positive x-axis is in positive y-direction.
2) Electric field at all points of positive y-axis is in negative x-direction.
3) Electric field at $(2,2)$ is $\sqrt{2}\,N/m$.
4) Electric field at x, y makes an angle $\theta = \tan^{-1}\left(\frac{y}{x}\right)$ with x-axis

SECTION-II (NUMERICAL VALUE TYPE)

This section contains **5 Numerical Value Type Questions.** The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **Nearest Integer** value (Example i,e. If answer is above **10** and less than **10.5** round off is **10** and If answer is from **10.5** and less than **11** round off is **11**).
Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases

Note:

From: Question number's 41 to 45 rules for Answer marking

If your answer is options 2,4 Then you have to fill the OMR sheet as '24'

If your answer is options 1,3,4 Then you have to fill the OMR sheet as '134'

And if your answer is options 1,2,3,4 then you have to fill the OMR sheet as '1234'

---

46. Hydrogen gas absorbs radiations of wavelength λ_0 and consequently emit radiations of 6 different wavelengths of which three wavelengths are shorter than λ_0. Choose the **CORRECT** statement(s).

1) The final energy state of the atom is $n=4$

2) The initial state of the atom may be $n=2$

3) There are two transitions in balmer series

4) There are three transitions belonging to Lyman series.

47. Select the **CORRECT** statement(s) for a particle performing SHM with angular frequency 'ω'. (in undamped SHM)

1) The displacement is zero in one time period

2) The distance travelled is 2A in one time period

3) Average acceleration is zero in one time period

4) Total energy of system remains constant with time

48. If a satellite orbits as close to the earth's surface as possible

1) Its speed is maximum

2) Time period of its revolution is minimum

3) The total energy of the 'earth plus satellite' system is minimum

4) The total energy of the 'earth plus satellite' system is maximum

49. Number of collisions per second of molecules of a gas on the wall of a container per m^2 will:

1) Increase if temperature and volume both are doubled.

2) Increase if temperature and volume both are halved.

3) Increase if pressure and temperature both are doubled.

4) Increase if pressure and temperature both are halved.

50. Choose the correct statement(s)

1) The density of nuclear matter is independent of the size of the nucleus.

2) The binding energy of nuclei first increases and then decreases as its mass number increases

3) A free neutron is stable

4) A free proton is stable

CHEMISTRY

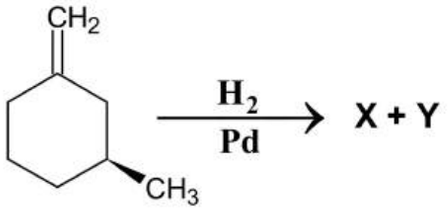
Max Marks: 100

SECTION-I (SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

51. For the following given reaction

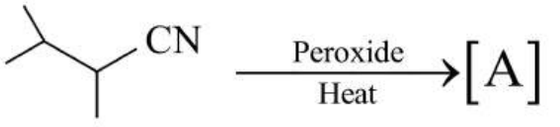


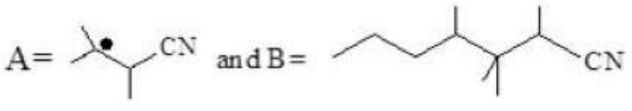
[X] & [Y] are-

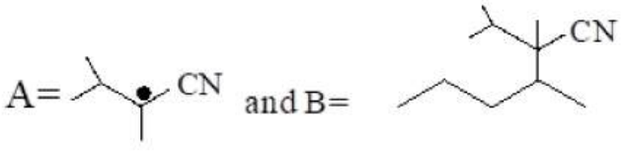
1) Enantiomer of each other **2)** Diastereomer of each other

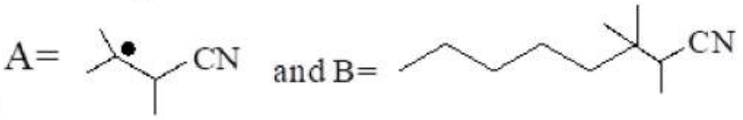
3) Both are meso compounds **4)** Constitutional isomer of each other

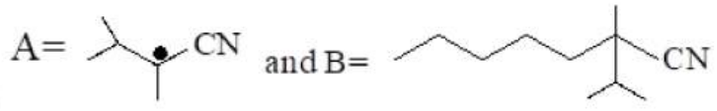
52. The major products A and B in the following reactions are:



1) 

2) 

3) 

4) 

53. Choose the correct option [true or false] for the following compounds

I) In C_2 molecule only π bonds are present

II) In C_2 molecule one π bond and one σ bond is present

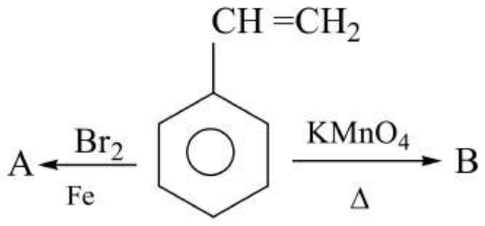
III) C_2 molecule is paramagnetic if s – p mixing is not operative

IV) Correct order of dipolemoment for chloromethanes is

$CCl_4 < CHCl_3 < CH_2Cl_2 < CH_3Cl$

1) TFTT **2)** FTFF **3)** TFTF **4)** TFFF

54.



Compound A and B respectively are :

1) *o* – bromo styrene, benzoic acid **2)** *p* – bromo styrene, benzaldehyde

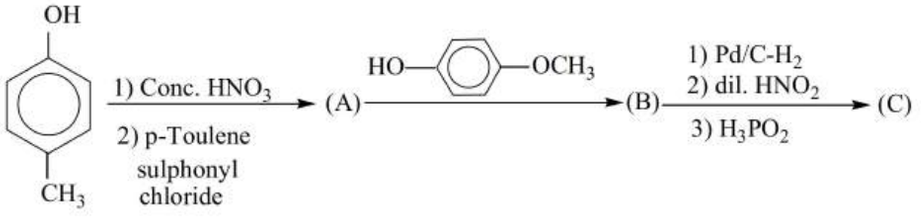
3) *m* – bromo styrene, benzaldehyde **4)** styrene dibromide, benzoic acid

55. The specific conductance of a saturated solution of silver bromide is $k\ Scm^{-1}$. The limiting ionic conductivity of Ag^+ *and* Br^- ions are x and y, respectively. The solubility of silver bromide in gL^{-1} is:

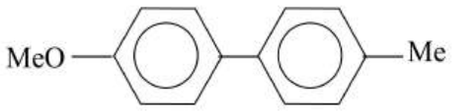
(molar mass of AgBr =188)

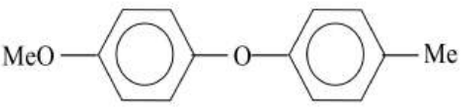
1) $\frac{k\times1000}{x-y}$ **2)** $\frac{k}{x+y}\times188$ **3)** $\frac{k\times1000\times188}{x+y}$ **4)** $\frac{x+y}{k}\times\frac{1000}{188}$

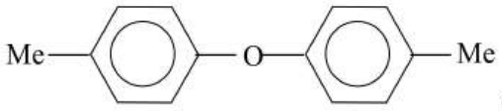
56.

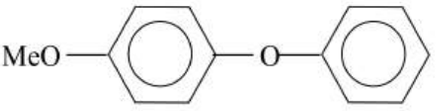


What is the final product (C)?

1) 

2) 

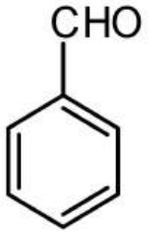
3) 

4) 

57. The degree of dissociation (α) of a weak electrolyte, A_xB_y is related to Vant't Hoff factor (i) by the expression:

1) $\alpha = \frac{i-1}{(x+y-1)}$ **2)** $\alpha = \frac{i-1}{(x+y+1)}$ **3)** $\alpha = \frac{x+y-1}{i-1}$ **4)** $\alpha = \frac{x+y+1}{i-1}$

58. In Cannizaro reaction, correct order of rate of reaction with respect to substrate



is

1) $p-Me_2N < p-NMe_2 < p-alkyl < H < p-Cl < m-Cl < m-NO_2$

2) $p-MeO < p-NMe_2 < p-alkyl < H < m-Cl < m-NO_2 < p-Cl$

3) $p-Me_2N < p-MeO < p-alkyl < H < p-Cl < m-Cl < m-NO_2$

4) $p-MeO < p-NMe_2 < p-alkyl < H < m-NO_2 < m-Cl < p-Cl$

59. The formation of $O_2^+[PtF_6]^-$ is the basis for the formation of xenon fluorides. This is because:

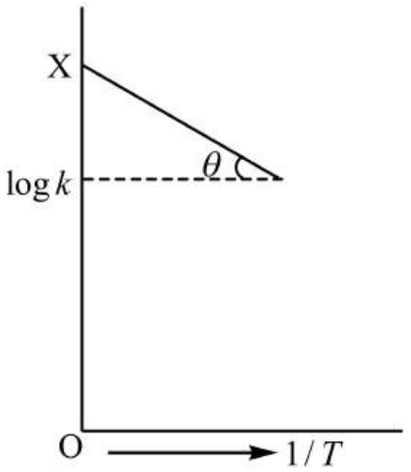
1) O_2 and Xe have comparable sizes

2) both O_2 and Xe are gases

3) O_2 and Xe have comparable ionization energies

4) O_2 and Xe have same electron gain enthalpy

60. Graph between log k and 1/T [k is rate constant (s^{-1}) and T the temperature (K)] is a straight line OX = 5, $\theta = \tan^{-1}(1/2.303)$. Hence $-E_a$ will be



1) $2.303 \times 2\,cal$ **2)** $2/2.303\,cal$ **3)** 2 cal **4)** $\frac{2.303}{2}cal$

61. Assertion:- $Na_2Cr_2O_7$ cannot be used as a primary standard in titrations.

Reason: - $Na_2Cr_2O_7$ is hygroscopic in nature

1) Assertion is True, Reason is true: Reason is the correct explanation for Assertion.

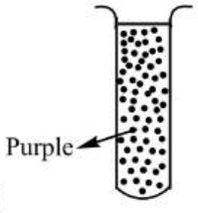
2) Assertion is true Reason is true: Reason is not the correct explanation for Assertion.

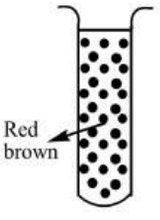
3) Assertion is True, Reason is False.

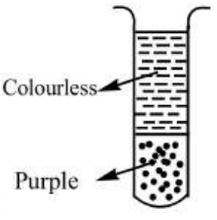
4) Assertion is False, Reason is true.

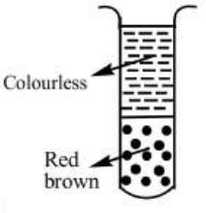
62. A student added aqueous chlorine to aqueous sodium bromide and the resulting mixture was shaken with an equal volume of trichloroethane

Which diagram best represents the observation made?

1)


2)


3)


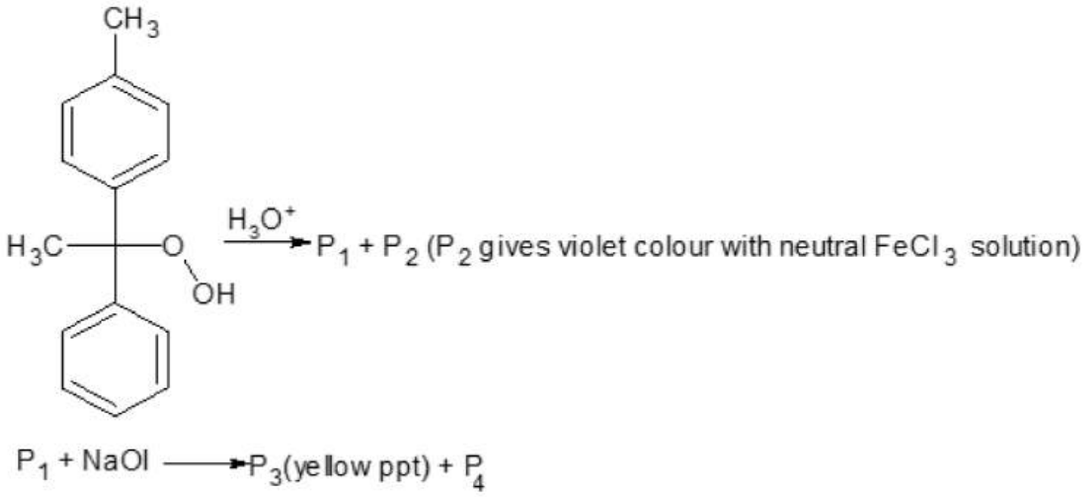
4)


63. Which of the following is the most soluble in water?

1) $Bi_2S_3\left(K_{SP}=1\times10^{-70}\right)$ **2)** $Ag_2S\left(K_{SP}=6\times10^{-51}\right)$

3) $CuS\left(K_{SP}=8\times10^{-37}\right)$ **4)** $MnS\left(K_{SP}=7\times10^{-16}\right)$

64. INCORRECT statement for the below sequence is



1) P_3 on reaction with Ag gives acetylene

2) P_4 on reaction with sodalime gives toluene

3) P_4 on reaction with sodalime gives benzene

4) P_1 on reaction with 2,4-DNP gives coloured compound

65. Match the Column – I and Column – II

	Column – I		Column – II
A)	Hypophosphoric acid	P)	All hydrogens are ionizable in water
B)	Pyrophosphoric acid	Q)	Lewis acid
C)	Boric acid	R)	Monobasic acid
D)	Hypophosphorous acid	S)	sp^3 hybridized central atom

1) A-PS; B-PS; C-QR; D-RS **2)** A-QR; B-PS; C-PQ; D-RS

3) A-PS; B-QR; C-RS; D-S **4)** A-QS; B-PR; C-PQ; D-P

66. Which of the following statements are correct with respect to $[NiCl_4]^{2-}$ and $[Ni(PPh_3)_2Cl_2]$?

1) In both cases Ni undergoes dsp^2 hybridisation

2) $[Ni(PPh_3)_2Cl_2]$ is tetrahedral

3) $[Ni(PPh_3)_2Cl_2]$ is square planar

4) $[NiCl_4]^{-2}$ is square planar

67. Which one of the following order is not in accordance with the property stated against it?

1) $F > Cl > Br > I$: Electro negativity

2) $F_2 > Cl_2 > Br_2 > I_2$: Bond dissociation energy

3) $F_2 > Cl_2 > Br_2 > I_2$: Oxidizing power

4) $HI > HBr > HCl > HF$: Acidic strength

68. For a reversible adiabatic ideal gas expansion $\frac{dP}{P}$ is equal to

1) $\gamma\frac{dV}{V}$ **2)** $-\gamma\frac{dV}{V}$ **3)** $\left(\frac{\gamma}{\gamma-1}\right)\frac{dV}{V}$ **4)** $\frac{dV}{V}$

69. Saturated solution of KNO_3 with agar-agar is used to make 'salt bridge' because:

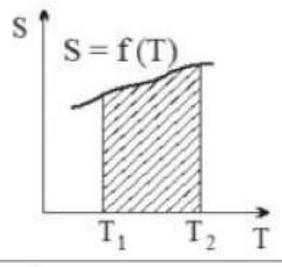
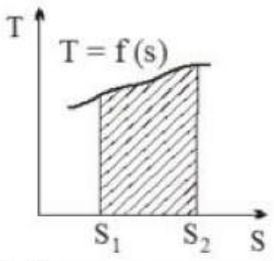
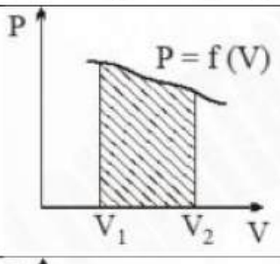
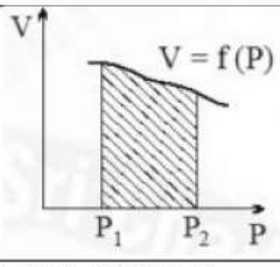
1) size of K^+ is greater than that of NO_3^-

2) velocity of NO_3^- is greater than that of K^+

3) velocities of both K^+ and NO_3^- are nearly the same

4) both velocities and size of K^+ and NO_3^- ions are same

70. Match the Column – I and Column – II

	Column – I (Graphs)		**Column – II (Area shown in the graph represents the magnitude of)**
A)		**P)**	**q**
B)		**Q)**	**w**
C)		**R)**	$(\Delta G)T$
D)		**S)**	$(\Delta G)P$

1) A-S, B-P, C-Q,D-R

2) A-S, B-Q, C-P,D-R

3) A-P, B-R, C-Q,D-S

4) A-R, B-P, C-S,D-R

SECTION-II (NUMERICAL VALUE TYPE)

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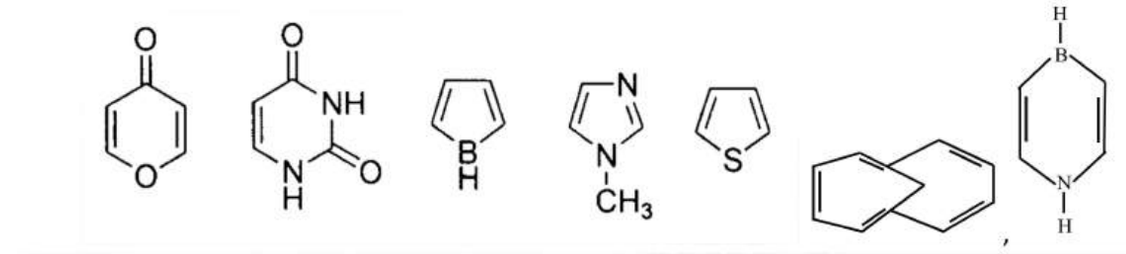
Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases

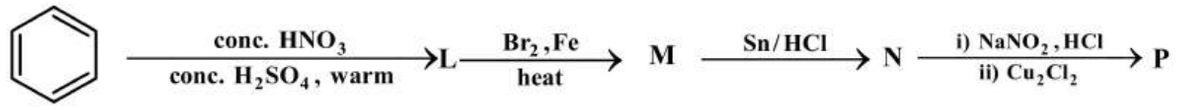
71. Among the following, the number of aromatic compound(s) is.....



72.

The value of (m + n) is

73. The product **P** obtained through the following sequence of reactions



According to **IUPAC** nomenclature, what position will be assign to **chlorine** atom from 1to 6 in product **P**

74. Maximum number of atoms present in a plane in diborane is X. Maximum number of atoms present in a plane in Borazine is Y. Then, what is the value of $\frac{X+Y}{2}$?

(Consider those planes which contain maximum number of atoms)

75. What will be the n-factor of the reactant in the following reaction?

$$Mn(NO_3)_2 \xrightarrow{\Delta} MnO_2 + NO$$

ANSWER KEY

MATHEMATICS

1	**2**	2	**2**	3	**2**	4	**4**	5	**4**
6	**1**	7	**4**	8	**4**	9	**2**	10	**4**
11	**1**	12	**2**	13	**2**	14	**1**	15	**3**
16	**2**	17	**4**	18	**3**	19	**3**	20	**1**
21	**66**	22	**6**	23	**6**	24	**6**	25	**6**

PHYSICS

26	**1**	27	**4**	28	**3**	29	**1**	30	**3**
31	**2**	32	**2**	33	**1**	34	**2**	35	**3**
36	**4**	37	**4**	38	**4**	39	**1**	40	**3**
41	**4**	42	**1**	43	**3**	44	**1**	45	**2**
46	**1234**	47	**134**	48	**123**	49	**23**	50	**124**

CHEMISTRY

51	**2**	52	**2**	53	**1**	54	**4**	55	**3**
56	**2**	57	**1**	58	**3**	59	**3**	60	**3**
61	**1**	62	**4**	63	**4**	64	**2**	65	**1**
66	**2**	67	**2**	68	**2**	69	**3**	70	**1**
71	**6**	72	**4**	73	**3**	74	**9**	75	**4**

SOLUTION
MATHEMATICS

1. Statement-I: $f(x)=x^3$ Not satisfies

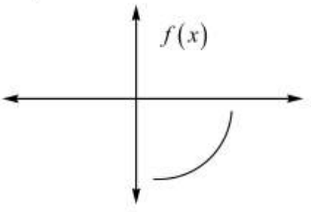
   Statement-II: For odd if $\lim_{x\to 0}$ exists it is 0

   Statement-III: from graph, it is correct

   Statement-IV: $f(x)=\begin{cases}\cos\left(\frac{1}{x}\right) & x\neq 0\\ 0 & x=0\end{cases}$ Not satisfies

2. Statement-II: $f(x)=-x^3$ at x=0 contradiction

   Statement-III: $\left(f^2(x)\right)^1=2f(x)f'(x)=-ve$

   Statement-IV: contradiction

3. $S_1 \to$ Z can be zero

   $S_2, S_3, S_4 \to$ Use properties of complex numbers

4. Let $f: R \to R$ is defined by $f(x)=\left(x^2+\sin x\right)(x-1)$

   Then, $f\left(1^+\right)=f\left(1^-\right)=f(1)=0$

   Let $(fg): R \to R$ is defined by $(fg)(x)=f(x).g(x)$

   Let $(fg)=h(x)=f(x).g(x)$ then $h: R \to R$

   $h'(x)=f'(x)g(x)+f(x)g'(x)$

   If g is differentiable at x=1

   $h'(1)=f'(1)g(1)+0, \quad \left[\because f(1)=0\right]$

   If g(x) is differentiable then h(x) I also differentiable (true)

   If g(x) is differentiable at x=1, then fg is also differentiable at x=1

   If g(c) is continuous at x=1, then $g\left(1^+\right)=g\left(1^-\right)=g(1)$

   $$h'\left(1^+\right)=\lim_{h\to 0^+}\frac{h(1+h)-h(1)}{h}$$

   $$h'\left(1^+\right)=\lim_{h\to 0^+}\frac{f(1+h)g(1+h)-0}{h}=f'(1)g(1)$$

   $$h'\left(1^-\right)=\lim_{h\to 0^+}\frac{f(1-h)g(1-h)-0}{-h}=f'(1)g(1)$$

   $\Rightarrow h(x)=f(x).g(x)$ is differentiable at x=1(True)

   So, If g is continuous at x=1, THEN fg is differentiable at x=1.

Option (b) (d) $h'(1^+)=\lim_{h\to 0^+}\frac{h(1+h)-h(1)}{-h}$

$h'(1^+)=\lim_{h\to 0^+}\frac{f(1+h)g(1+h)}{h}=f'(1)g(1^+)$

$h'(1^-)=\lim_{h\to 0^+}\frac{f(1-h)g(1-h)}{-h}=f'(1)g(1^-)$

$\Rightarrow g(1^+)=g(1^-)$

So, it does not mean that if fg is differentiable at x=1, then fg is continuous or differentiable at x=1

5. Statement-I: Use by parts 2 times
Statement-II: Indefinite integral +c must be kept
Statement-IV: $F(x)=\int \sin^2 x dx=g(x)+c$
$F(x+\pi)=F(x)$ Might not satisfy for every 'c', (also Integral contains linear expression in x)

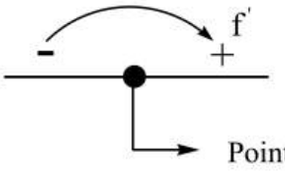
6. Given, $f(x)=\int_0^{x\tan^{-1}x}\frac{e^{t-\cos t}}{1+t^{2023}}dt$

$f'(x)=\frac{e^{x\tan^{-1}x-\cos(x\tan^{-1}x)}}{1+(x\tan^{-1}x)^{2023}}\cdot\left(\frac{x}{1+x^2}+\tan^{-1}x\right)$

For $x<0$, $\tan^{-1}x\in\left(-\frac{\pi}{2},0\right)$

For $x\geq 0$, $\tan^{-1}x\in\left[0,\frac{\pi}{2}\right]$ $\Rightarrow x\tan^{-1}\forall x\in R$

And $\frac{x}{1+x^2}+\tan^{-1}x=\begin{cases}>0 & \text{For } x>0\\ <0 & \text{For } x<0\\ 0 & \text{For } x=0\end{cases}$



i.e Point of minima

So, $f(x)$ is minimum at x=0

Here minimum value is $f(0)=\int_0^0=0$.

$\psi(x)$ and $\phi(x)$ can be negative functions

7. Use definition of Area. $S_1(F), S_2(F)$

8. When $x\in[0,1]$, then $\frac{dy}{dx}+2y=1\Rightarrow y=\frac{1}{2}+C_1e^{-2x}$ $\because y(0)=0\Rightarrow y(x)=\frac{1}{2}-\frac{1}{2}e^{-2x}$

Here, $y(1)=\frac{1}{2}-\frac{1}{2}e^{-2x}=\frac{e^2-1}{2e^2}$

When $x\notin[0,1]$ then $\frac{dy}{dx}+2y=0\Rightarrow C_2=\frac{e^2-1}{2}$

$\because y(1)=\frac{e^2-1}{2}\Rightarrow\frac{e^2-1}{2}=c^2e^{-2}\Rightarrow C_2=\frac{e^2-1}{2}$

$\because y(x)=\left(\frac{e^2-1}{2}\right)e^{-2x}\Rightarrow y\left(\frac{3}{2}\right)=\frac{e^2-1}{2e^3}$

9. $S_1\rightarrow V(ax+b)=a^2V(x)$

$S_2\rightarrow$ mean $(ax\pm b)=a\,mean(X)\pm b$

Mode $(x_1,x_2,.....x_n)=K$

Mode of $(ax_1\pm\alpha,ax_2\pm\alpha,.....ax_n\pm\alpha)=ak\pm\alpha$

central tendencies depend on shift of origin & scaling

Variance depends on scaling but not shift of origin

10. $f-g=x$ $\quad x$ *is rational*

$=-x$ $\quad x$ *is irrational*

11. Use graphs of $\sin^{-1}(\sin x)$ and $\cos^{-1}(\cos x)$

12. Apply Limits & Properties

13. a, b can be irrational

14. $P(X_i>Y_i)+P(X_i<Y_i)+P(X_i=Y_i)=1$

And $P(X_i>Y_i)=P(X_i<Y_i)=p$

For $i=2$ $\quad P(X_2=Y_2)=P(5,5)+P(4,4)=\frac{5}{12}\times\frac{5}{12}\times2+\frac{1}{6}\times\frac{1}{6}$

$=\frac{25}{72}+\frac{1}{36}=\frac{27}{72}=\frac{3}{8}$ $\quad P(X_2>Y)=P(10,0)=\frac{5}{12}\times\frac{5}{12}+\frac{5}{12}\times\frac{1}{6}\times2=\frac{5}{16}$

For $i=3$ $\quad P(X_3=Y_3)=P(6,6)+P(7,7)\quad=\frac{1}{6\times6\times6}+\frac{5}{12}\times\frac{1}{6}\times\frac{5}{12}\times6=\frac{77}{432}$

$P(X_3>Y_3)=\frac{1}{2}\left(1-\frac{77}{432}\right)=\frac{355}{864}$

$III\rightarrow T, IV\rightarrow S$

15. Refer to properties of conics

16. $S_1: a=b=c=0$ Then it is not linear

S2 is obviously True

17. Since, given $|a+b+c|=|a+b-c|$ $\quad|\vec{a}+\vec{b}+\vec{c}|^2=|\vec{a}+\vec{b}-\vec{c}|^2$

$\Rightarrow2\vec{a}\cdot\vec{b}+2\vec{b}\cdot\vec{c}+2\vec{c}\cdot\vec{a}=2\vec{a}\cdot\vec{b}-2\vec{b}\cdot\vec{c}-2\vec{c}\Rightarrow4\vec{a}\cdot\vec{c}=0$ So, (B) is incorrect

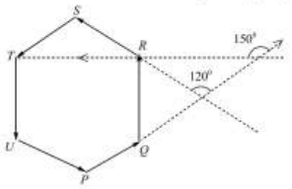
Now, $|\vec{a}+\lambda\vec{c}|^2\geq|\vec{a}|^2$ True $\forall\lambda\in R$ (A) is correct.

$\overrightarrow{PQ}\times\left(\overrightarrow{RS}+\overrightarrow{ST}\right)=\overrightarrow{PQ}\times\overrightarrow{RT}$ (using triangle law)

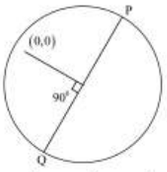
$= \left|\overrightarrow{PQ}\right| \times \left|\overrightarrow{RT}\right| \sin 150 \hat{n} \neq 0 \Rightarrow Statement-1\ is\ true.$

Also, $\overrightarrow{PQ} \times \overrightarrow{RS} = \left|\overrightarrow{PQ}\right| \times \left|\overrightarrow{RS}\right| \sin 120^0 \times \hat{n}_1 \neq 0$

And $\overrightarrow{PQ} \times \overrightarrow{ST} = \left|\overrightarrow{PQ}\right| \times \left|\overrightarrow{ST}\right| \sin 180^0 \times \hat{n}_2 \neq 0 \quad \therefore Statement-2 is\ false$

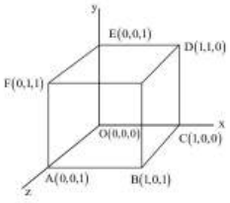


18. $AB = 0 \ |B| \neq 0 \quad AB = 0 \Rightarrow A = 0$
19. Draw graphs
20. Refer P & C synapses Integrated and objective
21. Since area of ΔOCP $\frac{1}{2} \times PC \times \sqrt{5} = \frac{\sqrt{35}}{2}; PC = \sqrt{7}$



$a_1^2 + b_1^2 + a_2^2 + b_2^2 = OP^2 + OQ^2 \quad = 2(5+7) = 24$

22.



Equation of face diagonal OD line is $I_1 : \vec{r} = \lambda\left(\hat{i} + \hat{j}\right)$

Equation of main diagonal BE is $I_2 : \vec{r} = \hat{j} + \mu\left(\hat{i} - \hat{j} + \hat{k}\right)$

Shortest distance $= \left| \frac{j.\left(\hat{i}+\hat{j}\right) \times \left(\hat{i}-\hat{j}+\hat{k}\right)}{\left(\hat{i}+\hat{j}\right) \times \left(\hat{i}-\hat{j}+\hat{k}\right)} \right| \left| \frac{j.\left(\hat{i}-\hat{j}-2k\right)}{\hat{i}-\hat{j}-2\hat{k}} \right| = \frac{1}{\sqrt{6}}$

In other case S.D is zero.

23. Statement-I: Refer to chord properties of conics

Statement -II: $P = \left\{\theta : \sin\theta - \cos\theta = \sqrt{2}\cos\theta\right\} \Rightarrow \sin\theta = \left(\sqrt{2}+1\right)\cos\theta \Rightarrow \tan\theta = \sqrt{2}+1$

$Now, Q = \left\{\theta : \sin\theta + \cos\theta = \sqrt{2}\sin\theta\right\} \Rightarrow \quad \theta = \left(\sqrt{2} - \ \right) \quad \theta \Rightarrow \tan\theta = \frac{1}{\sqrt{2}-1} \times \frac{\sqrt{2}+1}{\sqrt{2}+1}$

$\Rightarrow \quad \theta = \sqrt{2} + \qquad \therefore P = Q \qquad$ Statement -III: $(a-b)^2 + (b-c)^2 + (c-b)^2 = 0$

24. Statement-I: Use addition theorem of probability

Statement-II: Total number of relation both symmetric and reflexive = $2^{\left(\frac{n^2-n}{2}\right)}$

And total number of symmetric relation = $2^{\left(\frac{n^2+n}{2}\right)}$

Then number of symmetric relation which are not reflexive =

$2^{\frac{n(n+1)}{2}} - 2^{\left(\frac{n(n-1)}{2}\right)} = 2^{10} - 2^6 = 1024 - 64 = 960$

25. Apply De morgan's law $(B \cup C)' = B' \cap C'$

Complement of set B containing subsets of A which do not contains 2 but element 1.

And C' is a set containing subsets of A whose sum of elements is not prime.

So, we need to calculate number of subsets of (3, 4, 5, 6, 7} whose sum of elements plus 1 is composite.

Number of 5 elements subset = 1

Number of 4 elements subset which does not include 3 or 7=3

Number of 3 elements subset = 6 (except selecting {3, 4, 5},(3, 6, 7},{4, 5, 7}or{5, 6, 7})

Number of 2 elements subset =7 (except selecting (3, 7}, {4, 6}, {5, 7})

Number of 1 elements subset -3 (except selecting {4} or {6})

Number of 0 elements subset = 1

Here, $=1+3+6+7+3+1=21$

Therefore, $n(B \cup C)$=27-21= 107

Statement-II: $x = \left(8\sqrt{3}+13\right)^{13} = {}^{13}C_0\left(8\sqrt{3}\right)^{13} + {}^{13}C_1\left(8\sqrt{3}\right)^{12}(13)^1 + \ldots\ldots(i)$

$x' = \left(\sqrt{3} - \quad\right)^{13} = {}^{13}C_0\left(\sqrt{\ }\right)^{13} - {}^{13}C_1\left(\sqrt{\ }\right)^{12}(\quad)^1 + \qquad ii$

By (i)-(ii)

$x - x' = \left[{}^{13}C_0\left(\sqrt{3}\right)^{13}(\quad)^1 + {}^{13}C_3\left(\sqrt{3}\right)^{10}(\quad)^3 \quad\right]$

Therefore, $x - x'$ is even integer, hence [x] is even

Now, $y = \left(\sqrt{2} + \quad\right)^9 = {}^9C_0\left(\sqrt{2}\right)^9 + {}^9C_1\left(\sqrt{2}\right)^8(\quad)^1 + {}^9C_2\left(\sqrt{2}\right)^7(\quad)^2 \qquad iv$

By (iii) - (iv)

$y - y' = \left[{}^9C_1\left(\sqrt{2}\right)^8(\quad)^1 + {}^9C_3\left(\sqrt{3}\right)^6(\quad)^3 + \quad\right]$

$y - y'$ = Even integer hence [y] is even

Statement –IV: ns is quadratic without constant term

Statement –V:

Given expression: $\left(x+\sqrt{x^3-1}\right)^5 + \left(x-\sqrt{x^3-1}\right)^5$

We know that using binomial theorem,

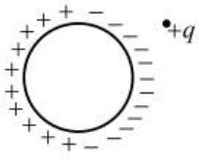
$(x+a)^n + (x-a)^n = 2\left[{}^nC_0x^n + {}^nC_2x^{n-2}a^2 + {}^nC_4x^{n-4}a^4 + \ldots\ldots\right]$

$\therefore$ The given expression $= 2\left[{}^5C_0x^5 + {}^5C_2x^3(x^3-1) + {}^5C_4x(x^3-1)^2\right]$

Since maximum power of x involved in the expansion is 7. Also only +Ve integral powers of x are involved in the expansion, therefore given expression is a polynomial of degree 7.

26. $V_d = \mu E = \frac{\mu.V}{d} \Rightarrow v_d \propto V$. If V (potential difference)

27. Net charge = 0



Net charge = 0

28. Acceleration of charged particle $\vec{a} = \frac{q}{m}\left(\vec{E} + \vec{v} \times \vec{B}\right)$

Released from rest $\Rightarrow \vec{a} = \frac{q}{m}\vec{E} = a_0(west)$ $\Rightarrow \vec{E} = \frac{ma_0}{e}(west)$

When it is projected towards north, acceleration due to magnetic force = $2a_0$

Therefore magnetic field $= \frac{2ma_0}{ev_0}(down)$, Direction of magnetic field $\overrightarrow{F_m} \rightarrow \left(\vec{v} \times \vec{B}\right)$

$-\hat{i} \rightarrow \left(\hat{j} \times -\hat{k}\right)$, The direction of magnetic force is towards west, for that the direction of magnetic field is vertically downward $\left(-\hat{k}\right)$

29. Here $\vec{\tau} = \vec{M} \times \vec{B} = \vec{O}\left(\because \vec{M} \uparrow\uparrow \vec{B}\right)$, Also parallel currents attract each other.

30. As seen from graph, $\Delta\ell_A = \Delta\ell_B \Rightarrow \frac{F_A L_A}{\pi r_A^2 Y_A} = \frac{F_B L_B}{\pi r_B^2 Y_B} \Rightarrow \frac{10 \times L}{\pi r_A^2 \times Y} = \frac{40 \times L}{\pi r_B^2 \times Y} \Rightarrow \frac{r_A}{r_B} = \frac{1}{2}$

31. Balance A read less than 2kg & balance B read more than 5kg due to buoyancy

32. $m = \frac{4}{3}\pi r^3 \rho m$, Keeping m constant, if r is halved, ρ will increased by a factor of 8.

Now, $V_0 \propto r^2\rho$ $V_0^{'} \propto \frac{r^2}{4}(8\rho)\, or\, V'O \propto 2r^2\rho$, Dividing, $\frac{V_0^{'}}{V_0} = 2\, or\, V_0^{'} = 2V_0$ or $V_0^{'} = 2V$

33. Saturation current is different so intensity is different but stopping potential is same and frequency is same so cathode material also same.

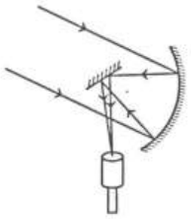
34. Slope of position-time graph gives velocity

35. Frictional force between two surfaces in contact always opposes relative motion between the surfaces in contact

36. $\mu = \frac{\text{Real thickness}(x)}{Apparent\ thickness(y)} \Rightarrow y = \frac{x}{\mu}$, $\frac{y_v}{y_R} = \frac{x}{\mu_v} \times \frac{\mu_R}{x} = \frac{\mu_R}{\mu_v}$, Since $\mu_v > \mu_R$ $\therefore y_R > y_v$

Red colour has maximum apparent thickness. Hence red colour is least raised.

37.



In a reflecting telescope secondary mirror turns light towards eyepiece which is outside the telescope tube

38. Due to scattering of light by water droplets

39. $\frac{Rotational\ K.E}{Total\ K.E} = \frac{2}{5} \Rightarrow \frac{\frac{1}{2}I\omega^2}{\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2} = \frac{2}{5} \quad \Rightarrow \frac{\frac{1}{2}mK^2\omega^2}{\frac{1}{2}mR^2\omega^2 + \frac{1}{2}mK^2\omega^2} = \frac{2}{5}$

$\Rightarrow \frac{K^2}{K^2+R^2} = \frac{2}{5} \Rightarrow K^2 = \frac{2}{3}R^2 \ or\ K = \sqrt{\frac{2}{3}}R$, So it will be hollow sphere

40. $F_1 = F_2 \qquad \because w_1 = \frac{1}{2}k_1x_1^2, \quad k_1x_1 = k_2x_2 = F \qquad w_1 = \frac{1}{2}k_1\left[\frac{F}{k_1}\right]^2 \qquad w_1 = \frac{1}{2}\frac{F^2}{k^1}$

$\therefore w_2 = \frac{1}{2}\frac{F^2}{k^2} \qquad \because k_1 > k_2 \qquad \therefore w_1 < w_2$

41. $P = \vec{F}.\vec{v}$, Tension is always perpendicular to velocity

42. $\left(x_m \propto \frac{1}{T}\right)$ for paramagnetic material

43. Since conducting shells come in contact they have same potential hence will flow to outer shell.

44. $f \propto V \qquad \& V \propto \sqrt{T}$ (where T is Temperature)

45. $E = -y\hat{i} - x\hat{j} \qquad \tan\theta = \frac{E_y}{E_x} = \frac{x}{y}$

46. Since only 6 different wavelengths are excited, therefore highest excited stat is $n-4$.
Two wavelengths are shorter than λ_0, Initially atoms were in excited state $n=2$
Corresponding transitions are $4 \to 3, 4 \to 2, 4 \to 1, 3 \to 2, 3 \to 1, 2 \to 1$.

47. After completion of every one oscillation particle returns to initial point with same velocity which it has initially at that point

48. For (A) : Orbital speed $v_0 = \sqrt{\frac{GM}{r}}$, For (B) : Time period of revolution $T^2 \propto r^3$

For (C/D) : Total energy $= -\frac{GMm}{2r}$

49. No. of collisions per unit area $\propto \frac{1}{time\ between\ two\ collisions \times area}$

$n/A \propto \frac{V_{rms}}{\text{distance b/w walls} \times A} \qquad V_1\ rms \propto \sqrt{T}$, Distance b/w walls x A volume

So $\frac{n}{A} \propto \frac{T^{1/2}}{v}$, If both T and V are halved, $\frac{n}{A}$ increases.

50. According to the standard Model, free protons are stable particles because their spontaneous decay has never been observed.
Free neutrons are unstable and decay into a proton, an electron, and an antineutrino through a process called beta decay.

CHEMISTRY

51. Key-2
Sol: Diastereomer of each other
52. Key: 2

Sol: (A) is more stable radical and undergoes Markovnikov addition to form (B)

53. I,III,IV are statements are Correct
54. KEY-4
55. $\Lambda_m = \frac{k}{M} \times 1000; (x+y) = \frac{k}{M} \times 1000$

$$\Rightarrow M = \frac{1000 \times k}{(x+y)}$$

Solubility $\left(in\ gL^{-1}\right) = \frac{k \times 1000 \times 188}{x+y}$

56. H_3PO_2 reduces diazonium salt into benzene derivative.
57. KEY-1

SOL. $A_x B_y \rightarrow xA^{y+} + yB^{x-}$

$1-\alpha \quad x\alpha \quad y\alpha$

$i = 1 - \alpha + x\alpha + y\alpha$

$\alpha = \frac{i-1}{(x+y-1)}$

58. KEY-3
SOL. : Cannizaro reaction

59. O_2 and Xe have comparable ionization energies
60. KEY-3

SOL. $\log k = \log A - \frac{E_a}{2.303RT} (y = c + mx)$

Slope $= \frac{-E_a}{2.303R} = \frac{1}{2.303} (given) \left(\tan\theta = \frac{1}{2.303} \right)$

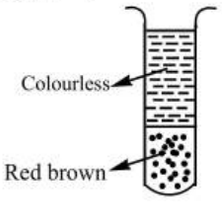
$-E_a = 2.303R \times slope$

$= 2.303 \times \frac{R}{2.303} = R = 2cal$

61. $Na_2Cr_2O_7$ is hygroscopic and that is why, it is not used as a primary standard in volumetric analysis.

62. KEY-4

SOL.



$Cl_2 + 2NaBr \rightarrow Br_2 + 2NaCl$

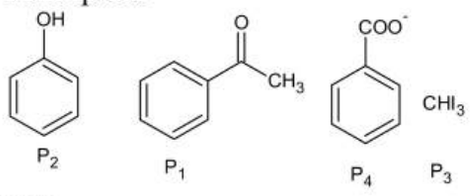
Cl_2 oxidises Br^- to Br_2 in trichloro ethane is reddish brown in colour. Two layers are observed as trichloro ethane is immisible with water.

63. KEY-4

SOL. Solubility is directly proportional to K_{Sp}. MnS has highest K_{Sp} anong the given substances and hence has highest solubility

64. KEY-2

SOL. Conceptual



65. KEY-1

66. Key-2

sol. Cl^- is weak ligand so no pairing of electrons take palce. so $[NiCl_4]^{-2}$ is tetrahedral. pph_3 group is bulkier one so it favours tetrahedral geometry, through pph_3 is strong field ligand.

67. KEY-2

SOL: (b) Bond dissociation energy orders

Cl_2 > Br_2 > F_2 > I_2

242.6 192.8 158.8 151.1 kj/mol

68. $PV^{\gamma} = K\ (K\ is\ \text{constant})$ $dPV^{\gamma} + P\gamma V^{\gamma-1}dV = 0$

$\frac{dP}{P} - \frac{\gamma V^{\gamma-1}}{V^{\gamma}}dV$ $\frac{dP}{P} = -\gamma\frac{dV}{V}$

69. KEY-3

70. KEY-1

71. KEY-6

SOL: CONCEPTUAL

72. pair of diastereomers is formed (m), therefore, two fractions are obtained

73. P= 1-Bromo 3-chloro Benezen

74. KEY-9

SOL. $B_2H_6 - 6 = x$ $B_3N_3H_6 - 12 = y$

$\frac{x+y}{2} = \frac{18}{2} = 9$

75. n-factor = 4