JEE MAIN 2026

Sample Paper - 16

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)

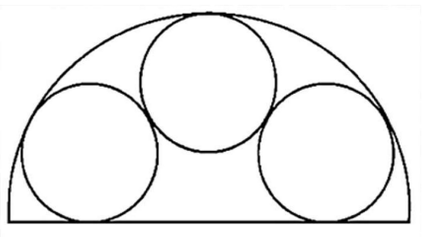
This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

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

1. *If* $\int \frac{2\sec x \tan x}{(\sec x - \tan x)^{10}} dx = (\sec x + \tan x)^{11}\left[p(\sec x - \tan x)^2 + q\right] + c$ *then* $\left(\frac{1}{p} + \frac{1}{q}\right)$ is equal to (where'c'is constant of integration)

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

2. Three identical circles, each of radius x, are drawn as shown in figure and tangent to a semi circle of radius a, then x in terms of a?



1) $\frac{a}{4}$ **2)** $\frac{a}{2}$ **3)** $\frac{a}{3}$ **4)** $\frac{2a}{3}$

3. The length of the latus rectum of the parabola $169\left[(x-1)^2 + (y-3)^2\right] = (5x - 12y + 17)^2$ *is*

1) $\frac{14}{13}$ **2)** $\frac{28}{13}$ **3)** $\frac{12}{13}$ **4)** $\frac{16}{13}$

4. A chord of the circle $x^2 + y^2 - 4x - 6y = 0$ passing through origin subtends an angle $\tan^{-1}(7/4)$ at the point where the circle meets positive y-axis, then equation of the chord is

1) $2x + 3y = 0$ **2)** $x + 2y = 0$ **3)** $x - 2y = 0$ **4)** $2x - 3y = 0$

5. If the system of equations $2x - y + z = 0, x - 2y + z = 0$ and $ax - y + 2z = 0$ has infinitely many solutions and $f(x)$ be a continuous function such that $f(5+x) + f(x) = 2 \forall x \in R,$ then $\int_0^{-2a} f(x)dx$ is equal to:

1) -10 **2)** -4a

3) $\int_0^a [x]dx$ [where [x] denotes G.I.F of x] **4)** 2a

6. For $x \geq 0$, the least value of a, for which $5^{1+x}+5^{1-x}, \frac{a}{2}, 25^{x}+25^{-x}$ are three consecutive terms of an A.P., is equal to:

1) 8 **2)** 12 **3)** 10 **4)** 16

7. $If\ f(x)=\begin{vmatrix} \cos x & x & 1 \\ 2\sin x & x^2 & 2x \\ \tan x & x & 1 \end{vmatrix}.then\ \lim_{x\to 0}\frac{f'(x)}{x}$ is equal to

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

8. If a,b,c are real numbers satisfying

$$\begin{vmatrix} (a^2+1)^2 & (ab+1)^2 & (ac+1)^2 \\ (ab+1)^2 & (b^2+1)^2 & (bc+1)^2 \\ (ac+1)^2 & (bc+1)^2 & (c^2+1)^2 \end{vmatrix} = k(a-b)^2(b-c)^2(c-a)^2 \ then\ k =$$

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

9. If $g(x)=\begin{cases} \frac{x\left(3e^{1/x}+4\right)}{2-e^{1/x}}, & x\neq 0 \\ 0 & x=0 \end{cases}$, then f(x) is

1) Continuous as well as differentiable at x=0

2) Continuous but not differentiable at x=0

3) Differentiable but not continuous at x=0

4) Discontinous every where

10. The equations of the sides AB, BC and CA of a triangle ABC are:

$2x+y=0, x+py=21a, (a\neq 0)\ and\ x-y=3$ respectively. Let P(2, a) be the centroid of $\Delta ABC.\ Then\ (BC)^2$ is equal to

1) 25 **2)** 36 **3)** 121 **4)** 122

11. Statement-1: The sum of rational terms in $\left(\sqrt{2}+\sqrt[3]{3}+\sqrt[6]{5}\right)^{10}$ *is* 1262

Statement-2: The number of irrational terms in the expansion of $\left(5^{1/6}+2^{1/8}\right)^{100}$ is 97

The correct statements among the following are

1) Statement-1 is true, statement-2 is true

2) Statement-1 is true, statement 2 is false

3) Statement-1 is false, statement 2 is true

4) Statement-1 is false, statement-2 is false

12. The length of perpendicular drawn from P(1,2,3) to the line $\frac{x-6}{3}=\frac{y-7}{2}=\frac{z-7}{-2}$ *is*

1) 9 **2)** 14 **3)** 7 **4)** 21

13. Nine balls of the same size and colour, numbered 1,2,….9, were put into an Urn. Now A draws a ball from Urn, noted that it is of number x, and puts it back. Then B also drawn a ball from the Urn and noted that it is of number y. Then probability that the inequality $x-2y+10>0$ to hold is

1) $\frac{52}{18}$ **2)** $\frac{59}{81}$ **3)** $\frac{60}{81}$ **4)** $\frac{61}{81}$

14. The Solution of the differential equation $\left(1+x^3\right)\frac{dy}{dx}+3x^2y+\cos^2 x-1=0$

1) $y\left(1+x^3\right)=\frac{x}{2}-\frac{1}{4}\sin 2x+C$ **2)** $y\left(1+x^3\right)=\frac{x}{2}+\frac{1}{4}\sin 2x+C$

3) $y\left(1+x^3\right)=\frac{x}{4}-\frac{1}{2}\sin 2x+C$ **4)** $y\left(1-x^3\right)=\frac{x}{2}-\frac{1}{4}\sin 2x+C$

15. Let $R=\left\{(a,b)\,|\,a-b\ \textit{is irrational}\ :a,b\ \textit{are real number}\right\}$, then relaltion R is

1) reflexive and symmetric relation **2)** transitive and symmetric

3) symmetric relation **4)** equivalence relation

16. The range of λ for which the line $z(1-\lambda i)-\bar{z}(1+\lambda i)=0$ divides two chords drawn from point $z_1=\sqrt{3}+i$ to the curve $|z|=2$ in the ratio 1:2 is

1) $\left(0,\sqrt{3}\right)$ **2)** $(1,2)$ **3)** $\left(\frac{1}{\sqrt{3}},1\right)$ **4)** $\left(0,\frac{1}{\sqrt{3}}\right)$

17. The number of real solutions of the equation $\sqrt{+\cos 2x} = \sqrt{2}\cos^{-1}(\cos x)\, in\, \left[\frac{\pi}{2}, \pi\right]$ is

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

18. Let the director circle of the hyperbola $H: \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1\ (a > b)$ be denoted by C_1 and let director circle of ellipse $E: \frac{x^2}{a^2} + \frac{y^2}{b^2} = \frac{1}{3}\ (a > b)$ be denoted by C_2 and C_2 is also the director circle of C_1 and let e_1 and e_2 be the eccentricities of the ellipse E and hyperbola H respectively. Then $\frac{e_2^2}{e_1^2}$ is equal to

1) 18 **2)** 12 **3)** 6 **4)** 24

19. $\sum_{i=1}^{10}(x_i - 5) = 5\ and\ \sum_{i=1}^{10}(x_i - 5)^2 = 125,$ variance of $x_1, x_2, ...x_{10}$ will be

1) $\frac{9}{4}$ **2)** $\frac{25}{4}$ **3)** $\frac{49}{4}$ **4)** $\frac{81}{4}$

20. Given that $x + y + z + t = 30$. Match the number of solutions to this equation in List-2 with constraints placed on x, y, z, t in List-1

List-I		List-II	
P)	$x, y, z, t \in I; x \geq -1, y \geq 3, z \geq 5, t \geq 0$	I)	585
Q)	$x, y, z, t \in I; x \geq 0, 2 \leq y \leq 7, 4 \leq z \leq 8, t \geq 1$	II)	680
R)	$x, y, z, t \in W$ *and* x, y *are odd while* z, t *are even*	III)	816
S)	$x, y, z, t \in N$ *and* t *is a multiple of* 5	IV)	580
		V)	2600

The correct option is:

1) $P \to (V), Q \to (I), R(II), S \to (IV)$ **2)** $P \to (I), Q \to (V), R(III), S \to (II)$

3) $P \to (II), Q \to (V), R(III), S \to (I)$ **4)** $P \to (III), Q \to (V), R(IV), S \to (IV)$

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 $f(x)=Max\left\{x^2,(1-x)^2,2x(1-x)\right\}$ where $0\le x\le 1,$ if the area of the region bounded by the curves $y=f(x),x-axis,x=0 and\ x=1\ is\ \frac{p}{q} then\ p+q$ __ (H.C.F of p,q is 1)

22. Let N denotes the sum of the numbers obtained when two dice are rolled. If the probability that $2^N<N!\ is\ \frac{m}{n},$ where m and n are coprime, then 4m-3n is equal to

23. If $2\sin\alpha\sin\beta+3\cos\beta+5\cos\alpha\sin\beta=\sqrt{38}\ \forall\alpha,\beta\in R, then$ $\det(adj(adjA))$ is equal to (where $A=\begin{bmatrix}\tan\beta & -\frac{1}{3}\\ 1 & \sin\alpha\end{bmatrix} is$ equal to__

24. Let $f:R\to R$ be defined as $f(x)=(2x-3\pi)^3+\frac{4x}{3}+\cos x\ and\ g=f^{-1}$ then the value of $7g'(2\pi)+3g''(2\pi)$ (where g' and g'' represent the 1st and 2nd order derivatives of g) is _____

25. Let $\vec{a}=-\hat{i}+\hat{j}+\hat{k},\vec{b}=2\hat{i}+\hat{k}$ and vector $\vec{c}$ satisfying conditions $(i)\left[\vec{a}\ \vec{b}\ \vec{c}\right]=0$ $(ii)\vec{b}.\vec{c}=$ $\vec{a}.\vec{c}.=7$. Then the value of $\frac{2}{7}|\vec{c}|^2$ is equal to

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. **STATEMENT-1:** A block of mass *m* starts moving on a rough horizontal surface with a velocity *v*. It stops due to friction between the block and the surface after moving through a certain distance. The surface is now tilted to an angle of 30^0 with the horizontal and the same block is made to go up on the surface with the same intial velocity *v*. The decrease in the mechanical energy in the second situation is smaller than that in the first situation.
STATEMENT-2: The coefficient of friction between the block and the surface decreases with the increase in the angle of inclination.
1) Statement-1 is True,statement-2 is True; statement-2 is a correct explanation for statement-1
2) Statement-1 is True,Statement-2 is True; Statement-2 is NOT a correct expalanation for statement-1
3) Statement-1 is True, statement-2 is False
4) Statement-1 is False, statement-2 is True

27. Given below are two statements one is labeled as Assertion (A) and other is labeled as Reason (R)

Assertion (A) : When a block is placed in a lift which is accelerating upwards then the body experiences the following three forces

(A) Weight (Mg) (B) Normal reaction (N) and

(C) Pseudo force (Ma) if 'a' is acceleration of lift

Reason (R) : Pseudo force is applied on a body only when the body is seen from an accelerated observer.

In the light of the above statements, choose the most appropriate answer from the options given below :
1) Both (A) and (R) are correct and (R) is the correct explanation of (A)
2) Both (A) and (R) are correct and (R) is not the correct explanation of (A)
3) (A) is correct but (R) is not correct
4) (A) is not correct but (R) is correct

28. **STATEMENT-1**: The stream of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down.

STATEMENT:-2: In any steady flow of an incompressible fluid, the volume flow rate of the fluid remains constant.

1) Statement-1 is True, statement-2 is True; statement-2 is a correct explanation for statement-1

2) Statement-1 is True, statement-2 is True; Statement-2 is NOT a correct expalanation for statement-1

3) Statement-1 is True, statement-2 is False

4) Statement-1 is False, statement-2 is True

29. Match the List-I with List-II and select the correct answer using the codes given below the list

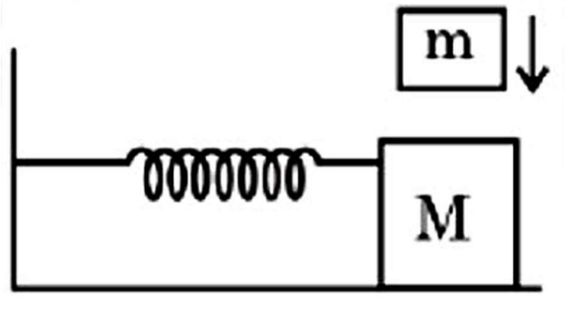
List-I	**List-II**
A. Boltzmann constant	**I.** $\left[ML^2T^{-1}\right]$
B. Coefficient of viscosity	**II.** $\left[ML^{-1}T^{-1}\right]$
C. Planck constant	**III.** $\left[MLT^{-3}K^{-1}\right]$
D. Thermal conductivity	**IV.** $\left[ML^2T^{-2}K^{-1}\right]$

Choose the correct answer from the options given below

1) A-III,B-I,C-II,D-IV **2)** A-III,B-II,C-I,D-IV

3) A-IV,B-II,C-I,D-III **4)** A-IV,B-I,C-II,D-III

30. Molten-wax of mass m drops on a block of mass M, which is oscillating on a frictionless table as shown. Select the **CORRECT** statements.



I) If the collision takes place at extreme position, amplitude does not change

II) If the collision takes place at mean position, amplitude decreases

III) If the collision takes place at mean position, time period increases

IV) If the collision takes place at extreme position, time period increases

Options:-

1) Only (I), (II) **2)** Only (II), (III)

3) Only (I), (IV) **4)** All (I), (II), (III), (IV)

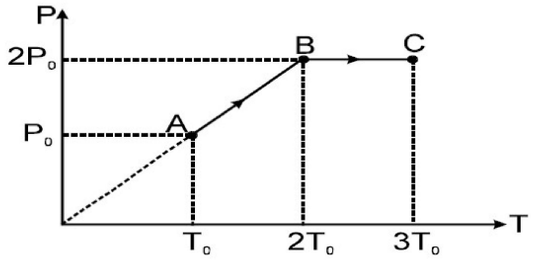
31. The centres of the turns of a toroid form a circle with a radius of 14.0 cm. The crosssectional area of each turn is $3.00cm^2$. It is wound with 5278 turns of fine wire, and the wire carries a current of 4.00 A. The core is filled with a paramagnetic material of magnetic susceptibility 2.90×10^{-4} What would the magnitude of the magnetic field within the substance?

1) 12.6 mT **2)** 30.16 mT **3)** 10.6 mT **4)** 16.6 mT

32. A charge of $4\,\mu$ C is to be divided into two parts . The distance between the two divided charges is constant. The magnitude of the divided charges so that the force between them is maximum, will be:

1) $1\mu C \text{ and } 3\mu C$ **2)** $2\mu C \text{ and } 2\mu C$ **3)** $0 \text{ and } 4\mu C$ **4)** $1.5\mu C \text{ and } 2.5\mu C$

33. One mole of ideal diatomic gas is taken from state $A\to B\to C$ as shown in P-T diagram. The total heat absorbed by the gas in the complete process is

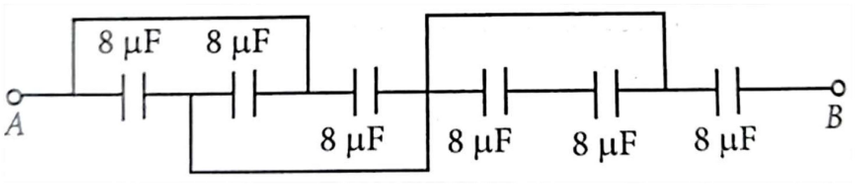


1) $2RT_0$ **2)** $3RT_0$ **3)** $4RT_0$ **4)** $6RT_0$

34. Two identical spherically symmetric planets, each of mass M, are somehow held at rest with respect to each other. Each planet has radius R, and the distance between the centers of the planets is 4R. If a rocket is launched from the surface of one planet with speed v, what is the minimum speed v so that the rocket can reach the other planet?

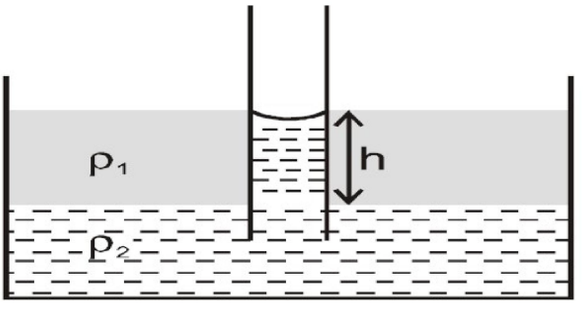
1) $\sqrt{\frac{2GM}{R}}$ **2)** $\sqrt{\frac{GM}{R}}$ **3)** $\sqrt{\frac{3GM}{4R}}$ **4)** $\sqrt{\frac{2GM}{3R}}$

35. The equivalent capacitance between points A and B in below shown figure will be



1) $6\mu F$ **2)** $\frac{32}{3}\mu F$ **3)** $32\mu F$ **4)** $2\mu F$

36. A container is partially filled with a liquid of density ρ_2. A capillary tube of radius r is vertically inserted in this liquid. Now another liquid of density $\rho_1\left(\rho_1 < \rho_2\right)$ is slowly poured in the container to a height h as shown. There is only denser liquid in the capillary tube. The rise of denser liquid in the capillary tube is also h. Assuming zero contact angle, the surface tension of heavier liquid is



1) $r\rho_2 gh$ **2)** $2\pi r\rho_2 gh$ **3)** $\frac{r}{2}\left(\rho_2-\rho_1\right)gh$ **4)** $2\pi r\left(\rho_2-\rho_1\right)gh$

37. A hydrogen atom in an excited state emits a photon which has the longest wavelength of the Paschen series. Further emissions from the atom cannot include the

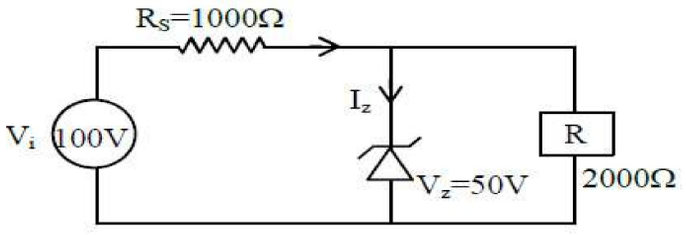
1) Longest wavelength of the Lyman series

2) Second longest wavelength of the Lyman series

3) Longest wavelength of the Balmer series

4) Second longest wavelength of the Balmer series

38. For the circuit shown below, calculate the value of I_z:



1) 25 mA **2)** 15 mA **3)** 10 mA **4)** 50 mA

39. In Young's double slit experiment, if we increase the separation between the plane of slits and the screen by keeping everything constant, then

1) Intensity of central maxima will increase but fringe width will decrease

2) Intensity of central maxima will decrease but fringe width will increase

3) Both intensity of central maxima and fringe width will increase

4) Both intensity of central maxima and fringe width will decrease

40. **STATEMENT-1**:Two cylinders, one hollow (metal) and the other solid (wood) with the same mass and identical dimensions are simultaneously allowed to roll without slipping down an inclined plane from the same height. The hollow cylinder will reach the bottom of the inclined plane first.

and

STATEMENT-2: By the principle of conservation of energy, the total kinetic energies of both the cylinders are identical when they reach the bottom of the incline.

1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1

2) Statement-1 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement-2

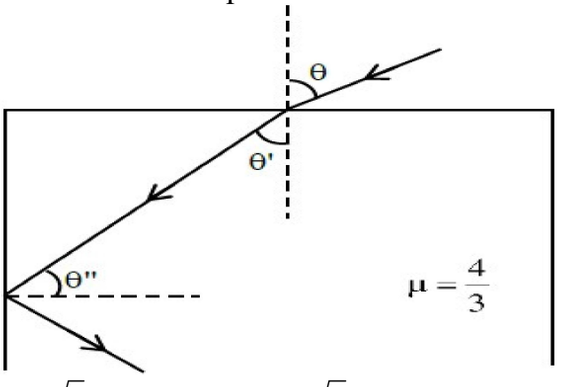
3) Statement-1 is True, Statement-2 is False

4) Statement-1 is False, Statement-2 is True

41. Two particles of equal mass m have respective initial velocities $u\,\hat{i}$ *and* $u\left(\frac{\hat{i}+\hat{j}}{2}\right)$. They collide completely inelastically. The energy lost in the process is

1) $\frac{3}{4}mu^2$ **2)** $\sqrt{\frac{2}{3}}mu^2$ **3)** $\frac{1}{3}mu^2$ **4)** $\frac{1}{8}mu^2$

42. A ray of light entering from air into a denser medium of refractive index $\frac{4}{3}$,as shown in figure. The light ray suffers total internal reflection at the adjacent surface as shown. The maximum value of angle θ should be equal to :



1) $\sin^{-1}\frac{\sqrt{7}}{3}$ **2)** $\sin^{-1}\frac{\sqrt{5}}{4}$ **3)** $\sin^{-1}\frac{\sqrt{7}}{4}$ **4)** $\sin^{-1}\frac{\sqrt{5}}{3}$

43. A nucleus with mass number 184 initially at rest emits an $\alpha-$particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the $\alpha-$ particle.

1) $5MeV$ **2)** $5.5MeV$ **3)** $0.12MeV$ **4)** $5.38MeV$

44. The magnetic flux through a coil perpendicular to its plane is varying according to the relation $\phi=\left(5t^3+4t^2+2t-5\right)$ Weber. If the resistance of the coil is 5 ohm, ,then the induced current through the coil at $t=2$ sec will be :

1) 15.6A **2)** 16.6A **3)** 17.6A **4)** 18.6A

45. An object of mass m is projected with a momentum p at an angle θ with the horizontal such that its maximum height (H) is half of its Range (R). Minimum kinetic energy of the particle in its path will be

1) $\frac{p^2}{8m}$ **2)** $\frac{3p^2}{4m}$ **3)** $\frac{p^2}{10m}$ **4)** $\frac{p^2}{5m}$

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

46. A plane electromagnetic wave travelling in non–magnetic medium is given by

$$E = \left(9\times10^{8}\, NC^{-1}\right)\sin\left[\left(9\times10^{8}\, rads^{-1}\right)t - \left(6m^{-1}\right)x\right]$$

where x is in metre and t is in seconds. The dielectric constant of the medium is_____

47. In an LCR series circuit, an inductor 30 mH and a resistor 1 Ω are connected to an AC source of angular frequency 300 rad/s. The value of capacitance for which, the current leads the voltage by 45^0 *is* $\frac{1}{x}\times10^{-3}F$. Then the value of x is ____.

48. A certain metallic surface is illuminated by monochromatic radiation of wavelength λ. The stopping potential for photoelectric current for this radiation is $3V_0$. If the same surface is illuminated with a radiation of wavelength 2λ, the stopping potential is V_0. The threshold wavelength of this surface for photoelectric effect is_____ λ.

49. A system consists of two types of gas molecules A and B having same number density $2\times10^{25}/m^3$. The diameter of A and B are 10 Å and 5 Å respectively. They suffer collision at room temperature. The ratio of average distance covered by the molecule A to that of B between two successive collision is ____$\times10^{-2}$

50. An organ pipe 40 cm long is open at both ends. The speed of sound in air is 360 ms^{-1}. The frequency of the second harmonic is ___Hz.

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. A gas mixture of 3 litres of propane (C_3H_8) and butane (C_4H_{10}) on complete combustion at 25^0 C produced 10 litre CO_2. Find out the composition of gas mixture (propane:Butane)

1) 2:1 **2)** 1:2 **3)** 1.5:1.5 **4)** 0.5:2.5

52. If λ_0 and λ be threshold wavelength and wavelength of incident light, the velocity of photoelectrons ejected from the metal surface is :

1) $\sqrt{\frac{2h}{m}(\lambda_0-\lambda)}$ **2)** $\sqrt{\frac{2hc}{m}(\lambda_0-\lambda)}$

3) $\sqrt{\frac{2hc}{m}\left(\frac{\lambda_0-\lambda}{\lambda\lambda_0}\right)}$ **4)** $\sqrt{\frac{2h}{m}\left(\frac{1}{\lambda_0}-\frac{1}{\lambda}\right)}$

53. The formation of the oxide ion $O^{2-}(g)$, from oxygen atom requires first an exothermic and then an endothermic step as shown below:

$O(g)+e^- \rightarrow O^-(g); \Delta_1 H^o = -141 kJ\ mol^{-1}$

$O^-_{(g)}+e^- \rightarrow O^{-2}_{(g)}, \Delta_2 H^o = +780 kJ\ mol^{-1}$

Thus process of formation of O^{-2} in gas phase is unfavourable even though O^{2-} is isoelectronic with neon. It is due to the fact that

1) electron repulsion out weighs the stability gained by achieving noble gas configuration

2) O^- ion has comparatively smaller size than oxygen atom

3) Oxygen is more electronegative

4) Addition of electron in oxygen results in larger size of the ion.

54. Among the following ions, the $p\pi - d\pi$ overlap could be possible in

1) NO_3^- **2)** PO_4^{3-} **3)** CO_3^{2-} **4)** NO_2^-

55. Bond enthalpies of H_2, X_2 *and* HX are in the ratio 2:1:2, if enthalpy of formation of HX *is* $-50 kJ\ mol^{-1}$, the bond enthalpy of X_2 is ?

1) $100 kJ\ mol^{-1}$ **2)** $300 kJ\ mol^{-1}$ **3)** $200\ kJ\ mol^{-1}$ **4)** $400 kJ\ mol^{-1}$

56. Concentration of Ag^+ ions in a saturated solution of Ag_2CrO_4 *is* $2.2\times10^{-4}\ mol\ L^{-1}$. Solubility product of Ag_2CrO_4 *is* :–

1) 2.66×10^{-12} **2)** 4.5×10^{-11} **3)** 5.3×10^{-12} **4)** 2.42×10^{-8}

57. 25.3g of sodium carbonate, Na_2CO_3 is dissolved in enough water to make 250 mL of solution. If sodium carbonate dissociates completely, molar concentration of sodium ions, $\left(Na^+\right)$and carbonate ions, $\left(CO_3^{2-}\right)$ respectively are (Molar mass of $Na_2CO_3 = 106g\ mol^{-1}$)

1) 0.955 M and 1.910M **2)** 1.910 M and 0.955 M

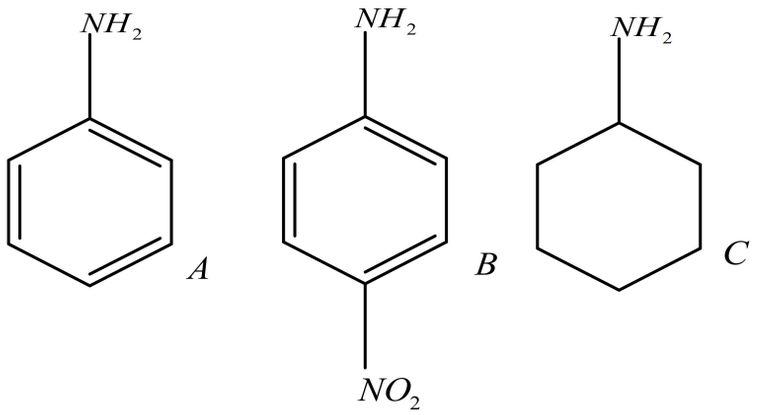
3) 1.90 M and 1.910 M **4)** 0.477 M and 0.477 M

58. Benzene reacts with n-propyl chloride in the presence of anhydrous $AlCl_3$ to give

1) 3 – Propyl-1- chlorobenzene **2)** n-Propylbenzene

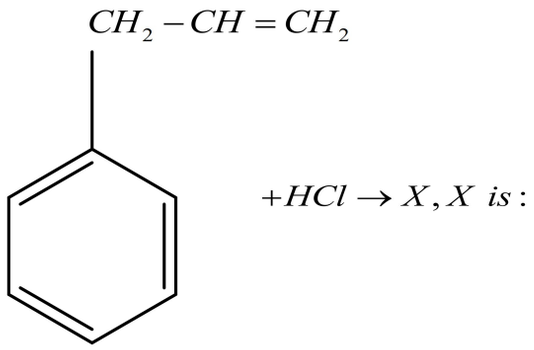
3) No reaction **4)** Isopropylbenzene

59. The correct order of basicity of the following compounds



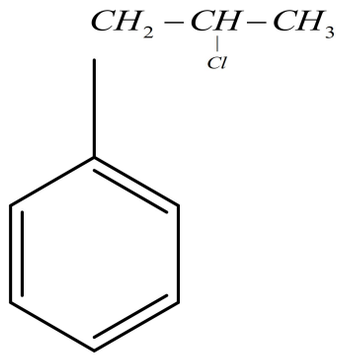
1) $B > A > C$ **2)** $A > B > C$ **3)** $C > A > B$ **4)** $C > B > A$

60.

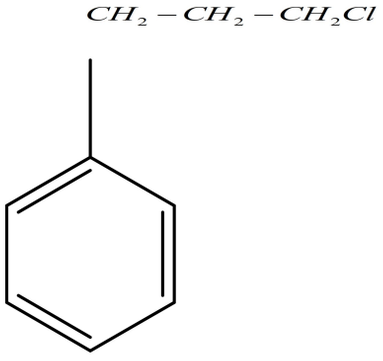


$+HCl \rightarrow X, X \text{ is}:$

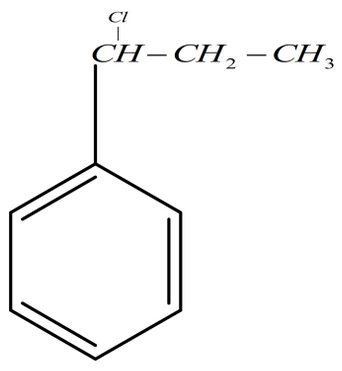
1)



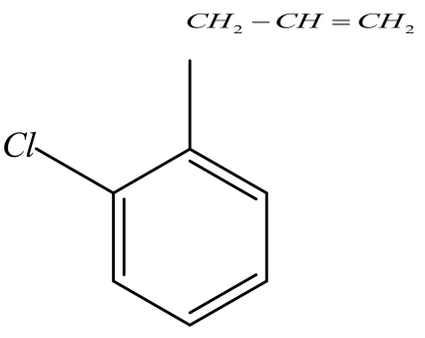
2)



3)

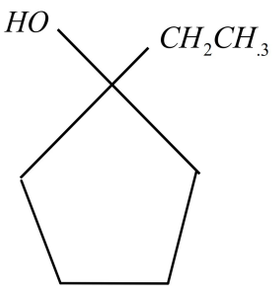


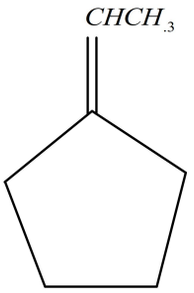
4)

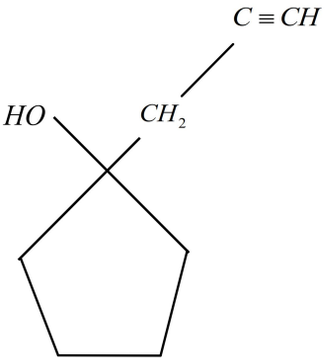


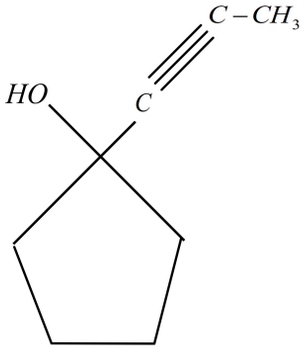
61. The major product of the following reaction

$$H_3C-C\equiv CH \xrightarrow[ether,-C_2H_6]{CH_3CH_2MgCl} \xrightarrow[H_3O^+]{\text{Cyclopentanone}}$$

1) 

2) 

3) 

4) 

62. Match the compounds given List-I with List II and select the suitable option given below:

	List-I		**List-II**
A)	Para-cresol	**i)**	Phenolphthalein
B)	Phthalic anhydride	**ii)**	Gives +ve test with neutral $FeCl_3$
C)	Aniline	**iii)**	Oil of wintergreen
D)	Methyl salicylate	**iv)**	Carbyl amine test

1) A-iv; B-i; C- ii ; D- ii **2)** **A-**iv; B-ii; C- iii; D- i

3)A-ii; B- iii; C- iv; D- i **4)** **A-**ii; B-i; C- iv ; D- iii

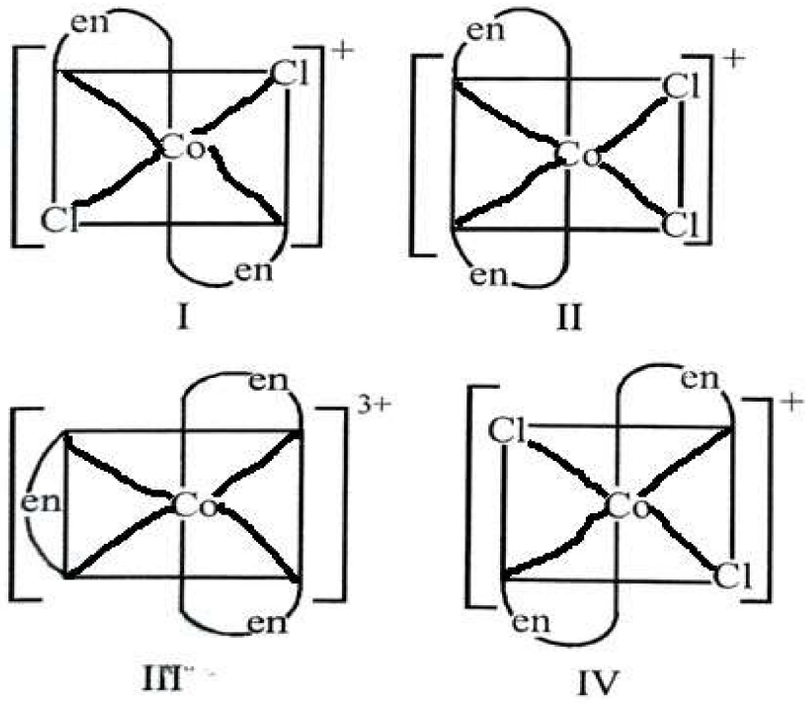
63. If one stand DNA has the sequence ATGCTTGA, the sequence in the complimentary stand would be

1) TACGAACT **2)** TCCGAACT **3)** TACGTACT **4)** TACGTAGT

64. Number of SP-carbons in Benzyne

1) 2 **2)** 0 **3)** 6 **4)** 4

65. Which of the following ions are optically active?



1) I only **2)** II only **3)** II and III **4)** IV only

66. Assertion: Boiling point of $PH_3 < AsH_3 < SbH_3 < NH_3$

Reason: NH_3 possess inter molecular H-Bonding

1) A is True, R is true R is correct explanation of A
2) A is True, R is True R is not correct explanation of A
3) A is True, R is false
4) A is false, R is True

67. Assertion: $H_3PO_4 + 2NaOH \rightarrow Na_2HPO_4 + 2H_2O$

Eq. wt of H_3PO_4 in above reaction is 49

Reason: In all reactions H_3PO_4 is a dibasic acid

1) A is True, R is true R is correct explanation of A
2) A is True, R is True R is not correct explanation of A
3) A is True, R is false
4) A is false, R is True

68. The $I.E_1$ among the group 13 member follows as

1) $B > Al > Ga < Tl < In$ **2)** $B > Ga > Al > Tl > In$

3) $B > Tl > Ga > Al > In$ **4)** $Al > Ga > Tl > B > In$

69. Consider the following statement:
(i) Atomic radii decreses across a row of the periodic table when we move from left to right
(ii) Atomic radii increases down the column as we move from top to bottom
(iii) screening effect order $s > p > d > f$

Correct statements are

1) (i) and (ii) only **2)** (i) and (iii) only

3) (ii) and (iii) only **4)** (i),(ii) and (iii)

70. Which of the following statements are correct?
(i) In Sandmeyer reaction nucleophiles like Cl^-, Br^- and CN^- are introduced in benzene ring in the presence of Cu^+ ion
(ii) In Gattermann reaction nucleophiles are introduced in benzene ring in the presence of copper powder and HCl.
(iii) The yield in Gattermann reaction is found to be better than Sandmayer reaction.

1) (i) and (ii) only **2)** (i), (ii) and (iii)

3) (ii) and (iii) only **4)** (i) and (iii) only

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

71. In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is

$$CH_3OH(l)+\frac{3}{2}O_2(g)\rightarrow CO_2(g)+2H_2O(l)$$

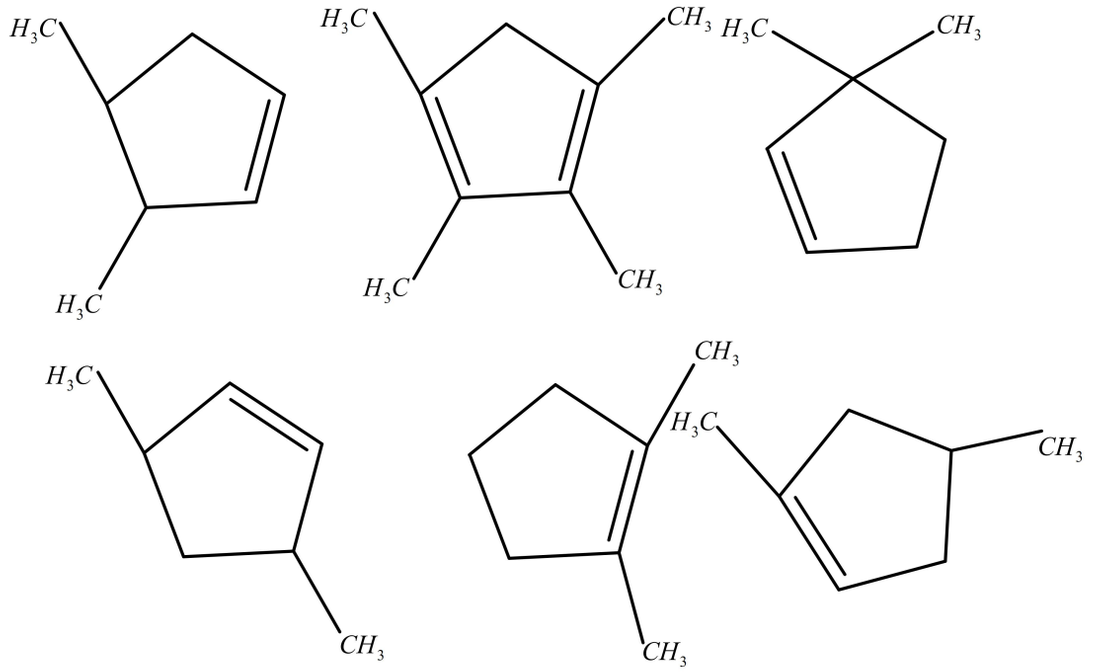
At 298 K standard Gibb's energies of formation for $CH_3OH(l), H_2O(l)$ and $CO_2(g)$ *are* $-166.2, -237.2$ *and* $-394.4 kJ\ mol^{-1}$ respectively. If standard enthalpy of combustion of methanol is $-726 kJ\ mol^{-1}$, find the efficiency (in%) of the fuel cell:

72. The half life period for catalytic decomposition of AB_3 at initial pressure 50mm Hg is 4 hrs and at initial pressure 100 mm Hg it is 2hrs. Find the order of reaction.

73. Number of ambidentate nucleophiles among the following

$CN^-, SCN^-, OH^-, CNO^-, SO_4^{2-}, HCO_2^-, NO_2^-, NO_3^-$

74. Number of compounds which forms aldehyde and ketone both in the same molecules on ozonolysis among the given compounds are



75. Number of lonepairs in I_3^-

ANSWER KEY

MATHEMATICS

1	**3**	2	**3**	3	**2**	4	**3**	5	**1**
6	**2**	7	**4**	8	**3**	9	**2**	10	**4**
11	**3**	12	**3**	13	**4**	14	**1**	15	**3**
16	**1**	17	**1**	18	**3**	19	**3**	20	**1**
21	**44**	22	**8**	23	**1**	24	**3**	25	**5**

PHYSICS

26	**3**	27	**4**	28	**1**	29	**3**	30	**4**
31	**2**	32	**2**	33	**4**	34	**4**	35	**1**
36	**3**	37	**4**	38	**1**	39	**2**	40	**4**
41	**4**	42	**1**	43	**4**	44	**1**	45	**3**
46	**4**	47	**3**	48	**4**	49	**25**	50	**900**

CHEMISTRY

51	**1**	52	**3**	53	**1**	54	**2**	55	**1**
56	**3**	57	**2**	58	**4**	59	**3**	60	**3**
61	**4**	62	**4**	63	**1**	64	**2**	65	**3**
66	**4**	67	**3**	68	**3**	69	**4**	70	**1**
71	**97**	72	**2**	73	**4**	74	**1**	75	**9**

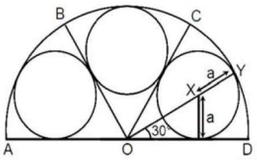
SOLUTION
MATHEMATICS

1. take $Let \quad \sec x - \tan x = t$

$then\ (2\sec x\ \tan x)dx = \left(1 - \frac{1}{t^2}\right)dt$

$I = -\frac{1}{9t^9} + \frac{1}{11t^{11}} + c \Rightarrow \frac{1}{p} + \frac{1}{q} = 2$

2. From the diagram, $\angle AOB = \angle BOC = \angle COD = 60^0 \qquad \Rightarrow \angle YOD = \frac{\pi}{6}$



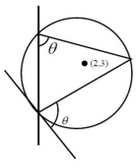
= Let X be the centre of right-hand circle, $OX \sin 30^0 = a$
Now $r = OY = 2a + a = a = r/3$

3. Given parabola is $(x-1)^2 + (y-3)^2 = \left(\frac{5x - 12y + 17}{13}\right)^2$

Focus $= (1,3)$, directrix is

$5x - 12y + 17 = 0 \qquad \therefore$ Length of latus rectum $= 2\left|\frac{5 - 36 + 17}{13}\right| = \frac{28}{13}$

4. Equation of tangent at origin is



$-2(x+0) - 3(y+0) = 0 \Rightarrow 2x + 3y = 0 \qquad \tan\theta = \frac{7}{4} \Rightarrow \left|\frac{m + \frac{2}{3}}{1 - \frac{2m}{3}}\right| = \frac{7}{4} \Rightarrow \frac{3m+2}{3-2m} = \frac{7}{4}$

$\Rightarrow 12m + 8 = 21 - 14m \Rightarrow 26m = 13 \Rightarrow m = \frac{1}{2} \qquad \therefore y = \frac{1}{2}x \Rightarrow x - 2y = 0$

5. $\Delta = 0, a = 5$

$\int_0^{-10} f(x)dx = \int_0^5 f(x)dx + \int_{-5}^{10} f(x+5)dx + \int_{-85}^{10} f(x)dxdx = 2\int_{-5}^{-10} dx = -10$

6. let $5^x = t; t > 0 \qquad A.m \geq G.m \qquad y^2 + 5y - (2+a) = 0; where\ y = t + \frac{1}{t} \geq 2 \qquad$ Since $a \geq 12$

7. $Applying\ R_1 \to R_1 - R_2 \qquad f(x) = \begin{vmatrix} \cos x - \tan x & 0 & 0 \\ 2\sin x & x^2 & 2x \\ \tan x & x & 1 \end{vmatrix} = (\cos x - \tan x)(x^2 - 2x^2)$

$= -x^2(\cos x - \tan x) \quad \therefore f'(x) = -2x(\cos x - \tan x)$

$-x^2\left(-\sin x-\sec^2 x\right)\ \ \therefore \lim_{x\to\infty}\frac{f'(x)}{x}=\lim_{x\to\infty}\left[-2\left(\cos x-\tan x\right)\right]\qquad +\lim_{x\to\infty}x\left(\sin x\sec^2 x\right)]\ \ =-2\times1=-2$

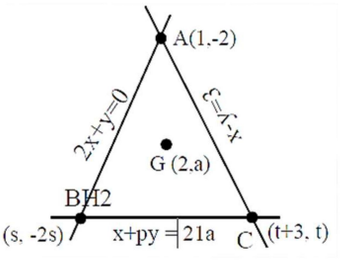
8. $\begin{vmatrix}1 & a & a^2\\ 1 & b & b^2\\ 1 & c & c^2\end{vmatrix}\begin{vmatrix}1 & 1 & 1\\ 2a & 2b & 2c\\ a^2 & b^2 & c^2\end{vmatrix}$

9. $f^1(0)=\underset{h\to0}{lt}\frac{f(0-h)-f(0)}{-h}\quad Rf^1(0)=\underset{h\to0}{lt}\frac{f(0+h)-f(0)}{h}$

$=\underset{h\to0}{lt}\left(\frac{h\left(3e^{1/h}+4\right)}{2-e^{1/h}}-0\right)\left(\frac{1}{h}\right)\quad \underset{n\to0}{lt}\left(\frac{-h\left(3e^{-1/h}+4\right)}{2-e^{-1/h}}-0\right)\left(\frac{-1}{h}\right)=2\qquad =\underset{h\to0}{lt}\left(\frac{3+4e^{-1/h}}{2e^{-1/h}-1}\right)=-3$

Since $Lf^1(0)\neq Rf^1(0)\qquad \therefore f(x)$ is differentiable *at x =0*. But *f(x)* is continuous at *x=0*

10. 2x + y = 0 ------(1)
x – y = 0 -----(2)
x + py = 21a -------(3)
solving (1) & (2) ⇒ A (1, -2)



centriod of triangle ABC is $\left(\frac{4+s+t}{3},\frac{-2-2s+t}{3}\right)=(2,a)$

$\Rightarrow s+t=2.....(4)\Rightarrow s=-a,t=2+a\ -2s+t=3a+2.....(5)$

Solving (4) 795) we get

$B(-a,2a);C(a+5,a+2)\therefore \text{Distance}(BC)^2=122$

11. Statement-1 General term= $\frac{10!}{\alpha!\beta!\gamma!}2^{\alpha/2}3^{\beta/3}5^{T/6}$ for rational terms

$\alpha=0,2,4,6,8,10,\quad \beta=0,3,6\qquad \gamma=0,6$

Hence possible sets= $(4,6,0),(4,0,6);(10,0,0)$

Hence, there are s rotational terms. $\therefore$ required = $\frac{10!}{4!6!}2^2 5\frac{10!}{10!}2^5=12632.$

Statement-3 $t_r+1, the(r+1)$ in the expansion of

$\left(5^{1/6}+2^{1/8}\right)^{10}$ *is* $t_r+1=\quad C_r\left(5\quad\right)^{100-r}\left(2^{1/8}\right)^r$

As 5 and 2 are relatively prime, t_r+1 will be rational if $\frac{100-r}{6}$ *and* $\frac{r}{8}$ *are* both integers. i.e

If 100-r is a multiple of 6 and r is a multiple of 8. As $0\le r\le 100,$ multiple of 8 upto 100 and corresponding value of 100-r r=0,8,16,24,…….88,96

100-r=100,92,84, 76,…..12,4

Out of 100-r, multiple of 6 are 84,60,36,12 $\therefore$ There are just four rational terms

$\Rightarrow$ Number of irrational terms is 101-4=97

12. Let N be $(3\lambda+6,2\lambda+7,2\lambda+7)$ such PN is perpendicular to the line

Then $\lambda=-1 \quad \therefore N=(3,5,9) \qquad \therefore PN=7$

13. Since each has equally 9 different possible results for A and B to draw a ball from the packet independently, the total number of possible events is $9^2=81.$*From* $a-2b+10>0$ we get $2b<a+10.$ We find that when $b=1,2,3,4,5$ a can take any value in 1,2,3,.....,9 to make the inequality hold. Then we have $9\times5=45$ admissible events

When b = 6, a can be 3, 4,…., 9 and there are 7 admissible events
When b = 7, a can be 5, 6, 7, 8, 9 and there are 5 admissible events
When b = 8, a can be 7, 8, 9 and there are 3 admissible events
When b = 9, a can be 9 and there are 1 admissible events

So, the required probability is $\frac{45+7+5+3+1}{81}=\frac{61}{81}$

14. $I.F=e^{\int\left(\frac{3x^2}{1+x^3}\right)dx}=1+x^3$

$y\left(1+x^3\right)=\int\frac{1-\cos(2x)}{2}dx \qquad y\left(1+x^3\right)=\frac{x}{2}-\frac{1}{4}\sin 2x+C$

15. $(a,a)\notin R$

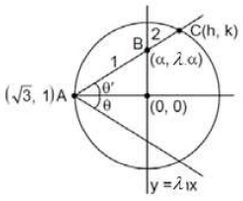
If $(a,b)\in R\Rightarrow(b,a)\in R$

If $(a,b)\in R,(b,c)\in R\Rightarrow(a,c)\notin R$

16. The line can be written as

$y=\lambda x \;\; and \;\; curve \;\; as \;\; x^2+y^2=4$

Let C(h,k) be a point on the circles and $A\left(\sqrt{3},1\right)$ be given point, then $\frac{h+2\sqrt{3}}{3}=a$



$\Rightarrow h=3\alpha-2\sqrt{3} \qquad \frac{k+2}{3}=\lambda\alpha\Rightarrow k=3\lambda\alpha-2$

Now, this point (h, k) lies on the circle $\Rightarrow\left(3\alpha-2\sqrt{3}\right)^2+\left(3\lambda\alpha-2\right)^2=4$

$9\alpha^2+12-12\sqrt{3}\alpha+9\lambda^2\alpha^2+4-12\lambda\alpha=4 \quad \Rightarrow \left(+\lambda^2\right)\alpha^2- \quad \alpha\left(\sqrt{3}+\lambda\right)+ \quad =$

$\left(+\lambda^2\right)\alpha^2- \quad \alpha\left(\sqrt{3}+\lambda\right)+ \quad = \quad 16\left(\sqrt{3}+\lambda\right)^2-4\times3\left(1+\lambda^2\right)(4)>0$

$\left(\sqrt{3}+\lambda\right)^2-3\left(1+\lambda^2\right)>0 \qquad 2\sqrt{3}\lambda-2\lambda^2>0 \qquad 2\sqrt{3}\lambda-2\lambda^2>0$

$2\lambda^2-2\sqrt{3}\lambda>0 \qquad \lambda\in\left(0,\sqrt{3}\right)$

17. Given, $\sqrt{1+\cos 2x}=\sqrt{2}\cos^{-1}(\cos x) \qquad \therefore\sqrt{2}|\cos x|=\sqrt{2}\,x$

For all $x\in\left[\frac{\pi}{2},\pi\right],-\cos x=x \qquad \Rightarrow$ No Solution

18. Ortho-centres of triangles formed by three tangents and corresponding normal to a parabola are equidistant from axis of parabola

19. Let $x_i-5=d_i\sigma_x^2=\sigma_d^2=\frac{\sum d_i^2}{n}-\left(\frac{\sum d_i}{n}\right)^2=\frac{125}{10}-\left(\frac{5}{10}\right)^2=\frac{25}{2}-\frac{1}{4}=\frac{49}{4}$

20. $(P)\ {}^{28}C_3=2600$

$(Q)\ {}^{26}C_3-{}^{20}C_3-{}^{21}C_3+{}^{15}C_3=585$

$(R)\ {}^{17}C_3=680$

$(S)\ {}^{24}C_2+{}^{19}C_2+{}^{14}C_2+{}^{9}C_2+{}^{4}C_2=580$

21. From fig it clear that $f(x)=\begin{cases}(1-x)^2 & 0\le x\le\frac{1}{3}\\ 2x(1-x) & \frac{1}{3}<x\le\frac{2}{3}\\ x^2 & \frac{2}{3}<x\le1\end{cases}$

The required area $A=\int_0^1 f(x) \quad =\int_0^{\frac{1}{3}}(1-x)^2\,dx+\int_{\frac{1}{3}}^{\frac{2}{3}}2x(1-x)\,dx+\int_{\frac{2}{3}}^{1}x^2dx$

$=\left[-\frac{1}{3}(1-x)^3\right]_0^{\frac{1}{3}}+\left[\left(x^2-\frac{2x^3}{3}\right)\right]_{\frac{1}{3}}^{\frac{2}{3}}+\left[\frac{x^3}{3}\right]_{\frac{2}{3}}^{1} \quad =\frac{17}{27}$ So, $\frac{p}{q}=\frac{17}{27}$ Hence p+q=17+27=44

22. $2^N<N!$ Which is true when $N\ge4$

$N=1(Not\ \ possible) \qquad N=2\ i.e.,(1,1)(Not\ \ possible)$

$\therefore$ required probability $=\frac{36-3}{36}=\frac{33}{36}=\frac{11}{12} \qquad \therefore m=11 and\ \ n=12$

$Now, 4m-3n=4(11)-3)12=44-36-8$

23. Let $\vec{p}=2\hat{i}+3\hat{j}+5\hat{k};\vec{q}=\sin\alpha\sin\beta\hat{i}+\cos\beta+\cos\alpha\sin\beta\hat{k}$

$|\vec{q}|=\sqrt{\sin^2\alpha\sin^2\beta+\cos^2\beta+\cos^2\alpha\sin^2\beta}=1$

$\Rightarrow\sin\alpha\sin\beta=2\lambda;\cos\beta=3\lambda;\cos\alpha\sin\beta=5\lambda$

$1=38\lambda^2;\lambda=\frac{1}{\sqrt{38}} \qquad \det A=\left[\frac{\sin\alpha\sin\beta}{\cos\beta}+\frac{1}{3}\right]=1$

24. $g'(2\pi)=3/7, g''(2\pi)=0$

25. *Let* $\vec{c}=\lambda\vec{a}+\mu\vec{b}$

Taking dot by $\vec{b}$

$0=\lambda(\vec{a}.\vec{b})+(\vec{b})^2=-\lambda+5\mu \quad \Rightarrow \lambda-5\mu=0.....(1)$

Again $\vec{a}.\vec{c}=7\Rightarrow\lambda\vec{a}^2+\mu(\vec{a}.\vec{b})=7 \quad \Rightarrow 3\lambda-\mu=7.....(2)$

Solving (1) and (2) $\lambda=\frac{5}{2},\mu=\frac{1}{2} \quad \Rightarrow \frac{2}{7}|\vec{c}|^2=\frac{1}{7}\times 35=5$

PHYSICS

26. In the first case the mechanical energy is completely converted into heat because of friction *i.e,* Decrease in mechanical energy $=\frac{1}{2}mv^2$

While is second case, a part of mechanical energy is converted into heat due to friction but another part of mechanical energy is retained in the from if potential energy of the block *i.e.,*

Decrease in mechanical energy $=\frac{1}{2}mv^2-mgh$

Therfore statement 1 is correct

Statement-2 is wrong. The coefficient of friction between the block and the surface does not depend on the angle of inclination.

27. Pseudo force is applied on a body only when the body is seen from an accelerated Observer

28. $av=$constant

29. conceptual

30. conceptual

31. $D=\frac{\mu_0 NI}{2\pi R}$

32. $f\alpha q_1 q_2$

33. Net heat absorbed by one mole of diatomic gas in going from A $\rightarrow$B (isochoric process) and B $\rightarrow$ C (isobaric process) is $\Delta Q=C_V\Delta T+C_P\Delta T=\frac{5}{2}RT_0+\frac{7}{2}RT_0\Delta Q=6RT_0$

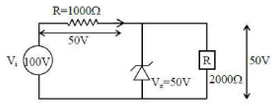
34. The gravitational force vanishes at the midway point between the planets, so the rocket only needs to have enough energy to get there. The initial and final gravitational potential energies are $U_i=-\frac{GMm}{R}-\frac{GMm}{3R}=-\frac{4GMm}{3R}$ *and* $U_f=-\frac{2GMm}{2R}=-\frac{GMm}{R}$

35. $C_{AB}=\frac{24\times 8}{24+8}=6\mu F$

36. $P_0+\rho_1 gh-\rho_2 gh+\frac{2T}{r}=P_0=T=\frac{r}{2}(\rho_2-\rho)gh$

37. Conceptual

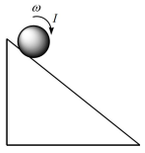
38. $I=\frac{50}{1000}=50mA \qquad R=1000\Omega$



$$I = \frac{50}{2000} = 25mA, I_z = I_{1000} - I_{2000} = 50 - 25 = 25\ mA$$

39. Use the basic concept of interference of light waves.

40. By conservation of energy, we have $\frac{1}{2}mv_c^2 + \frac{1}{2}I_c\omega^2 = mgh$



Moment of inertia of solid and hollow cylinders are given as $I_{solid} = \frac{MR^2}{2}$ $I_{hollow} = MR^2$

For pure rolling, we have $\omega = v_c / R$, As $I_{solid} < I_{hollow} \Rightarrow v_{solid} > v_{hollow}$

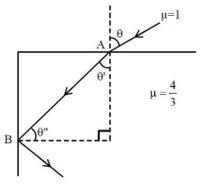
Hence solid cylinder will reach the bottom first.

41. $K_i = \frac{1}{2}m\left(u^2 + \frac{u^2}{2}\right) = \frac{3}{4}mu^2$

$$K_f = \frac{1}{2}(2m)\frac{u^2}{16} \times 10 = \frac{5}{8}mu^2$$

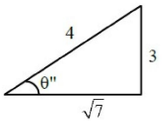
Loss in kinetic energy $\frac{3}{4}mu^2 - \frac{5}{8}mu^2 = \frac{1}{8}mu^2$

42.



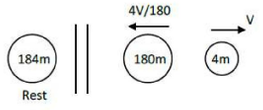
At maximum angle θ ray at point B goes in gazing emergence, at all less values of θ, TIR occurs. At point B $\frac{4}{3} \times \sin\theta" = 1 \times \sin 90^0$ $\theta" = \sin^{-1}\left(\frac{3}{4}\right)$ $\theta' = \left(\frac{\pi}{2} - \theta"\right)$

At point A $1 \times \sin\theta = \frac{4}{3} \times \sin\theta'$ $\sin\theta = \frac{4}{3} \times \sin\left(\frac{\pi}{2} - \theta"\right)$ $\sin\theta = \frac{4}{3}\cos\left[\cos^{-1}\frac{\sqrt{7}}{4}\right]$



$$\sin\theta = \frac{4}{3} \times \frac{\sqrt{7}}{4} \quad \theta = \sin^{-1}\left(\frac{\sqrt{7}}{3}\right)$$

43.



$$\frac{1}{2}(4m)v^2+\frac{1}{2}(180m)\left(\frac{4v}{180}\right)^2=5.5MeV \qquad \frac{1}{2}4mv^2\left[1+45\left(\frac{4}{180}\right)^2\right]=5.5MeV$$

$$\Rightarrow K.E_\alpha=\frac{5.5}{1+45.\left(\frac{4}{180}\right)^2}MeV \quad K.E_\alpha=5.38MeV$$

44. $i=\dfrac{|e|}{R}$

45. $1\times\dfrac{1}{2g}\left(\dfrac{p\sin\theta}{m}\right)^2=\dfrac{p\sin\theta}{mg}\times\dfrac{p\cos\theta}{m}$ $\dfrac{1}{2}\sin^2\theta=\sin\theta\cos\theta\Rightarrow\tan\theta=2$ $\therefore\cos\theta=\dfrac{1}{\sqrt{5}}$

Minimum kinetic energy $=\left(\dfrac{p\cos\theta}{2m}\right)^2=\dfrac{p^2}{2m}\times\dfrac{1}{5}=\dfrac{p^2}{10m}$

46. $V=\dfrac{\omega}{k}=\dfrac{9\times10^8}{6}=1.5\times10^8\,m/s$, Refractive index $\mu=\dfrac{C}{V}\Rightarrow\sqrt{K}=\dfrac{3\times10^8}{1.5\times10^8}$ $\therefore K=4$

47. $\tan\phi=\dfrac{x_C-x_L}{R}$ $\tan45=\dfrac{x_C-x_L}{R}$ $x_C-x_L=R$ $\dfrac{1}{\omega C}-\omega L=R$

$\dfrac{1}{\omega C}-300\times0.03=1$ $\dfrac{1}{\omega C}=10$ $C=\dfrac{1}{10\omega}=\dfrac{1}{10\times300}$ $C=\dfrac{1}{3}\times10^{-3}$ $x=3$

48. $KE=\dfrac{hc}{\lambda}-\phi.....(i)$

$e(3V_0)-\dfrac{hc}{\lambda_0}-\phi.....(i)$ $eV_0=\dfrac{hc}{2\lambda_0}-\phi.....(ii)$

Using (i) & (ii) $\phi=\dfrac{hc}{4\lambda_0}=\dfrac{hc}{\lambda_t}$ $\lambda_t=4\lambda_0$

49. $\therefore$ mean free path $\lambda=\dfrac{1}{\sqrt{2}\pi d^2n}$ $\dfrac{\lambda_1}{\lambda_2}=\dfrac{d_2^2n^2}{d_1^2n_1}$ $=\left(\dfrac{5}{10}\right)^2=0.25=25\times10^{-2}$

50. $\upsilon=\dfrac{2v}{2l}$

CHEMISTRY

51. $2\ C_3H_8 + 1C_4H_{10} + O_2 \rightarrow 10CO_2 + 13H_2O$

52. $\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{1}{2}mv^2 \qquad \frac{1}{2}mv^2 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$

$mv^2 = 2ch\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right] \qquad v^2 = \frac{2hc}{m}\left[\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right] \qquad v = \sqrt{\frac{2hc}{m}\left[\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right]}$

53. 2^{nd} electron affinity is positive

54. $p\pi - d\pi$ cannot formed by 2^{nd} period

55. $\frac{1}{2}H_2 + \frac{1}{2}X_2 \rightarrow HX\ \Delta H = -50$

$2a \qquad a \qquad 2a$

$\frac{2a}{2} + \frac{a}{2} - 2a = -50$

$3a - 4a = -100$

$a = 100$

56. $Ag_2CrO_4 \rightleftharpoons 2Ag^+ + CrO_4^{-2}$

$2.2\times10^{-4} 1.1\times10^{-4}$

$KSP = \left(2.2\times10^{-4}\right)^2\left(1.1\times10^{-4}\right) \qquad = 5.3\times10^{-12}$

57. $M = \frac{25.3}{106}\times\frac{1000}{250} \qquad = 0.9547 = 0.955M$

$\left[Na^+\right] = 1.910\left[CO_3\right]^{-2} = 0.955$

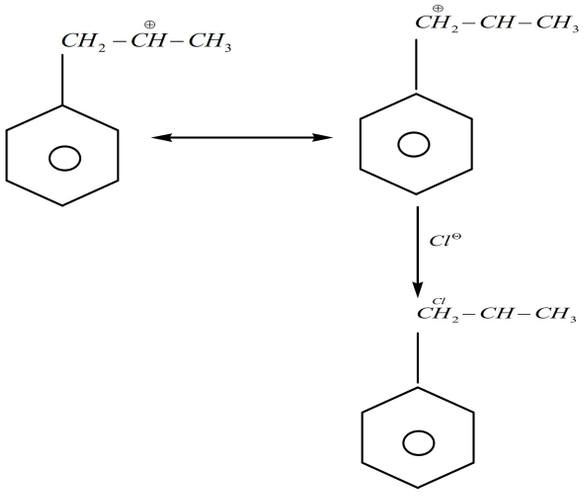
58.

$$CH_3 - CH_2 - CH_2 - Cl \xrightarrow{AlCl_3} CH_3 - CH_2 - CH_2^{+}$$

$$CH_3 - CH_2 - \overset{\oplus}{C}H_2 \xrightarrow[shift]{1,2-H^{\ominus}} CH_3 - CH^{\oplus} - CH_3$$

59. inductive effect

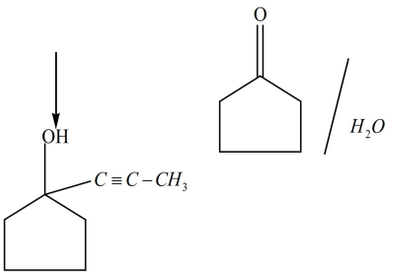
60.



61. $CH_2 - C \equiv CH \xrightarrow{CH_3CH_2MgCl}$

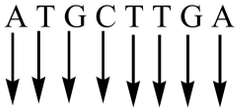
$CH_3 - C \equiv C - MgCl$

$CH_2 - C \equiv CH \xrightarrow{CH_3CH_2MgCl}$



62. Named reactions and uses

A T G C T T G A



T AC G A AC T

63.

64. No SP carbons in benzyne

65. Optical Isomerism

66. B.P $PH_3 < ASH_3 < NH_3 < SbH_3$

67. H_3PO_4 is Tribasic

68. I.E $B > Tl > Ga > Al > In$

69. periodic property

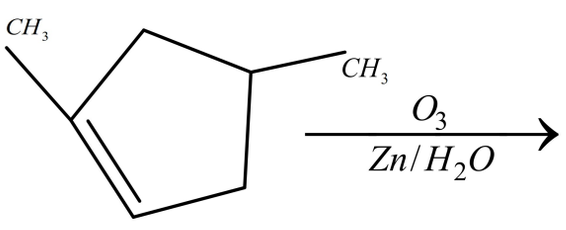
70. Sandmeyer and gatterman reactions

71. $\Delta G = \Delta G_p - \Delta G_r$

72. $\frac{t_1}{t_2} = \left(\frac{P_2}{P_1}\right)^{n-1}$

73. $CN^-, SCN^{-1}, NO_2^-, CNO^-$

74.



$CHO - CH_2 - \underset{\underset{CH}{|}}{CH} - CH - \overset{\overset{O}{\|}}{C} - CH_3$

75.