FIITJEE RBT-6 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 1 | QP Code: 100191 | PAPER - 1

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(i) **Part-A (08-13) –** Contains six (06) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **Part-B (01-08)** contains eight (08) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**___________________

Enrolment Number :____

SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

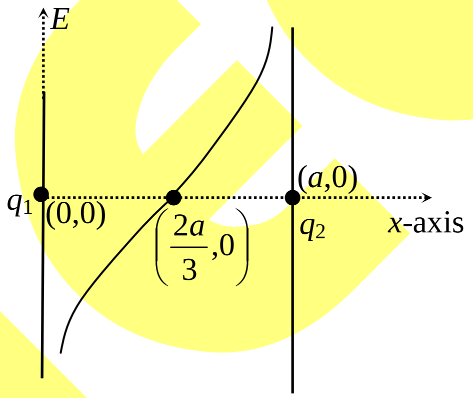
This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. If the dimensions of length are expressed as $G^x c^y h^z$; where G, c and h are the universal gravitational constant, speed of light and Planck's constant respectively, then

(A) $x = \frac{1}{2}, y = \frac{1}{2}$ (B) $x = \frac{1}{2}, z = \frac{1}{2}$

(C) $y = \frac{1}{2}, z = \frac{3}{2}$ (D) $y = -\frac{3}{2}, z = \frac{1}{2}$

2. If the electric field *E* is plotted, with distance from q_1 along the line joining of two, then (*E* is positive along +ve *x*-axis) it looks as shown in figure. From the plot we can say that



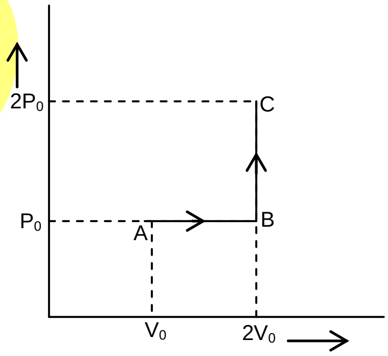
(A) q_1 and q_2 both are negative

(B) $\left|\frac{q_1}{q_2}\right| = 4$

(C) q_1 is positive and q_2 is negative

(D) $\left|\frac{q_1}{q_2}\right| = \frac{1}{4}$

3. One mole of an ideal monoatomic gas is taken from A to C along the path ABC. The temperature of the gas at A is T_0. For the process ABC (where R is gas constant)



(A) Heat absorbed by the gas is $\frac{11}{12}RT_0$

(B) Heat absorbed by the gas is $\frac{11}{2}RT_0$

(C) Work done by the gas = RT_0

(D) Change in internal energy of gas is $\frac{9}{2}RT_0$

4. The threshold wavelength for photoelectric mission from a material is 5200 Å. Photoelectrons will be emitted when this material is illuminated with monochromatic radiation from a:

(A) 50 watt infrared lamp (B) 20 watt infrared lamp

(C) 50 watt ultraviolet lamp (D) 20 watt ultraviolet lamp

Space For Rough Work

5. A capacitor is charged to a potential of V_0. It is connected with an inductor through a switch S. The switch is closed at time t = 0. Which of the following statements are correct?

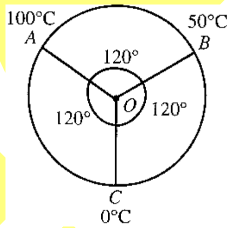
(A) The maximum current in the circuit is $V_0\sqrt{\frac{C}{L}}$

(B) Potential across capacitor becomes zero for the first time at time t = $\pi\sqrt{LC}$

(C) Energy stored in the inductor at time $t = \frac{\pi}{2}\sqrt{LC}$ is $\frac{1}{4}CV_0^2$

(D) Maximum energy stored in the inductor is $\frac{1}{2}CV_0^2$

6. A circular ring (centre O) of radius a, and of uniform cross section is made up of three different metallic rods AB, BC & CA joined together at the points A, B and C in pairs) of thermal conductivities α_1, α_2 and α_3, respectively (see diagram). The junction A, B and C are maintained at the temperatures 100°C, 50°C and 0°C, respectively. All the rods are of equal lengths and cross sections. Under steady state conditions, assume that no heat is lost from the sides of the rods. Let Q_1, Q_2 and Q_3 be the rates of transmission of heat along the three rods AB, BC and CA. Then which of the following is/are correct?



(A) $Q_1 = Q_2 = Q_3$ and all are transmitted in the clockwise sense

(B) Q_1 and Q_2 flow in clockwise sense and Q_3 in the anticlockwise sense

(C) $Q_1 : Q_2 : Q_3 : : \alpha_1 : \alpha_2 : 2\alpha_3$

(D) $\frac{Q_1}{\alpha_1} + \frac{Q_2}{\alpha_2} = \frac{Q_3}{\alpha_3}$

7. A 10 m long horizontal stainless steel wire AB of mass 1 kg whose end A is fixed, is connected to a massless string BC passing over a smooth pulley. String BC is connected to a container of mass 2 kg at end C. Water (density = 1×10^3 kg/m^3) is poured in the container at a constant rate of 2.25 litre/sec at t = 0. Also at t = 0, a pulse is generated at end A. Choose from the following the correct option(s).

(A) Time taken by the pulse to reach point B is 0.612 sec

(B) Time taken by the pulse to reach point B is 0.212 sec

(C) Tension in the string at this moment is 33.77 N

(D) Tension in the string at this moment is 24.77 N

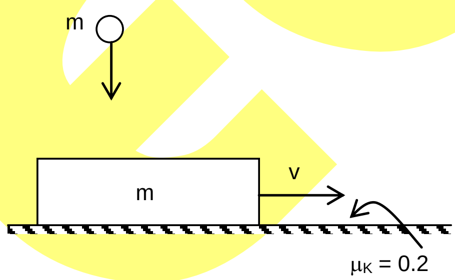
Space For Rough Work

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. A dipole of dipole moment *p* is kept at the centre of a ring of radius *R* and charge *q*. The dipole moment has direction along the axis of the ring. The resultant force on the ring due to the dipole is
(A) zero
(B) $\frac{pq}{4\pi\varepsilon_0 R^3}$
(C) $\frac{pq}{2\pi\varepsilon_0 R^3}$
(D) $\frac{pq}{4\pi\varepsilon_0 R^3}$ only if the charge is uniformly distributed on the ring.

9. A ball of mass m falls vertically from a height h and collides with a block of equal mass m moving horizontally with a velocity v on a surface. The coefficient of kinetic friction between the block and the surface is $\mu_k = 0.2$, while the coefficient of restitution (e) between the ball and the block is 0.5. There is no friction acting between the ball and the block. The velocity of the block just after the collision decreases by



(A) $0.5\sqrt{2gh}$ (B) 0 (C) $0.1\sqrt{2gh}$ (D) $0.3\sqrt{2gh}$

10. Consider elastic collision of a particle of mass m moving with a velocity u with another particle of the same mass at rest. After the collision the projectile and the struck particle move in direction making angle θ_1 and θ_2 respectively with the initial direction of motion. The sum of the angle $\theta_1 + \theta_2$ is
(A) 45^0 (B) 90^0 (C) 135^0 (D) 180^0

11. A ball is dropped from a height of 20 m above the surface of water in a lake. The refractive index of water is 4/3. A fish inside the lake, in the line of fall of the ball, is looking at the ball. At an instant when the ball is 12.8 m above the water surface the fish see the speed of ball as
(A) 9 m/s (B) 12 m/s (C) 16 m/s (D) 21.33 m/s

12. In Bohr model of the hydrogen atom, let R, V and E represent the radius of the orbit, speed of the electron and the total energy of the electron respectively. Which of the following quantities are proportional to the quantum number n:
(A) VR (B) RE (C) V (D) $\frac{R}{E}$

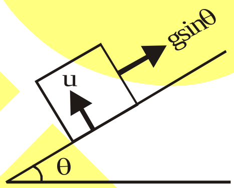
Space For Rough Work

13. A particle of mass m and charge q is projected in a region where an electric field is existing and given by $\vec{E} = E_0\hat{i}$, with a velocity $v_0\hat{j}$ from the origin at time t = 0, then choose the correct statement (assuming $m^2v_0^2 = 2qE_0mx_0$).
(A) radius of curvature of the particle when its x-coordinate becomes x_0 is $2x_0$.
(B) radius of curvature of the particle when its x-coordinate becomes x_0 is $4\sqrt{2}\,x_0$.
(C) speed of the particle when its x-coordinate becomes x_0 is v_0.
(D) speed of the particle when its x-coordinate becomes x_0 is $2v_0$.

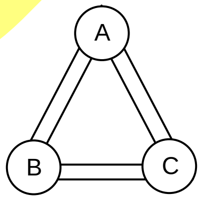
PART – B
(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

1. A cabin is moved up the inclined plane with constant acceleration g sinθ. A particle is projected with some velocity in a direction perpendicular to the inclined plane. If maximum height attained by particle perpendicular to inclined plane is same as range of particle with respect to the cabin parallel to plane then calculate values of cotθ.



2. Three metallic blocks A, B and C have masses m, m and 2m respectively. Specific heat of A, B and C are C, 2C and C respectively. Initial temperature of A, B and C are 10°C, 5°C and 5°C respectively. Now the blocks are connected by 3-identical rods as shown. Find the final temperature of block A on Celsius scale (Neglect any heat loss due to radiation).

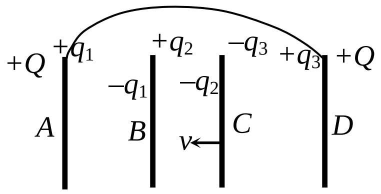


3. In an AC circuit the phase difference between emf and current is $\pi/3$ then the power factor of the circuit is n. Find 'n'.

4. A thin uniform rod of mass 'm', length 'ℓ' rotates uniformly about a vertical axis ω, form a conical pendulum, the upper end of the rod is hinged and θ is angle between rod and vertical. If the change of angular momentum of the rod about hinge is $\frac{m\ell^2}{x}\omega^2 \sin 2\theta$ then the value of 'x' will be

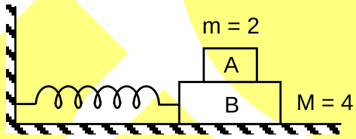
Space For Rough Work

5. In the diagram there are four conducting plates A, B, C and D placed parallel to each other at equal separation L. If plate C starts moving towards plate B with velocity v. The current (in mA) flowing in the wire connecting A and D is '2y'. Find 'y'. (assume all other plates to be fixed) (Given: $q_2 = 5\mu C$, $q_3 = 10\mu C$, v = 10 m/s, L = 0.05 m)



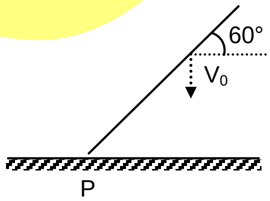
6. A mono-atomic gas undergo a process such that $P \propto \frac{1}{T^2}$. If final temperature is twice that of initial temperature of the gas in given process and molar heat capacity for this process is $\frac{nR}{2}$ then value of 'n' is

7. Block B of mass 4 kg resting on a frictionless horizontal surface and connected with spring of spring constant K = 10 as shown in figure.



Another block A of mass 2 kg is placed on the top of block B. Co-efficient of friction between the blocks is $\mu = 0.5$. Body B is displaced and released such that both bodies are moving together and perform simple harmonic motion. Maximum oscillation amplitude that permits body A and B to move together without slipping between the surfaces in contact of body A and B. (Consider g = 10 m/sec^2).

8. A rod of length $\ell = \frac{6}{7}$ meter forming an angle 60° with horizontal strikes a frictionless floor at point P with its velocity v_0 = 2 meter/second in downward direction and no angular velocity. Assume that collision at point P is perfectly elastic then angular velocity of the rod just after collision is



Space For Rough Work

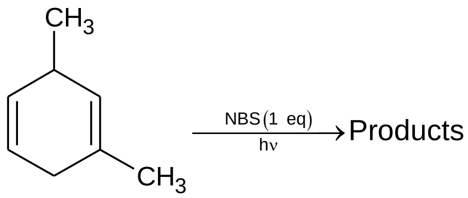
SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which order is/are correct for OCl_2, NCl_3 and BF_3 molecules?
(A) Tendency to form back π-bond: $BF_3 > OCl_2 > NCl_3$
(B) Polarity of covalent bond: B – F > O – Cl > N – Cl
(C) Dipole moment: $BF_3 > OCl_2 > NCl_3$
(D) Hydrolysis: $BF_3 > OCl_2 > NCl_3$

2. 

The characteristic(s) of the major product of above reaction is
(A) it is a conjugated cyclic diene.
(B) an α-keto acid is one of it's oxidation product.
(C) it contains five allylic hydrogen atoms.
(D) it forms an ether when reacts with aq. KOH

3. Which of the following are colourless or pale colour complexes?
(A) $[Mn(H_2O)_6]^{2+}$
(B) $[Mn(CN)_6]^{4-}$
(C) $[FeF_6]^{3-}$
(D) $[Fe(CN)_6]^{3-}$

4. Choose the incorrect statement(s) regarding the face centred cubic unit cell of a metal lattice?
(A) The metal atoms are present at the lattice points as well as voids.
(B) The metal atoms touch each other along the face diagonal.
(C) The body diagonal contains a relative number of $\frac{5}{4}$ atoms.
(D) The interatomic attraction force is uniform through out the crystal.

Space For Rough Work

5. $\left[Cr(H_2O)_6\right]^{3+} + 6NH_3 \longrightarrow \left[Cr(NH_3)_6\right]^{3+} + 6H_2O$

Which reaction(s) is/are thermodynamically more favourable then the one given above

(A) $\left[Cr(NH_3)_6\right]^{3+} + 3en \longrightarrow \left[Cr(en)_3\right]^{3+} + 6NH_3$

(B) $CrCl_3 \xrightarrow[\text{Reducing agent}]{CO} Cr(CO)_6$

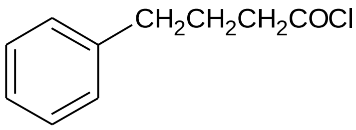
(C) $\left[Cr(NH_3)_6\right]^{3+} + 2dien \longrightarrow \left[Cr(dien)_2\right]^{3+} + 6NH_3$

(D) $Cr(OH)_3 + OH^- \longrightarrow \left[Cr(OH)_4\right]^-$

6. The product(s) of which reaction(s) show geometrical isomerism?

(A) $CH_3-CH=CH-C_2H_5 + CH_2N_2 \xrightarrow{\text{Heat}}$

(B) $CH_3-\underset{\underset{OH}{|}}{CH}-COOH \xrightarrow{\text{Heat}}$

(C) 

$\xrightarrow{\text{Anhy.}AlCl_3}$

(D) $CH_3-\underset{\underset{Cl}{|}}{CH}-\underset{\underset{Cl}{|}}{CH}-CH_3 \xrightarrow[\Delta]{\text{Zn dust}}$

7. Which of the following solutions mixtures show identical colligative properties?
[Assume complete dissociation of salts]

(A) 0.2 M $CaCl_2$ and 0.3 M KCl
(B) 0.4 M $C_6H_{12}O$ and 0.2 NaCl
(C) 0.1 M $AlCl_3$ and 0.1 M NH_2CONH_2
(D) 0.4 M $K_4[Fe(CN)_6]$ and 0.5 M $K_3[Fe(CN)_6]$

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. The incorrect statement regarding $Fe(CO)_5$ is

(A) it has trigonal bipyramidal structure
(B) both sigma donation and pi-acceptance takes place by the CO ligands
(C) on heating the complex, the oxidation number of Fe decreases as CO is a reducing agent
(D) the CO bond length in the complex increases as compared to the free CO

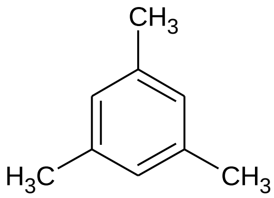
9. Which is correct statement for an ideal solution?

(A) The mole fraction of solute should be less than that of the solvent.
(B) The entropy of the system increases and that of the surrounding does not change
(C) $\Delta H_{mix} > 0$
(D) $\Delta G_{mix} = 0$

Space For Rough Work

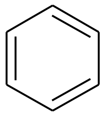
10. $CH_3-\underset{Cl}{\overset{Cl}{C}}-CH_2-CCl_3 \xrightarrow{H_2O/OH^-} \xrightarrow{H^+} \xrightarrow{Heat} (P)$

Which is a characteristic of (P)?

(A)  is formed when (P) reacts with hot conc. H_2SO_4

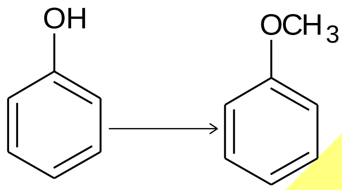
(B) in aqueous solution(P) remains in four different forms

(C) reaction of (P) with CH_3MgBr, forms secondary alcohol

(D) when heated in Al-tube,(P) forms 

11. How many elements of the fourth period of periodic table, contains 10 electrons in their orbitals, which azimuthal quantum number is 2?

(A) 10 (B) 5 (C) 6 (D) 8

12. 

Which reagent can't be used for above reaction?

(A) CH_2N_2/Δ (B) KOH and CH_3Cl

(C) CH_3Br and Na (D) Cl_2/H_2O and CH_3OH

13. $(NH_4)_2Cr_2O_7(s) \xrightarrow{Heating} P(s) + Q(g) + H_2O$

Select the incorrect statement

(A) the equivalent mass of $(NH_4)_2Cr_2O_7$ in above reaction is $\frac{M}{6}$

M = Molar mass of $(NH_4)_2Cr_2O_7$ in g mol^{-1} unit

(B) Q(g) is NH_3

(C) P(s) is a green solid

(D) P(s) is dissolve in HCl

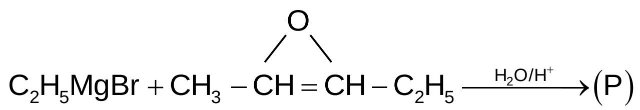
Space For Rough Work

PART – B
(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

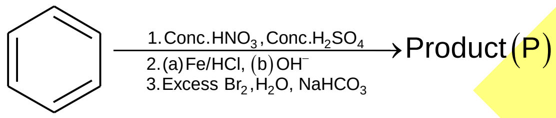
1. One mole of an ideal gas at 0.1 atm and 300 K, was heated to 320 K at constant pressure, this results in expansion of the gas. What is the entropy change of this reversible process in JK^{-1} mol^{-1} unit?

   [$\ell n(1.066) = 0.064$, R = 8.3 J K^{-1} mol^{-1}, $C_P = \frac{5}{2}R$]

2. 

   If x = Number of chiral carbon atoms in organic product P
   and y = Number of optical isomers possible for P

   What is the value of $\frac{x+y}{4}$?

3. 

   If the molar mass of the product(P) is expressed as (120x + 30) g mol^{-1}, what is the value of x? [At mass of Br = 80 g mol^{-1}]

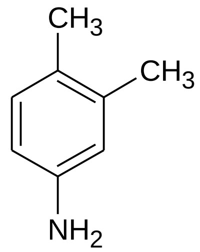
4. One litre of a buffer solution contains 0.5 mole of CH_3COONa and 0.3 mole of CH_3COOH. The pH of the solution is x. Now 0.1 mole of H^+ is added to the buffer solution, the pH changes to y. What is the value of |x – y}?

   [K_a of $CH_3COOH = 10^{-5}$][log $\frac{0.5}{0.3}$ = 0.22]

5. The octacarbonyl of Scandium does not involve back donation from metal to ligand. So the complex is weaker than that of other 3d-series metal. If the oxidation number of scandium in the carbonyl is +x, what is the value of x?

Space For Rough Work

6. Reaction of an organic compound(P) with Br_2 and KOH form an amine having the following structure.



$$P \xrightarrow{H_2O/H^+} Q \xrightarrow{MnO_4^-/H^+} R$$

If the sum of the number of oxygen atoms present in(P), (Q) and (R) is expressed as 10x, what is the value of 'x'?

7. The specific conductance or conductivity of an electrolyte AB is 4×10^{-3} $ohm^{-1}cm^{-1}$. What will be the degree of dissociation of the electrolyte in 0.1 M aqueous solution, if the limiting molar conductance Λ_m^0 is 100 ohm^{-1} cm^2mol^{-1}

8. The molecular formula of an octahedral complex is $CrN_6H_{18}Cl_3$. it shows cis- and trans isomerism and ionise in aqueous solution. If one mole of the complex is dissolved in water. How much gram of $AgNO_3$ is needed to produce sufficient amount of AgCl precipitate?

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. The solution of $\frac{dy}{dx} = \sqrt{y-x}$ is given by

(A) $x + C = 2\sqrt{y-x} + 2\log\left(\sqrt{y-x} - 1\right)$
(B) $x^2 + C = 2\sqrt{y-x} + \log\left(\sqrt{y-x} - 1\right)$
(C) $x + C = (y-x)^2 + \log(y-x-1)$
(D) $\sqrt{y-x} - 1 = C' e^{x/2 - \sqrt{y-x}}$

2. If n objects are arranged in a row, then the number of ways of selecting three of these objects so that no two of them are next to each other is

(A) $\frac{1}{6}(n-2)(n-3)(n-4)$
(B) ${}^{n-2}C_3$
(C) ${}^{n-3}C_3 + {}^{n-3}C_2$
(D) none of these

3. A four digit number (numbered from 0000 to 9999) is said to be lucky if the sum of first two digits is equal to the sum of its last two digits. If a four digit number is picked up at random, then the probability that it is lucky is

(A) > 0.065
(B) < 0.068
(C) 0.066
(D) 0.067

4. If $\sum_{k=1}^{n}\left(\sum_{m=1}^{k} m^2\right) = an^4 + bn^3 + cn^2 + dn + e$, then

(A) $a = \frac{1}{12}$
(B) $b = \frac{1}{16}$
(C) $d = \frac{1}{6}$
(D) $e = 0$

5. The function $f : R \to R$ satisfies $f(x^2)f''(x) = f'(x)f'(x^2)\ \forall x \in R$, given that $f(1) = 1$ and $f'''(1) = 8$, then

(A) $f'(1) = 2$
(B) $f''(1) = 4$
(C) $f'(1) = 4$
(D) $f''(1) = 2$

Space For Rough Work

6. Which of the following are CORRECT?

(A) If A and B are symmetric matrices of order 3 then $|AB - BA| = 0$

(B) If A and B are square matrices of order 'n' such that $AB = I_n$, then $BA = I_n$.

(C) The matrix $A = \begin{bmatrix} 9017 & 5148 & 7220 \\ 1234 & 2117 & 4848 \\ 4320 & 3648 & 1179 \end{bmatrix}$ is non-invertible.

(D) If two square matrices A and B of same order commute, then all positive integral powers of A and B commute.

7. Let solutions of the equation $(z-1-2i)^4 = 1$ be $\omega_1, \omega_2, \omega_3, \omega_4$ such that $|\omega_1| > |\omega_2| > |\omega_3| > |\omega_4|$. If $\arg\left(\frac{z-\omega_i}{z-\omega_j}\right) = \pm\frac{\pi}{2}$ represents a circle, then for different values of i, j where $i, j \in \{1, 2, 3, 4\}, i \neq j$ the number of different circles is λ, where λ lies in

(A) $\left[\frac{42\pi}{22}, \frac{49\pi}{22}\right]$ (B) $\left[\frac{35\pi}{22}, \frac{42\pi}{22}\right]$ (C) $\left[\frac{31\pi}{22}, \frac{37\pi}{22}\right]$ (D) $\left[\frac{29\pi}{22}, \frac{3\pi}{2}\right]$

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. The number of values of k for which the equation $x^3 - 3x + k = 0$ has two distinct roots lying in the interval (0, 1) is

(A) three (B) two
(C) infinitely many (D) zero

9. Let $a, b, p, q \in Q$ and suppose that $f(x) = x^2 + ax + b = 0$ and $g(x) = x^3 + px + q = 0$ have a common irrational root, then

(A) $f(x)$ divides $g(x)$ (B) $g(x) = x\,f(x)$
(C) $g(x) = (x - b - q)f(x)$ (D) none of these

10. The focal chord to $y^2 = 16x$ is tangent to $(x-6)^2 + y^2 = 2$, then the possible value of the slope of this chord, are

(A) $\{-1, 1\}$ (B) $\{-2, 2\}$ (C) $\left\{-2, \frac{1}{2}\right\}$ (D) $\left\{2, \frac{-1}{2}\right\}$

Space For Rough Work

11. Consider parabola $y^2 = 40x$, A circle $S = 0$ is drawn taking one of its focal chord as diameter. The extremeties of the focal chord being P_1 and P_2. A point 'P' is taken on the circumference of S = 0, then

(A) $\angle P_1PP_2 = \frac{\pi}{4}$

(B) x = 10 is a tangent to S = 0

(C) Combined equation of the tangents at P_1 and P_2 has $\left(\text{coeff. } x^2\right) + \left(\text{coeff. } y^2\right) = -2$

(D) Orthocenter of ΔP_1PP_2 lies on it

12. If $\cos^{-1}p + \cos^{-1}q + \cos^{-1}r = \pi$. Then value of $p^2 + q^2 + r^2 + 2pqr + 4$ is equal to

(A) 1 (B) 0
(C) 5 (D) 3

13. If $x_{n+1} = \sqrt{\frac{1}{2}(1 + x_n)}$, then $\cos\left[\frac{\sqrt{1 - x_0^2}}{x_1x_2x_3......\text{to infinite}}\right]\left(-1 < x_0 < 1\right)$ is equal to

(A) –1 (B) 1
(C) x_0 (D) $\frac{1}{x_0}$

PART – B
(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

1. The integer n for which $\lim_{n \to \infty} \frac{(\cos x - 1)(\cos x - e^x)}{x^n}$ is a finite non – zero number, then $\frac{1}{n}$ is

2. The sum of the products of the ten numbers $\pm 1, \pm 2, \pm 3, \pm 4$, and ± 5 taking two at a time is x, then $|x| =$

3. The circles having radii 1, 2, 3 touch each other externally then find the radius of the circle which cuts the three circles orthogonally.

4. If $x + \frac{1}{x} = 2\cos 20^\circ$, then the value of $\frac{1}{\left(x^3 + \frac{1}{x^3}\right)^{-1} + 1}$ is equal to

Space For Rough Work

5. Let $A=\{3,4,5,6\}$ and $B=\{1,2,3,...,10\}$ be two sets. Let a function f be defined from set A to set B, such that $f(i)-f(j)\geq 2\ \forall i>j$, where $i,j\in A$. If the number of such functions is N, then the value of $\frac{N}{5}$ is

6. In a scalene triangle ABC, the value of $\Delta\left[\frac{\tan\frac{A}{2}}{(a-b)(a-c)}+\frac{\tan\frac{B}{2}}{(b-a)(b-c)}+\frac{\tan\frac{C}{2}}{(c-a)(c-b)}\right]$ is (all notations are standard)

7. Let $a_1,a_2,a_3.....,a_{4001}$ are in A.P such that $\frac{1}{a_1a_2}+\frac{1}{a_2a_3}+...+\frac{1}{a_{4000}a_{4001}}=10$ and $a_2+a_{4000}=50$ then $\frac{10}{|a_1-a_{4001}|}$ is equal to

8. If CF is perpendicular from the centre C of the ellipse $\frac{x^2}{49}+\frac{y^2}{25}=1$ on the tangent at any point P, and G is the point where the normal at P meets the minor axis, then $(C.F.\ PG)^2$ is equal to $(40+\lambda)^2$ then $\lambda=$

Space For Rough Work

Q.P. Code: 100191

Answers

SECTION-1 : PHYSICS

PART – A

1.	**BD**	2.	**AB**	3.	**BCD**	4.	**CD**
5.	**AD**	6.	**BCD**	7.	**AC**	8.	**B**
9.	**D**	10.	**B**	11.	**C**	12.	**A**
13.	**B**						

PART – B

1.	**8**	2.	**6**	3.	**0.5**	4.	**6**
5.	**0.5**	6.	**9**	7.	**3**	8.	**8**

SECTION-2 : CHEMISTRY

PART – A

1.	AB	2.	ABC	3.	AC	4.	AC
5.	AC	6.	ABD	7.	ABD	8.	C
9.	B	10.	A	11.	D	12.	D
13.	B						

PART – B

1.	1.33 (Range 1.3 to 1.4)	2.	1.5	3.	2.5
4.	0.22[Range 0.2 to 0.3]	5.	3	6.	0.9
7.	0.4	8.	170		

SECTION-3 : MATHEMATICS

PART – A

1.	AD	2.	ABC	3.	ABD	4.	ACD
5.	AB	6.	ABD	7.	BD	8.	D
9.	A	10.	A	11.	D	12.	C
13.	C						

PART – B

1.	0.33	2.	55	3.	1	4.	0.5
5.	7	6.	1	7.	0.33	8.	9

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **BD**

Sol. Length $\propto G^x c^y h^z$

$L = \left[M^{-1}L^3T^{-2}\right]^x \left[LT^{-1}\right]^y \left[ML^2T^{-1}\right]^z$

By comparing the power of M, L and T in both sides we get

$-x + z = 0, 3x + y + 2z = 1$ and $-2x - y - z = 0$

By solving above three equations we get

$x = \frac{1}{2}, y = -\frac{3}{2}, z = \frac{1}{2}$

2. **AB**

Sol. q_1 and q_2 both are negative and $\frac{kq_1}{\left(\frac{2a}{3}\right)^2} = \frac{kq_2}{\left(\frac{a}{3}\right)^2} \Rightarrow \frac{q_1}{q_2} = 4$.

3. **BCD**

Sol. f = 3, n = 1 $\quad P_0V_0 = nRTo$

$H_{AB} = P_o(2V_o - V_0) + \frac{3}{2}P_o(2V_o - V_o) = \frac{5}{2}P_oV_o = \frac{5RT_0}{2}$

$H_{BC} = \frac{fn}{2}R(T_c - T_B) = \frac{3}{2}(2P_o2V_o - P_o2V_o) = 3P_oV_o = 3RTo$

$H_{AB-c} = \frac{5}{2}RT_O + 3RT_O = \frac{11}{2}RT_O$

$W_{AB-C} = P_oV_o + 0 = RT_O$

$\Delta UA - B - C = H_{ABC} - W_{ABC} = \frac{9}{2}RT_O$

4. **CD**

Sol. Threshold frequency is independent of intensity.

5. **AD**

Sol. $\frac{1}{2}Li_{max}^2 = \frac{1}{2}CV_o^2$

6. **BCD**

Sol. The flow of heat will always be in the direction of the temperature gradient from higher to lower temperature. Hence Q_1 in rod AB, Q_2 in rod BC will both be in clockwise sense while Q_3 in CA will be in anti-clockwise sense. Also, we have if L is the length of each rod and A its area of cross-section,

$Q_1 = \frac{\alpha_1 A(100 - 50)}{L} = (50\alpha_1)\frac{A}{L}$

$Q_2 = \frac{\alpha_2 A(50 - 0)}{L} = (50\alpha_2)\frac{A}{L}$

$Q_3 = \frac{\alpha_3 A(100 - 0)}{L} = (100\alpha_3)\frac{A}{L}$

Hence, $Q_1 : Q_2 : Q_3 :: \alpha_1 : \alpha_2 : 2\alpha_3$

Also,

$$\frac{Q_1}{\alpha_1}+\frac{Q_2}{\alpha_2}=\left(50\frac{A}{L}\right)+\left(50\frac{A}{L}\right)=\frac{100A}{L}=\frac{Q_3}{\alpha_3}$$

7. **AC**

Sol. Mass per unit length of the wire = 0.1 kg/m.
At any instant, tension in the string is (2 + 2.25 t) g N

$$v=\sqrt{\frac{(2+2.25\,t)g}{0.1}}$$

$$\int_0^{10} dx=10\int_0^t\sqrt{2+2.25\,t}\,dt$$

t = 0.612 s

$$T=\left(2+2.25\times0.612\right)\times10=33.77\text{ N}$$

8. **B**

Sol. The electric field due to the dipole on the circumference of the ring $E=\frac{p}{4\pi\varepsilon_0R^3}$ and it is directed normal to the plane of charged ring.

Hence force on the charged ring $F=qE=\frac{pq}{4\pi\varepsilon_0R^3}$

9. **D**

Sol. $\int Ndt=\frac{3MV}{2}$; $\frac{\int\mu Ndt}{m}=\Delta V$

10. **B**

Sol. Property of perfectly elastic collision.

11. **C**

Sol. $V=\frac{4}{3}\sqrt{2\times10\times7.2}=16$

12. **A**

Sol. $Vr=\frac{nh}{2\pi m}$, $rV\propto n$; $r\propto n^2$
$E\propto 1/n^2$ and $V\propto 1/n$

13. **B**

Sol. $v^2=v_0{}^2+2\left(\frac{qE_0}{m}\right)x_0$

$v=\sqrt{2}v_0$

$$a_n=\frac{qE_0}{m}\frac{v_0}{\sqrt{v_x^2+v_0^2}}$$

$$R=\frac{v^2}{a_n}=\frac{[m^2v_0^2+2qE_0mx_0]^{\frac{3}{2}}}{qE_0v_0m^2}=4\sqrt{2}\,x_0$$

PART – B

1. **8**

Sol. Maximum height = $\frac{u^2}{2g\cos\theta}$ ...(i)

Range = $\frac{1}{2}\times 2g\sin\theta\times\left(\frac{2u}{g\cos\theta}\right)^2$ ...(ii)

From (i) and (ii) cot θ = 8.

2. **6**

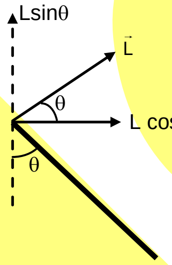
Sol. mc (10 – T) = m 2c (T–5) + 2mC (T-5)
T = 6°C.

3. **0.5**

Sol. Power factor = cos ϕ = cos π/3 = 1/2.

4. **6**

Sol. $\left|\frac{d\vec{L}}{dt}\right| = L\cos\theta\omega$

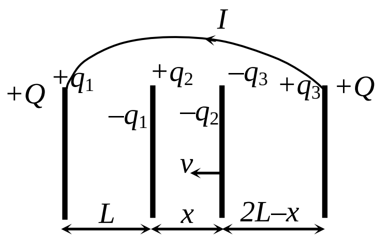


$= \frac{m\ell^2}{3}\omega\sin\theta\cos\theta\omega$

$= \frac{m\ell^2}{3}\omega^2\sin\theta\cos\theta$

5. **0.5**

Sol. $\frac{2q_1L}{2A\varepsilon_0}+\frac{2q_2x}{2A\varepsilon_0}-\frac{2q_3(2L-x)}{2A\varepsilon_0}=0$ ... (i)



$I=\frac{dq_1}{dt}=\frac{-dq_3}{dt}=\frac{dq_2}{dt}$ ... (ii)

From (i),

$q_1L+q_2x-2q_3L+q_3x=0$

$\Rightarrow \quad L\frac{dq_1}{dt}+x\frac{dq_2}{dt}+q_2\frac{dx}{dt}-2\frac{dq_3}{dt}L+x\frac{dq_3}{dt}+q_3\frac{dx}{dt}=0$

$\Rightarrow \quad I=\frac{v}{3L}(q_2+q_3)$ = 1 mA

6. **9**

Sol. $P\propto\frac{1}{T^2}$. $\Rightarrow$ PT^2 = constant

$P\left(\frac{PV}{nR}\right)^2$ = constant

P^3V^2 = constant

$PV^{2/3}$ = constant

Molar heat capacity $C=C_V+\frac{R}{1-x}$

$C=C_V+\frac{R}{1-\frac{2}{3}}=\frac{3R}{2}+3R=\frac{9R}{2}$

7. **3**

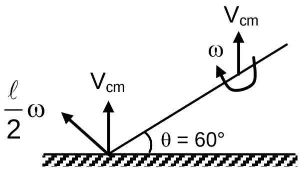
Sol. $m\omega^2 A \le \mu mg$

$$A \le \frac{\mu g}{\left[\frac{K}{(m+M)}\right]}$$

$$A \le \frac{0.5\times 10}{\left(\frac{10}{6}\right)} \le 3$$

8. **8**

Sol.



Impulse $I = m(V_{cm} + V_0)$ ...(1)

Angular Impulse $I\left(\frac{\ell}{2}\cos\theta\right) = \frac{m\ell^2}{12}\omega$ ...(2)

$\because$ e = 1

$\Rightarrow V_0 = V_{cm} + \frac{\ell}{2}\omega\cos\theta$ ...(3)

From equation (1) and (2)

$$m(V_{cm} + 2)\frac{\ell}{2}\cos\theta = \frac{m\ell^2}{12}\omega$$

$$(V_{cm} + 2)\frac{3}{\ell} = \omega$$

$\Rightarrow V_{cm} = \frac{\omega\ell}{3} - 2$ ...(4)

From equation (3) and (4)

$$2 = \frac{7\omega\ell}{12} - 2$$

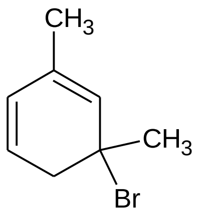
$\Rightarrow \omega = 8.$

SECTION-2 : CHEMISTRY
PART – A

1. AB

Sol. Back bond is stronger in BF_3 as compared to OCl_2 due to energy difference between overlapping orbitals. NCl_3 does not form back π-bond due to less electronegativity difference between N and Cl.

2. ABC

Sol. The major product is 

3. AC

Sol. Due to $t_{2g}^3 e_g^2$ configuration of Mn^{2+} and Fe^{3+} in their respective weak field complexes.

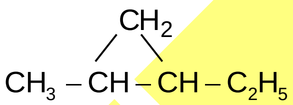
4. AC

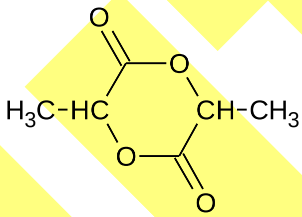
Sol. Close packing takes place along the face diagonal. No atom occupy the voids, as voids can hold smaller atoms or ions.

5. AC

Sol. In (A) and (C) entropy of solution increases.

6. ABD

Sol. (A) 

(B) 

(C) $CH_3 – CH = CHCH_3$

7. ABD

Sol. Colligative properties depend on the number of solute particles.

0.2 M$CaCl_2$ has $0.2 \times 3 = 0.6$ mole particles.

0.3 MKCl has $0.3 \times 2 = 0.6$ mole particles

Similarly, B and D contain same number of particles

8. C

Sol. Oxidation number of iron remains zero even after heating.

9. B

10. A

Sol. $CH_3-\overset{\overset{\large Cl}{|}}{\underset{\underset{\large Cl}{|}}{C}}-CH_2-CCl_3 \xrightarrow{H_2O} CH_3-\overset{\overset{\large O}{||}}{C}-CH_2-COO^- \xrightarrow{H^+}$

$CH_3-\overset{\overset{\large O}{||}}{C}-CH_2-COOH \xrightarrow[-CO_2]{\Delta} CH_3COCH_3$

11. D
Sol. The elements are
Cu, Zn, Ga, Ge, As, Se, Br and Kr

12. D
Sol. Reagents in A,B,C convert phenol to anisole.

13. B
Sol. Q(g) is N_2

PART – B

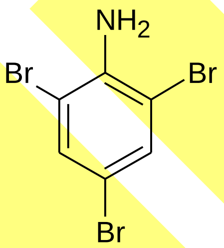
1. 1.33 (Range 1.3 to 1.4)

Sol. $\Delta S(\text{adiabatic}) = nC_p \ell n \frac{T_2}{T_1}$

2. 1.5

Sol. The product(P) is $CH_3-\underset{\underset{\large C_2H_5}{|}}{CH}-\overset{\overset{\large OH}{|}}{CH}-C_2H_5$

3. 2.5

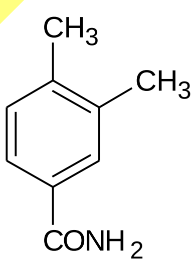
Sol. P is 

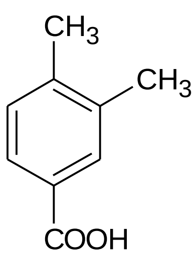
4. 0.22[Range 0.2 to 0.3]

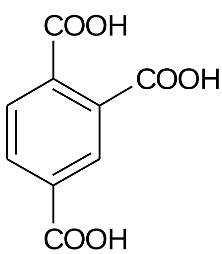
Sol. $p^H = p^{K_a} + \log\frac{[CH_3COONa]}{[CH_3COOH]}$

5. 3
Sol. Sc^{3+} contains no d-electron. So back donation does not take place.

6. 0.9

Sol. (P) is 

, (Q) is 

(R) is 

7. 0.4

Sol. $K = 4 \times 10^{-3}$ ohm^{-1} cm^2

$$\Lambda_m = K \times \frac{1000}{M}$$

$$= 4 \times 10^{-3} \times \frac{1000}{0.1} = 40 \text{ ohm}^{-1} \text{ cm}^2\text{mol}^{-1}$$

$$\alpha = \frac{\Lambda_m}{\Lambda_m^0} = \frac{40}{100} = 0.4$$

8. 170

Sol. The complex is $[Cr(NH_3)_4Cl_2]Cl.2NH_3$

SECTION-3 : MATHEMATICS
PART – A

1. AD

Sol. Let $\sqrt{y-x}=t$

$y-x=t^2$

$\frac{dy}{dx}=2t\frac{dt}{dx}+1$

$2t\frac{dt}{dx}+1=\sqrt{t}$

$\frac{2t}{\sqrt{t}-1}dt=dx$ which leads A and D as solutions

2. ABC

Sol. Let x_0 be the number of objects to the left of the first object chosen, x_1 the number of objects between the first and the second, x_2 the number of objects between the second and the third and x_3 the number of objects to the right of the third object. We have

$x_0, x_3 \ge 0,\ x_1, x_2 \ge 1$ and $x_0+x_1+x_2+x_3=n-3$ (1)

Put $x_1=y_1+1$ and $x_2=y_2+1$. Then (1) reads as

$x_0+y_1+y_2+x_3=n-5$ (2)

where $x_0, y_1, y_2, x_3 \ge 0$

The number of non – negative integral solution of (2) is ${}^{n-5+3}C_3={}^{n-2}C_3$

We have ${}^{n-2}C_3=\frac{1}{6}(n-2)(n-3)(n-4)$

Also, ${}^{n-3}C_3+{}^{n-3}C_2={}^{n-2}C_3$

3. ABD

Sol. The total number of ways of choosing the ticket is 1000. Let the four digits number on the ticket is 1000.

Let the four digits number on the ticket be $x_1x_2x_3x_4$.

Note that $0\le x_1+x_2\le 18$ and $0\le x_3+x_4\le 18$.

Also, the number of non – negative integral solutions of $x+y=m$ (with $0\le x, y\le 9$) is $m+1$ if $0\le m\le 9$ and is 19 – m if $10\le m\le 18$.

Thus, the number of favourable ways

$=1\times1\times1+2\times2+.......+10\times10+9\times9+8\times8+.............+1\times1$

$=2\left\{\frac{9\times10\times19}{6}\right\}+100=670$

$\therefore$ Probability of required event $=\frac{670}{1000}=0.067$

Note that $0.067>0.065$ and $0.067<0.068$.

4. ACD

Sol. $\sum_{k=1}^{n}\left(\sum_{m=1}^{k}m^2\right)=an^4+bn^3+cn^2+dn+e$

$\Rightarrow \sum_{k=1}^{n}\left[\frac{k(k+1)(2k+1)}{6}\right]=an^4+bn^3+cn^2+dn+e$

$\Rightarrow \frac{1}{6}\left\{2\sum_{k=1}^{n}k^3+3\sum_{k=1}^{n}k^2+\sum_{k=1}^{n}k\right\}=an^4+bn^3+cn^2+dn+e$

$$\Rightarrow \frac{1}{6}\left\{\frac{k^2(k+1)^2}{2}+\frac{k(k+1)(2k+1)}{2}+\frac{k(k+1)}{2}\right\}:$$

$an^4+bn^3+cn^2+dn+e$

$$\Rightarrow \frac{n^4}{12}+\frac{n^3}{3}+\frac{5n^2}{12}+\frac{n}{6}=an^4+bn^3+cn^2+dn+e$$

Therefore, $a=\frac{1}{12}; b=\frac{1}{3}; c=\frac{5}{12}; d=\frac{1}{6}; e=0$

5. AB

Sol: Let $f'(1)=a$ and $f''(1)=b$, putting x = 1 in the given equation we get $b=a^2$.
Differentiating the equation and putting x = 1 gives
$2ab+8=ab+2ab \Rightarrow ab=8 \Rightarrow a=2, b=4$

6. ABD

Sol: AB-BA is skew symmetric. Also in option C, $|A|\neq 0$. Rest are obvious.

7. BD

Sol: $(z-(1+2i))^4=1 \Rightarrow z=1^{1/4}+1+2i$

$z_1=1+2i+1=2+2i=\omega_2$

$z_2=1+2i-1=2i=\omega_3$

$z_3=1+2i+i=1+3i=\omega_1$

$z_4=1+2i-i=1+i=\omega_4$

$\lambda=5$ (circle on $\omega_1-\omega_4$ and $\omega_3-\omega_2$ will overlap)

8. D

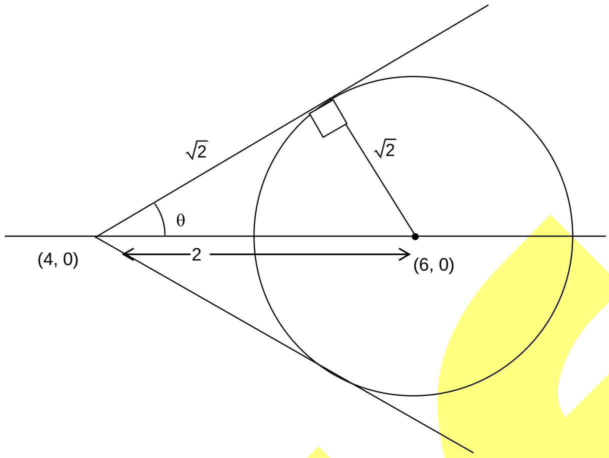
Sol: Let there be a value of k for which $x^3-3x+k=0$ has two distinct roots between 0 and 1. Let a, b be two distinct roots of $x^3-3x+k=0$ lying between 0 and 1 such that $a<b$. Let $f(x)=x^3-3x+k$. Then $f(a)=f(b)=0$. Since between any two roots of a polynomial f(x) there exist at least one root of its derivative $f'(x)$. Therefore $f'(x)=3x^2-3$ has at least one root between a and b. But $f'(x)=0$ has two roots equal to ± 1 which do not lie between a and b. Hence $f(x)=0$ has no real roots lying between 0 and 1 for any value of k.

9. A

Sol. Let $\alpha \in R-Q$ be a common root of $f(x)=0$ and $g(x)=0$.
Then $\alpha^2=-a\alpha-b$. Substituting this in $\alpha^3+p\alpha+q=0$, we get $(a^2-b+p)\alpha+ab+q=0$
As α is irrational and $a,b,p,q\in Q$, $p=b-a^2$, $q=-ab$. This gives, $g(x)=(x-a)f(x)$.

10. A

Sol. From diagram, $\theta = 45^o$
$\Rightarrow$ Slope $= \pm 1$,



11. D
Sol. $x = -10$ is the directrix of the given parabola. Hence the circle S = 0 will touch it. P_1P_2 is the diameter. So $\angle P_1P\,P_2 = 90^o$ and hence ΔP_1PP_2 is right angled and its orthocentre is point P. Tangents at extremeties of focal chord are perpendicular. Hence in their combined equation (coefficient x^2) + (coefficient y^2) = 0.

12. C
Sol. Let $\cos^{-1}p = \alpha,\ \cos^{-1}q = \beta,\ \cos^{-1}r = \gamma$

$\cos\alpha = p$
$\cos\beta = q$
$\cos\gamma = r$
$\alpha + \beta + \gamma = \pi$
$\Rightarrow \cos(\alpha + \beta) = \cos(\pi - \gamma)$
$\Rightarrow \cos\alpha\cos\beta - \sin\alpha.\sin\beta = -\cos\gamma$
$\Rightarrow pq - \sqrt{1-p^2}\,\sqrt{1-q^2} = -r$
$\Rightarrow pq + r = \sqrt{1-p^2}\,\sqrt{1-q^2}$
$2pqr + p^2q^2 + r^2 = (1-p^2)(1-q^2)$
$p^2 + q^2 + r^2 + 2pqr = 1$

13. C
Sol. Let $x_0 = \cos\theta$, then $x_1 = \sqrt{\frac{1}{2}(1+\cos\theta)} = \cos\frac{\theta}{2},\ x_2 = \cos\left(\frac{\theta}{2^2}\right),\ x_3 = \cos\left(\frac{\theta}{2^3}\right)$.... and so on.

So that $\left[\dfrac{\sqrt{1-x_0^2}}{x_1x_2x_3\text{.......to infinite}}\right]$

$$= \frac{\sin\theta}{\cos\frac{\theta}{2}\cos\frac{\theta}{2^2}\text{......}\cos\frac{\theta}{2^n}\text{......infinite}}$$

$$= \frac{2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{\cos\frac{\theta}{2}\cos\frac{\theta}{2^2}\text{.....}\cos\frac{\theta}{2^n}\text{.....infinite}}$$

$$= \frac{2^2\sin\frac{\theta}{2^2}\cos\frac{\theta}{2^2}}{\cos\frac{\theta}{2^2}\cos\frac{\theta}{2^3}\text{.......}\cos\frac{\theta}{2^n}\text{.....infinite}}$$

$$= \lim_{n\to\infty} \frac{2^n \sin\frac{\theta}{2^n}}{\cos\frac{\theta}{2^{n+1}}}$$

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

So that $\cos\left[\frac{\sqrt{1-x_0^2}}{x_1 x_2.....\text{inf}} \right] = \cos\theta = x_0$

PART – B

1. 0.33

Sol. $\lim\limits_{n\to\infty} \frac{(\cos x - 1)(\cos x - e^x)}{x^n}$

Limit $= \lim\limits_{x\to 0} \frac{2\sin^2\frac{x}{2}}{2^2\left(\frac{x}{2}\right)^2} \frac{e^x - \cos x}{x^{n-2}} = \frac{1}{2}\lim\limits_{x\to 0} \frac{e^x - \cos x}{x^{n-2}}$

($n \neq 1$ for then the limit = 0)

$= \frac{1}{2}\lim\limits_{x\to 0} \frac{e^x + \sin x}{(n-2)x^{n-3}}$.

So, if $n = 3$, the limit is $\frac{1}{2(n-2)}$ which is finite.

If $n = 4$, the limit is infinite.
Answer is 0.33.

2. 55

Sol. $(1-1+2-2+...+5-5)^2 =$

$1^2 + 1^2 + 2^2 + 2^2 + ... + 5^2 + 5^2 + 2S$.

3. 1

Sol. $\Delta = \sqrt{s(s-a)(s-b)(s-c)} = 6$

$\therefore r = \frac{\Delta}{s} = 1$

Answer is 1.

4. 0.5

Sol. Cubing on both sides apply
$\cos 3\theta = 4\cos^3\theta - 3\cos\theta$

5. 7

Sol. The problem corresponds to a selection of 4 non-consecutive integers out of first 10 natural numbers. Therefore $N = {}^7C_4$.

6. 1

Sol: Given expression $= \frac{(s-b)(s-c)}{(a-b)(a-c)} + \frac{(s-a)(s-c)}{(b-a)(b-c)} + \frac{(s-a)(s-b)}{(c-a)(c-b)} = 1$

7. 0.33

Sol: $\frac{4000}{a_1 a_{4001}} = 10 \Rightarrow a_1 a_{4001} = 400$

also $a_1 + a_{4001} = 50$

$\Rightarrow |a_1 - a_{4001}|^2 = 2500 - 1600$

$\Rightarrow |a_1 - a_{4001}| = 30$

8. 9

Sol. Equation of the tangent at P $(7\cos\theta, 5\sin\theta)$ on the ellipse is $\frac{x}{7}\cos\theta + \frac{y}{5}\sin\theta = 1$

then $(CF)^2 = \frac{7^2 \times 5^2}{5^2\cos^2\theta + 7^2\sin^2\theta}$

$= \frac{25 \times 49}{25\cos^2\theta + 49\sin^2\theta}$

Equation of the normal at P is $\frac{7x}{\cos\theta} - \frac{5y}{\sin\theta} = 7^2 - 5^2$

Coordinates of G are $\left(0, \frac{-24\sin\theta}{5}\right)$

$(PG)^2 = (7\cos\theta)^2 + \left(5\sin\theta + \frac{24\sin\theta}{5}\right)^2$

$= \frac{49}{25}\left(25\cos^2\theta + 49\sin^2\theta\right)$

So $(CF \,.\, PG)^2 = (49)^2 = 2401$