

2021-22



National Level Science Talent Search Examination

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CLASS XII (PCM)

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Questions : 60

Time : 60 minutes

INSTRUCTIONS

Read all instructions carefully before attempting any question.

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- You must complete the paper within the time allotted.
- Do not open this question paper until you are permitted to.
- You are not allowed to use a calculator.
- Figures herein are not to scale. Hence, you cannot depend on the estimate of size or measurement. Use your knowledge of the subject.
- Rough work shall be carried out only in the space provided for the same throughout this booklet. No separate sheets are allowed for the same.
- Return your answer sheet to the invigilator soon after completion and before leaving the examination hall. Take the question paper with you.
- There is no negative marking.
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UCN/QP-XII(PCM)/01



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01 The domain of the function $f(x) = \log(1-x) + \sqrt{x^2-1}$ is

- (A) $(0, 1)$ (B) $(-\infty, -1]$
(C) $(1, \infty)$ (D) $[-1, 1]$

02 The function $f : (-\infty, -1] \rightarrow (0, e^5]$ defined by $f(x) = e^{x^3-3x+2}$ is

- (A) Many one and onto (B) Many one and into
(C) One-one and onto (D) One-one and into

03 $\cot\left(\frac{\pi}{4} - 2 \cot^{-1} 3\right) =$

- (A) 1 (B) 7
(C) 4 (D) None of these

04 $\tan(\cos^{-1} x)$ is equal to

- (A) $\pm \sqrt{\frac{1-x^2}{x}}, x \neq 0$ (B) $\frac{\sqrt{1+x^2}}{x}, x \neq 0$
(C) $\frac{x}{\sqrt{1+x^2}}$ (D) $\frac{\sqrt{1-x^2}}{x}, x \neq 0$

05 If $A = \begin{bmatrix} i & 0 \\ 0 & i \end{bmatrix}$, $n \in \mathbf{N}$, then A^{4n} equals

- (A) $\begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ (B) $\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ (C) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (D) $\begin{bmatrix} i & 0 \\ 0 & i \end{bmatrix}$

06 The value of the determinant

$$\begin{vmatrix} b^2 - ab & b - c & bc - ac \\ ab - a^2 & a - b & b^2 - ab \\ bc - ac & c - a & ab - a^2 \end{vmatrix} \text{ is}$$

- (A) 1 (B) 0
(C) -1 (D) None of these

07 If $\alpha, \beta \neq 0$, $f(n) = \alpha^n + \beta^n$ and

$$\begin{vmatrix} 3 & 1 + f(1) & 1 + f(2) \\ 1 + f(1) & 1 + f(2) & 1 + f(3) \\ 1 + f(2) & 1 + f(3) & 1 + f(4) \end{vmatrix}$$

$$= K (1 - \alpha)^2 (1 - \beta)^2 (\alpha - \beta)^2 \text{ then } k = ?$$

- (A) $\alpha\beta$ (B) $\frac{1}{\alpha\beta}$ (C) 1 (D) -1

08 If $y = \sec(\tan^{-1} x)$, then $\frac{dy}{dx}$ at $x = 1$ is equal to

- (A) $\frac{1}{\sqrt{2}}$ (B) $\frac{1}{2}$ (C) 1 (D) $\sqrt{2}$

SPACE FOR ROUGH WORK

- 09** The length of the subtangent to the curve $x^2 + xy + y^2 = 7$ at $(1, -3)$ is
 (A) 3 (B) 5 (C) 15 (D) $3/5$
- 10** If the cubic $x^3 - px + q$ has three distinct real roots, where $p > 0$ and $q > 0$. Then, which one of the following holds ?

- (A) The cubic has maxima at both $\sqrt{\frac{p}{3}}$ and $-\sqrt{\frac{p}{3}}$
- (B) The cubic has minima at $\sqrt{\frac{p}{3}}$ and maxima at $-\sqrt{\frac{p}{3}}$
- (C) The cubic has minima at $-\sqrt{\frac{p}{3}}$ and maxima at $\sqrt{\frac{p}{3}}$
- (D) The cubic has minima at both $\sqrt{\frac{p}{3}}$ and $-\sqrt{\frac{p}{3}}$

- 11** $\int \frac{dx}{x^2(1+x^4)^{\frac{3}{4}}}$ is equal to

- (A) $-\frac{(1+x^4)^{\frac{1}{4}}}{x} + C$ (B) $\frac{(1+x^4)^{\frac{1}{4}}}{x} + C$
- (C) $-\frac{(1+x^4)^{\frac{3}{4}}}{x} + C$ (D) None of these

SPACE FOR ROUGH WORK

12 $\int_0^{2\pi} e^{\frac{x}{2}} \sin\left(\frac{x}{2} + \frac{\pi}{4}\right) dx =$

- (A) 2π (B) e^π (C) 0 (D) $2\sqrt{2}$

13 The area bounded by the curves $y^2 = 4x$ and $x^2 = 4y$ is

- (A) 0 (B) $\frac{32}{3}$ (C) $\frac{16}{3}$ (D) $\frac{8}{3}$

14 The order of the differential equation, of which $xy = ce^x + be^{-x} + x^2$ is a solution, is

- (A) 1 (B) 2
(C) 3 (D) None of these

15 The differential equation of family of parabolas with foci at the origin and axis along the x -axis is

(A) $y \left(\frac{dy}{dx}\right)^2 + 2x \frac{dy}{dx} - y = 0$

(B) $x \left(\frac{dy}{dx}\right)^2 + 2y \frac{dy}{dx} - y = 0$

(C) $y \left(\frac{dy}{dx}\right)^2 + 2x \frac{dy}{dx} + y = 0$

- (D) None of these

SPACE FOR ROUGH WORK

- 16** Let the population of rabbits surviving at a time t be governed by the differential equation $\frac{dp}{dt} = \frac{1}{2}p(t) - 200$.

If $p(0) = 100$, then $p(t)$ is equal to

- (A) $400 - 300e^{\frac{t}{2}}$ (B) $300 - 200e^{\frac{-t}{2}}$
 (C) $600 - 500e^{\frac{t}{2}}$ (D) $400 - 300e^{\frac{-t}{2}}$

- 17** If G is the centroid of the triangle ABC , then $GA + GB + GC =$

- (A) 0 (B) 1
 (C) -1 (D) None of these

- 18** If $a = (2, 1, -1)$, $b = (1, -1, 0)$ and $c = (5, -1, 1)$, then the unit vector parallel to $a + b - c$, but in the opposite direction is

- (A) $\frac{-1}{3}(2i - j + 2k)$ (B) $\frac{1}{3}(2i - j + 2k)$
 (C) $\frac{1}{3}(2i + j - 2k)$ (D) None of these

SPACE FOR ROUGH WORK

- 19 If the vectors $AB = 3i + 4k$ and $AC = 5i - 2j + 4k$ are the sides of a ΔABC , then the length of the median through A is
- (A) $\sqrt{18}$ (B) $\sqrt{72}$ (C) $\sqrt{33}$ (D) $\sqrt{45}$
- 20 The ratio in which the line joining $(1, 2, 3)$ and $(-3, 4, -5)$ is divided by xy -plane is
- (A) 5 : 3 (B) 3 : 5
(C) 2 : 3 (D) None of these
- 21 If the lines $\frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{-k}$ and $\frac{x-1}{k} = \frac{y-4}{2} = \frac{z-5}{1}$ are coplanar, then k can have
- (A) any value (B) exactly one value
(C) exactly two values (D) exactly three values
- 22 A bag contains 10 mangoes out of which 4 are rotten, two mangoes are taken out together. If one of them is found to be good, the probability that other is also good is
- (A) $\frac{1}{3}$ (B) $\frac{8}{15}$ (C) $\frac{5}{18}$ (D) $\frac{2}{3}$

SPACE FOR ROUGH WORK

23 Out of 13 applicants for a job, there are 5 women and 8 men. It is desired to select 2 persons for the job. The probability that atleast one of the selected persons will be a woman is

- (A) $\frac{25}{39}$ (B) $\frac{14}{39}$ (C) $\frac{5}{13}$ (D) $\frac{10}{13}$

24 Let A and B be two events such that

$$P(\overline{A \cup B}) = \frac{1}{6}, P(A \cap B) = \frac{1}{4} \text{ and } P(\overline{A}) = \frac{1}{4}, \text{ where } \overline{A}$$

stands for the complement of the event A. Then, the events A and B are

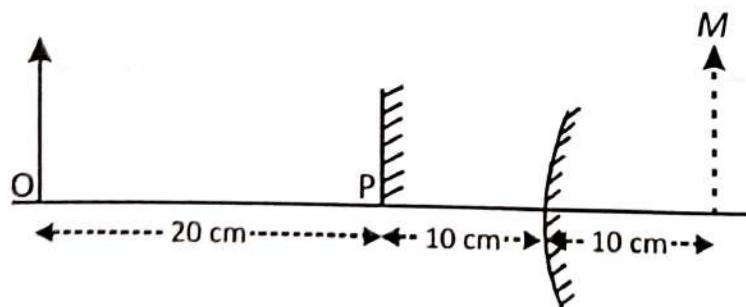
- (A) independent but not equally likely
 (B) independent and equally likely
 (C) mutually exclusive and independent
 (D) equally likely but not independent

25 Inequations $3x - y \geq 3$ and $4x - y > 4$

- (A) have solution for positive x and y
 (B) have no solution for positive x and y
 (C) have solution for all x
 (D) have solution for all y

SPACE FOR ROUGH WORK

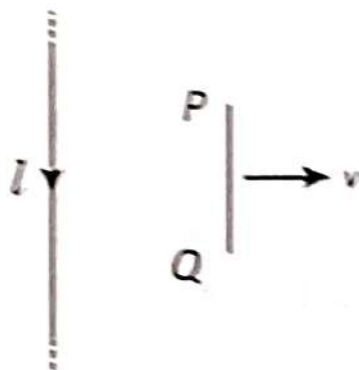
- 26 A current of 10 A is maintained in a conductor of cross-section 10^{-4} m^2 . If the number density of free electrons be $9 \times 10^{28} \text{ m}^{-3}$, calculate the drift velocity of free electrons. Given charge on electron, $e = 1.6 \times 10^{-19} \text{ C}$.
- (A) $3.12 \times 10^{-3} \text{ m s}^{-1}$ (B) $4.56 \times 10^{-4} \text{ m s}^{-1}$
 (C) $5.78 \times 10^{-5} \text{ m s}^{-1}$ (D) $6.94 \times 10^{-6} \text{ m s}^{-1}$
- 27 The amplitude of magnetic field of a plane e.m. wave is $8 \times 10^{-7} \text{ T}$. Calculate the amplitude of the electric field.
- (A) 118 V/m (B) 240 V/m
 (C) 356 V/m (D) 497 V/m
- 28 Three charges $10 \mu\text{C}$, $5 \mu\text{C}$ and $-5 \mu\text{C}$ are placed in air at the three corners A, B and C of an equilateral triangle of side 0.1 m. Find the resultant force experienced by charge placed at corner A.
- (A) 15 N (B) 35 N (C) 45 N (D) 55 N
- 29 A small plane mirror strip is kept at a distance of 10 cm in front of a convex mirror, with its plane normal to the principal axis. An object is placed at a distance of 20 cm from the plane mirror as shown below. Calculate the focal length of the convex mirror, if the images formed by the plane mirror and the convex mirror coincide, without parallax.



- (A) + 25 cm (B) - 20 cm (C) + 15 cm (D) - 10 cm

- 30** 60 J of work must be done to move electric charge equal to 5 C from a point, where potential is +20 V to another point, where potential is V volt. Find the value of V.
(A) 14 V (B) 18 V (C) 24 V (D) 32 V
- 31** Of the following pairs of species, which one will have the same electronic configuration for both members ?
(A) Li^+ and Na^+ (B) He and Ne^+
(C) H and Li (D) C and N^+
- 32** A bar magnet placed in a uniform magnetic field of strength 0.3 T, with its axis at 30° to the field, experiences a torque of 0.06 N m. What is the magnetic moment of the bar magnet ?
(A) 0.3 A m^2 (B) 0.5 A m^2
(C) 0.9 A m^2 (D) 0.4 A m^2
- 33** A photocell is illuminated by a small bright source placed 1 m away. When the same source of light is placed 0.5 m away, the number of electrons emitted by photocathode would
(A) decrease by a factor of 4.
(B) increase by a factor of 4.
(C) decrease by a factor of 2.
(D) increase by a factor of 2.
- 34** The frequency of an alternating current is 50 Hz and it has a peak value of 10 A. Find the time taken for the current to reach the peak value starting from zero.
(A) $0.2 \times 10^{-9} \text{ s}$ (B) $0.3 \times 10^{-7} \text{ s}$
(C) $0.4 \times 10^{-5} \text{ s}$ (D) $0.5 \times 10^{-3} \text{ s}$

- 35 A steady current I flows in an infinitely long straight wire. A conducting rod parallel to the wire moves away from it with constant velocity v as shown in figure. If P and Q are the ends of the rod, then

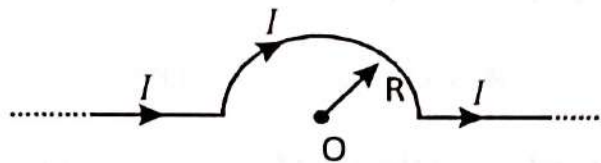


- (A) P is positive w.r.t. Q
 (B) P is negative w.r.t. Q
 (C) Both are at the same potential
 (D) Nothing can be said because the rod does not form a loop.
- 36 A series battery of 6 lead accumulators each of emf 2.0 V and internal resistance 0.25Ω is charged by a 230 V d.c. mains. To limit the charging current, a series resistance of 53Ω is used in the charging circuit. What is (a) the power supplied by the mains and (b) the power dissipated as heat both in W ?
- (A) 1650, 534 (B) 735, 615
 (C) 815, 752 (D) 920, 872
- 37 The Young's double slit experiment is performed with blue and with green light of wavelength 4360 \AA and 5460 \AA respectively. If x is the distance of 4th maximum from the central one, then
- (A) $x(\text{blue}) = x(\text{green})$ (B) $x(\text{blue}) > x(\text{green})$
 (C) $x(\text{blue}) < x(\text{green})$ (D) $\frac{x(\text{blue})}{x(\text{green})} = \frac{5460}{4360}$

38 An electric dipole consists of two charges $+5 \mu\text{C}$ and $-5 \mu\text{C}$ separated by a distance of 1.5° A . The dipole is placed in a uniform electric field of strength $5 \times 10^5 \text{ Vm}^{-1}$. Find its potential energy.

- (A) $1.23 \times 10^{-8} \text{ J}$ (B) $2.97 \times 10^{-9} \text{ J}$
(C) $3.75 \times 10^{-10} \text{ J}$ (D) $4.18 \times 10^{-11} \text{ J}$

39 The magnetic field B at the centre O of the semi-circular wire as shown below is given by



- (A) $\frac{\mu_o I}{2R}$ (inwards) (B) $\frac{\mu_o I}{4R}$ (inwards)
(C) $\frac{\mu_o I}{2R}$ (outwards) (D) $\frac{\mu_o I}{4R}$ (outwards)

40 A photocell employs photoelectric effect to convert

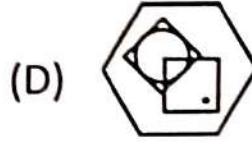
- (A) change in the frequency of light into a change in the electric current.
(B) change in the frequency of light into a change in electric voltage.
(C) change in the intensity of illumination into a change in photoelectric current.
(D) change in the intensity of illumination into a change in the work function of the photocathode.

- 41** 30 mL of 0.13 M NiSO_4 is electrolysed using a current of 360 milliamperes for 35.3 minutes. How much of the metal would have been plated out if current efficiency is 100% ? ($\text{Ni} = 58.7$)
- (A) 0.1165 g (B) 0.2318 g
(C) 1.9387 g (D) 2.1794 g
- 42** Amongst the following, identify the species with an atom in + 6 oxidation state
- (A) MnO_4^- (B) $\text{Cr}(\text{CN})_6^{3-}$ (C) NiF_6^{2-} (D) CrO_2Cl_2
- 43** The radius of a divalent cation A^{2+} is 94 pm and of divalent anion B^{2-} is 146 pm. The compound AB has
- (A) rock salt structure
(B) zinc blende structure
(C) antifluorite structure
(D) cesium chloride like structure
- 44** The basicities of phosphorous acid, orthophosphoric acid and meta phosphoric acid are respectively
- (A) 3, 2 and 1 (B) 2, 3 and 1
(C) 2, 1 and 3 (D) 1, 2 and 3
- 45** Aniline is treated with a mixture of sodium nitrite and hypophosphorous acid, the product formed is
- (A) Aniline diazonium hypophosphite
(B) Benzene
(C) Anilinium hypophosphite
(D) Aniline diazonium hypophosphite

- 46** Primary, secondary and tertiary alcohols may be distinguished by converting them into the corresponding nitroparaffins which are then treated with
- (A) Aqueous NaOH (B) Conc. H_2SO_4
(C) Conc. HCl (D) $NaNO_2 + \text{dil. HCl}$
- 47** Ferrous and ferric ions in solution may be distinguished by
- (A) Silver nitrate solution
(B) Lead acetate solution
(C) Acidified solution of $KMnO_4$
(D) Sodium chloride solution
- 48** Calculate the half life period of a first order reaction where the specific rate constant is 200 s^{-1} .
- (A) $1.253 \times 10^{-7} \text{ s}$ (B) $2.768 \times 10^{-5} \text{ s}$
(C) $3.465 \times 10^{-3} \text{ s}$ (D) $4.812 \times 10^{-2} \text{ s}$
- 49** Of the following statements about enzymes which one is/are not true ?
- (i) Enzymes lack in nucleophilic groups.
(ii) Enzymes are highly specific both in binding chiral substrates and in catalysing their reactions.
(iii) Enzymes catalyse chemical reactions by lowering the energy of activation.
(iv) Pepsin is a proteolytic enzyme.
- (A) (i) and (iv) (B) (i) and (iii)
(C) (ii), (iii) and (iv) (D) (i)

- 50 What is the shape of $\text{Fe}(\text{CO})_5$ molecule ?
(A) Tetrahedral (B) Octahedral
(C) Trigonal bipyramidal (D) Square pyramidal
- 51 12 g of urea is dissolved in 1 litre of water and 68.4 g of sucrose is dissolved in 1 litre of water. The lowering of vapour pressure of first case is
(A) equal to second (B) greater than second
(C) less than second (D) double that of second
- 52 Arsenic sulphide is a negative sol. The reagent with least precipitating power is
(A) AlCl_3 (B) NaCl
(C) CaF_2 (D) Glucose
- 53 Isobutyl bromide may be obtained from isobutylene and HBr in the presence of
(A) Peroxide (B) Hydroquinone
(C) Diphenylamine (D) All the above
- 54 The correct order of bond angles (smallest first) in H_2S , NH_3 , BF_3 and SiH_4 is
(A) $\text{H}_2\text{S} < \text{SiH}_4 < \text{NH}_3 < \text{BF}_3$
(B) $\text{NH}_3 < \text{H}_2\text{S} < \text{SiH}_4 < \text{BF}_3$
(C) $\text{H}_2\text{S} < \text{NH}_3 < \text{SiH}_4 < \text{BF}_3$
(D) $\text{H}_2\text{S} < \text{NH}_3 < \text{BF}_3 < \text{SiH}_4$
- 55 Aldol condensation will not take place in :
(A) HCHO (B) $\text{CH}_3\text{CH}_2\text{CHO}$
(C) CH_3CHO (D) CH_3COCH_3

- 56** To which hexagon below can a dot be added so that both dots then meet the same conditions as in the hexagon above ?



- 57** Should there be a compulsory military training for each college student in India ?

- I) No, this goes against the basic democratic right of an individual to choose his/her own programs.
- II) Yes, this is the only way to build a strong and powerful nation.

- (A) If only (I) is strong
- (B) If only (II) is strong
- (C) If either (I) or (II) is strong
- (D) If both (I) and (II) are strong

SPACE FOR ROUGH WORK

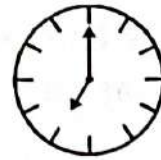
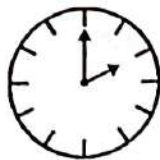
58 On a certain island, the rainfall follows a very reliable pattern. If it rains in the morning, it is clear in the afternoon. One family comes to the island for their vacation. When they leave, there are 12 clear mornings and 13 clear afternoons. How long was their vacation if it rained for 15 days ?

- (A) 20 days (B) 22 days
 (C) 28 days (D) 18 days

59 If $X + Y$ means X is the daughter of Y ; $X - Y$ means X is the brother of Y ; $X \% Y$ means X is the father of Y and $X \times Y$ means X is the sister of Y . Which of the following means I is the niece of J ?

- (A) $J - N \% C \times I$ (B) $I \times C - N \% J$
 (C) $J + M \times C \% I$ (D) $I \times C + N - J$

60 Exactly how many minutes is it before 7:00 am, if 40 min ago it was three times as many minutes past 2:00 am ?



- (A) 60 (B) 65 (C) 70 (D) 75

SPACE FOR ROUGH WORK