JEE (MAIN)

TEST PAPER

SUBJECT : PHYSICS,CHEMISTRY, MATHEMATICS   *TEST CODE : TSJMT217*

QUESTION PAPER

TIME : 3 HRS   *MARKS : 300*

INSTRUCTIONS

GENERAL INSTRUCTIONS :

1. This test consists of 75 questions.
2. There are three parts in the question paper A, B, C consisting of Physics, Chemistry and Mathematics having 25 questions in each part.
3. 20 questions will be Multiple choice questions & 5 quetions will have answer to be filled as numerical value.
4. Marking scheme :

Type of Questions	Total Number of Questions	Correct Answer	Incorrect Answer	Unanswered
MCQ's	20	+4	Minus One Mark(-1)	No Mark (0)
Numerical Values	5	+4	No Mark (0)	No Mark (0)

5. There is only one correct responce for each question. Filling up more than one responce in each question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 4 above.

**OPTICAL MARK RECOGNITION (OMR) :**

6. The OMR will be provided to the students.
7. Darken the appropriate bubbles on the OMR sheet by applying sufficient pressure.
8. The OMR sheet will be collected by the invigilator at the end of the examination.
9. Do not tamper with or mutilate the OMR. Do not use the OMR for rough work.
10. Write your name, Batch name, name of the center, Test Code, roll number and signature with pen in the space provided for this purpose on the OMR. Do not write any of these details anywhere else on the OMR.

**DARKENING THE BUBBLES ON THE OMR :**

11. Use a BLACK BALL POINT PEN to darken the bubbles on the OMR.
12. Darken the bubble COMPLETELY.
13. Darken the bubbles ONLY IF you are sure of the answer. There is NO WAY to erase or "un- darken" a darkened bubble.

Part - A - PHYSICS

Q.1   A string if negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by
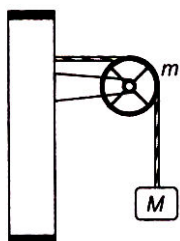
(a) $\sqrt{2}Mg$

(b) $\sqrt{2}mg$

(c) $g\sqrt{(M+m)^2 + m^2}$

(d) $g\sqrt{(M+m)^2 + M^2}$

Q.2   Two masses of 1 g and 4 g are moving with equal kinetic energies. The ratio of the magnitudes of their momenta is

(a) $4:1$ (b) $\sqrt{2}:1$ (c) $1:2$ (d) $1:16$

Q.3   A ball is fropped vertically from a height d above he ground. It hits the ground and bounces up vertically to a height $d/2$. Neglecting subsequent motion and air resistance, its velocity v varies with height h above the ground as
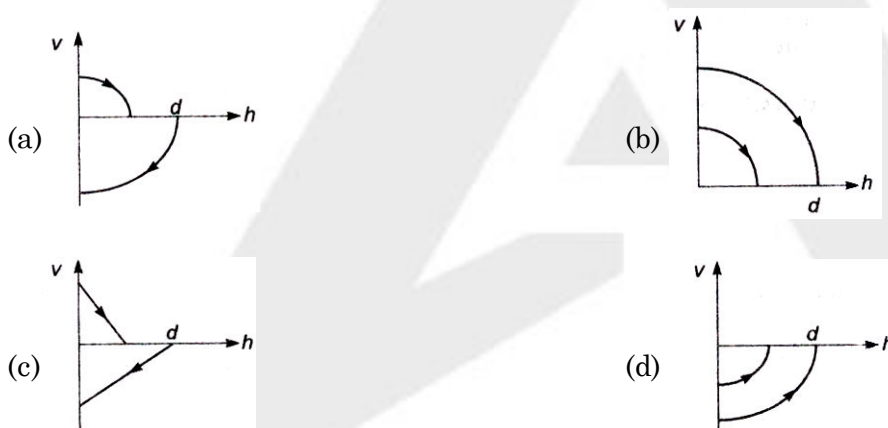
Q.4   Distance of the centre of mass of a solid uniform cone from its vertex is z_0. If the radius of its base is R and its height is h, then is z_0 equal to

(a) $\dfrac{3h}{4}$ (b) $\dfrac{h^2}{4R}$ (c) $\dfrac{5h}{8}$ (d) $\dfrac{3h^2}{8R}$

Q.5   A small object of uniform density rolls up a curved surface with an initial velocity v.

It reaches up to a maximum height of $\dfrac{3v^2}{4g}$ with respect to the initial position. The object is

(a) ring   (b) solid sphere

(c) hollow sphere   (d) disc

Q.6   A highly rigid cubical block A of small mass Ma and side L is fixed rigidly on to anoher cubical block B of the same dimensions and of low modulus of rigidity η such that the lower

face of A completely covers the upper face of B. The lower face of B rigidly held on a horizontal surface. A small force F is applied perpendicular to one of the side faces of A. After the the force is withdrawn, block A executes small oscillations, the time period of which is given by

(a) $2\pi\sqrt{M\eta L}$ 　　　　(b) $2\pi\sqrt{\dfrac{M\eta}{L}}$ 　　　　(c) $2\pi\sqrt{\dfrac{M\eta}{\eta}}$ 　　　　(d) $2\pi\sqrt{\dfrac{M}{\eta L}}$

Q.7　　A cube has a side of length $1.2\times10^{-2}\,m$ Calculate its volume.

(a) $1.7\times10^{-6}\,m^3$ 　　　(b) $1.73\times10^{-6}\,m^3$ 　　　(c) $1.70\times10^{-6}\,m^3$ 　　　(d) $1.732\times10^{-6}\,m^2$

Q.8　　A wooden block, with a coin placed on its top, floats in water as shown in figure. The distance l and h are shown there. After sometime the coin falls into the water. Then
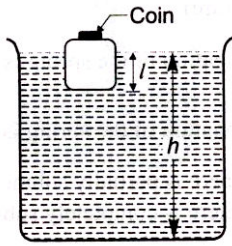

(a) l decreases and h increases 　　　　　　(b) l increases and h decreases
(c) Both l and h increase 　　　　　　　　　(d) Both l and h decrease

Q.9　　A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/s. A plumb bob is suspended from the roof of the car by a light rigid rod. The angle made by the rod with the vertical is (Take g = 10 m/s²)

(a) zero 　　　　　　(b) 30° 　　　　　　(c) 45° 　　　　　　(d) 60°

Q.10　　Liquid oxygen at 50 K is heated to 300 K at constant pressure of 1 atm. The rate of heating is constant. Which of the following graphs represent the variation of temperature with time?
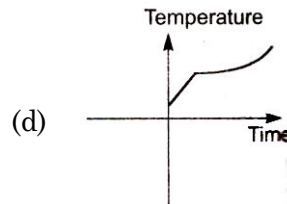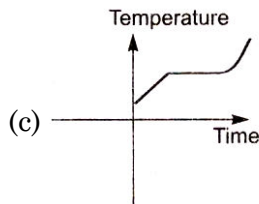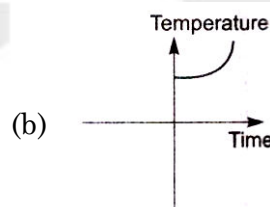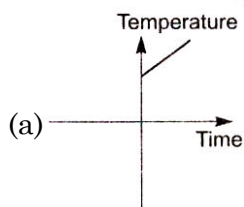
Q.11　　Consider an expanding sphere of instataneous radius R whose total mass remains constant. The expansion is such that the instataneous density ρ remains uniform throughout the volume. The rate of fractional change in density $\left(\dfrac{1}{p}\dfrac{d\rho}{dt}\right)$ is constat. The velocity v of any point of the surface of the expanding sphere is proportional to

(a) R   (b) $\dfrac{1}{R}$ (c) R^3 (d) $R^{\frac{2}{3}}$

Q.12 From a tower of height H, a particle is thrown vertically upwards with a speed u. The time taken by the particle to hit the ground, is n times that taken by it to reach the highest point of its path. The relation between H, u and n is

(a) $\dfrac{2n-1}{2n}$ (b) $\dfrac{2n+1}{2n-1}$ (c) $\dfrac{2n-1}{2n+1}$ (d) $\dfrac{2n}{2n+1}$

Q.13 A pulse of light of duration 100 ns is absorbed completely by a small object initially at rest. Power of the pulse is 30 mV and the speed of light is 3×10^8 ms^{-1}. The final momentum of the object is

(a) 0.3×10^{-17} kg $-$ ms^{-1} (b) 1.0×10^{-17} kg $-$ ms^{-1}

(c) 3.0×10^{-17} kg $-$ ms^{-1} (d) 9.0×10^{-17} kg $-$ ms^{-1}

Q.14 From a solid sphere of mass M and radius R, a cube of maximum possible volume is cut. Moment of inertia of cube about an axis passing through its centre and perpendicular bisector is I. What is the ratio l/R such that the moment of inertia is minimum?

(a) $\dfrac{MR^2}{32\sqrt{2}\pi}$ (b) $\dfrac{4MR^2}{9\sqrt{3}\pi}$ (c) $\dfrac{MR^2}{16\sqrt{2}\pi}$ (d) $\dfrac{4MR^2}{3\sqrt{3}\pi}$

Q.15 If a piece of metal is heated to temperature θ and then allowed to cool in a room which is at temperature θ_0. The graph between the temperature T of the metal and time t will be closed to


Q.16 One mole of diatomic ideal gas undergoes a cyclic process ABC as shown in figure. The process BC is adiabatic. The temperatures at A, B and C 400 K, 800 K and 600 K, respectively. Choose the correct statement.
(a) The change in internal energy in whole cyclic process is 250 R
(b) The change in internal energy in the process CA is 700 R.
(c) The change in internal energy in the process AB is-350 R.
(d) The change in internal energy in the process BC is-500 R.

Q.17 A ball is dropped from a height of 20 m above the surface of water in a lake. The refractive index of water is $\dfrac{4}{3}$. 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 sees the speed of ball as

(a) $9\, ms^{-1}$ (b) $12\, ms^{-1}$ (c) $16\, ms^{-1}$ (d) $21.33\, ms^{-1}$

Q.18   The region between teo concentric spheres of radii a and b, respectively (see the figure),

has volume charge density $\rho = \dfrac{A}{r}$, where, A is a constat and r is the distance from the

centre. At the centre of the spheres is a point charge Q. The value of A, such that the
electric field in the region between the spheres will be constant, is
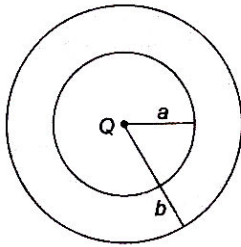
(a) $\dfrac{Q}{2\pi a^2}$ (b) $\dfrac{Q}{2\pi(b^2 - a^2)}$ (c) $\dfrac{2Q}{\pi(a^2 - b^2)}$ (d) $\dfrac{2Q}{\pi a^2}$

Q.19   Two long parallel wires are at a distance 2d apart. They carry steady equal currents
following out of the plane of the paper as shown. The variation of the magnetic field B along
the line XX' is given by
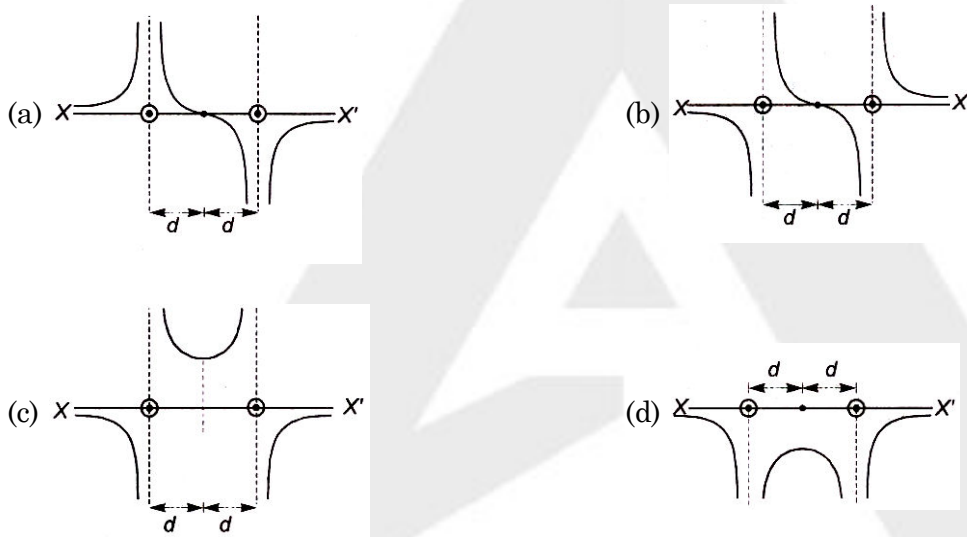
Q.20   A glass tube of uniform internal radius (r) has a value separating the two identical ends.
Initially, the valve is in a tightly closed position. End 1 has a hemispherial soap bubble of
radius r. End 2 has sub-hemispherical soap bubbles as shown in figure.
Just after opening the value.
(a) air from end 1 flows towards end 2. No change in the volume of the soap bubbles.
(b) air form end 1 flows towards end 2. Volume of the soap bubble at end 1 decreases.
(c) no change occurs
(d) air from end 2 flows towards end 1. Volume of the soap bubble at end 1
     decreases
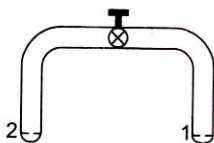
Q.21   A source of sound of frequency 600 Hz is placed inside water. The speed of sound in water is

1500m/s and in air it is 300 m/s. The frequency of sound recorded by an observer who is standing in air is_____?

Q.22 A galvanometer having a coil resistance of $100\,\Omega$ gives a full scale deflection when a current of 1 mA is passed through it. The value of the resistance which can convert this galvanometer into ammeter giving a full scale deflection for a current of 10 A, is_____?

Q.23 A whistle giving out 450 Hz approches a stationary observer at a speed of 33 m/s. The frequency heard by the observer (in Hz) is (Speed of sound = 330 m/s) ?

Q.24 A simple pendulum has a time period T_1 when on the earth's surface and T_2 when taken to a height R above the earth's surface, where R is the radius of the earth. The value of T_2/T_1 is _____?

Q.25 A point particle of mass m, moves along the uniformly through track PQR as shown in the figure. The coefficient of frition, between the particle and the rough track equals μ. The particle is released from rest, from the point P and it comes to rest at a point R. The energies lost by the ball, over the parts PQ and QR of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR. The values of the coefficient of friction μ and the distance $x(= QR)$, are respectively close to ?
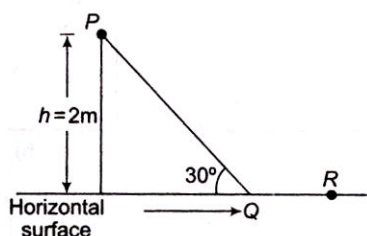
Part - B - CHEMISTRY

Q.26 Which of the following compound is covalent?
(a) H_2 (b) CaO   (c) KCl   (d) Na_2S

Q.27 A liquid is in equilibrium with its vapour at it's boiling point. On the average, the molecules in the two phases have equal
(a) inter-molecular forces   (b) potential energy
(c) kinetic energy   (d) total energy

Q.28 The radius of an atomic nucleus is of the order of

(a) $10^{-1}\,cm$ (b) $10^{-13}\,cm$ (c) $10^{-15}\,cm$ (d) $10^{-8}\,cm$

Q.29 The species which by defination has zero standard molar enthalpy of formation at 298 K is

(a) $Br_2(g)$ (b) $Cl_2(g)$ (c) $H_2O(g)$ (d) $CH_4(g)$

Q.30 Plots showing the variation of the rate constat (k) with temperature (T) are given below. The plot that follows Arrhenius equation is
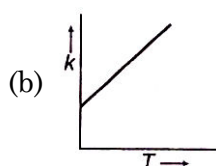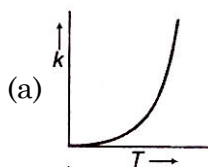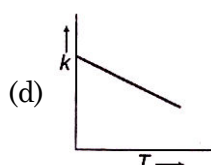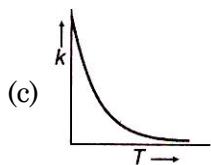
Q.31 Calcium is obtained by
(a) electrolysis of molten $CaCl_2$
(b) electrolysis of soultion of $CaCl_2$ in water
(c) reduction of $CaCl_2$ with carbon
(d) roasting of limestone

Q.32 Which one of the following ores is best concentrated by froth floatation method?
(a) Siderite   (b) Galena   (c) Malachite   (d) MAgnetie

Q.33 An azeotropic solution of two liquids has boiling point lower than either of them when it
(a) shows negative deviation from Raoult's law
(b) shows no deviation from Raoult's law
(c) shows positive deviation from Raoult's law
(d) is saturated

Q.34 The statement that is not correct for the periodic classification of elements, is
(a) the properties of elemets are the periodic functions of their atomic numbers.
(b) non-metallic elements are lesser in number than metallic elemets
(c) the first ioniosation energies of elements along a period do not vary in a regular manner with increase in atomic number
(d) for transition elements the d-subshell are filled with electrons monotonically with increase in atomic number

Q.35 The species present in solution whn CO_2 is dissolved in water are
(a) $CO_2, H_2CO_3, HCO_3^-, CO_3^{2-}$
(b) H_2CO_3, CO_3^{2-}
(c) HCO_3^-, CO_3^{2-}
(d) CO_2, H_2CO_3

Q.36 The major product of the following reaction sequence is
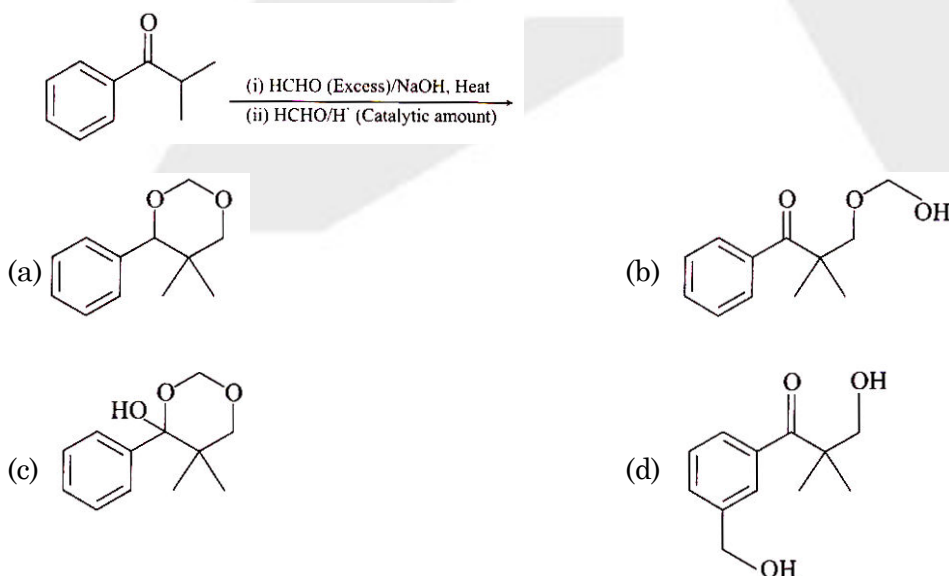
Q.37 Benzamide on tratement with $POCl_3$ gives
(a) aniline
(b) benzonitrile
(c) chlorobenzene
(d) benzyl amine

Q.38 Which of the following compounds will give significant amount of *meta*-product during mononitration reaction?

(a) OH	(b) OCOCH$_3$	(c) NH$_2$	(d) NHCOCH$_3$
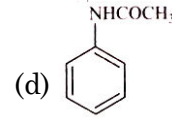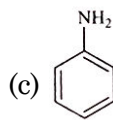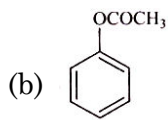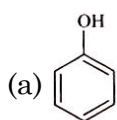
Q.39   Which of the following 0.1 M aqueous solution will have the lowest freezing point?
(a) Potassium sulphate   (b) Sodium chlordie
(c) Urea   (d) Glucose

Q.40   Among the electrolytes $Na_2SO_4, CaCl_2, Al_2(SO_4)_3$ and NH_4Cl, the most effective coagulating agent for Sb_2S_3 sol is
(a) Na_2SO_4 (b) $CaCl_2$ (c) $Al2(SO_4)_3$ (d) NH_4Cl

Q.41   Which of the following compounds is metallic and ferromagnetic?
(a) CrO_2 (b) VO_2 (c) MnO_2 (d) TiO_2

Q.42   Among the following, the compound that can be most readily sulphonated is
(a) benzene   (b) nitrobenzene
(c) toluene   (d) chlorobenzene

Q.43   Phenol reacts with bromine in carbon disulphide at low temperature to give
(a) *m*-bromophenol   (b) *o*-and *p*-bromophenol
(c) *p*-bromophenol   (d) 2,4,6-tribromophenol

Q.44   A positron is emitted from $^{23}_{11}Na$. The ratio of the atomic mass and atomic number of the resulting nuclide is
(a) 22/10   (b) 22/11   (c) 23/10   (d) 23/12

Q.45   Concentrated nitric acid upon long standing, turns yellow-brown due to the formation of
(a) NO   (b) NO_2 (c) N_2O (d) N_2O_4

Q.46   The volume strength of 1.5 N H_2O_2 is_____?

Q.47   The arrangement of X^- ions around A^+ ion in solid AX is given in the figure (not drawn to scale). If the radius of X^- is 250 pm, the radius of A^+ is_____?
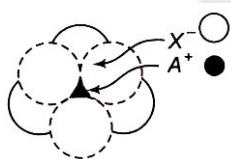
Q.48   The number of geometric isomers that can exist for square planar $[Pt(Cl)(py)(NH_3)(NH_2OH)]^+$ is (py = pyridine).

Q.49   The number of stereoisomers obtained by bromination of *trans*-2-butene is_____?

Q.50   If one litre of air is passed repeatedly over heated copper and magnesium till no further reduction in volume takes place, the volume finally obtained would be approximately?

Part - C - MATHEMATICS

Q.51   The different letters of an alphabet are given. WOrds with five letters are formed from these given letters. The, the number of words which have at least one letter repeated, is
(a) 69760   (b) 30240   (c) 99748   (d) None

Q.52   If three distinct numbers are chosen randomly from the first 100 natural numbers, then the probability that all three of them are divisible by both 2 and 3, is

(a) $\dfrac{4}{55}$ (b) $\dfrac{4}{35}$ (c) $\dfrac{4}{33}$ (d) $\dfrac{4}{1155}$

Q.53   Let α and β be the roots of equation $x^2 - 6x - 2 = 0$. If $a_n = \alpha^n - \beta^n$, $n \geq 1$, for then the value of $\dfrac{a_{10} - 2a_8}{2a_9}$ is

(a) 6   (b) -6 (c) 3   (d) -3

Q.54   The system of linear equations $x + \lambda y - z = 0$; $\lambda x - y - z = 0$; $x + y - \lambda z = 0$ has a non-trivial solution for
(a) infinitely many values of λ (b) exactly one value of λ
(c)   exactly two values of λ (d) exactly three values of λ

Q.55   The normal to the curve at $x^2 + 2xy - 3y^2 = 0$ at $(1,1)$
(a) does not meet the curve again
(b) meets in the curve again the second quadrant
(c) meets the curve again in the third quadrant
(d) meets the curve agin in the fourth quadrant

Q.56   The value of the integral $\displaystyle\int_{-\pi/2}^{\pi/2} \left(x^2 + \log \dfrac{\pi - x}{\pi + x} \right) \cos x \, dx$ is

(a) 0   (b) $\dfrac{\pi^2}{2} - 4$ (c) $\dfrac{\pi^2}{2} + 4$ (d) $\dfrac{\pi^2}{2}$

Q.57   The lines $2x - 3y = 5$ and $3x - 4y = 7$ are diameters of a circle of area 154 sq units. Then, the equation of this circle is

(a) $x^2 + y^2 + 2x - 2y = 62$ (b) $x^2 + y^2 + 2x - 2y = 47$

(c) $x^2 + y^2 - 2x + 2y = 47$ (d) $x^2 + y^2 - 2x + 2y = 62$

Q.58   The differential equation determines a family of circles with
(a) variable radii and a fixed centre at $(0,1)$
(b) variable radii a fixed centre at $(0,-1)$
(c) fixed radius 1 and variable centres along the X-axis
(d) fixed radius 1 and variable centres along the Y-axis

Q.59   The equation $\dfrac{x^2}{1-r} - \dfrac{y^2}{1+r} = 1, \left| r \right| < 1$ represents
(a) an ellipse   (b) a hyperbola   (c) a circle   (d) None of the above

Q.60   Consider an infinite geometric series with first term a and common ratio r. If its sum is 4 and the second term is 3/4, then
(a) $a = 4/7, \ r = 3/7$ (b) $a = 2, \ r = 3/8$
(c) $a = 3/2, \ r = 1/2$ (d) $a = 3, r = 1/4$

Q.61   In the binomial expansion of $(a-b)^n, n \geq 5$ the sum of the 5th and 6th terms is zero. Then a/b equals

(a) $\dfrac{n-5}{6}$ (b) $\dfrac{n-4}{5}$ (c) $\dfrac{5}{n-4}$ (d) $\dfrac{6}{n-5}$

Q.62   Let $\theta \in \left(0, \dfrac{\pi}{4}\right)$ and $t_1 = (\tan)^{\tan\theta}, t_2 = (\tan\theta)^{\cot\theta},$

$t_3 = (\cot\theta)^{\tan\theta}$ and $t_4 = (\cot\theta)^{\tan\theta}$, then

(a) $t_1 > t_2 > t_3 > t_4$ (b) $t_4 > t_3 > t_1 > t_2$

(c) $t_3 > t_1 > t_2 > t_4$ (d) $t_2 > t_3 > t_1 > t_4$

Q.63   If $\vec{a} = (\hat{i} + \hat{j} + \hat{k}), \vec{a}.\vec{b} = 1$ and $\vec{a} \times \vec{b} = \hat{j} - \hat{k}$, then $\vec{b}$ is equal to

(a) $\hat{i} - \hat{j} + \hat{k}$ (b) $2\hat{j} - \hat{k}$

(c) $\hat{i}$ (d) $2\hat{i}$

Q.64   The $\int \dfrac{\cos^3 x + \cos^5 x}{\sin^2 x + \sin^4 x} dx$ value of

(a) $\sin x - 6\tan^{-1}(\sin x) + c$ (b) $\sin x - 2(\sin x)^{-1} + c$

(c) $\sin x - 2(\sin x)^{-1} - 6\tan^{-1}(\sin x) + c$ (d) $\sin x - 2(\sin x)^{-1} + 5\tan^{-1}(\sin x) + c$

Q.65   Area of the region is $\{(x,y)\} \in R^2 : y \geq \sqrt{|x+3|}, 5y \leq (x+9) \leq 15\}$ equal to

(a) $\dfrac{1}{6}$ (b) $\dfrac{4}{3}$ (c) $\dfrac{3}{2}$ (d) $\dfrac{5}{3}$

Q.66   Let PQ and RS be tangents at the extremities of the diameter PR of a circle of radius r. If PS and RQ intersect at a point X on the circumference of the circle, then $2r$ equals

(a) $\sqrt{PQ.RS}$ (b) $\dfrac{PQ+RS}{2}$ (c) $\dfrac{2PQ.RS}{PQ+RS}$ (d) $\sqrt{\dfrac{PQ^2 + RS^2}{2}}$

Q.67   Orthocentre of triangle with vertics (0,0), (3,4) and (4,0) is

(a) $\left(3, \dfrac{5}{4}\right)$ (b) (3,12)   (c) $\left(3, \dfrac{3}{4}\right)$ (d) (3,9)

Q.68   Let (x,y) be any point on the parabola Let P be the point that divides the line segment from (0,0) to (x,y) in the ratio 1 : 3. Then, the locus of P is

(a) $x^2 = y$ (b) $y^2 = 2x$ (c) $y^2 = x$ (d) $x^2 = 2y$

Q.69   The curve described paarametrically by $x = t^2 + t + 1, \quad y = t^2 - t + 1$ represents

(a) a pair of straight lines   (b) an ellipse
(c) a parabola   (d) a hyperbola

Q.70   Distnace between two parallel planes $2x + y + 2z = 8$ and $4x + 2y + 4z + 5 = 0$ is

(a) $\dfrac{3}{2}$ (b) $\dfrac{5}{2}$ (c) $\dfrac{7}{2}$ (d) $\dfrac{9}{2}$

Q.71 The number of integral values of k for which the equation $7\cos x + 5\sin x = 2k + 1$ has solution, is_____?

Q.72 The mean of the data set comprising of 16 observations is 16. If one of the observations valued 16 is deleted and three new observations valued 3,4 and 5 added to the data, then the mean of the resultant data is_____?

Q.73 What is the standard deviation of the following series

Measurments	0 - 10	10 - 20	20 - 30	30 - 40
Frequency	1	3	4	2

Q.74 India plays two matches each with West Indies and Australia. In any match the prob ability of india getting point 0, 1 and 2 are 0.45, 0.05 and 0.05 respectively. Assuming that the outcomes are independents, the probability of india getting at least 7 points is _____?

Q.75 Let x_1, x_2, ..., x_n be n observations such that $\sum x_i^2 = 400$ and $\sum x_i = 80$ Then a possible value of n among the following is _____?

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ROUGH WORK