A Division of Aggarwal Educare
Aggarwal CLASSES™

JEE (MAIN)

TEST PAPER

SUBJECT : PHYSICS,CHEMISTRY, MATHEMATICS ***TEST CODE : TEST PAPER-6***

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 From the equation $\theta = rg / v^2$, one can obtain the angle of banking θ for a cyclist taking a curve (the symbols have their usual meaning). Then say, it is
(a) Both dimensionally and numerically correct
(b) Neither numerically nor dimensonally correct
(c) Dimensionally correct only
(d) Numerically correct only

Q.2 An object moving with a speed of 6.25 m/s is decelerated at a rate given by :

$\frac{dv}{dt} = -25\sqrt{v}$ Where v is instantaneous speed. The time taken by the object to come to rest would be
(a) 1 s (b) 2 s (c) 4 s (d) 8 s

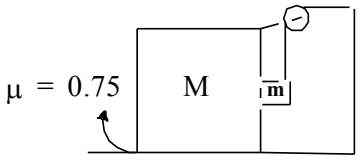
Q.3 A water fountain on the ground sprinkles water all around it, if the speed of water coming out of the fountain is *v,* the total area around the fountain that gets wet is

(a) $\pi \frac{v^2}{g}$ (b) $\pi \frac{v^4}{g^2}$ (c) $\frac{\pi v^2}{2\, g^2}$ (d) $\pi \frac{v^2}{g^2}$

Q.4 A man cycling at the rate of 15 km/h along the north. He is under the influence of wind blowing at the rate of $15\sqrt{2}$ km/h in south-east direction. Find the direction and the distance covered by him in a time of 2 h, from his starting position.
(a) 45 km along the east (b) 45 km along the west
(c) 30 km along the east (d) 30 km along the west

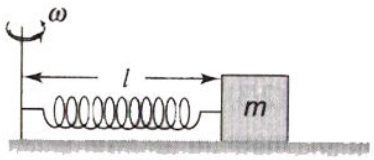
Q.5 A light string passing over a smooth light pulley connects two blocks of masses, m_1 and m_2 (vertically). If the acceleration of the system is g/8 then the ratio of the masses is :
(a) 8 : 1 (b) 9 : 7 (c) 1 : 8 (d) 7 : 9

Q.6 Two blocks (*m* and M) are arrenged as shown in fig. If there is friction between ground and M only and other surfaces are frictionless. The coefficient of friction between ground and M is $\mu = 0.75$. The maximum ratio of *m* and M (*m*/M) so that the system remains at rest is



(a) 1/4 (b) 3 (c) 1/3 (d) None of these

Q.7 A particle of mass m is fixed to one end of a light spring of force constant k and unstrestched lenth *l*. The system is roteded about the other end of the spring with an angular velocity ω, in gravity -free space. The increase in length of the spring will be



(a) $\frac{m\omega^2 l}{k}$ (b) $\frac{m\omega^2 l}{k - m\omega^2}$ (c) $\frac{m\omega^2 l}{k + m\omega^2}$ (d) None of these

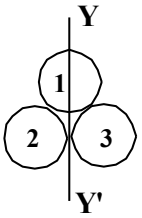
Q.8 A mass of M kg is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45^{o} with the initial vertical direction is

(a) $\frac{mg}{\sqrt{2}}$ (b) $mg(\sqrt{2}-1)$ (c) $mg(\sqrt{2}+1)$ (d) $mg\sqrt{2}$

Q.9 A neutron travelin with a velocity v and $K \cdot E$, E collides perfectly elastically head on with the nucleus of an atom of mass number A at rest. The fraction of total energy retained by nuetron is

(a) $\left(\frac{A-1}{A+1}\right)^2$ (b) $\left(\frac{A+1}{A-1}\right)^2$ (c) $\left(\frac{A-1}{A}\right)^2$ (d) $\left(\frac{A+1}{A}\right)^2$

Q.10 Three rings each of mass M and radius R are arrenged as shown in the fig. The moment of inertia of the system about YY' wll be

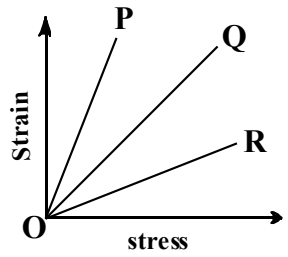


(a) $3MR^2$ (b) $\frac{3}{2}MR^2$ (c) $5MR^2$ (d) $\frac{7}{2}MR^2$

Q.11 The escape velocity for a plane is v_e. A tunnel is dug along a diameter of the planet and small body is dropped into it at the surface. When the body reaches the centre of the planet, its speed will be

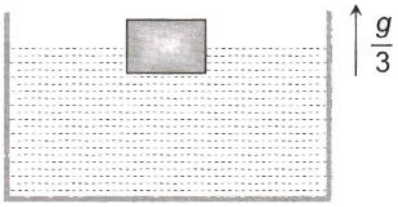
(a) v_e (b) $\frac{v_e}{\sqrt{2}}$ (c) $\frac{v_e}{2}$ (d) Zero

Q.12 The strain-stress curves of three wires different materials are shown in fig. P, Q and R are the elastic limits of the wires. The fig shows that



(a) Elasticity of wire P is maximum
(b) Elasticity of wire Q is maximum
(c) Tensile strength of R is maximum
(d) None of the above is true.

Q.13 A cubical block is floating in a liquid with half of its volume imersed in the liquid fig when the whole system accelerates upward with acceleration of g/3. the fraction of volume immersed in the liquid will be



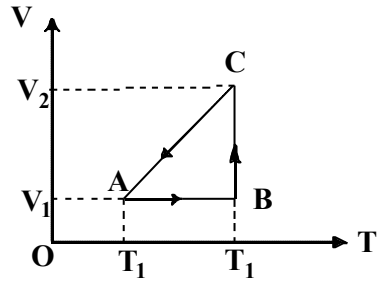
(a) $\frac{1}{2}$ (b) $\frac{3}{8}$ (c) $\frac{2}{3}$ (d) $\frac{3}{4}$

Q.14 The coefficienty of apparent expansion of a liquid in a copper vessal is C and in a silver vessel S. The coefficient of volume expansion of copper is λ_C · What is the coefficient of linear expansion of silver ?

(a) $(C + \gamma_C + S)/3$ (b) $(C - \gamma_C + S)/3$

(c) $(C + \gamma_C - S)/3$ (d) $(C - \gamma_C - S)/3$

Q.15 A cyclic process for 1 mol of an ideal gas is shown in fig in the V -T diagram. The work done in AB, BC and CA respectively, is



(a) $0, RT_2 \ In\left(\frac{V_1}{V_2}\right), R(T_1 - T_2)$ (b) $R(T_1 - T_2), 0, RT_1 \ In \frac{V_1}{V_2}$

(c) $0, RT_2 \ In\left(\frac{V_1}{V_2}\right), R(T_1 - R_2)$ (d) $0, RT_2 \ In\left(\frac{V_2}{V_1}\right), R(T_2 - R_1)$

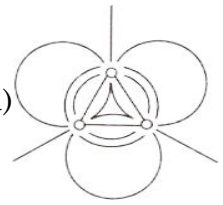
Q.16 A gas mixture consists of 2 mol of oxygen and 4 mol of argon at temperature T. Neglecting all vibrational modes, the total internal energy of the system is

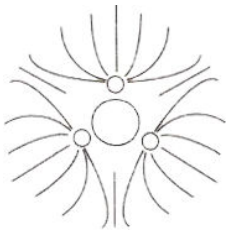
(a) 4RT (b) 15RT (c) 9RT (d) 11RT

Q.17 A simple pendulum is executivng SHM with a time period T. If the length of the pendulum is increased by 21 % the percentage increase in the time period of the pendulum is

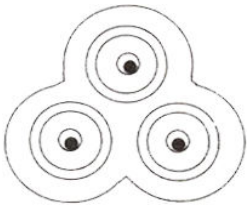
(a) 10% (b) 21% (c) 30% (d) 50%

Q.18 Three positive charges of equal value q are palced at the vertices of an equilateral triangle . The resulting lines of force should be sketched as in

(a) 

(b) 

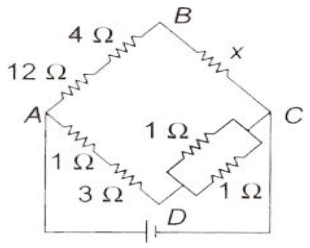
(c)

(d) 

Q.19 A solid conducting sphere having a charge Q is surrounding by an uncharged concentric conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of -3Q, the new potential differece between the
two surfaces is

(a) V (b) 2V (c) 4V (d) -2V

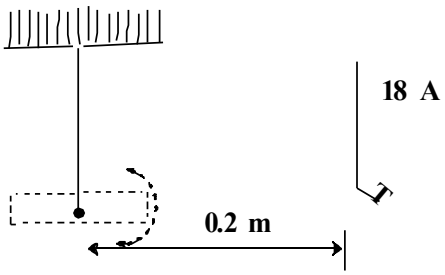
Q.20 In the combination of resistance shown in fig 32, the potential difference between B and D is zero when unknown resistance (x) is



(a) 4Ω (b) 2Ω

(c) 3Ω (d) The emf of the cell is reuired

Q.21 Fig shows a short magnet executing small oscillations in a vibration magnetometers in Earth's mangnetic field having horizontal component $24\mu T$. The period of oscilation is 0.1 s. When the key K is closed, an upward current of 18 A is established as shown. The new time period is _____ .



Q.22 A parallel plate capacitor with air between the plates has a capacitance of 9 pF. The separation between its plates is d. The space between the plates is now filled with two dielectrics. One of the the eielectrics has dielectric constant $k_1 = 3$ and thickness d/3 while the other on has dielectric constant $k_2 = 6$ and thickness 2d/3. Capacitance of the capacitor is now _____ .

Q.23 A vibrating string of certain length l under the tension T resonates with a mode corresponding to the first overtune (third harmonic) of an air column of length 75 cm inside a tube closed at one end. The string alos generates 4 beats/s when excited along with a tuning fork of frequency n, Now when the tension of the string is slightly increased, the number of beats reduces to 2 s. Assuming the velocity of sound in air to be 340 m/s, the frequency n of the tunining fork in Hz is _____ .

Q.24 The minimum intensity of light to be detected by human eye is 10^{10} W/m. The number of photons of wavelength 5.6×10^{7} m entering the eye with pupil area 10^{-6} m^2 per second for vision is nearly _____ .

Q.25 A parallel plate capacitor consists of two circular plates each of radius 12 cm and separated by 5.0 mm. The capacitor is being charged by external source. The charging current is constant and is equal to 0.15 A. The rate of change of potential difference between the plates will be _____ .

Part - B - CHEMISTRY

Q.26 About 0.078 g of hydrocarbon occupy 22.4 g mL of volume at 1 atm and 0^0C. The empirical formula of the hydrocarbon in CH. The molecular formula is :

(a) C_2H_2 (b) C_4H_4 (c) C_6H_6 (d) C_8H_8

Q.27 The wave number of electromagnetic radiation emitted during the transition of electron in-between two levels of Li^{2+} ion whose principal quantum numbers sum is 4 and difference is 2 is :

(a) $3.5\ R_H$ (b) $4R_H$ (c) $8R_H$ (d) $\frac{8}{9}R_H$

Q.28 Strongest intermolecular hydrogen bond is present in the following molecule pairs :

(a) SiH_4 and SiF (b) $CH_3-\overset{\overset{O}{||}}{C}-CH_3$ and $CHCl_3$

(c) $H-\overset{\overset{O}{||}}{C}-OH$ and $CH_3-\overset{\overset{O}{||}}{C}-OH$ (d) H_2O and H_2O_2

Q.30 A gaseous mixture containing He, CH_4, and SO_4 was allowed to effuse through a fine hole. Find the molar ratio of the gases coming out initially if the mixture contain He, CH_4 and SO_2 in 1 : 2 : 3 mole ratio :

(a) 2 : 2 : 3 (b) 6 : 6 : 1 (c) $\sqrt{2}:\sqrt{2}:3$ (d) 4 : 4 : 3

Q.31 For which of the following equation will ΔH be equal to ΔU ?

(a) $H_{2(g)}+\frac{1}{2}O_{2(g)}\rightarrow H_2O_{(1)}$ (b) $H_{2(g)}+I_{2(g)}\rightarrow 2HI_{(g)}$

(c) $2NO_{2(g)}\rightarrow N_2O_{4(g)}$ (d) $4NO_{2(g)}+O_{2(g)}\rightarrow 2N_2O_{5(g)}$

Q.32 For the system $3A+2B \rightleftharpoons C$ the concentration of C and D at equilibrium was 0.8 mol /L, then the equilibrium constant K_c will be :

(a) $\frac{[3A][2B]}{C}$ (b) $\frac{C}{[3A][2B]}$ (c) $\frac{[A]^3[B]^2}{[C]}$ (d) $\frac{[C]}{[A]^3[B]^2}$

Q.33 Select the right expression for determining packing fraction (PF) of NaCl unit cell (assume ideal), if ions along an edge diagnol are absent :

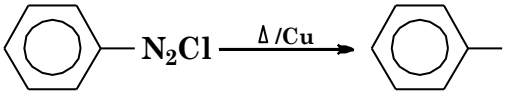
(a) $PF=\frac{\frac{4}{3}\pi(r_+^3+r_-^3)}{16\sqrt{2}r^3}$ (b) $PF=\frac{\frac{4}{3}\pi(\frac{5}{3}r_+^3+4r_-^3)}{16\sqrt{2}r^3}$

(c) $PF=\frac{\frac{4}{3}\pi(\frac{5}{3}r_+^3+r_-^3)}{16\sqrt{2}r_-^3}$ (d) $PF=\frac{\frac{4}{3}\pi(\frac{7}{2}r_+^3+4r_-^3)}{16\sqrt{2}r_-^3}$

Q.34 A 0.001 molal solution of $[Pt(NH_3)_4Cl_4]$ in water had a freezing point depression of 0.0054^0C. If K_f for water is 1.80 the correct formulation for the above molecule is :

(a) $[Pt(NH_3)_4\ Cl_3]Cl$ (b) $[Pt(NH_3)_4Cl]Cl_2$
(c) $[Pt(NH_3)_4Cl_2]Cl_3$ (d) $[Pt(NH_3)_4Cl_4]$

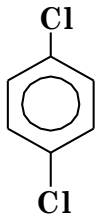
Q.35 In a cell that utilizes the reaction $Zn(s) + 2H^+(aq.) \longrightarrow Zn^{2+}(aq.) + H_2(g)$, addition of H_2SO_4 to cathode compartment will ;
(a) Increase the E and shift equilibrium to the left
(b) Lower the E and shift equilibrium to the right.
(c) Increase the E and shift equilibrium to the right
(d) Lower the E and shift equilibrium to the left

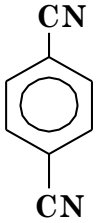
Q.36 

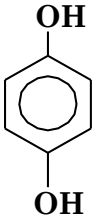
In this reaction, half life is independent of concentration of reactant. After 10 min, the volume of N_2 gas is 10 L and after complete reaction, it is 50 L. Hence the rate constant is :
(a) (2.303/10) log 5 min^{-1} (b) (2.303/10) log 1.25 min^{-1}
(c) (2.303/10) log 2 min^{-1} (d) (2.303/10) log 4 min^{-1}

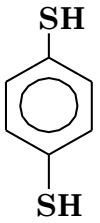
Q.37 Which of the following methods is used for sol destruction ?
(a) Condensation
(b) Dialysis
(c) Diffusion through animal membrane
(d) Addition of an electrolyte

Q.38 For Which of the following molecules $\mu \neq 0$?

(I) 

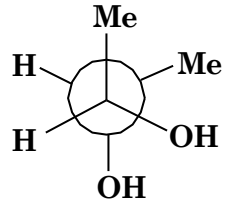
(II) 

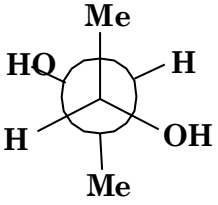
(III) 

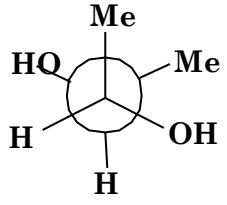
(IV) 

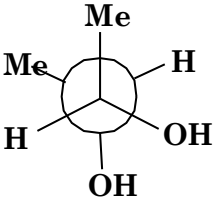
(a) Only I (b) I and II (c) Only III (d) III and IV

Q.39 Most stable form of meso-2,3-butandiol is :

(a) 

(b) 

(c) 

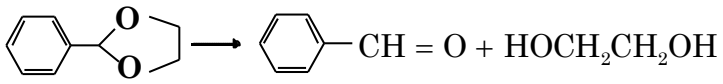
(d) 

Q.40 Rate of addition of halogen acid (HX) is least in :
(a) $CH_2 = CHCl$ (b) $CH_2 = CH_2$
(c) $CH_3 - CH = CH_2$ (d) $(CH_3)_2 C = CH_2$

Q.41 Which of the following compound on boiling with $KMnO_4$ (alk.) and subsequent acidification will not give benzoic acid ?

(a) Benzyl alcohol (b) Acetophenone
(c) Anisole (d) Toluene

Q.42 Which reagent and /or reaction conditions will be best suited to bring about the following conversion ?



(a) $LiAlH_4$, H_2O (b) H_2O, H_2SO_4
(c) H_2O, NaOH, heat (d) PCC, CH_2Cl_2

Q.43 Nitrosoamines ($R_2N - N = O$) are soluble in water. On heating them with concentrated H_2SO_4, they give secondary amines, The reaction is called :

(a) Perkin's reaction (b) Fittig's reaction
(c) Sandmeyer's reaction (d) Liebermann's nitroso reaction

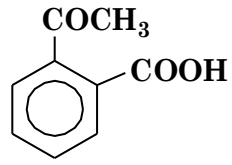
Q.44 In the estimation of sulphur, organic compound on treating with conc, HNO_3 is converted into :

(a) SO_2 (b) CH_2
(c) H_2SO_4 (d) SO_3

Q.45 In the process of forming mercerized cellulose, the swelling of cellulose is caused by ?

(a) water (b) Na_2CO_3
(c) aqueous NaOH (d) aqueous HCl

Q.46 A spirin is a pain reliver with $pK_a = 2$. Two tablets each containing 0.09 g of asprin are dissolved in 100 mL solution. pH will be _____ .



Q.47 Two nuclides X and Y are isotonic to each other with mass number 70 and 72 respectively. If the atomic number of X is 34, then that of Y would be _____ .

Q.48 A litre of CO_2 gas at 15°C and 1.00 atm dissolves in 1.00 L of water at the same temperature when the pressure of CO_2 is 1.00 atm. Compute the molar concentration of CO_2 in a solution over which the partial pressure of CO_2 is 150 Torr at this temperature .

Q.49 $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O \quad E^0 = 1.51V$

$MnO_2 + 4H^+ + 2e^- \longrightarrow Mn^{2+} + 2H_2O \quad E^0 = 1.23\,V$

$E^0_{MnO_4^-} \mid MnO_2$ is ?

Q.50 Molar conductance of a 1.5 M solution of an electrolyte is found to be 138.9 S cm^2. The specific conductance of this solution is _____ .

Part - C - MATHEMATICS

Q.51 The value of $\sum_{n=1}^{\infty}(-1)^{n+1}\left(\frac{n}{5^n}\right)$ equals

(a) $\frac{5}{12}$ (b) $\frac{5}{24}$ (c) $\frac{5}{36}$ (d) $\frac{5}{16}$

Q.52 If c and d are the roots of the equation $(x-a)\,(x-b)-\mathrm{k}=0,$ then a and b are the roots of the equation

(a) $(x+c)\,(x-d)+\mathrm{k}=0$ (b) $(x-c)\,(x-d)-\mathrm{k}=0$

(c) $(x-c)\,(x-d)+\mathrm{k}=0$ (d) $(x+c)\,(x+d)-\mathrm{k}=0$

Q.53 The value of $\sum_{k=1}^{6}\sin\frac{2\pi\mathrm{k}}{7}-i\cos\frac{2\pi\mathrm{k}}{7}$ is

(a) -1 (b) 0 (c) $-i$ (d) i

Q.54 Let $\mathrm{A}=\begin{pmatrix}1 & 2\\ 3 & 4\end{pmatrix}\mathrm{B}=\begin{pmatrix}a & 0\\ 0 & b\end{pmatrix},\ a, b\in N\cdot$ Then

(a) There cannot exist any B such that AB = BA
(b) There exists more thant one but finite number B's such that AB = BA
(c) There exists exactly one B such that AB = BA
(d) There exist infinitely many B's such that AB = AB

Q.55 If $f\,a\neq p, b\neq q, c\neq r,$ and $\begin{vmatrix}p & b & c\\ a & q & c\\ a & b & r\end{vmatrix}=0$ then the value of $\frac{p}{p-q}+\frac{q}{q-b}+\frac{r}{r-c}$ is equal to

(a) -1 (b) 1 (c) -2 (d) 2

Q.56 For $2\leq r\leq n,$ $\binom{n}{r}+2\binom{n}{r-1}+\binom{n}{r-2}=$

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

Q.57 The number of ways in which 10 persons can go in two boats, so that there may be 5 on each boat, supposing that two particular persons will not go in the same boat is

(a) $\frac{1}{2}({}^{10}\mathrm{C}_5)$ (b) $\frac{1}{2}({}^{8}\mathrm{C}_5)$ (c) $2\times{}^{8}\mathrm{C}_4$ (d) ${}^{8}\mathrm{C}_4$

Q.58 The sum of the series $\sum_{n=1}^{\infty}\frac{2n}{(2n+1)!}$ is

(a) e (b) e^{-1} (c) $2e$ (d) None of these

Q.59 The points $(-a, -b)$, (a, b), and (a^2, ab) are

(a) Vertices of an equilateral triangle
(b) Vertices of a right-angled triangle
(c) Vertices of an isosceles triangle
(d) Collinear

Q.60 A straight line is drawn through $P(3, 4)$ to meet the axis of x and y at A and B respectively. If the rectangle $OACB$ is completed, then locus of C, is

(a) $\frac{x}{3}+\frac{y}{4}=1$ (b) $\frac{4}{x}+\frac{3}{y}=1$ (c) $\frac{3}{x}+\frac{4}{y}=1$ (d) $\frac{x}{4}+\frac{y}{3}=1$

Q.61 Tangent PA and PB are drawn to $x^2 + y^2 = a^2$ From the point $P(x_1, y_1)$. Equation of the circumcircle of triangle PAB is

(a) $x^2 + y^2 - xx_1 - yy_1 = 0$
(b) $x^2 + y^2 + xx_1 - yy_1 = 0$
(c) $x^2 + y^2 + xx_1 - yy_1 = 0$
(d) $x^2 + y^2 + xx_1 + yy_1 = 0$

Q.62 The area of the triangle formed by the tangent and the normal to the parabola $y^2 = 4ax$, both drawn at the end of the latus rectum, and the axis of the parabola is

(a) $2\sqrt{2}\ a^2$ (b) $2a^2$ (c) $4a^2$ (d) None of these

Q.63 Which of the following equations in parametiric form does not represent a hyperbola, where "t" is a parameter.

(a) $x = \frac{a}{2}\left(t+\frac{1}{t}\right)$ and $x = \frac{b}{2}\left(t-\frac{1}{t}\right)$
(b) $\frac{tx}{a} - \frac{y}{b} + t = 0$ and $\frac{x}{a} - \frac{ty}{b} - 1 = 0$
(c) $x = e^t + e^{-1}$ and $y = e^t - e^{-t}$
(d) $x^2 - 6 = 2\ \cos t\ \boldsymbol{y}^2 + 2 = 4\ \cos^2 \frac{t}{2}$

Q.64 If the function $f: [1, \infty) \to [1, \infty)$ is defined by $f(x) = 2^{x(x-1)}$ then $f^{-1}(x)$ is

(a) $\left(\frac{1}{2}\right)^{x(x-1)}$
(b) $\frac{1}{2}(1 + \sqrt{1 + 4\log_2 x})$
(c) $\frac{1}{2}(1 - \sqrt{1 + 4\log_2 x})$
(d) not defined

Q.65 The value of $\lim\limits_{x\to\infty}\left(\frac{x^2 \sin\left(\frac{1}{x}\right) - x}{1 - |x|}\right)$ is

(a) 0 (b) 1 (c) -1 (d) None of these

Ans: (a)

Q.66 If $f(x) = 2\ \sin^{-1}\sqrt{1-x} + \sin^{-1}\left(2\sqrt{x(1-x)}\right)$ where $x \in \left(0\frac{1}{2}\right)$ then $f'(x)$ is equal to

(a) $\frac{2}{\sqrt{x(1-x)}}$ (b) zero (c) $-\frac{2}{\sqrt{x(1-x)}}$ (d) π

Q.67 Water runs into an inverted conical tent at the rate of 20 cubic feet per minute and leaks out at the rate of 5 cubic feet per minute. The height of the water in three times the radius of the water's surface. The radius of the water surface in increasing when radius is 5 feet, is

(a) $\frac{1}{5\pi}$ ft / min (b) $\frac{1}{10\pi}$ ft / min (c) $\frac{1}{15\pi}$ ft / min (d) None

Q.68 The function $f(x) = \cot^{-1} x + x$ increase in the interval

(a) $(1, \infty)$ (b) $(-1, \infty)$ (c) $(-\infty, \infty)$ (d) $(0, \infty)$

Q.69 $\int \frac{\sin^6 x}{\cos^8 x}\, dx =$

(a) $\tan^7 x + c$ (b) $\frac{\tan^7 x}{7} + c$ (c) $\frac{\tan 7x}{7} + c$ (d) $\sec^7 x + c$

Q.70 If $\int_0^x f(t)\, dt = x + \int_x^1 t\, f(t)\, dt$, then the value of $f(1)$ is

(a) $\frac{1}{2}$ (b) 0 (c) 1 (d) $-\frac{1}{2}$

Q.71 In a class of 55 students, the number of students studying different subjects are 23 in mathematics, 24 in physics, 19 in chemistry, 12 in mathematics and physics, 9 in mathematics and chemistry, 7 in physics and chemistry, and 4 in all the three subject. The number of students who have taken exactly one subject is ?

Q.72 If $f(x) = \begin{cases} x, & x < 0 \\ 1, & 0 \le x < 2 \\ -1, & x \ge 2 \end{cases}$ and $g(x) = \begin{cases} 3x; & x \le 1 \\ 1; & x > 1. \end{cases}$ Then the sum of all values of x where $f(x) + g(x)$ is discontinuous is ?

Q.73 A particle acted by constant forces $4\hat{i} + \hat{j} - 3\hat{k}$ and $3\hat{i} + \hat{j} - \hat{k}$ displaced from the point $\hat{i} + 2\hat{j} + 3\hat{k}$ to the point $5\hat{i} + 4\hat{j} + \hat{k}$. The total work done by the forces is ?

Q.74 $\lim_{x \to \frac{\pi}{4}} \left(\frac{1 - \tan x}{1 - \sqrt{2} \sin x} \right)$ is equal to _____.

Q.75 The number of arrangements of the letters of the word BANANA in which the two N's do not appear adjacently, is _____.

Part A - PHYSICS

Q.1 From the equation $\theta = rg / v^2$, one can obtain the angle of banking θ for a cyclist taking a curve (the symbols have their usual meaning). Then say, it is
(a) Both dimensionally and numerically correct
(b) Neither numerically nor dimensonally correct
(c) Dimensionally correct only
(d) Numerically correct only

Q.2 An object moving with a speed of 6.25 m/s is decelerated at a rate given by :

$\frac{dv}{dt} = -25\sqrt{v}$ Where v is instantaneous speed. The time taken by the object to come to rest would be
(a) 1 s (b) 2 s (c) 4 s (d) 8 s

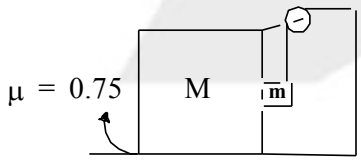
Q.3 A water fountain on the ground sprinkles water all around it, if the speed of water coming out of the fountain is *v,* the total area around the fountain that gets wet is

(a) $\pi \frac{v^2}{g}$ (b) $\pi \frac{v^4}{g^2}$ (c) $\frac{\pi v^2}{2\, g^2}$ (d) $\pi \frac{v^2}{g^2}$

Q.4 A man cycling at the rate of 15 km/h along the north. He is under the influence of wind blowing at the rate of $15\sqrt{2}$ km/h in south-east direction. Find the direction and the distance covered by him in a time of 2 h, from his starting position.
(a) 45 km along the east (b) 45 km along the west
(c) 30 km along the east (d) 30 km along the west

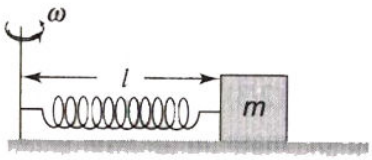
Q.5 A light string passing over a smooth light pulley connects two blocks of masses, m_1 and m_2 (vertically). If the acceleration of the system is g/8 then the ratio of the masses is :
(a) 8 : 1 (b) 9 : 7 (c) 1 : 8 (d) 7 : 9

Q.6 Two blocks (*m* and M) are arrenged as shown in fig. If there is friction between ground and M only and other surfaces are frictionless. The coefficient of friction between ground and M is $\mu = 0.75$. The maximum ratio of *m* and M (*m*/M) so that the system remains at rest is



(a) 1/4 (b) 3 (c) 1/3 (d) None of these

Q.7 A particle of mass m is fixed to one end of a light spring of force constant k and unstrestched lenth *l*. The system is roteded about the other end of the spring with an angular velocity ω, in gravity -free space. The increase in length of the spring will be



(a) $\frac{m\omega^2 l}{k}$ (b) $\frac{m\omega^2 l}{k - m\omega^2}$ (c) $\frac{m\omega^2 l}{k + m\omega^2}$ (d) None of these

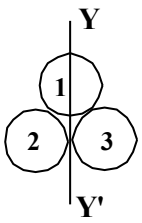
Q.8 A mass of M kg is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45^o with the initial vertical direction is

(a) $\frac{mg}{\sqrt{2}}$ (b) $mg(\sqrt{2}-1)$ (c) $mg(\sqrt{2}+1)$ (d) $mg\sqrt{2}$

Q.9 A neutron travelin with a velocity v and $K \cdot E$, E collides perfectly elastically head on with the nucleus of an atom of mass number A at rest. The fraction of total energy retained by nuetron is

(a) $\left(\frac{A-1}{A+1}\right)^2$ (b) $\left(\frac{A+1}{A-1}\right)^2$ (c) $\left(\frac{A-1}{A}\right)^2$ (d) $\left(\frac{A+1}{A}\right)^2$

Q.10 Three rings each of mass M and radius R are arrenged as shown in the fig. The moment of inertia of the system about YY' wll be

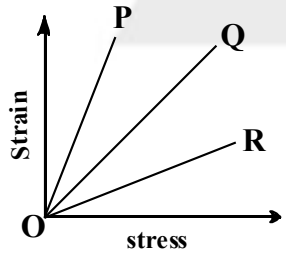


(a) $3MR^2$ (b) $\frac{3}{2}MR^2$ (c) $5MR^2$ (d) $\frac{7}{2}MR^2$

Q.11 The escape velocity for a plane is v_e. A tunnel is dug along a diameter of the planet and small body is dropped into it at the surface. When the body reaches the centre of the planet, its speed will be

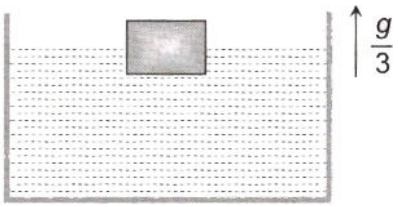
(a) v_e (b) $\frac{v_e}{\sqrt{2}}$ (c) $\frac{v_e}{2}$ (d) Zero

Q.12 The strain-stress curves of three wires different materials are shown in fig. P, Q and R are the elastic limits of the wires. The fig shows that



(a) Elasticity of wire P is maximum (b) Elasticity of wire Q is maximum
(c) Tensile strength of R is maximum (d) None of the above is true.

Q.13 A cubical block is floating in a liquid with half of its volume imersed in the liquid fig when the whole system accelerates upward with acceleration of g/3. the fraction of volume immersed in the liquid will be



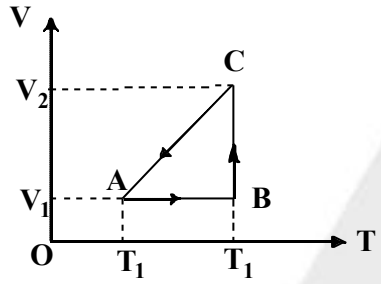
(a) $\frac{1}{2}$ (b) $\frac{3}{8}$ (c) $\frac{2}{3}$ (d) $\frac{3}{4}$

Q.14 The coefficienty of apparent expansion of a liquid in a copper vessal is C and in a silver vessel S. The coefficient of volume expansion of copper is λ_C · What is the coefficient of linear expansion of silver ?

(a) $(C + \gamma_C + S)/3$ (b) $(C - \gamma_C + S)/3$

(c) $(C + \gamma_C - S)/3$ (d) $(C - \gamma_C - S)/3$

Q.15 A cyclic process for 1 mol of an ideal gas is shown in fig in the V -T diagram. The work done in AB, BC and CA respectively, is



(a) $0, RT_2 \ In\left(\frac{V_1}{V_2}\right), R(T_1 - T_2)$ (b) $R(T_1 - T_2), 0, RT_1 \ In \frac{V_1}{V_2}$

(c) $0, RT_2 \ In\left(\frac{V_1}{V_2}\right), R(T_1 - R_2)$ (d) $0, RT_2 \ In\left(\frac{V_2}{V_1}\right), R(T_2 - R_1)$

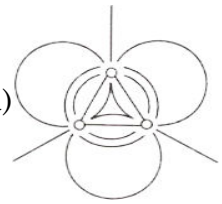
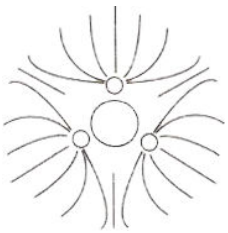
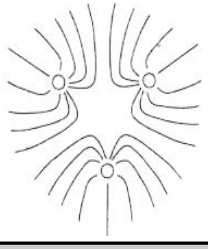
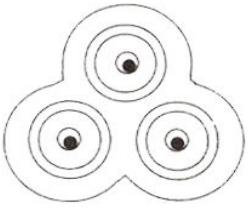
Q.16 A gas mixture consists of 2 mol of oxygen and 4 mol of argon at temperature T. Neglecting all vibrational modes, the total internal energy of the system is

(a) 4RT (b) 15RT (c) 9RT (d) 11RT

Q.17 A simple pendulum is executivng SHM with a time period T. If the length of the pendulum is increased by 21 % the percentage increase in the time period of the pendulum is

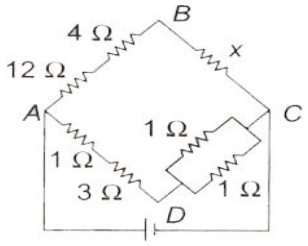
(a) 10% (b) 21% (c) 30% (d) 50%

Q.18 Three positive charges of equal value q are palced at the vertices of an equilateral triangle . The resulting lines of force should be sketched as in

(a)  (b)  (c)  (d) 

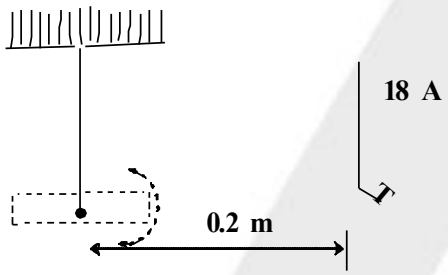
Q.19 A solid conducting sphere having a charge Q is surrounding by an uncharged concentric conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of -3Q, the new potential differece between the
two surfaces is
(a) V (b) 2V (c) 4V (d) -2V

Q.20 In the combination of resistance shown in fig 32, the potential difference between B and D is zero when unknown resistance (x) is



(a) 4Ω (b) 2Ω
(c) 3Ω (d) The emf of the cell is reuired

Q.21 Fig shows a short magnet executing small oscillations in a vibration magnetometers in Earth's mangnetic field having horizontal component $24\mu T$. The period of oscilation is 0.1 s. When the key K is closed, an upward current of 18 A is established as shown. The new time period is _____ .



Q.22 A parallel plate capacitor with air between the plates has a capacitance of 9 pF. The separation between its plates is d. The space between the plates is now filled with two dielectrics. One of the the eielectrics has dielectric constant $k_1 = 3$ and thickness d/3 while the other on has dielectric constant $k_2 = 6$ and thickness 2d/3. Capacitance of the capacitor is now _____ .

Q.23 A vibrating string of certain length l under the tension T resonates with a mode corresponding to the first overtune (third harmonic) of an air column of length 75 cm inside a tube closed at one end. The string alos generates 4 beats/s when excited along with a tuning fork of frequency n, Now when the tension of the string is slightly increased, the number of beats reduces to 2 s. Assuming the velocity of sound in air to be 340 m/s, the frequency n of the tunining fork in Hz is _____ .

Q.24 The minimum intensity of light to be detected by human eye is 10^{10} W/m. The number of photons of wavelength 5.6×10^{7} m entering the eye with pupil area 10^{-6} m^2 per second for vision is nearly _____ .

Q.25 A parallel plate capacitor consists of two circular plates each of radius 12 cm and separated by 5.0 mm. The capacitor is being charged by external source. The charging current is constant and is equal to 0.15 A. The rate of change of potential difference between the plates will be _____ .

Part - B - CHEMISTRY

Q.26 About 0.078 g of hydrocarbon occupy 22.4 g mL of volume at 1 atm and 0^0C. The empirical formula of the hydrocarbon in CH. The molecular formula is :

(a) C_2H_2 (b) C_4H_4 (c) C_6H_6 (d) C_8H_8

Q.27 The wave number of electromagnetic radiation emitted during the transition of electron in-between two levels of Li^{2+} ion whose principal quantum numbers sum is 4 and difference is 2 is :

(a) $3.5\ R_H$ (b) $4R_H$ (c) $8R_H$ (d) $\frac{8}{9}R_H$

Q.28 Strongest intermolecular hydrogen bond is present in the following molecule pairs :

(a) SiH_4 and SiF

(b) $CH_3-\overset{\overset{O}{||}}{C}-CH_3$ and $CHCl_3$

(c) $H-\overset{\overset{O}{||}}{C}-OH$ and $CH_3-\overset{\overset{O}{||}}{C}-OH$

(d) H_2O and H_2O_2

Q.30 A gaseous mixture containing He, CH_4, and SO_4 was allowed to effuse through a fine hole. Find the molar ratio of the gases coming out initially if the mixture contain He, CH_4 and SO_2 in 1 : 2 : 3 mole ratio :

(a) 2 : 2 : 3 (b) 6 : 6 : 1 (c) $\sqrt{2}:\sqrt{2}:3$ (d) 4 : 4 : 3

Q.31 For which of the following equation will ΔH be equal to ΔU ?

(a) $H_{2(g)}+\frac{1}{2}O_{2(g)}\rightarrow H_2O_{(1)}$ (b) $H_{2(g)}+I_{2(g)}\rightarrow 2HI_{(g)}$

(c) $2NO_{2(g)}\rightarrow N_2O_{4(g)}$ (d) $4NO_{2(g)}+O_{2(g)}\rightarrow 2N_2O_{5(g)}$

Q.32 For the system $3A+2B \rightleftharpoons C$ the concentration of C and D at equilibrium was 0.8 mol /L, then the equilibrium constant K_c will be :

(a) $\frac{[3A][2B]}{C}$ (b) $\frac{C}{[3A][2B]}$ (c) $\frac{[A]^3[B]^2}{[C]}$ (d) $\frac{[C]}{[A]^3[B]^2}$

Q.33 Select the right expression for determining packing fraction (PF) of NaCl unit cell (assume ideal), if ions along an edge diagnol are absent :

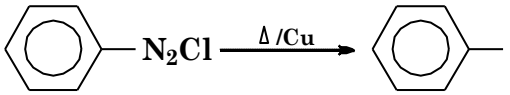
(a) $PF=\frac{\frac{4}{3}\pi(r_+^3+r_-^3)}{16\sqrt{2}r^3}$ (b) $PF=\frac{\frac{4}{3}\pi(\frac{5}{3}r_+^3+4r_-^3)}{16\sqrt{2}r^3}$

(c) $PF=\frac{\frac{4}{3}\pi(\frac{5}{3}r_+^3+r_-^3)}{16\sqrt{2}r_-^3}$ (d) $PF=\frac{\frac{4}{3}\pi(\frac{7}{2}r_+^3+4r_-^3)}{16\sqrt{2}r_-^3}$

Q.34 A 0.001 molal solution of $[Pt(NH_3)_4Cl_4]$ in water had a freezing point depression of 0.0054^0C. If K_f for water is 1.80 the correct formulation for the above molecule is :

(a) $[Pt(NH_3)_4 Cl_3]Cl$ (b) $[Pt(NH_3)_4Cl]Cl_2$
(c) $[Pt(NH_3)_4Cl_2]Cl_3$ (d) $[Pt(NH_3)_4Cl_4]$

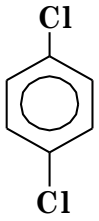
Q.35 In a cell that utilizes the reaction $Zn(s)+2H^+(aq.)\longrightarrow Zn^{2+}(aq.)+H_2(g)$, addition of H_2SO_4 to cathode compartment will ;
(a) Increase the E and shift equilibrium to the left
(b) Lower the E and shift equilibrium to the right.
(c) Increase the E and shift equilibrium to the right
(d) Lower the E and shift equilibrium to the left

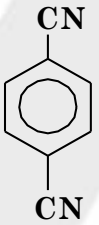
Q.36 

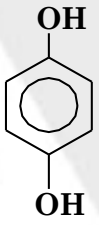
In this reaction, half life is independent of concentration of reactant. After 10 min, the volume of N_2 gas is 10 L and after complete reaction, it is 50 L. Hence the rate constant is :
(a) (2.303/10) log 5 min^{-1} (b) (2.303/10) log 1.25 min^{-1}
(c) (2.303/10) log 2 min^{-1} (d) (2.303/10) log 4 min^{-1}

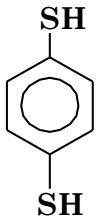
Q.37 Which of the following methods is used for sol destruction ?
(a) Condensation
(b) Dialysis
(c) Diffusion through animal membrane
(d) Addition of an electrolyte

Q.38 For Which of the following molecules $\mu \neq 0$?

(I) 

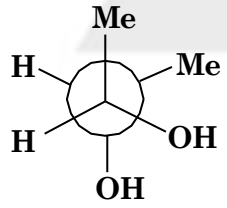
(II) 

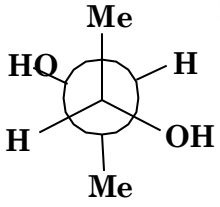
(III) 

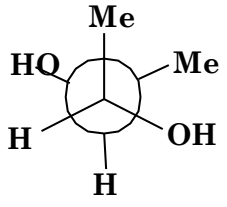
(IV) 

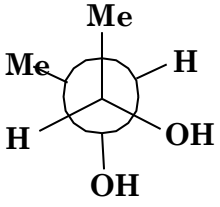
(a) Only I (b) I and II (c) Only III (d) III and IV

Q.39 Most stable form of meso-2,3-butandiol is :

(a) 

(b) 

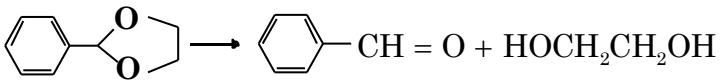
(c) 

(d) 

Q.40 Rate of addition of halogen acid (HX) is least in :
(a) $CH_2 = CHCl$ (b) $CH_2 = CH_2$
(c) $CH_3 - CH = CH_2$ (d) $(CH_3)_2 C = CH_2$

Q.41 Which of the following compound on boiling with $KMnO_4$ (alk.) and subsequent acidification will not give benzoic acid ?
(a) Benzyl alcohol (b) Acetophenone
(c) Anisole (d) Toluene

Q.42 Which reagent and /or reaction conditions will be best suited to bring about the following conversion ?



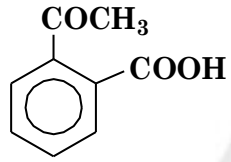
(a) $LiAlH_4$, H_2O (b) H_2O, H_2SO_4
(c) H_2O, NaOH, heat (d) PCC, CH_2Cl_2

Q.43 Nitrosoamines ($R_2N - N = O$) are soluble in water. On heating them with concentrated H_2SO_4, they give secondary amines, The reaction is called :
(a) Perkin's reaction (b) Fittig's reaction
(c) Sandmeyer's reaction (d) Liebermann's nitroso reaction

Q.44 In the estimation of sulphur, organic compound on treating with conc, HNO_3 is converted into :
(a) SO_2 (b) CH_2
(c) H_2SO_4 (d) SO_3

Q.45 In the process of forming mercerized cellulose, the swelling of cellulose is caused by ?
(a) water (b) Na_2CO_3
(c) aqueous NaOH (d) aqueous HCl

Q.46 A spirin is a pain reliver with $pK_a = 2$. Two tablets each containing 0.09 g of asprin are dissolved in 100 mL solution. pH will be _____ .



Q.47 Two nuclides X and Y are isotonic to each other with mass number 70 and 72 respectively. If the atomic number of X is 34, then that of Y would be _____ .

Q.48 A litre of CO_2 gas at 15^0C and 1.00 atm dissolves in 1.00 L of water at the same temperature when the pressure of CO_2 is 1.00 atm. Compute the molar concentration of CO_2 in a solution over which the partial pressure of CO_2 is 150 Torr at this temperature .

Q.49 $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O \quad E^0 = 1.51V$

$MnO_2 + 4H^+ + 2e^- \longrightarrow Mn^{2+} + 2H_2O \quad E^0 = 1.23\,V$

$E^0_{MnO_4^-} \mid MnO_2$ is ?

Q.50 Molar conductance of a 1.5 M solution of an electrolyte is found to be 138.9 S cm^2. The specific conductance of this solution is _____ .

Part - C - MATHEMATICS

Q.51 The value of $\sum_{n=1}^{\infty}(-1)^{n+1}\left(\frac{n}{5^n}\right)$ equals

(a) $\frac{5}{12}$ (b) $\frac{5}{24}$ (c) $\frac{5}{36}$ (d) $\frac{5}{16}$

Q.52 If c and d are the roots of the equation $(x-a)(x-b)-\mathrm{k}=0$, then a and b are the roots of the equation

(a) $(x+c)(x-d)+\mathrm{k}=0$ (b) $(x-c)(x-d)-\mathrm{k}=0$

(c) $(x-c)(x-d)+\mathrm{k}=0$ (d) $(x+c)(x+d)-\mathrm{k}=0$

Q.53 The value of $\sum_{k=1}^{6}\sin\frac{2\pi\mathrm{k}}{7}-i\cos\frac{2\pi\mathrm{k}}{7}$ is

(a) -1 (b) 0 (c) $-i$ (d) i

Q.54 Let $\mathrm{A}=\begin{pmatrix}1 & 2\\ 3 & 4\end{pmatrix}$ $\mathrm{B}=\begin{pmatrix}a & 0\\ 0 & b\end{pmatrix}$, $a, b \in N$. Then

(a) There cannot exist any B such that AB = BA
(b) There exists more thant one but finite number B's such that AB = BA
(c) There exists exactly one B such that AB = BA
(d) There exist infinitely many B's such that AB = AB

Q.55 If $f\ a \neq p, b \neq q, c \neq r,$ and $\begin{vmatrix}p & b & c\\ a & q & c\\ a & b & r\end{vmatrix}=0$ then the value of $\frac{p}{p-q}+\frac{q}{q-b}+\frac{r}{r-c}$ is equal to

(a) -1 (b) 1 (c) -2 (d) 2

Q.56 For $2 \le r \le n$, $\binom{n}{r}+2\binom{n}{r-1}+\binom{n}{r-2}=$

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

Q.57 The number of ways in which 10 persons can go in two boats, so that there may be 5 on each boat, supposing that two particular persons will not go in the same boat is

(a) $\frac{1}{2}({}^{10}\mathrm{C}_5)$ (b) $\frac{1}{2}({}^{8}\mathrm{C}_5)$ (c) $2\times{}^{8}\mathrm{C}_4$ (d) ${}^{8}\mathrm{C}_4$

Q.58 The sum of the series $\sum_{n=1}^{\infty}\frac{2n}{(2n+1)!}$ is

(a) e (b) e^{-1} (c) $2e$ (d) None of these

Q.59 The points $(-a, -b)$, (a, b), and (a^2, ab) are

(a) Vertices of an equilateral triangle (b) Vertices of a right-angled triangle
(c) Vertices of an isosceles triangle (d) Collinear

Q.60 A straight line is drawn through $P(3, 4)$ to meet the axis of x and y at A and B respectively. If the rectangle $OACB$ is completed, then locus of C, is

(a) $\frac{x}{3}+\frac{y}{4}=1$ (b) $\frac{4}{x}+\frac{3}{y}=1$ (c) $\frac{3}{x}+\frac{4}{y}=1$ (d) $\frac{x}{4}+\frac{y}{3}=1$

Q.61 Tangent PA and PB are drawn to $x^2 + y^2 = a^2$ From the point $P(x_1, y_1)$. Equation of the circumcircle of triangle PAB is

(a) $x^2 + y^2 - xx_1 - yy_1 = 0$ (b) $x^2 + y^2 + xx_1 - yy_1 = 0$
(c) $x^2 + y^2 + xx_1 - yy_1 = 0$ (d) $x^2 + y^2 + xx_1 + yy_1 = 0$

Q.62 The area of the triangle formed by the tangent and the normal to the parabola $y^2 = 4ax$, both drawn at the end of the latus rectum, and the axis of the parabola is

(a) $2\sqrt{2}\ a^2$ (b) $2a^2$ (c) $4a^2$ (d) None of these

Q.63 Which of the following equations in parametiric form does not represent a hyperbola, where "t" is a parameter.

(a) $x = \frac{a}{2}\left(t+\frac{1}{t}\right)$ and $x = \frac{b}{2}\left(t-\frac{1}{t}\right)$ (b) $\frac{tx}{a}-\frac{y}{b}+t=0$ and $\frac{x}{a}-\frac{ty}{b}-1=0$
(c) $x = e^t + e^{-1}$ and $y = e^t - e^{-t}$ (d) $x^2 - 6 = 2\ \cos t\ y^2 + 2 = 4\ \cos^2\frac{t}{2}$

Q.64 If the function $f: [1, \infty) \to [1, \infty)$ is defined by $f(x) = 2^{x(x-1)}$ then $f^{-1}(x)$ is

(a) $\left(\frac{1}{2}\right)^{x(x-1)}$ (b) $\frac{1}{2}(1+\sqrt{1+4\log_2 x})$
(c) $\frac{1}{2}(1-\sqrt{1+4\log_2 x})$ (d) not defined

Q.65 The value of $\lim\limits_{x\to\infty}\left(\frac{x^2\sin\left(\frac{1}{x}\right)-x}{1-|x|}\right)$ is

(a) 0 (b) 1 (c) -1 (d) None of these

Ans: (a)

Q.66 If $f(x) = 2\ \sin^{-1}\sqrt{1-x} + \sin^{-1}\left(2\sqrt{x(1-x)}\right)$ where $x \in \left(0\frac{1}{2}\right)$ then $f'(x)$ is equal to

(a) $\frac{2}{\sqrt{x(1-x)}}$ (b) zero (c) $-\frac{2}{\sqrt{x(1-x)}}$ (d) π

Q.67 Water runs into an inverted conical tent at the rate of 20 cubic feet per minute and leaks out at the rate of 5 cubic feet per minute. The height of the water in three times the radius of the water's surface. The radius of the water surface in increasing when radius is 5 feet, is

(a) $\frac{1}{5\pi}$ ft / min (b) $\frac{1}{10\pi}$ ft / min (c) $\frac{1}{15\pi}$ ft / min (d) None

Q.68 The function $f(x) = \cot^{-1} x + x$ increase in the interval

(a) $(1, \infty)$ (b) $(-1, \infty)$ (c) $(-\infty, \infty)$ (d) $(0, \infty)$

Q.69 $\int \frac{\sin^6 x}{\cos^8 x}\, dx =$

(a) $\tan^7 x + c$ (b) $\frac{\tan^7 x}{7} + c$ (c) $\frac{\tan 7x}{7} + c$ (d) $\sec^7 x + c$

Q.70 If $\int_0^x f(t)\, dt = x + \int_x^1 t\, f(t)\, dt$, then the value of $f(1)$ is

(a) $\frac{1}{2}$ (b) 0 (c) 1 (d) $-\frac{1}{2}$

Q.71 In a class of 55 students, the number of students studying different subjects are 23 in mathematics, 24 in physics, 19 in chemistry, 12 in mathematics and physics, 9 in mathematics and chemistry, 7 in physics and chemistry, and 4 in all the three subject. The number of students who have taken exactly one subject is ?

Q.72 If $f(x) = \begin{cases} x, & x < 0 \\ 1, & 0 \le x < 2 \\ -1, & x \ge 2 \end{cases}$ and $g(x) = \begin{cases} 3x; & x \le 1 \\ 1; & x > 1. \end{cases}$ Then the sum of all values of x where $f(x) + g(x)$ is discontinuous is ?

Q.73 A particle acted by constant forces $4\hat{i} + \hat{j} - 3\hat{k}$ and $3\hat{i} + \hat{j} - \hat{k}$ displaced from the point $\hat{i} + 2\hat{j} + 3\hat{k}$ to the point $5\hat{i} + 4\hat{j} + \hat{k}$. The total work done by the forces is ?

Q.74 $\lim_{x \to \frac{\pi}{4}} \left(\frac{1 - \tan x}{1 - \sqrt{2} \sin x} \right)$ is equal to _____.

Q.75 The number of arrangements of the letters of the word BANANA in which the two N's do not appear adjacently, is _____ .

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