Central Board of Secondary Education

Question Paper Name :	JEE Main 2015 Paper 1 (B.E./B.Tech) Apr 11 Single slot
Subject Name :	Paper 1 (B.E./B.Tech)
Duration :	180
Total Marks :	360

Paper 1 (B.E./B.Tech)

Mathematics

Section Number :	1
Number of Questions :	30
Number of Questions to be attempted :	30
Section Marks :	120

Question Number : 1 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Let $A=\{x_1, x_2, ..., x_7\}$ and $B=\{y_1, y_2, y_3\}$ be two sets containing seven and three distinct elements respectively. Then the total number of functions $f : A \to B$ that are onto, if there exist exactly three elements x in A such that $f(x)=y_2$, is equal to :

(1) $14 \cdot {}^7C_2$

(2) $16 \cdot {}^7C_3$

(3) $12 \cdot {}^7C_2$

(4) $14 \cdot {}^7C_3$

Question Number : 2 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If z is a non-real complex number, then the minimum value of $\frac{\text{Im } z^5}{(\text{Im } z)^5}$ is :

(1) -1

(2) -2

(3) -4

(4) -5

Question Number : 3 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If the two roots of the equation, $(a-1)(x^4+x^2+1)+(a+1)(x^2+x+1)^2=0$ are real and distinct, then the set of all values of 'a' is :

(1) $\left(-\frac{1}{2}, 0\right)$

(2) $(-\infty, -2) \cup (2, \infty)$

(3) $\left(-\frac{1}{2}, 0\right) \cup \left(0, \frac{1}{2}\right)$

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

Question Number : 4 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If A is a 3×3 matrix such that $|5.\ \text{adj}A|=5$, then $|A|$ is equal to :

(1) $\pm\frac{1}{5}$

(2) ±5

(3) ±1

(4) $\pm\frac{1}{25}$

Question Number : 5 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If $\begin{vmatrix} x^2+x & x+1 & x-2 \\ 2x^2+3x-1 & 3x & 3x-3 \\ x^2+2x+3 & 2x-1 & 2x-1 \end{vmatrix} = ax-12$,

then 'a' is equal to :

(1) 12

(2) 24

(3) -12

(4) -24

Question Number : 6 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If in a regular polygon the number of diagonals is 54, then the number of sides of this polygon is :

(1) 10

(2) 12

(3) 9

(4) 6

Question Number : 7 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The term independent of x in the binomial expansion of

$\left(1-\frac{1}{x}+3x^5\right)\left(2x^2-\frac{1}{x}\right)^8$ is :

(1) 400

(2) 496

(3) -400

(4) -496

Question Number : 8 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The sum of the 3^{rd} and the 4^{th} terms of a G.P. is 60 and the product of its first three terms is 1000. If the first term of this G.P. is positive, then its 7^{th} term is :

(1) 7290

(2) 320

(3) 640

(4) 2430

Question Number : 9 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If $\sum_{n=1}^{5} \frac{1}{n(n+1)(n+2)(n+3)} = \frac{k}{3}$, then k is equal to :

(1) $\frac{55}{336}$

(2) $\frac{17}{105}$

(3) $\frac{1}{6}$

(4) $\frac{19}{112}$

Question Number : 10 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Let k be a non-zero real number. If

$$f(x) = \begin{cases} \dfrac{(e^x - 1)^2}{\sin\left(\frac{x}{k}\right)\log\left(1 + \frac{x}{4}\right)}, & x \neq 0 \\ 12, & x = 0 \end{cases}$$

is a continuous function, then the value of k is :

(1) 1

(2) 2

(3) 3

(4) 4

Question Number : 11 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The equation of a normal to the curve,

$\sin y = x \sin\left(\frac{\pi}{3} + y\right)$ at $x = 0$, is :

(1) $2x + \sqrt{3}\, y = 0$

(2) $2y - \sqrt{3}\, x = 0$

(3) $2y + \sqrt{3}\, x = 0$

(4) $2x - \sqrt{3}\, y = 0$

Question Number : 12 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Let k and K be the minimum and the maximum values of the function $f(x) = \frac{(1+x)^{0.6}}{1+x^{0.6}}$ in [0, 1] respectively, then the ordered pair (k, K) is equal to :

(1) $(1, 2^{0.6})$

(2) $(2^{-0.4}, 2^{0.6})$

(3) $(2^{-0.6}, 1)$

(4) $(2^{-0.4}, 1)$

Question Number : 13 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

From the top of a 64 metres high tower, a stone is thrown upwards vertically with the velocity of 48 m/s. The greatest height (in metres) attained by the stone, assuming the value of the gravitational acceleration $g = 32\ m/s^2$, is :

(1) 100

(2) 88

(3) 128

(4) 112

Question Number : 14 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If $\int \frac{\log\left(t+\sqrt{1+t^2}\right)}{\sqrt{1+t^2}}\,dt = \frac{1}{2}(g(t))^2 + C$, where C is a constant, then g(2) is equal to :

(1) $2\log(2+\sqrt{5})$

(2) $\log(2+\sqrt{5})$

(3) $\frac{1}{\sqrt{5}}\log(2+\sqrt{5})$

(4) $\frac{1}{2}\log(2+\sqrt{5})$

Question Number : 15 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Let $f : \mathbf{R} \to \mathbf{R}$ be a function such that $f(2-x) = f(2+x)$ and $f(4-x) = f(4+x)$, for all $x \in \mathbf{R}$ and $\int_0^2 f(x)\,dx = 5$. Then the value of $\int_{10}^{50} f(x)\,dx$ is :

(1) 80

(2) 100

(3) 125

(4) 200

Question Number : 16 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Let $f : (-1, 1) \to \mathbf{R}$ be a continuous function. If $\int_0^{\sin x} f(t)\,dt = \frac{\sqrt{3}}{2}x$, then $f\left(\frac{\sqrt{3}}{2}\right)$ is equal to :

(1) $\frac{\sqrt{3}}{2}$

(2) $\sqrt{3}$

(3) $\sqrt{\frac{3}{2}}$

(4) $\frac{1}{2}$

Question Number : 17 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The solution of the differential equation $y\,dx - (x + 2y^2)\,dy = 0$ is $x = f(y)$.
If $f(-1) = 1$, then $f(1)$ is equal to :

(1) 4

(2) 3

(3) 2

(4) 1

Question Number : 18 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A straight line L through the point $(3, -2)$ is inclined at an angle of $60°$ to the line $\sqrt{3}\,x + y = 1$. If L also intersects the x-axis, then the equation of L is :

(1) $y + \sqrt{3}\,x + 2 - 3\sqrt{3} = 0$

(2) $y - \sqrt{3}\,x + 2 + 3\sqrt{3} = 0$

(3) $\sqrt{3}\,y - x + 3 + 2\sqrt{3} = 0$

(4) $\sqrt{3}\,y + x - 3 + 2\sqrt{3} = 0$

Question Number : 19 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If the incentre of an equilateral triangle is $(1, 1)$ and the equation of its one side is $3x + 4y + 3 = 0$, then the equation of the circumcircle of this triangle is :

(1) $x^2 + y^2 - 2x - 2y - 2 = 0$

(2) $x^2 + y^2 - 2x - 2y - 14 = 0$

(3) $x^2 + y^2 - 2x - 2y + 2 = 0$

(4) $x^2 + y^2 - 2x - 2y - 7 = 0$

Question Number : 20 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If a circle passing through the point $(-1, 0)$ touches y-axis at $(0, 2)$, then the length of the chord of the circle along the x-axis is :

(1) $\frac{3}{2}$

(2) $\frac{5}{2}$

(3) 3

(4) 5

Question Number : 21 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If the distance between the foci of an ellipse is half the length of its latus rectum, then the eccentricity of the ellipse is :

(1) $\frac{1}{2}$

(2) $\frac{2\sqrt{2}-1}{2}$

(3) $\sqrt{2}-1$

(4) $\frac{\sqrt{2}-1}{2}$

Question Number : 22 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Let PQ be a double ordinate of the parabola, $y^2=-4x$, where P lies in the second quadrant. If R divides PQ in the ratio 2 : 1, then the locus of R is :

(1) $9y^2=4x$

(2) $9y^2=-4x$

(3) $3y^2=2x$

(4) $3y^2=-2x$

Question Number : 23 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The shortest distance between the z-axis and the line

$x+y+2z-3=0=2x+3y+4z-4,$ is :

(1) 1

(2) 2

(3) 3

(4) 4

Question Number : 24 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A plane containing the point (3, 2, 0) and the line $\frac{x-1}{1}=\frac{y-2}{5}=\frac{z-3}{4}$ also contains the point :

(1) $(0, -3, 1)$

(2) $(0, 7, 10)$

(3) $(0, 7, -10)$

(4) $(0, 3, 1)$

Question Number : 25 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

In a parallelogram ABCD, $|\overrightarrow{AB}|=a$, $|\overrightarrow{AD}|=b$ and $|\overrightarrow{AC}|=c$, then $\overrightarrow{DB}\cdot\overrightarrow{AB}$ has the value :

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

(2) $\frac{1}{4}\left(a^2+b^2-c^2\right)$

(3) $\frac{1}{3}\left(b^2+c^2-a^2\right)$

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

Question Number : 26 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If the lengths of the sides of a triangle are decided by the three throws of a single fair die, then the probability that the triangle is of maximum area given that it is an isosceles triangle, is :

(1) $\frac{1}{26}$

(2) $\frac{1}{27}$

(3) $\frac{1}{21}$

(4) $\frac{1}{15}$

Question Number : 27 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If the mean and the variance of a binomial variate X are 2 and 1 respectively, then the probability that X takes a value greater than or equal to one is :

(1) $\frac{1}{16}$

(2) $\frac{9}{16}$

(3) $\frac{3}{4}$

(4) $\frac{15}{16}$

Question Number : 28 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If $\cos\alpha + \cos\beta = \frac{3}{2}$ and $\sin\alpha + \sin\beta = \frac{1}{2}$ and θ is the arithmetic mean of α and β, then $\sin 2\theta + \cos 2\theta$ is equal to :

(1) $\frac{3}{5}$

(2) $\frac{4}{5}$

(3) $\frac{7}{5}$

(4) $\frac{8}{5}$

Question Number : 29 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Let 10 vertical poles standing at equal distances on a straight line, subtend the same angle of elevation α at a point O on this line and all the poles are on the same side of O. If the height of the longest pole is 'h' and the distance of the foot of the smallest pole from O is 'a' ; then the distance between two consecutive poles, is :

(1) $\frac{h\sin\alpha + a\cos\alpha}{9\sin\alpha}$

(2) $\frac{h\cos\alpha - a\sin\alpha}{9\cos\alpha}$

(3) $\frac{h\cos\alpha - a\sin\alpha}{9\sin\alpha}$

(4) $\frac{h\sin\alpha + a\cos\alpha}{9\cos\alpha}$

Question Number : 30 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Consider the following statements :

P : Suman is brilliant.

Q : Suman is rich.

R : Suman is honest.

The negation of the statement,

"Suman is brilliant and dishonest if and only if Suman is rich" can be equivalently expressed as :

(1) $\sim Q \leftrightarrow \sim P \wedge R$

(2) $\sim Q \leftrightarrow \sim P \vee R$

(3) $\sim Q \leftrightarrow P \vee \sim R$

(4) $\sim Q \leftrightarrow P \wedge \sim R$

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Physics

Section Number : 2
Number of Questions : 30
Number of Questions to be attempted : 30
Section Marks : 120

Question Number : 31 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

If electronic charge e, electron mass m, speed of light in vacuum c and Planck's constant h are taken as fundamental quantities, the permeability of vacuum μ_0 can be expressed in units of :

(1) $\left(\frac{hc}{me^2}\right)$

(2) $\left(\frac{h}{me^2}\right)$

(3) $\left(\frac{h}{ce^2}\right)$

(4) $\left(\frac{mc^2}{he^2}\right)$

Question Number : 32 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A vector $\vec{A}$ is rotated by a small angle $\Delta\theta$ radians ($\Delta\theta << 1$) to get a new vector $\vec{B}$.

In that case $|\vec{B} - \vec{A}|$ is :

(1) 0

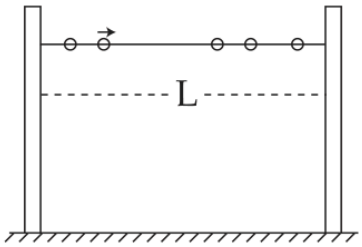
(2) $|\vec{A}|\left(1 - \frac{\Delta\theta^2}{2}\right)$

(3) $|\vec{A}|\,\Delta\theta$

(4) $|\vec{B}|\,\Delta\theta - |\vec{A}|$

Question Number : 33 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A large number (n) of identical beads, each of mass m and radius r are strung on a thin smooth rigid horizontal rod of length L (L>>r) and are at rest at random positions. The rod is mounted between two rigid supports (see figure). If one of the beads is now given a speed v, the average force experienced by each support after a long time is (assume all collisions are elastic) :



(1) $\frac{mv^2}{L - nr}$

(2) $\frac{mv^2}{L - 2nr}$

(3) $\frac{mv^2}{2(L - nr)}$

(4) zero

Question Number : 34 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A particle is moving in a circle of radius r under the action of a force $F = \alpha r^2$ which is directed towards centre of the circle. Total mechanical energy (kinetic energy + potential energy) of the particle is (take potential energy = 0 for r = 0) :

(1) αr^3

(2) $\frac{1}{2}\alpha r^3$

(3) $\frac{4}{3}\alpha r^3$

(4) $\frac{5}{6}\alpha r^3$

Question Number : 35 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A uniform thin rod AB of length L has linear mass density $\mu(x) = a + \frac{bx}{L}$, where x is measured from A. If the CM of the rod lies at a distance of $\left(\frac{7}{12}L\right)$ from A, then a and b are related as :

(1) $a = b$

(2) $a = 2b$

(3) $2a = b$

(4) $3a = 2b$

Question Number : 36 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A particle of mass 2 kg is on a smooth horizontal table and moves in a circular path of radius 0.6 m. The height of the table from the ground is 0.8 m. If the angular speed of the particle is 12 rad s^{-1}, the magnitude of its angular momentum about a point on the ground right under the centre of the circle is :

(1) 8.64 kg $m^2 s^{-1}$

(2) 11.52 kg $m^2 s^{-1}$

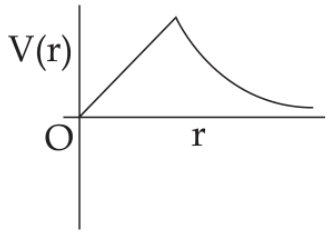
(3) 14.4 kg $m^2 s^{-1}$

(4) 20.16 kg $m^2 s^{-1}$

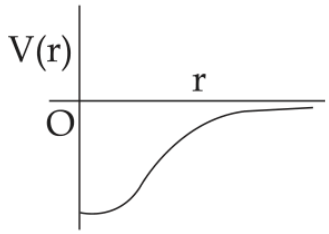
Question Number : 37 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which of the following most closely depicts the correct variation of the gravitation potential V(r) due to a large planet of radius R and uniform mass density ? *(figures are not drawn to scale)*

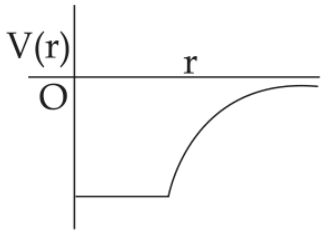
(1)



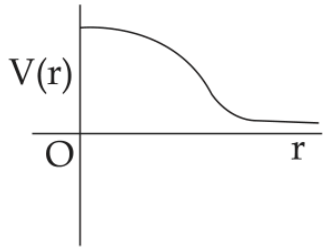
(2)



(3)



(4)



Question Number : 38 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A cylindrical block of wood (density $= 650$ kg m^{-3}), of base area 30 cm^2 and height 54 cm, floats in a liquid of density 900 kg m^{-3}. The block is depressed slightly and then released. The time period of the resulting oscillations of the block would be equal to that of a simple pendulum of length (nearly) :

(1) 65 cm

(2) 52 cm

(3) 39 cm

(4) 26 cm

Question Number : 39 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A beaker contains a fluid of density ρ kg/m^3, specific heat S J/kg°C and viscosity η. The beaker is filled up to height h. To estimate the rate of heat transfer per unit area $(\dot{Q}/A)$ by convection when beaker is put on a hot plate, a student proposes that it should depend on η, $\left(\frac{S\Delta\theta}{h}\right)$ and $\left(\frac{1}{\rho g}\right)$ when $\Delta\theta$ (in °C) is the difference in the temperature between the bottom and top of the fluid. In that situation the correct option for $(\dot{Q}/A)$ is :

(1) $\eta \frac{S\Delta\theta}{h}$

(2) $\eta\left(\frac{S\Delta\theta}{h}\right)\left(\frac{1}{\rho g}\right)$

(3) $\frac{S\Delta\theta}{\eta h}$

(4) $\left(\frac{S\Delta\theta}{\eta h}\right)\left(\frac{1}{\rho g}\right)$

Question Number : 40 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

An experiment takes 10 minutes to raise the temperature of water in a container from 0°C to 100°C and another 55 minutes to convert it totally into steam by a heater supplying heat at a uniform rate. Neglecting the specific heat of the container and taking specific heat of water to be 1 cal/g °C, the heat of vapourization according to this experiment will come out to be :

(1) 530 cal/g

(2) 540 cal/g

(3) 550 cal/g

(4) 560 cal/g

Question Number : 41 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Using equipartition of energy, the specific heat (in $J\,kg^{-1}\,K^{-1}$) of aluminium at room temperature can be estimated to be (atomic weight of aluminium $= 27$)

(1) 25

(2) 410

(3) 925

(4) 1850

Question Number : 42 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A pendulum with time period of $1s$ is losing energy due to damping. At certain time its energy is 45 J. If after completing 15 oscillations, its energy has become 15 J, its damping constant (in s^{-1}) is :

(1) $\frac{1}{30} ln\, 3$

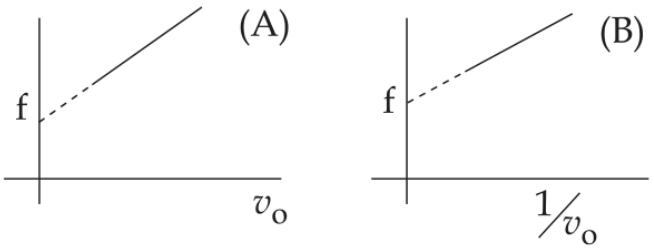
(2) $\frac{1}{15} ln\, 3$

(3) 2

(4) $\frac{1}{2}$

Question Number : 43 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A source of sound emits sound waves at frequency f_0. It is moving towards an observer with fixed speed v_s(v_s<v, where v is the speed of sound in air). If the observer were to move towards the source with speed v_0, one of the following two graphs (A and B) will give the correct variation of the frequency f heard by the observer as v_0 is changed.



The variation of f with v_0 is given correctly by :

(1) graph A with slope $= \frac{f_0}{(v - v_s)}$

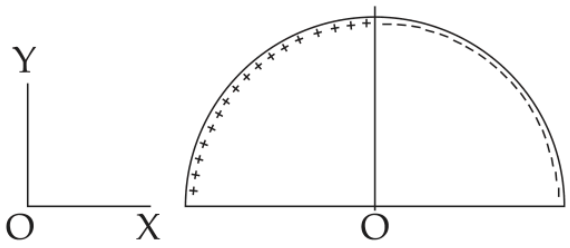
(2) graph A with slope $= \frac{f_0}{(v + v_s)}$

(3) graph B with slope $= \frac{f_0}{(v - v_s)}$

(4) graph B with slope $= \frac{f_0}{(v + v_s)}$

Question Number : 44 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A wire, of length L(=20 cm), is bent into a semi-circular arc. If the two equal halves, of the arc, were each to be uniformly charged with charges $\pm Q$, $[|Q| = 10^3\ \varepsilon_0$ Coulomb where ε_0 is the permittivity (in SI units) of free space] the net electric field at the centre O of the semi-circular arc would be :



(1) $(50 \times 10^3\ \text{N/C})\ \hat{j}$

(2) $(25 \times 10^3\ \text{N/C})\ \hat{i}$

(3) $(25 \times 10^3\ \text{N/C})\ \hat{j}$

(4) $(50 \times 10^3\ \text{N/C})\ \hat{i}$

Question Number : 45 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

An electric field $\vec{E} = \left(25\ \hat{i} + 30\ \hat{j}\right) \text{NC}^{-1}$ exists in a region of space. If the potential at the origin is taken to be zero then the potential at $x = 2$ m, $y = 2$ m is :

(1) -130 J

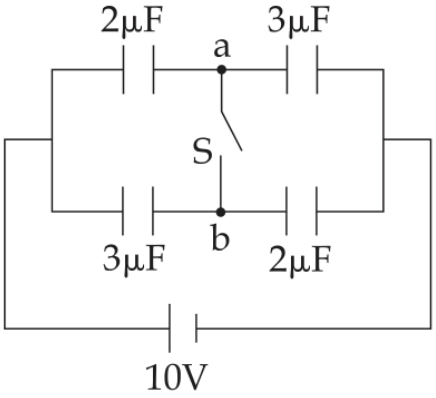
(2) -120 J

(3) -140 J

(4) -110 J

Question Number : 46 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

In figure is shown a system of four capacitors connected across a 10 V battery. Charge that will flow from switch S when it is closed is :



(1) 5 μC from b to a

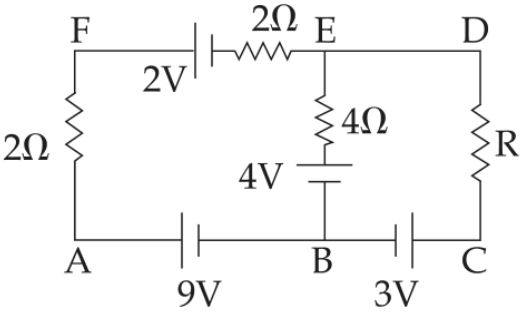
(2) 20 μC from a to b

(3) 5 μC from a to b

(4) zero

Question Number : 47 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

In the electric network shown, when no current flows through the 4 Ω resistor in the arm EB, the potential difference between the points A and D will be :



(1) 3 V

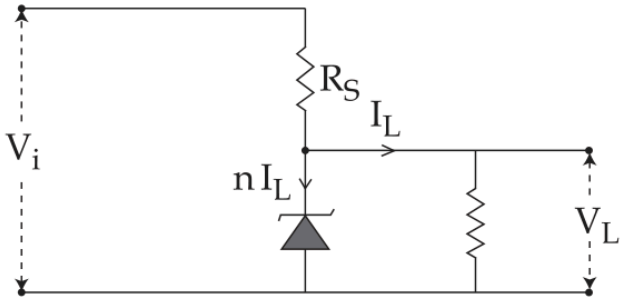
(2) 4 V

(3) 5 V

(4) 6 V

Question Number : 48 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The value of the resistor, R_S, needed in the dc voltage regulator circuit shown here, equals :



(1) $(V_i - V_L)/n\ I_L$

(2) $(V_i + V_L)/n\ I_L$

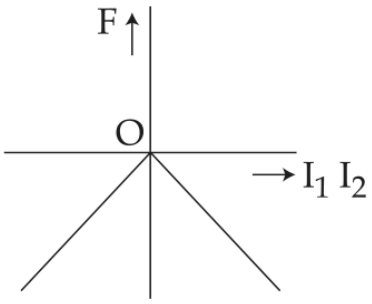
(3) $(V_i - V_L)/(n+1)\ I_L$

(4) $(V_i + V_L)/(n+1)\ I_L$

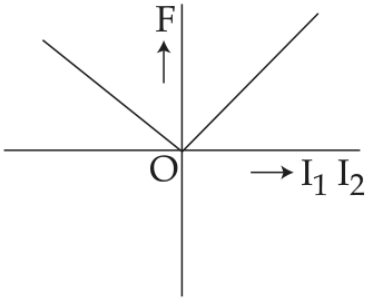
Question Number : 49 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Two long straight parallel wires, carrying (adjustable) currents I_1 and I_2, are kept at a distance d apart. If the force 'F' between the two wires is taken as 'positive' when the wires repel each other and 'negative' when the wires attract each other, the graph showing the dependence of 'F', on the product I_1I_2, would be :

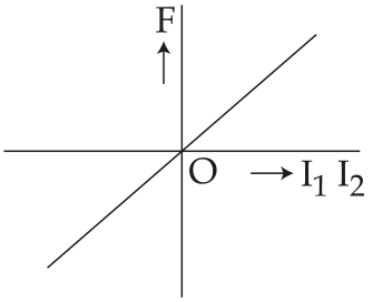
(1)



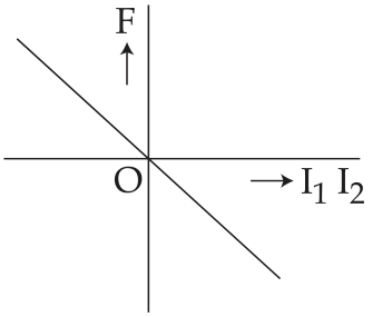
(2)



(3)

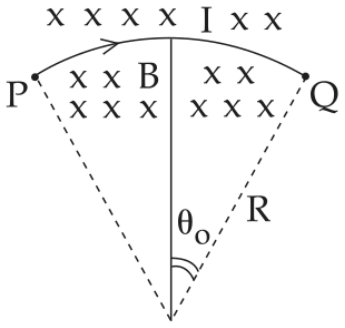


(4)



Question Number : 50 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A wire carrying current I is tied between points P and Q and is in the shape of a circular arch of radius R due to a uniform magnetic field B (perpendicular to the plane of the paper, shown by xxx) in the vicinity of the wire. If the wire subtends an angle $2\theta_0$ at the centre of the circle (of which it forms an arch) then the tension in the wire is :



(1) IBR

(2) $\frac{IBR}{\sin\theta_0}$

(3) $\frac{IBR}{2\sin\theta_0}$

(4) $\frac{IBR\theta_0}{\sin\theta_0}$

Question Number : 51 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A short bar magnet is placed in the magnetic meridian of the earth with north pole pointing north. Neutral points are found at a distance of 30 cm from the magnet on the East - West line, drawn through the middle point of the magnet. The magnetic moment of the magnet in Am^2 is close to :

(Given $\frac{\mu_0}{4\pi} = 10^{-7}$ in SI units and B_H = Horizontal component of earth's magnetic field = 3.6×10^{-5} Tesla.)

(1) 9.7

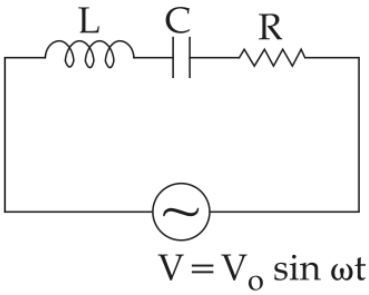
(2) 4.9

(3) 19.4

(4) 14.6

Question Number : 52 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

For the LCR circuit, shown here, the current is observed to lead the applied voltage. An additional capacitor C′, when joined with the capacitor C present in the circuit, makes the power factor of the circuit unity. The capacitor C′, must have been connected in :



$V = V_o \sin \omega t$

(1) series with C and has a magnitude $\frac{1 - \omega^2 LC}{\omega^2 L}$.

(2) series with C and has a magnitude $\frac{C}{(\omega^2 LC - 1)}$.

(3) parallel with C and has a magnitude $\frac{C}{(\omega^2 LC - 1)}$.

(4) parallel with C and has a magnitude $\frac{1 - \omega^2 LC}{\omega^2 L}$.

Question Number : 53 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

For plane electromagnetic waves propagating in the z direction, which one of the following combination gives the correct possible direction for $\vec{E}$ and $\vec{B}$ field respectively ?

(1) $\left(\hat{i} + 2\hat{j}\right)$ and $\left(2\hat{i} - \hat{j}\right)$

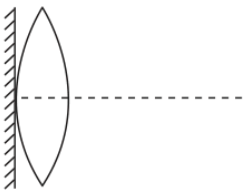
(2) $\left(-2\hat{i} - 3\hat{j}\right)$ and $\left(3\hat{i} - 2\hat{j}\right)$

(3) $\left(2\hat{i} + 3\hat{j}\right)$ and $\left(\hat{i} + 2\hat{j}\right)$

(4) $\left(3\hat{i} + 4\hat{j}\right)$ and $\left(4\hat{i} - 3\hat{j}\right)$

Question Number : 54 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A thin convex lens of focal length 'f' is put on a plane mirror as shown in the figure. When an object is kept at a distance 'a' from the lens - mirror combination, its image is formed at a distance $\frac{a}{3}$ in front of the combination. The value of 'a' is :



(1) f

(2) 2f

(3) 3f

(4) $\frac{3}{2}$f

Question Number : 55 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

In a Young's double slit experiment with light of wavelength λ the separation of slits is d and distance of screen is D such that $D >> d >> \lambda$. If the Fringe width is β, the distance from point of maximum intensity to the point where intensity falls to half of maximum intensity on either side is :

(1) $\frac{\beta}{2}$

(2) $\frac{\beta}{4}$

(3) $\frac{\beta}{3}$

(4) $\frac{\beta}{6}$

Question Number : 56 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Unpolarized light of intensity I_0 is incident on surface of a block of glass at Brewster's angle. In that case, which one of the following statements is true ?

(1) transmitted light is partially polarized with intensity $I_0/2$.

(2) transmitted light is completely polarized with intensity less than $I_0/2$.

(3) reflected light is completely polarized with intensity less than $I_0/2$.

(4) reflected light is partially polarized with intensity $I_0/2$.

Question Number : 57 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The de - Broglie wavelength associated with the electron in the $n=4$ level is :

(1) two times the de-Broglie wavelength of the electron in the ground state

(2) four times the de-Broglie wavelength of the electron in the ground state

(3) half of the de-Broglie wavelength of the electron in the ground state

(4) $1/4^{th}$ of the de-Broglie wavelength of the electron in the ground state

Question Number : 58 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Let N_β be the number of β particles emitted by 1 gram of Na^{24} radioactive nuclei (half life = 15 hrs) in 7.5 hours, N_β is close to (Avogadro number $=6.023\times10^{23}$/g. mole) :

(1) 6.2×10^{21}

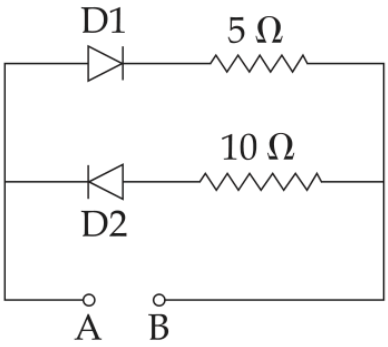
(2) 7.5×10^{21}

(3) 1.25×10^{22}

(4) 1.75×10^{22}

Question Number : 59 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A 2V battery is connected across AB as shown in the figure. The value of the current supplied by the battery when in one case battery's positive terminal is connected to A and in other case when positive terminal of battery is connected to B will respectively be :



(1) 0.2 A and 0.1 A

(2) 0.4 A and 0.2 A

(3) 0.1 A and 0.2 A

(4) 0.2 A and 0.4 A

Question Number : 60 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The AC voltage across a resistance can be measured using a :

(1) potentiometer

(2) moving coil galvanometer

(3) moving magnet galvanometer

(4) hot wire voltmeter

Chemistry

Section Number :	3
Number of Questions :	30
Number of Questions to be attempted :	30
Section Marks :	120

Question Number : 61 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

$A + 2B + 3C \rightleftharpoons AB_2C_3$

Reaction of 6.0 g of A, 6.0×10^{23} atoms of B, and 0.036 mol of C yields 4.8 g of compound AB_2C_3. If the atomic mass of A and C are 60 and 80 amu, respectively, the atomic mass of B is (Avogadro no. $= 6 \times 10^{23}$) :

(1) 70 amu

(2) 60 amu

(3) 50 amu

(4) 40 amu

Question Number : 62 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

When does a gas deviate the most from its ideal behaviour ?

(1) At low pressure and low temperature

(2) At low pressure and high temperature

(3) At high pressure and low temperature

(4) At high pressure and high temperature

Question Number : 63 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

At temperature T, the average kinetic energy of any particle is $\frac{3}{2}$ kT. The de Broglie wavelength follows the order :

(1) Thermal proton > Visible photon > Thermal electron

(2) Thermal proton > Thermal electron > Visible photon

(3) Visible photon > Thermal electron > Thermal neutron

(4) Visible photon > Thermal neutron > Thermal electron

Question Number : 64 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Molecule AB has a bond length of 1.617Å and a dipole moment of 0.38 D. The fractional charge on each atom (absolute magnitude) is : ($e_0 = 4.802 \times 10^{-10}$ esu)

(1) 0

(2) 0.05

(3) 0.5

(4) 1.0

Question Number : 65 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

For the equilibrium, $A(g) \rightleftharpoons B(g)$, ΔH is -40 kJ/mol. If the ratio of the activation energies of the forward (E_f) and reverse (E_b) reactions is $\frac{2}{3}$ then :

(1) $E_f = 60$ kJ/mol ; $E_b = 100$ kJ/mol

(2) $E_f = 30$ kJ/mol ; $E_b = 70$ kJ/mol

(3) $E_f = 80$ kJ/mol ; $E_b = 120$ kJ/mol

(4) $E_f = 70$ kJ/mol ; $E_b = 30$ kJ/mol

Question Number : 66 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Determination of the molar mass of acetic acid in benzene using freezing point depression is affected by :

(1) dissociation

(2) association

(3) partial ionization

(4) complex formation

Question Number : 67 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The increase of pressure on ice $\rightleftharpoons$ water system at constant temperature will lead to :

(1) no effect on the equilibrium

(2) a decrease in the entropy of the system

(3) a shift of the equilibrium in the forward direction

(4) an increase in the Gibbs energy of the system

Question Number : 68 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

At 298 K, the standard reduction potentials are 1.51 V for $MnO_4^- | Mn^{2+}$, 1.36 V for $Cl_2 | Cl^-$, 1.07 V for $Br_2 | Br^-$, and 0.54 V for $I_2 | I^-$. At pH = 3, permanganate is expected to oxidize : $\left(\frac{RT}{F} = 0.059\ V\right)$

(1) Cl^-, Br^- and I^-

(2) Cl^- and Br^-

(3) Br^- and I^-

(4) I^- only

Question Number : 69 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

$A + 2B \rightarrow C$, the rate equation for this reaction is given as

$$Rate = k[A][B].$$

If the concentration of A is kept the same but that of B is doubled what will happen to the rate itself ?

(1) halved

(2) the same

(3) doubled

(4) quadrupled

Question Number : 70 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Under ambient conditions, which among the following surfactants will form micelles in aqueous solution at lowest molar concentration ?

(1) $CH_3(CH_2)_{15}\overset{\oplus}{N}(CH_3)_3\overset{\ominus}{Br}$

(2) $CH_3 - (CH_2)_{13} - OSO_3^- Na^+$

(3) $CH_3 - (CH_2)_8 - \overset{\ominus}{COO}\ Na^+$

(4) $CH_3(CH_2)_{11}\overset{\oplus}{N}(CH_3)_3Br^-$

Question Number : 71 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Choose the incorrect formula out of the four compounds for an element X below :

(1) X_2Cl_3

(2) X_2O_3

(3) $X_2(SO_4)_3$

(4) XPO_4

Question Number : 72 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Calamine is an ore of :

(1) Aluminium

(2) Copper

(3) Iron

(4) Zinc

Question Number : 73 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which physical property of dihydrogen is **wrong** ?

(1) Colourless gas

(2) Odourless gas

(3) Tasteless gas

(4) Non-inflammable gas

Question Number : 74 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which of the alkaline earth metal halides given below is essentially covalent in nature ?

(1) $MgCl_2$

(2) $BeCl_2$

(3) $SrCl_2$

(4) $CaCl_2$

Question Number : 75 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which of the following compounds has a P – P bond ?

(1) $H_4P_2O_5$

(2) $H_4P_2O_6$

(3) $H_4P_2O_7$

(4) $(HPO_3)_3$

Question Number : 76 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Chlorine water on standing loses its colour and forms :

(1) HCl only

(2) $HOCl$ and $HOCl_2$

(3) HCl and $HOCl$

(4) HCl and $HClO_2$

Question Number : 77 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which of the following statements is **false** ?

(1) CrO_4^{2-} is tetrahedral in shape

(2) $Cr_2O_7^{2-}$ has a $Cr-O-Cr$ bond

(3) $Na_2Cr_2O_7$ is a primary standard in volumetry

(4) $Na_2Cr_2O_7$ is less soluble than $K_2Cr_2O_7$

Question Number : 78 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

When concentrated HCl is added to an aqueous solution of $CoCl_2$, its colour changes from reddish pink to deep blue. Which complex ion gives blue colour in this reaction ?

(1) $[CoCl_6]^{4-}$

(2) $[CoCl_6]^{3-}$

(3) $[CoCl_4]^{2-}$

(4) $[Co(H_2O)_6]^{2+}$

Question Number : 79 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which of the following complex ions has electrons that are symmetrically filled in both t_{2g} and e_g orbitals ?

(1) $[CoF_6]^{3-}$

(2) $[Co(NH_3)_6]^{2+}$

(3) $[Mn(CN)_6]^{4-}$

(4) $[FeF_6]^{3-}$

Question Number : 80 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Addition of phosphate fertilisers to water bodies causes :

(1) enhanced growth of algae

(2) increase in amount of dissolved oxygen in water

(3) deposition of calcium phosphate

(4) increase in fish population

Question Number : 81 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Match the organic compounds in **column - I** with the Lassaigne's test results in **column - II** appropriately :

Column - I		**Column - II**	
(A)	Aniline	(i)	Red color with $FeCl_3$
(B)	Benzene sulfonic acid	(ii)	Violet color with sodium nitroprusside
(C)	Thiourea	(iii)	Blue color with hot and acidic solution of $FeSO_4$

(1) (A) - (ii) ; (B) - (i) ; (C) - (iii)

(2) (A) - (iii) ; (B) - (ii) ; (C) - (i)

(3) (A) - (ii) ; (B) - (iii) ; (C) - (i)

(4) (A) - (iii) ; (B) - (i) ; (C) - (ii)

Question Number : 82 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which of the following pairs of compounds are positional isomers ?

(1) $CH_3-CH_2-CH_2-CH_2-CHO$

and $CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-CH_3$

(2) $CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-CH_3$ and

$CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CHO$

(3) $CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-CH_3$ and

$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$

(4) $CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$ and

$\begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>\!\!CH-CH_2-CHO$

Question Number : 83 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

The number of structural isomers for C_6H_{14} is :

(1) 3

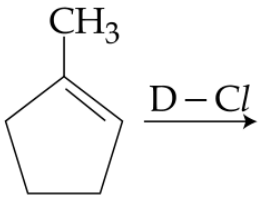
(2) 4

(3) 5

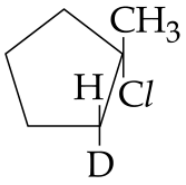
(4) 6

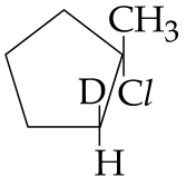
Question Number : 84 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

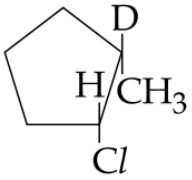
What is the major product expected from the following reaction ?

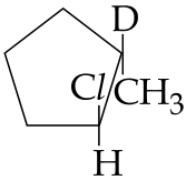


Where D is an isotope of Hydrogen.

(1) 

(2) 

(3) 

(4) 

Question Number : 85 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

In the reaction sequence

$2\,CH_3CHO \xrightarrow{OH^-} A \xrightarrow{\Delta} B$; the product B is :

(1) $CH_3-CH_2-CH_2-CH_2-OH$

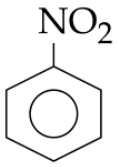
(2) $CH_3-CH=CH-CHO$

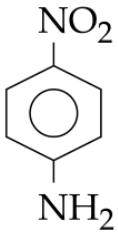
(3) $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$

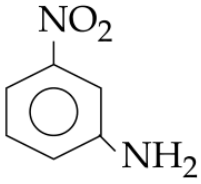
(4) $CH_3-CH_2-CH_2-CH_3$

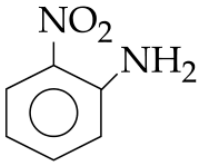
Question Number : 86 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which compound exhibits maximum dipole moment among the following ?

(1) 

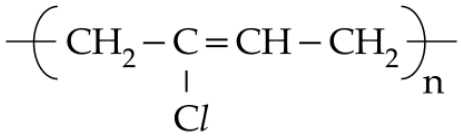
(2) 

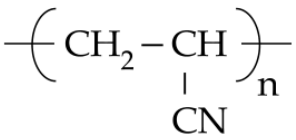
(3) 

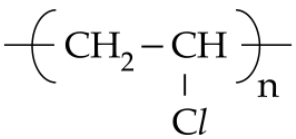
(4) 

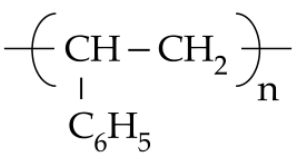
Question Number : 87 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which one of the following structures represents the neoprene polymer ?

(1) 

(2) 

(3) 

(4) 

Question Number : 88 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Accumulation of which of the following molecules in the muscles occurs as a result of vigorous exercise ?

(1) Glucose

(2) Glycogen

(3) L-lactic acid

(4) Pyruvic acid

Question Number : 89 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which artificial sweetener contains chlorine ?

(1) Aspartame

(2) Saccharin

(3) Sucralose

(4) Alitame

Question Number : 90 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A pink coloured salt turns blue on heating. The presence of which cation is most likely ?

(1) Cu^{2+}

(2) Fe^{2+}

(3) Zn^{2+}

(4) Co^{2+}

- o 0 o -