Central Board of Secondary Education

Question Paper Name :	JEE Main 2016 Paper 1 (B.E./B.Tech) Apr 9 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

For $x \in \mathbf{R}$, $x \neq 0$, $x \neq 1$, let $f_0(x) = \dfrac{1}{1-x}$ and $f_{n+1}(x) = f_0(f_n(x))$, $n = 0, 1, 2, \ldots$ Then the value of $f_{100}(3) + f_1\left(\dfrac{2}{3}\right) + f_2\left(\dfrac{3}{2}\right)$ is equal to :

(1) $\dfrac{8}{3}$

(2) $\dfrac{5}{3}$

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

(4) $\dfrac{1}{3}$

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

The point represented by $2+i$ in the Argand plane moves 1 unit eastwards, then 2 units northwards and finally from there $2\sqrt{2}$ units in the south-westwards direction. Then its new position in the Argand plane is at the point represented by :

(1) $2+2i$

(2) $1+i$

(3) $-1-i$

(4) $-2-2i$

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

If the equations $x^2+bx-1=0$ and $x^2+x+b=0$ have a common root different from -1, then $|b|$ is equal to :

(1) $\sqrt{2}$

(2) 2

(3) 3

(4) $\sqrt{3}$

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

If $P=\begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$, $A=\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$ and $Q=PAP^T$, then $P^T Q^{2015} P$ is :

(1) $\begin{bmatrix} 0 & 2015 \\ 0 & 0 \end{bmatrix}$

(2) $\begin{bmatrix} 2015 & 1 \\ 0 & 2015 \end{bmatrix}$

(3) $\begin{bmatrix} 2015 & 0 \\ 1 & 2015 \end{bmatrix}$

(4) $\begin{bmatrix} 1 & 2015 \\ 0 & 1 \end{bmatrix}$

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

The number of distinct real roots of the equation, $\begin{vmatrix} \cos x & \sin x & \sin x \\ \sin x & \cos x & \sin x \\ \sin x & \sin x & \cos x \end{vmatrix} = 0$ in the interval $\left[-\frac{\pi}{4}, \frac{\pi}{4}\right]$ is :

(1) 4

(2) 3

(3) 2

(4) 1

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

If the four letter words (need not be meaningful) are to be formed using the letters from the word "MEDITERRANEAN" such that the first letter is R and the fourth letter is E, then the total number of all such words is :

(1) $\frac{11!}{(2!)^3}$

(2) 110

(3) 56

(4) 59

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

For $x \in \mathbf{R}$, $x \neq -1$, if

$(1+x)^{2016} + x(1+x)^{2015} + x^2(1+x)^{2014} + \ldots\ldots + x^{2016} = \sum_{i=0}^{2016} a_i x^i$, then a_{17} is equal to :

(1) $\frac{2017!}{17!\ 2000!}$

(2) $\frac{2016!}{17!\ 1999!}$

(3) $\frac{2017!}{2000!}$

(4) $\frac{2016!}{16!}$

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

Let x, y, z be positive real numbers such that $x+y+z=12$ and $x^3y^4z^5=(0.1)\ (600)^3$. Then $x^3+y^3+z^3$ is equal to :

(1) 270

(2) 258

(3) 342

(4) 216

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

The value of $\sum_{r=1}^{15} r^2\left(\frac{{}^{15}C_r}{{}^{15}C_{r-1}}\right)$ is equal to :

(1) 560

(2) 680

(3) 1240

(4) 1085

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

If $\lim_{x\to\infty}\left(1+\frac{a}{x}-\frac{4}{x^2}\right)^{2x}=e^3$, then '$a$' is equal to :

(1) 2

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

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

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

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

If the function

$$f(x)=\begin{cases}-x, & x<1\\ a+\cos^{-1}(x+b), & 1\le x\le 2\end{cases}$$

is differentiable at $x=1$, then $\frac{a}{b}$ is equal to :

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

(2) $\frac{-\pi-2}{2}$

(3) $\frac{\pi+2}{2}$

(4) $-1-\cos^{-1}(2)$

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

If the tangent at a point P, with parameter t, on the curve $x=4t^2+3$, $y=8t^3-1$, $t\in\mathbf{R}$, meets the curve again at a point Q, then the coordinates of Q are :

(1) $(t^2+3,\ -t^3-1)$

(2) $(4t^2+3,\ -8t^3-1)$

(3) $(t^2+3,\ t^3-1)$

(4) $(16t^2+3,\ -64t^3-1)$

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

The minimum distance of a point on the curve $y=x^2-4$ from the origin is :

(1) $\frac{\sqrt{19}}{2}$

(2) $\sqrt{\frac{15}{2}}$

(3) $\frac{\sqrt{15}}{2}$

(4) $\sqrt{\frac{19}{2}}$

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

If

$$\int \frac{dx}{\cos^3 x\sqrt{2\sin 2x}} = (\tan x)^{A} + C(\tan x)^{B} + k,$$

where k is a constant of integration, then $A + B + C$ equals :

(1) $\frac{21}{5}$

(2) $\frac{16}{5}$

(3) $\frac{7}{10}$

(4) $\frac{27}{10}$

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

If $2\int_0^1 \tan^{-1} x\,dx = \int_0^1 \cot^{-1}(1 - x + x^2)\,dx,$

then $\int_0^1 \tan^{-1}(1 - x + x^2)\,dx$ is equal to :

(1) $\log 4$

(2) $\frac{\pi}{2} + \log 2$

(3) $\log 2$

(4) $\frac{\pi}{2} - \log 4$

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

The area (in sq. units) of the region described by

$A=\{(x, y) \mid y \geq x^2-5x+4,\ x+y \geq 1,\ y \leq 0\}$

is :

(1) $\frac{7}{2}$

(2) $\frac{19}{6}$

(3) $\frac{13}{6}$

(4) $\frac{17}{6}$

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

If $f(x)$ is a differentiable function in the interval $(0, \infty)$ such that $f(1) = 1$ and

$$\lim_{t \to x} \frac{t^2 f(x) - x^2 f(t)}{t - x} = 1, \text{ for each } x>0,$$

then $f\left(\frac{3}{2}\right)$ is equal to :

(1) $\frac{13}{6}$

(2) $\frac{23}{18}$

(3) $\frac{25}{9}$

(4) $\frac{31}{18}$

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

If a variable line drawn through the intersection of the lines $\frac{x}{3}+\frac{y}{4}=1$ and $\frac{x}{4}+\frac{y}{3}=1$, meets the coordinate axes at A and B, $(A \neq B)$, then the locus of the midpoint of AB is :

(1) $6xy=7(x+y)$

(2) $4(x+y)^2-28(x+y)+49=0$

(3) $7xy=6(x+y)$

(4) $14(x+y)^2-97(x+y)+168=0$

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

The point (2, 1) is translated parallel to the line L : $x-y=4$ by $2\sqrt{3}$ units. If the new point Q lies in the third quadrant, then the equation of the line passing through Q and perpendicular to L is :

(1) $x+y=2-\sqrt{6}$

(2) $x+y=3-3\sqrt{6}$

(3) $x+y=3-2\sqrt{6}$

(4) $2x+2y=1-\sqrt{6}$

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

A circle passes through $(-2,4)$ and touches the y-axis at (0, 2). Which one of the following equations can represent a diameter of this circle ?

(1) $4x+5y-6=0$

(2) $2x-3y+10=0$

(3) $3x+4y-3=0$

(4) $5x+2y+4=0$

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

Let a and b respectively be the semi-transverse and semi-conjugate axes of a hyperbola whose eccentricity satisfies the equation $9e^2-18e+5=0$. If S(5, 0) is a focus and $5x=9$ is the corresponding directrix of this hyperbola, then a^2-b^2 is equal to :

(1) 7

(2) -7

(3) 5

(4) -5

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

If the tangent at a point on the ellipse $\frac{x^2}{27}+\frac{y^2}{3}=1$ meets the coordinate axes at A and B, and O is the origin, then the minimum area (in sq. units) of the triangle OAB is :

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

(2) $3\sqrt{3}$

(3) $9\sqrt{3}$

(4) 9

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

The shortest distance between the lines $\frac{x}{2}=\frac{y}{2}=\frac{z}{1}$ and $\frac{x+2}{-1}=\frac{y-4}{8}=\frac{z-5}{4}$ lies in the interval :

(1) [0, 1)

(2) [1, 2)

(3) (2, 3]

(4) (3, 4]

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

The distance of the point $(1, -2, 4)$ from the plane passing through the point $(1, 2, 2)$ and perpendicular to the planes $x-y+2z=3$ and $2x-2y+z+12=0$, is :

(1) $2\sqrt{2}$

(2) 2

(3) $\sqrt{2}$

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

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

In a triangle ABC, right angled at the vertex A, if the position vectors of A, B and C are respectively $3\hat{i}+\hat{j}-\hat{k}$, $-\hat{i}+3\hat{j}+p\hat{k}$ and $5\hat{i}+q\hat{j}-4\hat{k}$, then the point (p, q) lies on a line :

(1) parallel to x-axis.

(2) parallel to y-axis.

(3) making an acute angle with the positive direction of x-axis.

(4) making an obtuse angle with the positive direction of x-axis.

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

If the mean deviation of the numbers $1, 1+d, ..., 1+100d$ from their mean is 255, then a value of d is :

(1) 10.1

(2) 20.2

(3) 10

(4) 5.05

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

If A and B are any two events such that $P(A) = \frac{2}{5}$ and $P(A \cap B) = \frac{3}{20}$, then the conditional probability, $P(A|(A' \cup B'))$, where A′ denotes the complement of A, is equal to :

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

(2) $\frac{5}{17}$

(3) $\frac{8}{17}$

(4) $\frac{11}{20}$

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

The number of $x \in [0, 2\pi]$ for which

$$\left|\sqrt{2\sin^4 x + 18\cos^2 x} - \sqrt{2\cos^4 x + 18\sin^2 x}\right| = 1$$

is :

(1) 2

(2) 4

(3) 6

(4) 8

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

If m and M are the minimum and the maximum values of

$4 + \frac{1}{2}\sin^2 2x - 2\cos^4 x$, $x \in \mathbf{R}$, then

$M - m$ is equal to :

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

(2) $\frac{9}{4}$

(3) $\frac{7}{4}$

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

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

Consider the following two statements :

P : If 7 is an odd number, then 7 is divisible by 2.

Q : If 7 is a prime number, then 7 is an odd number.

If V_1 is the truth value of the contrapositive of P and V_2 is the truth value of contrapositive of Q, then the ordered pair (V_1, V_2) equals :

(1) (T, T)

(2) (T, F)

(3) (F, T)

(4) (F, F)

- o O o -

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

In the following 'I' refers to current and other symbols have their usual meaning. Choose the option that corresponds to the dimensions of electrical conductivity :

(1) $ML^{-3}T^{-3}I^2$

(2) $M^{-1}L^3T^3I$

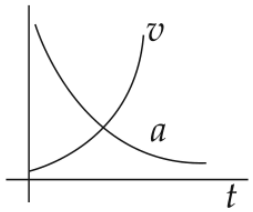
(3) $M^{-1}L^{-3}T^3I^2$

(4) $M^{-1}L^{-3}T^3I$

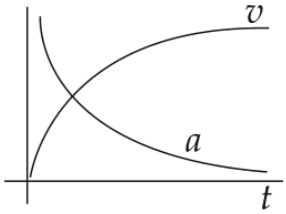
Question Number : 32 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which of the following option correctly describes the variation of the speed v and acceleration 'a' of a point mass falling vertically in a viscous medium that applies a force $F = -kv$, where 'k' is a constant, on the body ? (Graphs are schematic and not drawn to scale)

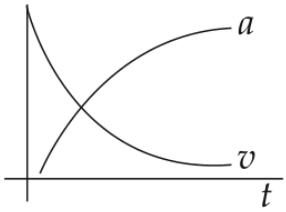
(1)



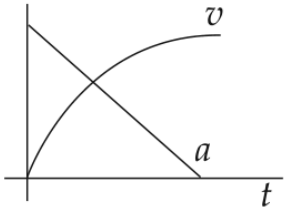
(2)



(3)



(4)



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

A rocket is fired vertically from the earth with an acceleration of $2g$, where g is the gravitational acceleration. On an inclined plane inside the rocket, making an angle θ with the horizontal, a point object of mass m is kept. The minimum coefficient of friction $\mu_{\min}$ between the mass and the inclined surface such that the mass does not move is :

(1) $\tan\theta$

(2) $2\tan\theta$

(3) $3\tan\theta$

(4) $\tan 2\theta$

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

A car of weight W is on an inclined road that rises by 100 m over a distance of 1 km and applies a constant frictional force $\frac{W}{20}$ on the car. While moving uphill on the road at a speed of 10 ms^{-1}, the car needs power P. If it needs power $\frac{P}{2}$ while moving downhill at speed v then value of v is :

(1) 20 ms^{-1}

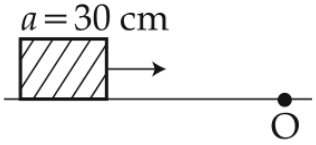
(2) 15 ms^{-1}

(3) 10 ms^{-1}

(4) 5 ms^{-1}

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

A cubical block of side 30 cm is moving with velocity 2 ms^{-1} on a smooth horizontal surface. The surface has a bump at a point O as shown in figure. The angular velocity (in rad/s) of the block immediately after it hits the bump, is :



(1) 5.0

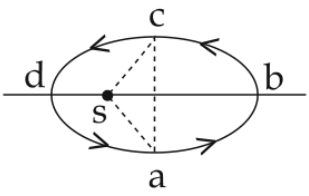
(2) 6.7

(3) 9.4

(4) 13.3

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

Figure shows elliptical path abcd of a planet around the sun S such that the area of triangle csa is $\frac{1}{4}$ the area of the ellipse. (See figure) With db as the semimajor axis, and ca as the semiminor axis. If t_1 is the time taken for planet to go over path abc and t_2 for path taken over cda then :



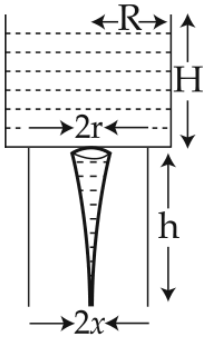
(1) $t_1 = t_2$

(2) $t_1 = 2t_2$

(3) $t_1 = 3t_2$

(4) $t_1 = 4t_2$

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



Consider a water jar of radius R that has water filled up to height H and is kept on a stand of height h (see figure). Through a hole of radius r (r << R) at its bottom, the water leaks out and the stream of water coming down towards the ground has a shape like a funnel as shown in the figure. If the radius of the cross-section of water stream when it hits the ground is x. Then :

(1) $x = r\left(\frac{H}{H+h}\right)$

(2) $x = r\left(\frac{H}{H+h}\right)^{\frac{1}{2}}$

(3) $x = r\left(\frac{H}{H+h}\right)^{\frac{1}{4}}$

(4) $x = r\left(\frac{H}{H+h}\right)^{2}$

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

200 g water is heated from 40°C to 60°C. Ignoring the slight expansion of water, the change in its internal energy is close to (Given specific heat of water = 4184 J/kg/K) :

(1) 8.4 kJ

(2) 4.2 kJ

(3) 16.7 kJ

(4) 167.4 kJ

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

The ratio of work done by an ideal monoatomic gas to the heat supplied to it in an isobaric process is :

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

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

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

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

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

Two particles are performing simple harmonic motion in a straight line about the same equilibrium point. The amplitude and time period for both particles are same and equal to A and T, respectively. At time $t = 0$ one particle has displacement A while the other one has displacement $\frac{-A}{2}$ and they are moving towards each other. If they cross each other at time t, then t is :

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

(2) $\frac{5T}{6}$

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

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

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

Two engines pass each other moving in opposite directions with uniform speed of 30 m/s. One of them is blowing a whistle of frequency 540 Hz. Calculate the frequency heard by driver of second engine before they pass each other. Speed of sound is 330 m/sec :

(1) 450 Hz

(2) 540 Hz

(3) 648 Hz

(4) 270 Hz

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

The potential (in volts) of a charge distribution is given by

$V(z) = 30 - 5z^2$ for $|z| \leq 1$ m

$V(z) = 35 - 10\,|z|$ for $|z| \geq 1$ m.

$V(z)$ does not depend on x and y. If this potential is generated by a constant charge per unit volume ρ_0 (in units of ϵ_0) which is spread over a certain region, then choose the correct statement.

(1) $\rho_0 = 10\ \epsilon_0$ for $|z| \leq 1$ m and $\rho_0 = 0$ elsewhere

(2) $\rho_0 = 20\ \epsilon_0$ in the entire region

(3) $\rho_0 = 40\ \epsilon_0$ in the entire region

(4) $\rho_0 = 20\ \epsilon_0$ for $|z| \leq 1$ m and $\rho_0 = 0$ elsewhere

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

Three capacitors each of 4 μF are to be connected in such a way that the effective capacitance is 6 μF. This can be done by connecting them :

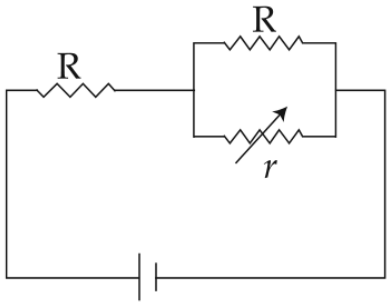
(1) all in series

(2) two in series and one in parallel

(3) all in parallel

(4) two in parallel and one in series

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



In the circuit shown, the resistance r is a variable resistance. If for $r = f\,\mathrm{R}$, the heat generation in r is maximum then the value of f is :

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

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

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

(4) 1

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

A magnetic dipole is acted upon by two magnetic fields which are inclined to each other at an angle of 75°. One of the fields has a magnitude of 15 mT. The dipole attains stable equilibrium at an angle of 30° with this field. The magnitude of the other field (in mT) is close to :

(1) 11

(2) 36

(3) 1

(4) 1060

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

A 50 Ω resistance is connected to a battery of 5 V. A galvanometer of resistance 100 Ω is to be used as an ammeter to measure current through the resistance, for this a resistance r_s is connected to the galvanometer. Which of the following connections should be employed if the measured current is within 1% of the current without the ammeter in the circuit ?

(1) $r_s = 0.5\ \Omega$ in parallel with the galvanometer

(2) $r_s = 0.5\ \Omega$ in series with the galvanometer

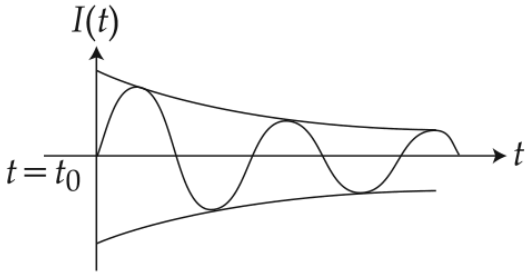
(3) $r_s = 1\ \Omega$ in series with galvanometer

(4) $r_s = 1\ \Omega$ in parallel with galvanometer

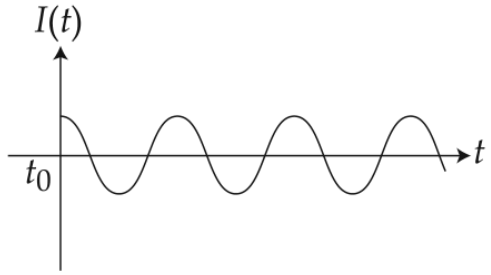
Question Number : 47 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A series LR circuit is connected to a voltage source with $V(t) = V_0 \sin\Omega t$. After very large time, current $I(t)$ behaves as $\left(t_0 >> \frac{L}{R}\right)$:

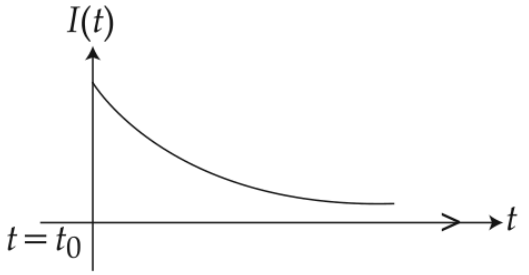
(1)



(2)



(3)



(4)



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

Microwave oven acts on the principle of :

(1) transferring electrons from lower to higher energy levels in water molecule

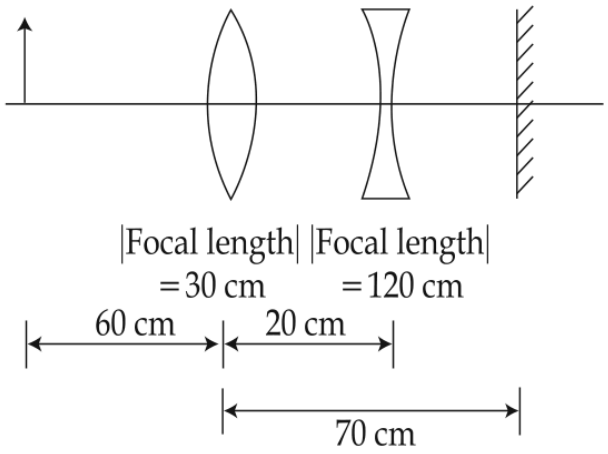
(2) giving rotational energy to water molecules

(3) giving vibrational energy to water molecules

(4) giving translational energy to water molecules

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

A convex lens, of focal length 30 cm, a concave lens of focal length 120 cm, and a plane mirror are arranged as shown. For an object kept at a distance of 60 cm from the convex lens, the final image, formed by the combination, is a real image, at a distance of :



(1) 60 cm from the convex lens

(2) 60 cm from the concave lens

(3) 70 cm from the convex lens

(4) 70 cm from the concave lens

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

In Young's double slit experiment, the distance between slits and the screen is 1.0 m and monochromatic light of 600 nm is being used. A person standing near the slits is looking at the fringe pattern. When the separation between the slits is varied, the interference pattern disappears for a particular distance d_0 between the slits. If the angular resolution of the eye is $\frac{1^\circ}{60}$, the value of d_0 is close to :

(1) 1 mm

(2) 2 mm

(3) 4 mm

(4) 3 mm

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

When photons of wavelength λ_1 are incident on an isolated sphere, the corresponding stopping potential is found to be V. When photons of wavelength λ_2 are used, the corresponding stopping potential was thrice that of the above value. If light of wavelength λ_3 is used then find the stopping potential for this case :

(1) $\frac{hc}{e}\left[\frac{1}{\lambda_3}-\frac{1}{\lambda_2}-\frac{1}{\lambda_1}\right]$

(2) $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{\lambda_2}-\frac{1}{\lambda_1}\right]$

(3) $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{3}{2\lambda_1}\right]$

(4) $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{1}{\lambda_1}\right]$

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

A hydrogen atom makes a transition from $n=2$ to $n=1$ and emits a photon. This photon strikes a doubly ionized lithium atom ($z=3$) in excited state and completely removes the orbiting electron. The least quantum number for the excited state of the ion for the process is :

(1) 2

(2) 3

(3) 4

(4) 5

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

The truth table given in fig. represents :

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(1) AND - Gate

(2) OR - Gate

(3) NAND - Gate

(4) NOR - Gate

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

An audio signal consists of two distinct sounds : one a human speech signal in the frequency band of 200 Hz to 2700 Hz, while the other is a high frequency music signal in the frequency band of 10200 Hz to 15200 Hz. The ratio of the AM signal bandwidth required to send both the signals together to the AM signal bandwidth required to send just the human speech is :

(1) 3

(2) 5

(3) 6

(4) 2

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

A simple pendulum made of a bob of mass m and a metallic wire of negligible mass has time period 2 s at $T = 0°C$. If the temperature of the wire is increased and the corresponding change in its time period is plotted against its temperature, the resulting graph is a line of slope S. If the coefficient of linear expansion of metal is α then the value of S is :

(1) α

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

(3) 2α

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

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

A uniformly tapering conical wire is made from a material of Young's modulus Y and has a normal, unextended length L. The radii, at the upper and lower ends of this conical wire, have values R and $3R$, respectively. The upper end of the wire is fixed to a rigid support and a mass M is suspended from its lower end. The equilibrium extended length, of this wire, would equal :

(1) $L\left(1+\frac{2}{9}\frac{Mg}{\pi YR^2}\right)$

(2) $L\left(1+\frac{1}{3}\frac{Mg}{\pi YR^2}\right)$

(3) $L\left(1+\frac{1}{9}\frac{Mg}{\pi YR^2}\right)$

(4) $L\left(1+\frac{2}{3}\frac{Mg}{\pi YR^2}\right)$

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

To know the resistance G of a galvanometer by half deflection method, a battery of emf V_E and resistance R is used to deflect the galvanometer by angle θ. If a shunt of resistance S is needed to get half deflection then G, R and S are related by the equation :

(1) $2S\,(R+G)=RG$

(2) $S\,(R+G)=RG$

(3) $2S=G$

(4) $2G=S$

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

To find the focal length of a convex mirror, a student records the following data :

Object Pin	Convex Lens	Convex Mirror	Image Pin
22.2 cm	32.2 cm	45.8 cm	71.2 cm

The focal length of the convex lens is f_1 and that of mirror is f_2. Then taking index correction to be negligibly small, f_1 and f_2 are close to :

(1) $f_1=12.7$ cm $\quad f_2=7.8$ cm

(2) $f_1=7.8$ cm $\quad f_2=12.7$ cm

(3) $f_1=7.8$ cm $\quad f_2=25.4$ cm

(4) $f_1=15.6$ cm $\quad f_2=25.4$ cm

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

An experiment is performed to determine the I - V characteristics of a Zener diode, which has a protective resistance of $R=100\ \Omega$, and a maximum power of dissipation rating of 1 W. The minimum voltage range of the DC source in the circuit is :

(1) 0 – 5 V

(2) 0 – 8 V

(3) 0 – 12 V

(4) 0 – 24 V

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

An unknown transistor needs to be identified as a *npn* or *pnp* type. A multimeter, with +ve and −ve terminals, is used to measure resistance between different terminals of transistor. If terminal 2 is the base of the transistor then which of the following is correct for a *pnp* transistor ?

(1) +ve terminal 1, −ve terminal 2, resistance high

(2) +ve terminal 2, −ve terminal 1, resistance high

(3) +ve terminal 3, −ve terminal 2, resistance high

(4) +ve terminal 2, −ve terminal 3, resistance low

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

The amount of arsenic pentasulphide that can be obtained when 35.5 g arsenic acid is treated with excess H_2S in the presence of conc. HCl (assuming 100% conversion) is :

(1) 0.50 mol

(2) 0.25 mol

(3) 0.125 mol

(4) 0.333 mol

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

At very high pressures, the compressibility factor of one mole of a gas is given by :

(1) $\frac{pb}{RT}$

(2) $1 + \frac{pb}{RT}$

(3) $1 - \frac{pb}{RT}$

(4) $1 - \frac{b}{(VRT)}$

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

The total number of orbitals associated with the principal quantum number 5 is :

(1) 5

(2) 10

(3) 20

(4) 25

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

Which intermolecular force is most responsible in allowing xenon gas to liquefy ?

(1) Dipole - dipole

(2) Ion - dipole

(3) Instantaneous dipole - induced dipole

(4) Ionic

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

A reaction at 1 bar is non-spontaneous at low temperature but becomes spontaneous at high temperature. Identify the correct statement about the reaction among the following :

(1) Both ΔH and ΔS are negative.

(2) Both ΔH and ΔS are positive.

(3) ΔH is positive while ΔS is negative.

(4) ΔH is negative while ΔS is positive.

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

The solubility of N_2 in water at 300 K and 500 torr partial pressure is 0.01 g L^{-1}. The solubility (in g L^{-1}) at 750 torr partial pressure is :

(1) 0.0075

(2) 0.015

(3) 0.02

(4) 0.005

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

For the reaction,
$A(g) + B(g) \rightarrow C(g) + D(g)$, ΔH° and ΔS° are, respectively, -29.8 kJ mol^{-1} and -0.100 kJ K^{-1} mol^{-1} at 298 K. The equilibrium constant for the reaction at 298 K is :

(1) 1.0×10^{-10}

(2) 1.0×10^{10}

(3) 10

(4) 1

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

What will occur if a block of copper metal is dropped into a beaker containing a solution of 1M $ZnSO_4$?

(1) The copper metal will dissolve and zinc metal will be deposited.

(2) The copper metal will dissolve with evolution of hydrogen gas.

(3) The copper metal will dissolve with evolution of oxygen gas.

(4) No reaction will occur.

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

The reaction of ozone with oxygen atoms in the presence of chlorine atoms can occur by a two step process shown below :

$$O_3(g) + Cl^{\bullet}(g) \rightarrow O_2(g) + ClO^{\bullet}(g) \quad \text{—— (i)}$$

$$k_i = 5.2 \times 10^9 \text{ L mol}^{-1} \text{ s}^{-1}$$

$$ClO^{\bullet}(g) + O^{\bullet}(g) \rightarrow O_2(g) + Cl^{\bullet}(g) \quad \text{—— (ii)}$$

$$k_{ii} = 2.6 \times 10^{10} \text{ L mol}^{-1} \text{ s}^{-1}$$

The closest rate constant for the overall reaction $O_3(g) + O^{\bullet}(g) \rightarrow 2\ O_2(g)$ is :

(1) $5.2 \times 10^9 \text{ L mol}^{-1} \text{ s}^{-1}$

(2) $2.6 \times 10^{10} \text{ L mol}^{-1} \text{ s}^{-1}$

(3) $3.1 \times 10^{10} \text{ L mol}^{-1} \text{ s}^{-1}$

(4) $1.4 \times 10^{20} \text{ L mol}^{-1} \text{ s}^{-1}$

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

A particular adsorption process has the following characteristics : (i) It arises due to van der Waals forces and (ii) it is reversible. Identify the correct statement that describes the above adsorption process :

(1) Enthalpy of adsorption is greater than 100 kJ mol^{-1}.

(2) Energy of activation is low.

(3) Adsorption is monolayer.

(4) Adsorption increases with increase in temperature.

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

The non-metal that does **not** exhibit positive oxidation state is :

(1) Oxygen

(2) Iodine

(3) Chlorine

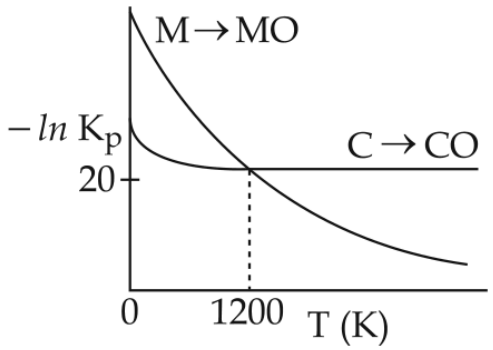
(4) Fluorine

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

The plot shows the variation of $-ln\ K_p$ versus temperature for the two reactions.

$$M(s) + \frac{1}{2} O_2(g) \rightarrow MO(s) \text{ and}$$

$$C(s) + \frac{1}{2} O_2(g) \rightarrow CO(s)$$



Identify the correct statement :

(1) At T>1200 K, carbon will reduce MO(s) to M(s).

(2) At T<1200 K, the reaction $MO(s) + C(s) \rightarrow M(s) + CO(g)$ is spontaneous.

(3) At T<1200 K, oxidation of carbon is unfavourable.

(4) Oxidation of carbon is favourable at all temperatures.

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

Identify the **incorrect** statement regarding heavy water :

(1) It reacts with Al_4C_3 to produce CD_4 and $Al(OD)_3$.

(2) It is used as a coolant in nuclear reactors.

(3) It reacts with CaC_2 to produce C_2D_2 and $Ca(OD)_2$.

(4) It reacts with SO_3 to form deuterated sulphuric acid (D_2SO_4).

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

The correct order of the solubility of alkaline-earth metal sulphates in water is :

(1) Mg < Ca < Sr < Ba

(2) Mg < Sr < Ca < Ba

(3) Mg > Sr > Ca > Ba

(4) Mg > Ca > Sr > Ba

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

Match the items in **Column I** with its main use listed in **Column II** :

Column I	**Column II**
(A) Silica gel	(i) Transistor
(B) Silicon	(ii) Ion-exchanger
(C) Silicone	(iii) Drying agent
(D) Silicate	(iv) Sealant

(1) (A)-(iii), (B)-(i), (C)-(iv), (D)-(ii)

(2) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii)

(3) (A)-(ii), (B)-(iv), (C)-(i), (D)-(iii)

(4) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii)

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

The group of molecules having identical shape is :

(1) SF_4, XeF_4, CCl_4

(2) $ClF_3, XeOF_2, XeF_3^+$

(3) BF_3, PCl_3, XeO_3

(4) PCl_5, IF_5, XeO_2F_2

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

Which one of the following species is stable in aqueous solution ?

(1) Cr^{2+}

(2) Cu^+

(3) MnO_4^{3-}

(4) MnO_4^{2-}

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

Which one of the following complexes will consume more equivalents of aqueous solution of $Ag(NO_3)$?

(1) $Na_3[CrCl_6]$

(2) $[Cr(H_2O)_5Cl]Cl_2$

(3) $[Cr(H_2O)_6]Cl_3$

(4) $Na_2[CrCl_5(H_2O)]$

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

Identify the correct trend given below :

(Atomic No. = Ti : 22, Cr : 24 and Mo : 42)

(1) Δ_o of $[Cr(H_2O)_6]^{2+}$ > $[Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+}$ > $[Ti(H_2O)_6]^{2+}$

(2) Δ_o of $[Cr(H_2O)_6]^{2+}$ > $[Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+}$ < $[Ti(H_2O)_6]^{2+}$

(3) Δ_o of $[Cr(H_2O)_6]^{2+}$ < $[Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+}$ > $[Ti(H_2O)_6]^{2+}$

(4) Δ_o of $[Cr(H_2O)_6]^{2+}$ < $[Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+}$ < $[Ti(H_2O)_6]^{2+}$

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

BOD stands for :

(1) Biological Oxygen Demand

(2) Bacterial Oxidation Demand

(3) Biochemical Oxygen Demand

(4) Biochemical Oxidation Demand

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

An organic compound contains C, H and S. The minimum molecular weight of the compound containing 8% sulphur is :

(atomic weight of S = 32 amu)

(1) $200\ g\ mol^{-1}$

(2) $400\ g\ mol^{-1}$

(3) $600\ g\ mol^{-1}$

(4) $300\ g\ mol^{-1}$

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

The hydrocarbon with seven carbon atoms containing a neopentyl and a vinyl group is :

(1) 2, 2-dimethyl-4-pentene

(2) Isopropyl-2-butene

(3) 4, 4-dimethylpentene

(4) 2, 2-dimethyl-3-pentene

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

5 L of an alkane requires 25 L of oxygen for its complete combustion. If all volumes are measured at constant temperature and pressure, the alkane is :

(1) Ethane

(2) Propane

(3) Butane

(4) Isobutane

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

The gas evolved on heating CH_3MgBr in methanol is :

(1) HBr

(2) Methane

(3) Ethane

(4) Propane

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

Bouveault-Blanc reduction reaction involves :

(1) Reduction of an acyl halide with H_2/Pd.

(2) Reduction of an ester with Na/C_2H_5OH.

(3) Reduction of a carbonyl compound with Na/Hg and HCl.

(4) Reduction of an anhydride with $LiAlH_4$.

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

The test to distinguish primary, secondary and tertiary amines is :

(1) Carbylamine reaction

(2) $C_6H_5SO_2Cl$

(3) Sandmeyer's reaction

(4) Mustard oil test

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

Assertion : Rayon is a semisynthetic polymer whose properties are better than natural cotton.

Reason : Mechanical and aesthetic properties of cellulose can be improved by acetylation.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion.

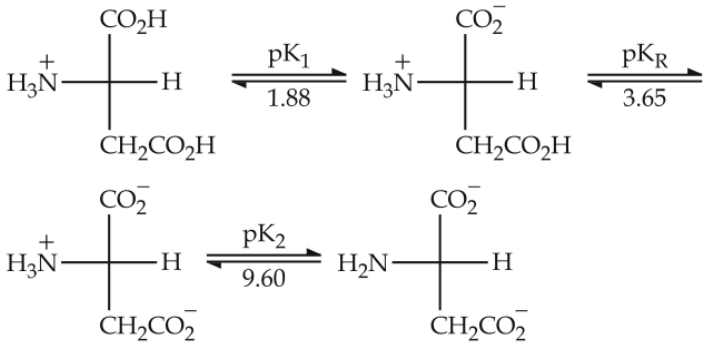
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion.

(3) Assertion is incorrect statement, but the reason is correct.

(4) Both assertion and reason are incorrect.

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

Consider the following sequence for aspartic acid :



The *pI* (isoelectric point) of aspartic acid is :

(1) 1.88

(2) 3.65

(3) 5.74

(4) 2.77

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

The artificial sweetener that has the highest sweetness value in comparison to cane sugar is :

(1) Aspartane

(2) Saccharin

(3) Sucralose

(4) Alitame

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

The most appropriate method of making egg-albumin sol is :

(1) Break an egg carefully and transfer the transparent part of the content to 100 mL of 5% w/V saline solution and stir well.

(2) Break an egg carefully and transfer only the yellow part of the content to 100 mL of 5% w/V saline solution and stir well.

(3) Keep the egg in boiling water for 10 minutes. After removing the shell, transfer the white part of the content to 100 mL of 5% w/V saline solution and homogenize with a mechanical shaker.

(4) Keep the egg in boiling water for 10 minutes. After removing the shell, transfer the yellow part of the content to 100 mL of 5% w/V saline solution and homogenize with a mechanical shaker.