Central Board of Secondary Education

Question Paper Name :	JEE Main 2016 Paper 1 (B.E./B.Tech) Apr 10 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 $P = \{\theta : \sin\theta - \cos\theta = \sqrt{2}\cos\theta\}$ and

$Q = \{\theta : \sin\theta + \cos\theta = \sqrt{2}\sin\theta\}$ be two sets. Then :

(1) $P \subset Q$ and $Q - P \neq \phi$

(2) $Q \not\subset P$

(3) $P \not\subset Q$

(4) $P = Q$

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

If x is a solution of the equation,

$\sqrt{2x+1} - \sqrt{2x-1} = 1, \left(x \geq \frac{1}{2}\right)$, then

$\sqrt{4x^2 - 1}$ is equal to :

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

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

(3) 2

(4) $2\sqrt{2}$

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

Let $z=1+ai$ be a complex number, $a > 0$, such that z^3 is a real number. Then the sum $1+z+z^2+.....+z^{11}$ is equal to :

(1) $-1250\sqrt{3}\,i$

(2) $1250\sqrt{3}\,i$

(3) $1365\sqrt{3}\,i$

(4) $-1365\sqrt{3}\,i$

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

Let A be a 3×3 matrix such that $A^2-5A+7I=O$.

Statement - I : $A^{-1}=\frac{1}{7}(5I-A)$.

Statement - II : The polynomial A^3-2A^2-3A+I can be reduced to $5(A-4I)$.

Then :

(1) Statement-I is true, but Statement-II is false.

(2) Statement-I is false, but Statement-II is true.

(3) Both the statements are true.

(4) Both the statements are false.

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

If $A=\begin{bmatrix}-4 & -1\\ 3 & 1\end{bmatrix}$, then the determinant of the matrix $(A^{2016}-2A^{2015}-A^{2014})$ is :

(1) 2014

(2) -175

(3) 2016

(4) -25

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

If $\frac{{}^{n+2}C_6}{{}^{n-2}P_2} = 11$, then n satisfies the equation :

(1) $n^2+3n-108=0$

(2) $n^2+5n-84=0$

(3) $n^2+2n-80=0$

(4) $n^2+n-110=0$

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

If the coefficients of x^{-2} and x^{-4} in the expansion of $\left(x^{\frac{1}{3}} + \frac{1}{2x^{\frac{1}{3}}}\right)^{18}$, $(x > 0)$, are m and n respectively, then $\frac{m}{n}$ is equal to :

(1) 182

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

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

(4) 27

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

Let $a_1, a_2, a_3, \ldots\ldots, a_n, \ldots\ldots$ be in A.P. If $a_3+a_7+a_{11}+a_{15}=72$, then the sum of its first 17 terms is equal to :

(1) 306

(2) 153

(3) 612

(4) 204

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

The sum $\sum_{r=1}^{10} (r^2+1) \times (r!)$ is equal to :

(1) $(11)!$

(2) $10 \times (11!)$

(3) $101 \times (10!)$

(4) $11 \times (11!)$

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

$\lim\limits_{x\to 0} \dfrac{(1-\cos 2x)^2}{2x\tan x - x\tan 2x}$ is :

(1) -2

(2) $-\dfrac{1}{2}$

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

(4) 2

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

Let $a, b \in \mathbf{R}$, $(a \neq 0)$. If the function f defined as

$$f(x) = \begin{cases} \dfrac{2x^2}{a} & , \quad 0 \le x < 1 \\ a & , \quad 1 \le x < \sqrt{2} \\ \dfrac{2b^2 - 4b}{x^3} & , \quad \sqrt{2} \le x < \infty \end{cases}$$

is continuous in the interval $[0, \infty)$, then an ordered pair (a, b) is :

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

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

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

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

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

Let $f(x)=\sin^4 x+\cos^4 x$. Then f is an increasing function in the interval :

(1) $\left]0, \frac{\pi}{4}\right[$

(2) $\left]\frac{\pi}{4}, \frac{\pi}{2}\right[$

(3) $\left]\frac{\pi}{2}, \frac{5\pi}{8}\right[$

(4) $\left]\frac{5\pi}{8}, \frac{3\pi}{4}\right[$

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

Let C be a curve given by $y(x)=1+\sqrt{4x-3}$, $x>\frac{3}{4}$. If P is a point on C, such that the tangent at P has slope $\frac{2}{3}$, then a point through which the normal at P passes, is :

(1) $(2, 3)$

(2) $(4, -3)$

(3) $(1, 7)$

(4) $(3, -4)$

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

The integral $\int \frac{dx}{(1+\sqrt{x})\sqrt{x-x^2}}$ is equal to :

(where C is a constant of integration.)

(1) $-2\sqrt{\frac{1+\sqrt{x}}{1-\sqrt{x}}}+C$

(2) $-2\sqrt{\frac{1-\sqrt{x}}{1+\sqrt{x}}}+C$

(3) $-\sqrt{\frac{1-\sqrt{x}}{1+\sqrt{x}}}+C$

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

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

The value of the integral

$$\int_4^{10} \frac{\left[x^2\right]dx}{\left[x^2-28x+196\right]+\left[x^2\right]}, \text{ where } [x]$$

denotes the greatest integer less than or equal to x, is :

(1) 6

(2) 3

(3) 7

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

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

For $x \in \mathbf{R}$, $x \neq 0$, if $y(x)$ is a differentiable function such that

$$x\int_1^x y(t)\,dt = (x+1)\int_1^x t\,y(t)\,dt\,,\ \text{then}\ y(x)$$

equals :

(where C is a constant.)

(1) $\frac{C}{x}e^{-\frac{1}{x}}$

(2) $\frac{C}{x^2}e^{-\frac{1}{x}}$

(3) $\frac{C}{x^3}e^{-\frac{1}{x}}$

(4) $Cx^3\,e^{\frac{1}{x}}$

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

The solution of the differential equation

$$\frac{dy}{dx} + \frac{y}{2}\sec x = \frac{\tan x}{2y},\ \text{where}\ 0 \le x < \frac{\pi}{2},$$

and $y(0) = 1$, is given by :

(1) $y = 1 - \frac{x}{\sec x + \tan x}$

(2) $y^2 = 1 + \frac{x}{\sec x + \tan x}$

(3) $y^2 = 1 - \frac{x}{\sec x + \tan x}$

(4) $y = 1 + \frac{x}{\sec x + \tan x}$

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

A ray of light is incident along a line which meets another line, $7x-y+1=0$, at the point (0, 1). The ray is then reflected from this point along the line, $y+2x=1$. Then the equation of the line of incidence of the ray of light is :

(1) $41x-38y+38=0$

(2) $41x+25y-25=0$

(3) $41x+38y-38=0$

(4) $41x-25y+25=0$

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

A straight line through origin O meets the lines $3y=10-4x$ and $8x+6y+5=0$ at points A and B respectively. Then O divides the segment AB in the ratio :

(1) 2 : 3

(2) 1 : 2

(3) 4 : 1

(4) 3 : 4

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

Equation of the tangent to the circle, at the point (1, -1), whose centre is the point of intersection of the straight lines $x-y=1$ and $2x+y=3$ is :

(1) $4x+y-3=0$

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

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

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

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

P and Q are two distinct points on the parabola, $y^2=4x$, with parameters t and t_1 respectively. If the normal at P passes through Q, then the minimum value of t_1^2 is :

(1) 2

(2) 4

(3) 6

(4) 8

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

A hyperbola whose transverse axis is along the major axis of the conic, $\frac{x^2}{3} + \frac{y^2}{4} = 4$ and has vertices at the foci of this conic. If the eccentricity of the hyperbola is $\frac{3}{2}$, then which of the following points does **NOT** lie on it ?

(1) $(0, 2)$

(2) $\left(\sqrt{5}, 2\sqrt{2}\right)$

(3) $\left(\sqrt{10}, 2\sqrt{3}\right)$

(4) $\left(5, 2\sqrt{3}\right)$

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

ABC is a triangle in a plane with vertices A(2, 3, 5), B(-1, 3, 2) and C(λ, 5, μ). If the median through A is equally inclined to the coordinate axes, then the value of $(\lambda^3 + \mu^3 + 5)$ is :

(1) 1130

(2) 1348

(3) 676

(4) 1077

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

The number of distinct real values of λ for which the lines $\frac{x-1}{1} = \frac{y-2}{2} = \frac{z+3}{\lambda^2}$ and $\frac{x-3}{1} = \frac{y-2}{\lambda^2} = \frac{z-1}{2}$ are coplanar is :

(1) 4

(2) 1

(3) 2

(4) 3

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

Let ABC be a triangle whose circumcentre is at P. If the position vectors of A, B, C and P are $\vec{a}, \vec{b}, \vec{c}$ and $\frac{\vec{a}+\vec{b}+\vec{c}}{4}$ respectively, then the position vector of the orthocentre of this triangle, is :

(1) $\vec{a}+\vec{b}+\vec{c}$

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

(3) $\vec{0}$

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

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

The mean of 5 observations is 5 and their variance is 124. If three of the observations are 1, 2 and 6 ; then the mean deviation from the mean of the data is :

(1) 2.4

(2) 2.8

(3) 2.5

(4) 2.6

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

An experiment succeeds twice as often as it fails. The probability of at least 5 successes in the six trials of this experiment is :

(1) $\frac{240}{729}$

(2) $\frac{192}{729}$

(3) $\frac{256}{729}$

(4) $\frac{496}{729}$

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

If $A>0$, $B>0$ and $A+B=\frac{\pi}{6}$, then the minimum value of $\tan A+\tan B$ is :

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

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

(3) $4-2\sqrt{3}$

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

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

The angle of elevation of the top of a vertical tower from a point A, due east of it is 45°. The angle of elevation of the top of the same tower from a point B, due south of A is 30°. If the distance between A and B is $54\sqrt{2}$ m, then the height of the tower (in metres), is :

(1) $36\sqrt{3}$

(2) 54

(3) $54\sqrt{3}$

(4) 108

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

The contrapositive of the following statement,

"If the side of a square doubles, then its area increases four times", is :

(1) If the side of a square is not doubled, then its area does not increase four times.

(2) If the area of a square increases four times, then its side is doubled.

(3) If the area of a square increases four times, then its side is not doubled.

(4) If the area of a square does not increase four times, then its side is not doubled.

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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

A, B, C and D are four different physical quantities having different dimensions. None of them is dimensionless. But we know that the equation $AD = C\ ln(BD)$ holds true. Then which of the combination is **not** a meaningful quantity ?

(1) $A^2 - B^2C^2$

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

(3) $\frac{A}{B} - C$

(4) $\frac{C}{BD} - \frac{AD^2}{C}$

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

A particle of mass M is moving in a circle of fixed radius R in such a way that its centripetal acceleration at time t is given by $n^2 R t^2$ where n is a constant. The power delivered to the particle by the force acting on it, is :

(1) $M n^2 R^2 t$

(2) $M n R^2 t$

(3) $M n R^2 t^2$

(4) $\frac{1}{2} M n^2 R^2 t^2$

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

Concrete mixture is made by mixing cement, stone and sand in a rotating cylindrical drum. If the drum rotates too fast, the ingredients remain stuck to the wall of the drum and proper mixing of ingredients does not take place. The maximum rotational speed of the drum in revolutions per minute(rpm) to ensure proper mixing is close to :

(Take the radius of the drum to be 1.25 m and its axle to be horizontal) :

(1) 0.4

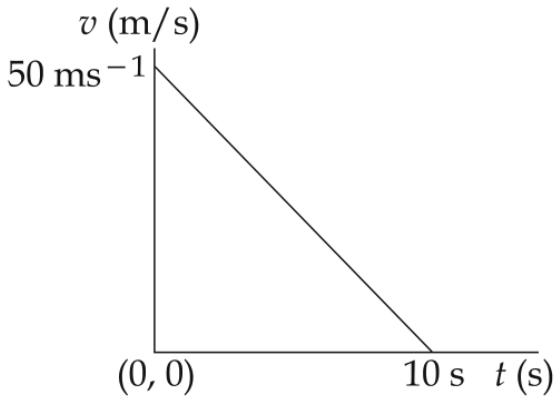
(2) 1.3

(3) 8.0

(4) 27.0

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

Velocity-time graph for a body of mass 10 kg is shown in figure. Work-done on the body in first two seconds of the motion is :



(1) 12000 J

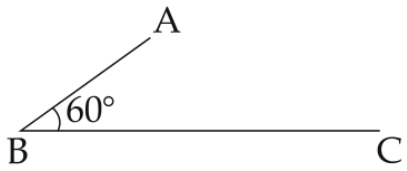
(2) −12000 J

(3) −4500 J

(4) −9300 J

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

In the figure shown ABC is a uniform wire. If centre of mass of wire lies vertically below point A, then $\frac{BC}{AB}$ is close to :



(1) 1.85

(2) 1.37

(3) 1.5

(4) 3

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

An astronaut of mass m is working on a satellite orbiting the earth at a distance h from the earth's surface. The radius of the earth is R, while its mass is M. The gravitational pull F_G on the astronaut is :

(1) Zero since astronaut feels weightless

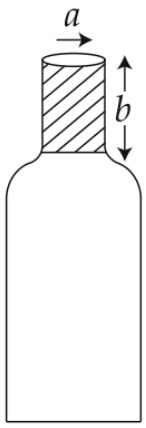
(2) $0 < F_G < \frac{GMm}{R^2}$

(3) $\frac{GMm}{(R+h)^2} < F_G < \frac{GMm}{R^2}$

(4) $F_G = \frac{GMm}{(R+h)^2}$

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

A bottle has an opening of radius a and length b. A cork of length b and radius $(a+\Delta a)$ where $(\Delta a << a)$ is compressed to fit into the opening completely (See figure). If the bulk modulus of cork is B and frictional coefficient between the bottle and cork is μ then the force needed to push the cork into the bottle is :



(1) $(\pi\mu B\, b)\, \Delta a$

(2) $(2\pi\mu B\, b)\, \Delta a$

(3) $(\pi\mu B\, b)\, a$

(4) $(4\pi\mu B\, b)\, \Delta a$

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

A Carnot freezer takes heat from water at 0°C inside it and rejects it to the room at a temperature of 27°C. The latent heat of ice is 336×10^3 J kg^{-1}. If 5 kg of water at 0°C is converted into ice at 0°C by the freezer, then the energy consumed by the freezer is close to :

(1) 1.67×10^5 J

(2) 1.68×10^6 J

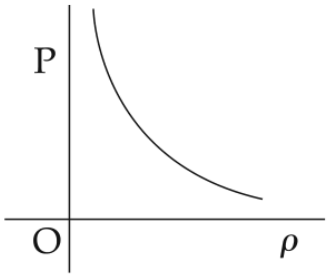
(3) 1.51×10^5 J

(4) 1.71×10^7 J

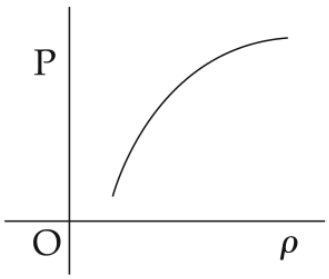
Question Number : 39 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

Which of the following shows the correct relationship between the pressure 'P' and density ρ of an ideal gas at constant temperature ?

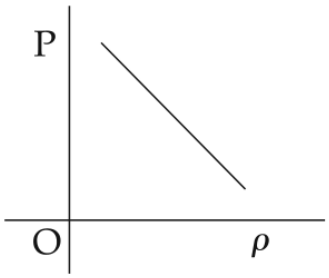
(1)



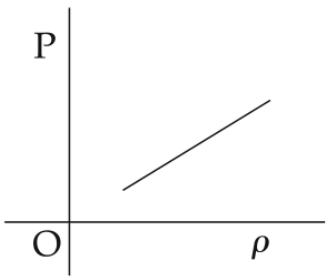
(2)



(3)



(4)



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

In an engine the piston undergoes vertical simple harmonic motion with amplitude 7 cm. A washer rests on top of the piston and moves with it. The motor speed is slowly increased. The frequency of the piston at which the washer no longer stays in contact with the piston, is close to :

(1) 0.1 Hz

(2) 1.2 Hz

(3) 0.7 Hz

(4) 1.9 Hz

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

A toy-car, blowing its horn, is moving with a steady speed of 5 m/s, away from a wall. An observer, towards whom the toy car is moving, is able to hear 5 beats per second. If the velocity of sound in air is 340 m/s, the frequency of the horn of the toy car is close to :

(1) 680 Hz

(2) 510 Hz

(3) 340 Hz

(4) 170 Hz

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

Within a spherical charge distribution of charge density $\rho(r)$, N equipotential surfaces of potential $V_0, V_0+\Delta V, V_0+2\Delta V,$ ..... $V_0+N\Delta V$ ($\Delta V>0$), are drawn and have increasing radii $r_0, r_1, r_2,.....r_N$, respectively. If the difference in the radii of the surfaces is constant for all values of V_0 and ΔV then :

(1) $\rho(r)\ \alpha\ r$

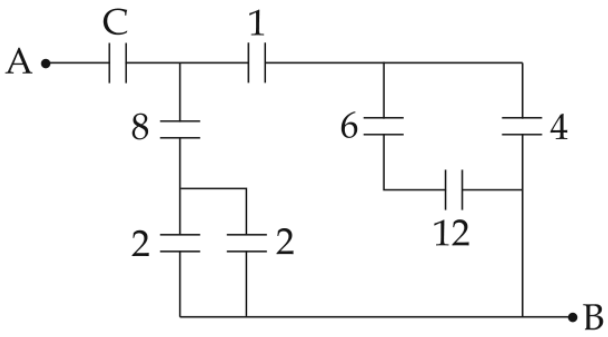
(2) $\rho(r)$ = constant

(3) $\rho\ (r)\ \alpha\ \frac{1}{r}$

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

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

Figure shows a network of capacitors where the numbers indicates capacitances in micro Farad. The value of capacitance C if the equivalent capacitance between point A and B is to be 1 μF is :



(1) $\frac{31}{23}\ \mu F$

(2) $\frac{32}{23}\ \mu F$

(3) $\frac{33}{23}\ \mu F$

(4) $\frac{34}{23}\ \mu F$

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

The resistance of an electrical toaster has a temperature dependence given by $R(T) = R_0\ [1 + \alpha(T - T_0)]$ in its range of operation. At $T_0 = 300$ K, $R = 100\ \Omega$ and at $T = 500$ K, $R = 120\ \Omega$. The toaster is connected to a voltage source at 200 V and its temperature is raised at a constant rate from 300 to 500 K in 30 s. The total work done in raising the temperature is :

(1) $400\ ln\ \frac{1.5}{1.3}$ J

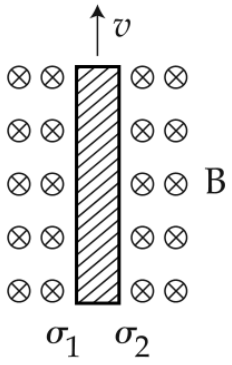
(2) $200\ ln\ \frac{2}{3}$ J

(3) $400\ ln\ \frac{5}{6}$ J

(4) 300 J

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

Consider a thin metallic sheet perpendicular to the plane of the paper moving with speed 'v' in a uniform magnetic field B going into the plane of the paper (See figure). If charge densities σ_1 and σ_2 are induced on the left and right surfaces, respectively, of the sheet then (ignore fringe effects) :



(1) $\sigma_1 = \epsilon_0 v\,B,\ \sigma_2 = -\epsilon_0 v\,B$

(2) $\sigma_1 = \frac{\epsilon_0 v\,B}{2},\ \sigma_2 = \frac{-\epsilon_0 v B}{2}$

(3) $\sigma_1 = \sigma_2 = \epsilon_0 vB$

(4) $\sigma_1 = \frac{-\epsilon_0 v B}{2},\ \sigma_2 = \frac{\epsilon_0 v B}{2}$

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

A fighter plane of length 20 m, wing span (distance from tip of one wing to the tip of the other wing) of 15 m and height 5 m is flying towards east over Delhi. Its speed is 240 ms^{-1}. The earth's magnetic field over Delhi is 5×10^{-5} T with the declination angle ~0° and dip of θ such that $\sin\theta = \frac{2}{3}$. If the voltage developed is V_B between the lower and upper side of the plane and V_W between the tips of the wings then V_B and V_W are close to :

(1) $V_B = 45\ mV;\ V_W = 120\ mV$ with right side of pilot at higher voltage

(2) $V_B = 45\ mV;\ V_W = 120\ mV$ with left side of pilot at higher voltage

(3) $V_B = 40\ mV;\ V_W = 135\ mV$ with right side of pilot at high voltage

(4) $V_B = 40\ mV;\ V_W = 135\ mV$ with left side of pilot at higher voltage

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

A conducting metal circular-wire-loop of radius r is placed perpendicular to a magnetic field which varies with time as $B = B_0 e^{-t/\tau}$, where B_0 and τ are constants, at time $t = 0$. If the resistance of the loop is R then the heat generated in the loop after a long time $(t \to \infty)$ is :

(1) $\frac{\pi^2 r^4 B_0^4}{2\tau R}$

(2) $\frac{\pi^2 r^4 B_0^2}{2\tau R}$

(3) $\frac{\pi^2 r^4 B_0^2\ R}{\tau}$

(4) $\frac{\pi^2 r^4 B_0^2}{\tau R}$

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

Consider an electromagnetic wave propagating in vacuum. Choose the correct statement :

(1) For an electromagnetic wave propagating in $+x$ direction the electric field is $\vec{E} = \frac{1}{\sqrt{2}} E_{yz}(x, t)\left(\hat{y} - \hat{z}\right)$ and the magnetic field is $\vec{B} = \frac{1}{\sqrt{2}} B_{yz}(x, t)\left(\hat{y} + \hat{z}\right)$

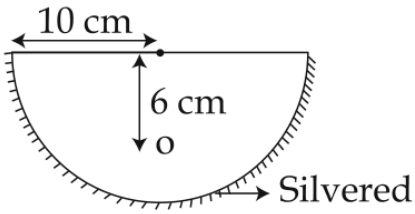
(2) For an electromagnetic wave propagating in $+x$ direction the electric field is $\vec{E} = \frac{1}{\sqrt{2}} E_{yz}(y, z, t)\left(\hat{y} + \hat{z}\right)$ and the magnetic field is $\vec{B} = \frac{1}{\sqrt{2}} B_{yz}(y, z, t)\left(\hat{y} + \hat{z}\right)$

(3) For an electromagnetic wave propagating in $+y$ direction the electric field is $\vec{E} = \frac{1}{\sqrt{2}} E_{yz}(x, t)\,\hat{y}$ and the magnetic field is $\vec{B} = \frac{1}{\sqrt{2}} B_{yz}(x, t)\,\hat{z}$

(4) For an electromagnetic wave propagating in $+y$ direction the electric field is $\vec{E} = \frac{1}{\sqrt{2}} E_{yz}(x, t)\,\hat{z}$ and the magnetic field is $\vec{B} = \frac{1}{\sqrt{2}} B_{z}(x, t)\,\hat{y}$

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

A hemispherical glass body of radius 10 cm and refractive index 1.5 is silvered on its curved surface. A small air bubble is 6 cm below the flat surface inside it along the axis. The position of the image of the air bubble made by the mirror is seen :



(1) 14 cm below flat surface

(2) 30 cm below flat surface

(3) 20 cm below flat surface

(4) 16 cm below flat surface

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

Two stars are 10 light years away from the earth. They are seen through a telescope of objective diameter 30 cm. The wavelength of light is 600 nm. To see the stars just resolved by the telescope, the minimum distance between them should be (1 light year $= 9.46 \times 10^{15}$m) of the order of :

(1) 10^6 km

(2) 10^8 km

(3) 10^{11} km

(4) 10^{10} km

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

A photoelectric surface is illuminated successively by monochromatic light of wavelengths λ and $\frac{\lambda}{2}$. If the maximum kinetic energy of the emitted photoelectrons in the second case is 3 times that in the first case, the work function of the surface is :

(1) $\frac{hc}{3\lambda}$

(2) $\frac{hc}{2\lambda}$

(3) $\frac{hc}{\lambda}$

(4) $\frac{3\,hc}{\lambda}$

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

A neutron moving with a speed 'v' makes a head on collision with a stationary hydrogen atom in ground state. The minimum kinetic energy of the neutron for which inelastic collision will take place is :

(1) 10.2 eV

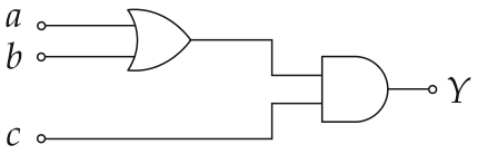
(2) 16.8 eV

(3) 12.1 eV

(4) 20.4 eV

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

To get an output of 1 from the circuit shown in figure the input must be :



(1) $a=0, b=1, c=0$

(2) $a=1, b=0, c=0$

(3) $a=1, b=0, c=1$

(4) $a=0, b=0, c=1$

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

A modulated signal $C_m(t)$ has the form $C_m(t) = 30 \sin 300\pi t + 10 (\cos 200\pi t - \cos 400\pi t)$. The carrier frequency f_c, the modulating frequency (message frequency) f_ω, and the modulation index μ are respectively given by :

(1) $f_c = 200$ Hz ; $f_\omega = 50$ Hz ; $\mu = \frac{1}{2}$

(2) $f_c = 150$ Hz ; $f_\omega = 50$ Hz ; $\mu = \frac{2}{3}$

(3) $f_c = 150$ Hz ; $f_\omega = 30$ Hz ; $\mu = \frac{1}{3}$

(4) $f_c = 200$ Hz ; $f_\omega = 30$ Hz ; $\mu = \frac{1}{2}$

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

A particle of mass m is acted upon by a force F given by the empirical law $F = \frac{R}{t^2} v(t)$.

If this law is to be tested experimentally by observing the motion starting from rest, the best way is to plot :

(1) $v(t)$ against t^2

(2) $\log v(t)$ against $\frac{1}{t^2}$

(3) $\log v(t)$ against t

(4) $\log v(t)$ against $\frac{1}{t}$

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

A thin 1 m long rod has a radius of 5 mm. A force of 50 πkN is applied at one end to determine its Young's modulus. Assume that the force is exactly known. If the least count in the measurement of all lengths is 0.01 mm, which of the following statements is **false** ?

(1) $\frac{\Delta Y}{Y}$ gets minimum contribution from the uncertainty in the length.

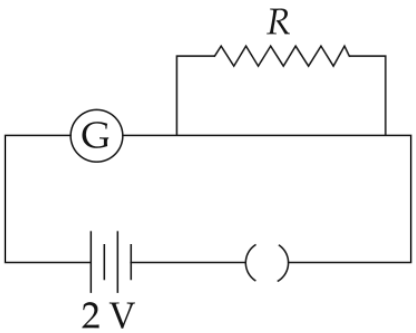
(2) The figure of merit is the largest for the length of the rod.

(3) The maximum value of Y that can be determined is 10^{14} N/m^2.

(4) $\frac{\Delta Y}{Y}$ gets its maximum contribution from the uncertainty in strain.

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

A galvanometer has a 50 division scale. Battery has no internal resistance. It is found that there is deflection of 40 divisions when $R = 2400\ \Omega$. Deflection becomes 20 divisions when resistance taken from resistance box is 4900 Ω. Then we can conclude :



(1) Resistance of galvanometer is 200 Ω.

(2) Full scale deflection current is 2 mA.

(3) Current sensitivity of galvanometer is 20 μA/division.

(4) Resistance required on R.B. for a deflection of 10 divisions is 9800 Ω.

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

To determine refractive index of glass slab using a travelling microscope, minimum number of readings required are :

(1) Two

(2) Three

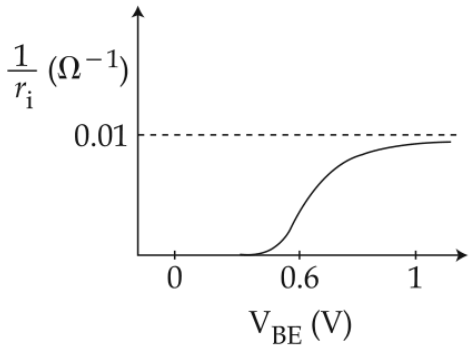
(3) Four

(4) Five

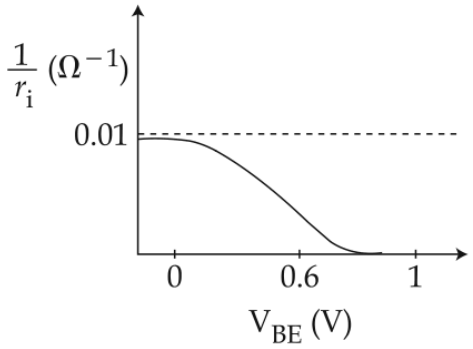
Question Number : 59 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

A realistic graph depicting the variation of the reciprocal of input resistance in an input characteristics measurement in a common-emitter transistor configuration is :

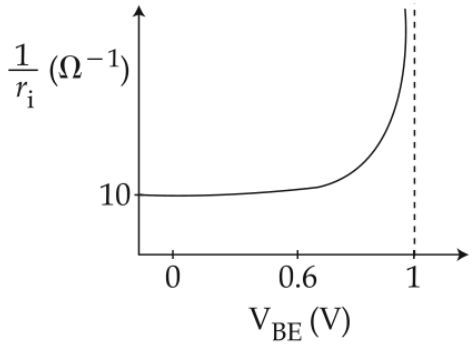
(1)



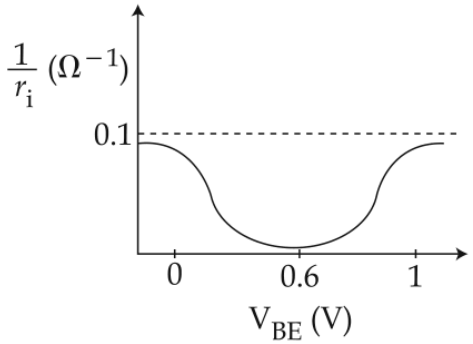
(2)



(3)



(4)



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

The ratio (R) of output resistance r_0, and the input resistance r_i in measurements of input and output characteristics of a transistor is typically in the range :

(1) $R \sim 10^2 - 10^3$

(2) $R \sim 1 - 10$

(3) $R \sim 0.1 - 0.01$

(4) $R \sim 0.1 - 1.0$

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 volume of 0.1N dibasic acid sufficient to neutralize 1 g of a base that furnishes 0.04 mole of OH^- in aqueous solution is :

(1) 200 mL

(2) 400 mL

(3) 600 mL

(4) 800 mL

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

Initially, the *root mean square (rms)* velocity of N_2 molecules at certain temperature is u. If this temperature is doubled and all the nitrogen molecules dissociate into nitrogen atoms, then the new *rms* velocity will be :

(1) $u/2$

(2) $2u$

(3) $4u$

(4) $14u$

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

Aqueous solution of which salt will **not** contain ions with the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6$?

(1) NaF

(2) NaCl

(3) KBr

(4) CaI_2

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

The bond angle H-X-H is the greatest in the compound :

(1) CH_4

(2) NH_3

(3) H_2O

(4) PH_3

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

If 100 mole of H_2O_2 decompose at 1 bar and 300 K, the work done (kJ) by one mole of $O_2(g)$ as it expands against 1 bar pressure is :

$$2H_2O_2(l) \rightleftharpoons 2H_2O(l) + O_2(g)$$

$(R = 8.3\ J\ K^{-1}\ mol^{-1})$

(1) 62.25

(2) 124.50

(3) 249.00

(4) 498.00

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

An aqueous solution of a salt MX_2 at certain temperature has a van't Hoff factor of 2. The degree of dissociation for this solution of the salt is :

(1) 0.33

(2) 0.50

(3) 0.67

(4) 0.80

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

A solid XY kept in an evacuated sealed container undergoes decomposition to form a mixture of gases X and Y at temperature T. The equilibrium pressure is 10 bar in this vessel. K_p for this reaction is :

(1) 5

(2) 10

(3) 25

(4) 100

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

Oxidation of succinate ion produces ethylene and carbon dioxide gases. On passing 0.2 Faraday electricity through an aqueous solution of potassium succinate, the total volume of gases (at both cathode and anode) at STP (1 atm and 273 K) is :

(1) 2.24 L

(2) 4.48 L

(3) 6.72 L

(4) 8.96 L

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

The rate law for the reaction below is given by the expression $k\,[A][B]$

$$A + B \rightarrow \text{Product}$$

If the concentration of B is increased from 0.1 to 0.3 mole, keeping the value of A at 0.1 mole, the rate constant will be :

(1) k

(2) $k/3$

(3) $3k$

(4) $9k$

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

Gold numbers of some colloids are : Gelatin : 0.005 - 0.01, Gum Arabic : 0.15 - 0.25; Oleate : 0.04 - 1.0; Starch : 15 - 25. Which among these is a better protective colloid ?

(1) Gelatin

(2) Gum Arabic

(3) Oleate

(4) Starch

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

The following statements concern elements in the periodic table. Which of the following is true ?

(1) All the elements in Group 17 are gases.

(2) The Group 13 elements are all metals.

(3) Elements of Group 16 have lower ionization enthalpy values compared to those of Group 15 in the corresponding periods.

(4) For Group 15 elements, the stability of +5 oxidation state increases down the group.

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

Extraction of copper by smelting uses silica as an additive to remove :

(1) Cu_2S

(2) FeO

(3) FeS

(4) Cu_2O

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

Identify the reaction which does **not** liberate hydrogen :

(1) Reaction of zinc with aqueous alkali.

(2) Electrolysis of acidified water using Pt electrodes.

(3) Allowing a solution of sodium in liquid ammonia to stand.

(4) Reaction of lithium hydride with B_2H_6.

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

The commercial name for calcium oxide is :

(1) Milk of lime

(2) Slaked lime

(3) Limestone

(4) Quick lime

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

Assertion : Among the carbon allotropes, diamond is an insulator, whereas, graphite is a good conductor of electricity.

Reason : Hybridization of carbon in diamond and graphite are sp^3 and sp^2, respectively.

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

Identify the **incorrect** statement :

(1) S_2 is paramagnetic like oxygen.

(2) Rhombic and monoclinic sulphur have S_8 molecules.

(3) S_8 ring has a crown shape.

(4) The S-S-S bond angles in the S_8 and S_6 rings are the same.

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

Identify the correct statement :

(1) Iron corrodes in oxygen-free water.

(2) Iron corrodes more rapidly in salt water because its electrochemical potential is higher.

(3) Corrosion of iron can be minimized by forming a contact with another metal with a higher reduction potential.

(4) Corrosion of iron can be minimized by forming an impermeable barrier at its surface.

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

Which of the following is an example of homoleptic complex ?

(1) $[Co(NH_3)_6]Cl_3$

(2) $[Pt(NH_3)_2Cl_2]$

(3) $[Co(NH_3)_4Cl_2]$

(4) $[Co(NH_3)_5Cl]Cl_2$

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

The transition metal ions responsible for color in ruby and emerald are, respectively :

(1) Cr^{3+} and Co^{3+}

(2) Co^{3+} and Cr^{3+}

(3) Co^{3+} and Co^{3+}

(4) Cr^{3+} and Cr^{3+}

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

Which one of the following substances used in dry cleaning is a better strategy to control environmental pollution ?

(1) Tetrachloroethylene

(2) Carbon dioxide

(3) Sulphur dioxide

(4) Nitrogen dioxide

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

Sodium extract is heated with concentrated HNO_3 before testing for halogens because :

(1) Silver halides are totally insoluble in nitric acid.

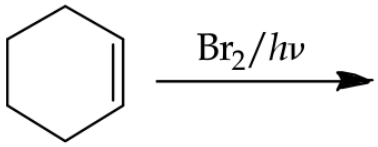
(2) Ag_2S and AgCN are soluble in acidic medium.

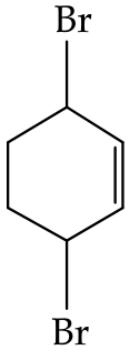
(3) S^{2-} and CN^-, if present, are decomposed by conc. HNO_3 and hence do not interfere in the test.

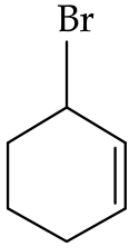
(4) Ag reacts faster with halides in acidic medium.

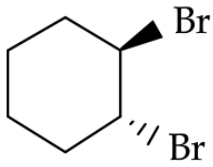
Question Number : 82 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

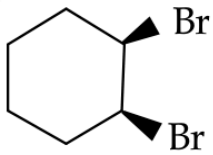
Bromination of cyclohexene under conditions given below yields :



(1) 

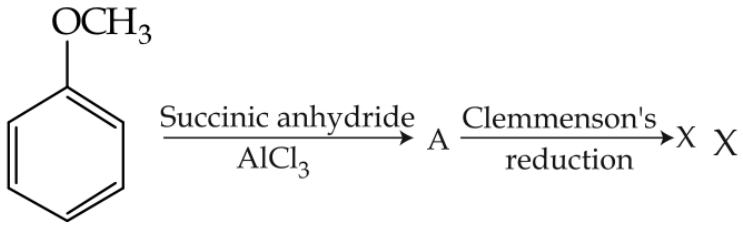
(2) 

(3) 

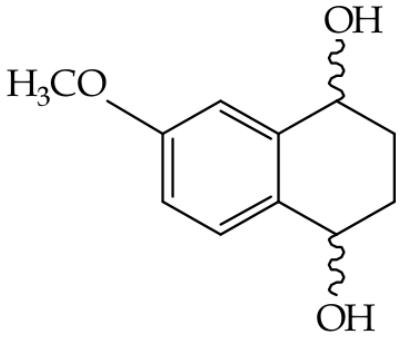
(4) 

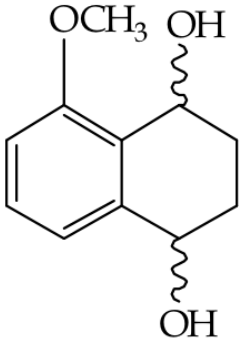
Question Number : 83 Question Type : MCQ Correct Marks : 4 Wrong Marks : 1

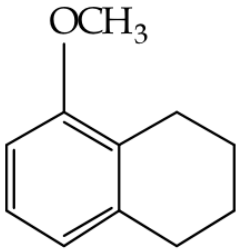
Consider the reaction sequence below :

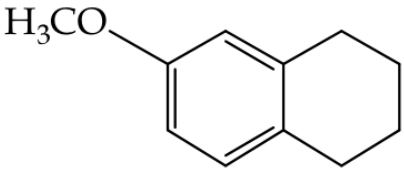


is :

(1) 

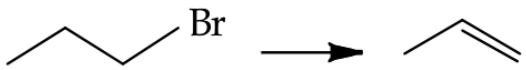
(2) 

(3) 

(4) 

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

Which one of the following reagents is **not** suitable for the elimination reaction ?



(1) $NaOH/H_2O$

(2) NaOEt/EtOH

(3) $NaOH/H_2O$-EtOH

(4) NaI

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

The correct statement about the synthesis of erythritol ($C(CH_2OH)_4$) used in the preparation of PETN is :

(1) The synthesis requires four aldol condensations between methanol and ethanol.

(2) The synthesis requires two aldol condensations and two Cannizzaro reactions.

(3) The synthesis requires three aldol condensations and one Cannizzaro reaction.

(4) Alpha hydrogens of ethanol and methanol are involved in this reaction.

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

Fluorination of an aromatic ring is easily accomplished by treating a diazonium salt with HBF_4. Which of the following conditions is correct about this reaction ?

(1) Only heat

(2) $NaNO_2/Cu$

(3) Cu_2O/H_2O

(4) NaF/Cu

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

Which of the following polymers is synthesized using a free radical polymerization technique ?

(1) Teflon

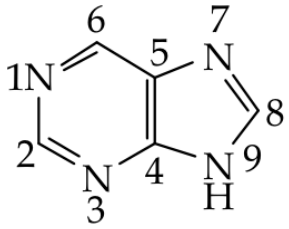
(2) Terylene

(3) Melamine polymer

(4) Nylon 6,6

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

The "N" which does **not** contribute to the basicity for the compound is :



(1) N 7

(2) N 9

(3) N 1

(4) N 3

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

Which of the following is a bactericidal antibiotic ?

(1) Erythromycin

(2) Tetracycline

(3) Chloramphenicol

(4) Ofloxacin

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

Observation of "Rhumann's purple" is a confirmatory test for the presence of :

(1) Reducing sugar

(2) Cupric ion

(3) Protein

(4) Starch