Q.1 Identify the correct statement regarding an equipotential surface:

(A) An equipotential surface and electric line of force never intersect each other.
(B) An equipotential surface and electric line of force intersect at an angle of 45°.
(C) An equipotential surface and electric line of force intersect at an angle of 90°.
(D) An equipotential surface and electric line of force intersect at an angle of 60°.

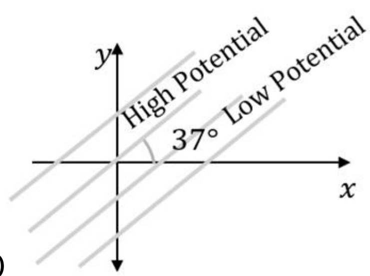
Q.2 A uniform electric field pointing in positive x-direction exists in a region. Let A be the origin, B be the point on the x-axis at $x = 1$ cm and C be the point on the y-axis at $y = 1$ cm. Then, the potentials at the points A, B and C satisfy

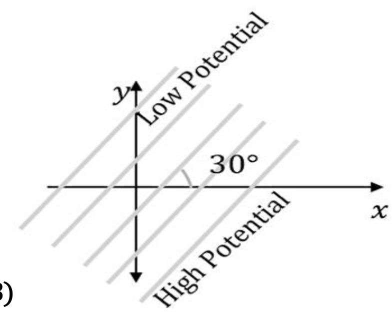
(A) $V_A < V_B$ **(B)** $V_A > V_B$ **(C)** $V_A < V_C$ **(D)** $V_A > V_C$

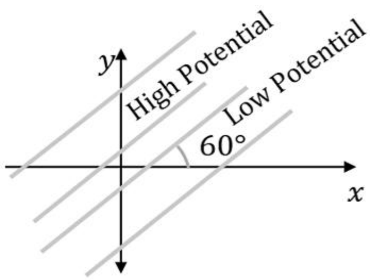
Q.3 The equation of an equipotential line in an electric field is $y = 2x$, then the electric field strength vector at $(1, 2)$ may be:

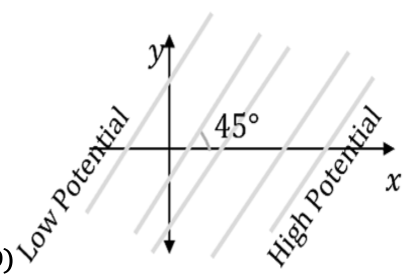
(A) $4\hat{i} + 3\hat{j}$ **(B)** $4\hat{i} + 8\hat{j}$ **(C)** $8\hat{i} + 4\hat{j}$ **(D)** $-8\hat{i} + 4\hat{j}$

Q.4 The electric filed intensity at all point in space is given by $\vec{E} = (\sqrt{3}\,\hat{i} - \hat{j})$ V/m. The equipotential lines in xy plane will be represented by:

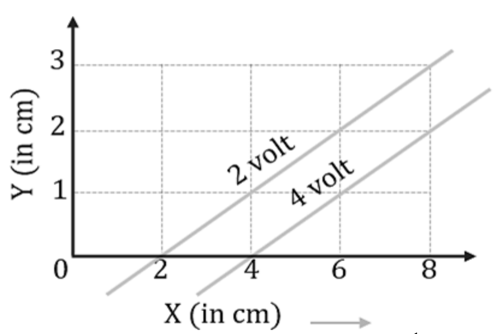
(A) 

(B) 

(C) 

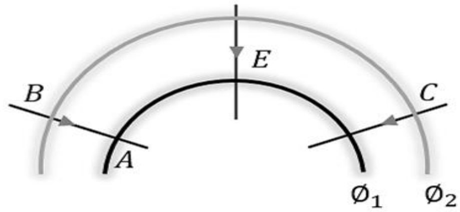
(D) 

Q.5 Figure shows two equipotential lines in XY plane for an electric field. The scales are marked. The X −component E_x and Y −component E_y of the electric field in the space between these equipotential lines are respectively



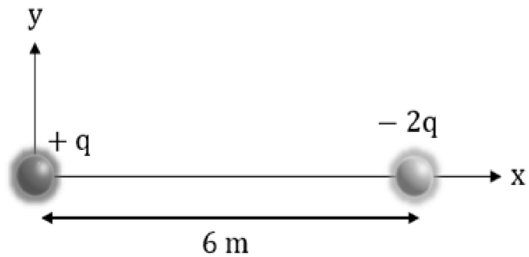
(A) $+100\ Vm^{-1}, -200\ Vm^{-1}$ **(B)** $+200\ Vm^{-1}, +100\ Vm^{-1}$
(C) $-100\ Vm^{-1}, +200\ Vm^{-1}$ **(D)** $-200\ Vm^{-1}, +100\ Vm^{-1}$

Q.6 In moving from A to B along an electric field line, the work done by the electric field on an electron is 6.4×10^{-19} J. If ϕ_1 and ϕ_2 are equipotential surfaces, then the potential difference $V_C - V_A$



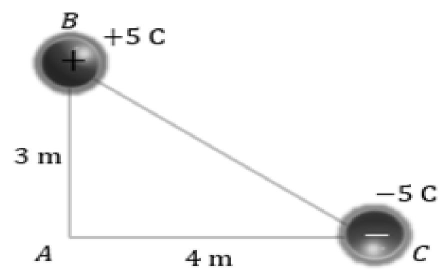
(A)-4 V **(B)**4 V **(C)**Zero **(D)**6.4 V

Q.7 Two-point charges $+q$ and $-2q$ are placed at a distance 6 m part on a horizontal plane. Find the locus of a point on this plane where the electric potential has zero value.



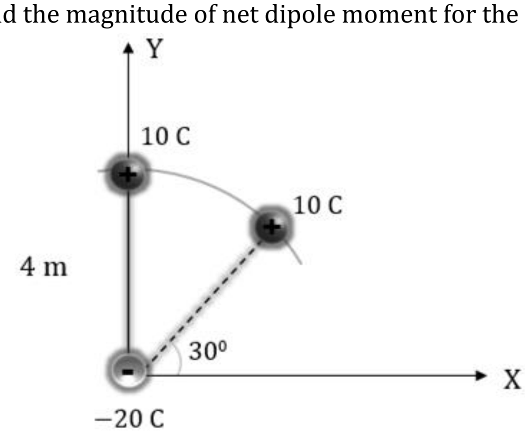
(A) Circle with radius 4 m and centre $(-2,0)$. **(B)** Circle with radius 4 m and centre $(0,0)$.
(C) Circle with radius 2 m and centre $(-2,0)$. **(D)** Circle with radius 4 m and centre $(0,-2)$.

Q.8 Find the electric dipole moment due to two charges kept at end points of hypotenuse of a right-angled triangle as shown in figure.



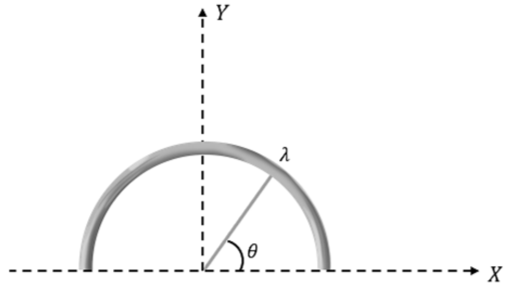
(A)15 C − m along AB **(B)**20 C − m along AC **(C)**25 C − m along BC **(D)**25 C − m along CB

Q.9 Two positive charges (+10 C) are kept on the arc of a circle and a negative charge (−20 C) at the origin (centre of circle). Find the magnitude of net dipole moment for the given system



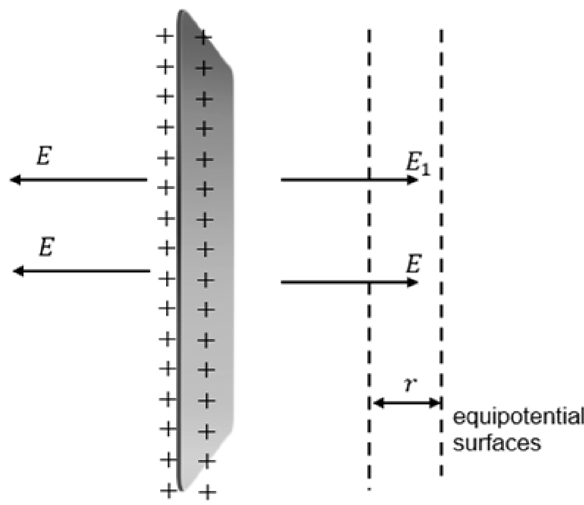
(A)59.3 C − m **(B)**69.3 C − m **(C)**79.3 C − m **(D)**89.3 C − m

Q.10 A semicircular ring of radius R as shown in figure has charge per unit length $\lambda = \lambda_o \cos\theta$. Electric dipole moment of this ring is



(A) λR^2 (B) $2\lambda R^2$ (C) $\frac{\lambda R^2}{2}$ (D) $\frac{3}{2}\lambda R^2$

Q.11 An infinite conducting sheet has surface charge density σ. The distance between two equipotential surfaces is r. The potential difference between these two surfaces is



(A) $\frac{\sigma r}{2\varepsilon_\circ}$ (B) $\frac{\sigma r}{\varepsilon_\circ}$ (C) $\frac{\sigma}{\varepsilon_\circ r}$ (D) $\frac{\sigma}{2\varepsilon_\circ r}$

WORK SHEET

Relative Motion in 1D

Q.1 A motorbike is being chased by a car. The motorbike moves with the speed of 20 m/sand has acceleration of $5\ m/s^2$. Whereas the car has a speed of 30 m/s and accelerates with $3\ m/s^2$. If the initial separation between motorbike and car is 80 m, find the distance by which the car will miss the motorbike.

(A)55 M **(B)**30 M **(C)**35 M **(D)**40 M

Banking Angle

Q.2 A railway track is banked by making the outer rail 10 cm higher than the inner rail. The distance between the rails is 2 m. If the speed limit for trains on this track is 72 km/h, what will be the radius

(A)80 M **(B)**500 M **(C)**800 M **(D)**1000 M

Radial & Tangential Acceleration for Non-Uniform Circular Motion

Q.3 A 40 kg mass at the end of a rope of length l, oscillates in a vertical plane with angular amplitude θo. What is the tension T in the rope when it makes an angle θ with the vertical? If the breaking strength of the rope is 80 kgf, what is the maximum angular amplitude θmax with which the mass can oscillate without the rope breaking?

(A)$T = mg(2\cos\theta - 3\cos\theta_0), \theta_{max} = 30°$ **(B)**$T = mg(3\cos\theta - 2\cos\theta_0), \theta_{max} = 60°$

(C)$T = mg(2\cos\theta - 3\cos\theta_0), \theta_{max} = 60°$ **(D)**$T = mg(3\cos\theta - 2\cos\theta_0), \theta_{max} = 30°$

Carnot Cycle

Q.4 The temperature inside and outside of the refrigerator is 260 K and 315 K respectively. Assuming that the refrigerator cycle is reversible, calculate the heat delivered to the surroundings for every joule of work done.

(A)5 J **(B)**6.19 J **(C)**6 J **(D)**5.73 J

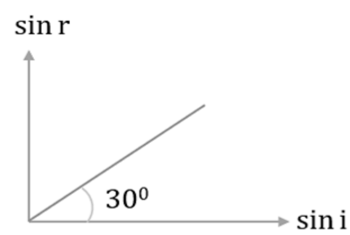
Wien's Displacement Law

Q.5 Two metal spheres of the same material have radii r and 2r and they emit thermal radiation with maximum intensities at wavelengths λ and 2λ respectively. The respective ratio of the radiant energy emitted by them per second will be

(A)4: 1 **(B)**1: 4 **(C)**8: 1 **(D)**1: 8

TIR

Q.6 A ray of monochromatic light is incident on the plane surface of separation between two media x and y with angle of incident i in the medium y. The graph shows the relation between sin i and sin r (where r is angle of refraction). The total internal reflection can take place when the incidence is in medium



(A)X **(B)**Y **(C)**both x and y **(D)**Insufficient

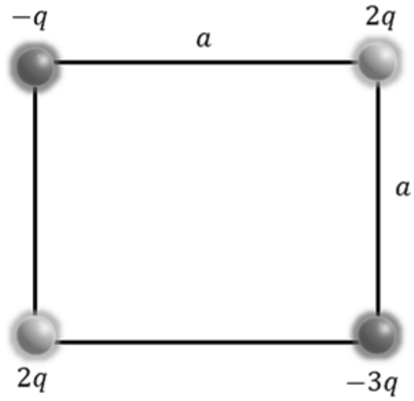
Moving Object, Stationary Lens

Q.7 The origin of x and y coordinates is the pole of a concave mirror of focal length 20 cm. The $x - axis$ is the optical axis with $x > 0$ being the rear side of mirror. A point object at the point (30 cm, 1 cm) is moving with a velocity 10 cm/s in positive $x-$direction. The velocity of the image in cm/s is approximately

(A)$-80\hat{i}+8\hat{j}$ **(B)**$-40\hat{i}-2\hat{j}$ **(C)**$-40\hat{i}+2\hat{j}$ **(D)**$40\hat{i}-4\hat{j}$

Dipole Moment

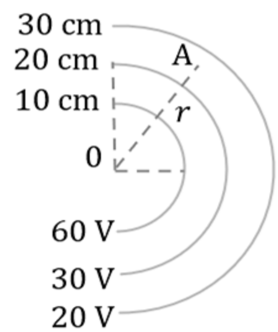
Q.8 Charges are placed on corners of the square of side a (as shown in figure). Find the magnitude of the net dipole moment.



(A)qa **(B)**$\sqrt{2}$qa **(C)**$\sqrt{3}$qa **(D)**2qa

Equipotential Surfaces

Q.9 Figure shows equipotential concentric surfaces Centred at O. The magnitude of the electric field at a distance r measured from Ois:



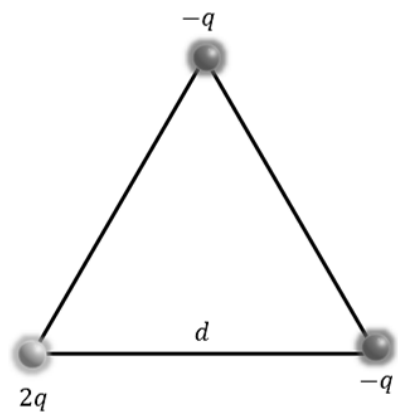
(A)$\frac{9}{r^2}$ Vm^{-1} **(B)**$\frac{6}{r^2}$ Vm^{-1} **(C)**$\frac{2}{r^2}$ Vm^{-1} **(D)**$\frac{16}{r^2}$ Vm^{-1}

Dipole Moment

Q.10 An HCl molecule has a dipole moment of 3.4×10^{-30} C − m. Assuming that equal and opposite charges lie on the two atoms to form a dipole, what is the magnitude of this charge? The separation between the two atoms of HCl is 1.0×10^{-10} m.

(A)1.4×10^{-20} C **(B)**2.4×10^{-20} C **(C)**3.4×10^{-20} C **(D)**4.4×10^{-20} C

Q.11 Three charges are arranged on the vertices of an equilateral triangle as shown in figure. Find the magnitude of the dipole moment of the combination.



(A)$\sqrt{2}$qd (B)$\sqrt{3}$qd (C)$\sqrt{5}$qd (D)$\sqrt{6}$qd

Dipoles

Q.12 The formation of a dipole is due to two equal and dissimilar point charges placed at a

(A)short distance (B)long distance (C)above each other (D)None of these

Equipotential Surfaces

Q.13 An infinite conducting sheet has surface charge density σ. The distance between two equipotential surfaces is r. The potential difference between these two surfaces is

(A)$\frac{\sigma r}{2\varepsilon_0}$ (B)$\frac{\sigma r}{\varepsilon_0}$ (C)$\frac{\sigma}{\varepsilon_0 r}$ (D)$\frac{\sigma}{2\varepsilon_0 r}$

Q.14 Equipotential surfaces associated with an electric field which is increasing in magnitude along the $x-$ direction are

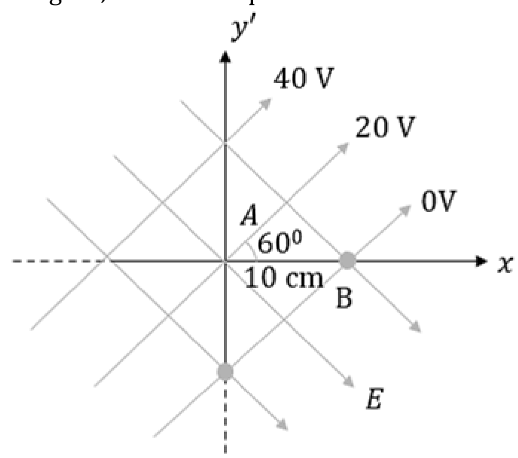
(A)Planes parallel to YZ- plane

(B)Planes parallel to XY- plane

(C)Planes parallel to XZ- plane

(D)Coaxial cylinders of increasing radii around thex- axis

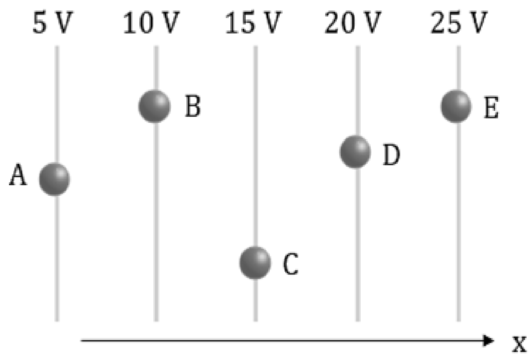
Q.15 For the electric field shown in figure, its vector representation will be



(A)$\vec{E} = 200\,\hat{i} - \frac{200}{\sqrt{3}}\,\hat{j}$ (B)$\vec{E} = 100\,\hat{i} - 100\sqrt{3}\,\hat{j}$

(C)$\vec{E} = \frac{50}{\sqrt{3}}\,\hat{i} - \frac{100}{\sqrt{3}}\,\hat{j}$ (D)$\vec{E} = 10\,\hat{i} - 5\sqrt{2}\,\hat{j}$

Q.16 The figure shows a set of equipotential surfaces. There are a few points marked on them. An electron is being moved from one point to other. Which of the following statements is/are correct?



(A) The electric field is directed along +x axis

(B) Work done by the electric field, in moving the electron from B to C, is positive

(C) Work done by the electric field, in moving the electron from C to D, is from D to E

(D) As the electron moves from E to A, the potential energy increases

Work Energy Theorem

Q.17 A rough disc of mass m rotates freely with an angular velocity ω. If another rough disc of mass m/2 and of the same radius but spinning in the opposite sense with angular speed ω is kept on the first disc. Then:

(A) The final angular speed of the disc is $\frac{\omega}{3}$

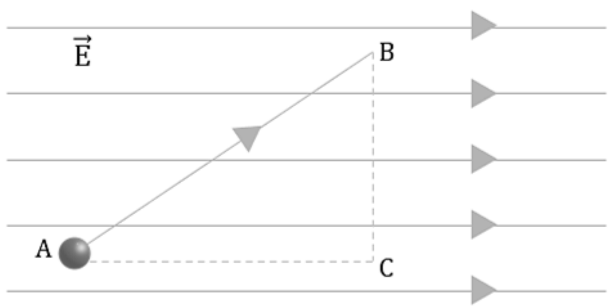
(B) The net work done by friction is zero

(C) The fiction does a positive job on the lighter disc

(D) The net work done by friction is $\frac{-mr^2\omega^2}{3}$

Equipotential Surfaces

Q.18 An electron is taken from point A to point B along the path AB in a uniform electric field of intensity $E = 10$ V/m. Side AB = 5 m, and side BC = 3 m. Then, the amount of external work done on the electron (in eV) is



Angular Analogue of Linear Momentum

Q.19 A particle of mass 13 kg moves with 5 m/s in $y - z$ plane along the path $5y = 12z + 60$. Here y and z are in meters. Magnitude of angular momentum of the particle about origin (in kgm^{2}s^{-1}), when the particle is at $z = 10$ m, is

[Your answer must be an integer]

Wave Speed expression

Q.20 A wave pulse starts propagating in the positive x − direction along a non uniform wire of length 10 m with a mass per unit length given by $m = m_0 + \alpha x$ and under a tension of 100 N. Find the time taken by the pulse in seconds to travel from the lighter end $x = 0$ to the heavier end. ($m_0 = 10^{-2}$ kg/m and $\alpha = 9 \times 10^{-3}$ kg/m^2). Answer upto 2 decimal places

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(C)	(B)	(D)	(C)	(C)	(B)	(A)	(D)	(B)	(B)
Q.	11									
Sol.	(C)									
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(A)	(C)	(B)	(D)	(A)	(B)	(C)	(B)	(B)	(C)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(B)	(A)	(B)	(A)	(A)	(B),(C),(D)	(A),(D)			