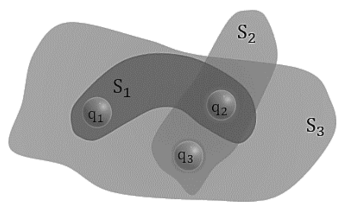
Q.1 If the flux of the electric field through a closed surface is zero, then
(A) The electric field must be zero everywhere on the surface
(B) The total charge enclosed within the surface must be zero
(C) The electric field must be uniform throughout the closed surface
(D) The charge outside the surface must be zero

Q.2 Choose the correct option for the given assertion and reason.
Assertion: Gauss's Theorem can only be applied for a closed surface.
Reason: Electric flux passing through an open surface can be obtained as well.
(A) Both assertion and reason are true, and reason is not the correct explanation of assertion
(B) Both assertion and reason are true, and reason is the correct explanation of assertion
(C) Assertion is false, but reason is true
(D) Assertion is true, but reason is false.

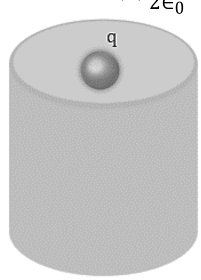
Q.3 Three charges of $\mathbf{q_1 = 1 \times 10^{-6}\ C}$, $\mathbf{q_2 = 2 \times 10^{-6}\ C}$ and $\mathbf{q_3 = -3 \times 10^{-6}\ C}$ have been placed as shown. Then, the net electric flux will be maximum for the surface
(A) S_1 **(B)** S_2 **(C)** S_3 **(D)** Same for all three.



Q.4 Find the flux of the electric field through a spherical surface of radius **R** due to a charge of $\mathbf{10^{-7}\ C}$ at the center and another equal charge at a point **2R** away from the center. (Take $\mathbf{\epsilon_0 = 9 \times 10^{-12}\ C^2/N - m^2}$)
(A) $1.1 \times 10^4\ \mathrm{N - m^2/C}$ **(B)** $2.1 \times 10^4\ \mathrm{N - m^2/C}$
(C) $3.1 \times 10^4\ \mathrm{N - m^2/C}$ **(D)** $4.1 \times 10^4\ \mathrm{N - m^2/C}$

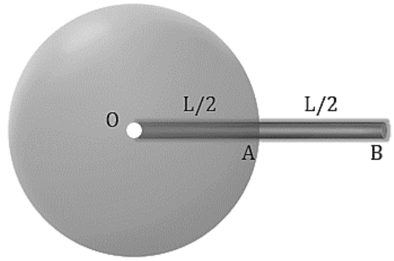
Q.5 The electric flux from a cube of edge **l** is $\boldsymbol{\phi}$. If edge of the cube is made **2l** and charge enclosed is halved, then the flux value will be
(A) 4ϕ **(B)** 2ϕ **(C)** $\phi/2$ **(D)** ϕ

Q.6 A charge **q** is placed at the center of the open end of a cylindrical vessel as shown in the figure. The flux of the electric field through the surface of the vessel is
(A) Zero **(B)** $\frac{q}{\epsilon_0}$ **(C)** $\frac{q}{2\epsilon_0}$ **(D)** $\frac{2q}{\epsilon_0}$

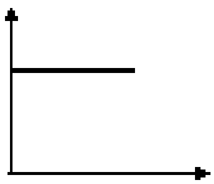
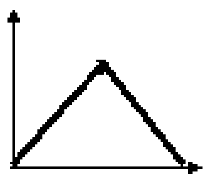


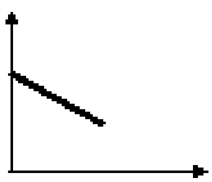
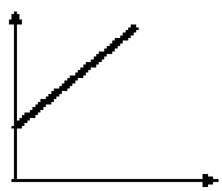
Q.7 A charge **Q** is uniformly distributed over a rod of length **L**. Consider a hypothetical sphere of radius $\mathbf{\frac{L}{2}}$ with the center of the sphere at one end of the rod. Find the value of flux passing through the entire surface of the sphere

(A) $2\varepsilon_0$ (B) $\frac{Q}{\varepsilon_0}$ (C) $\frac{Q}{3\varepsilon_0}$ (D) $\frac{2Q}{\varepsilon_0}$



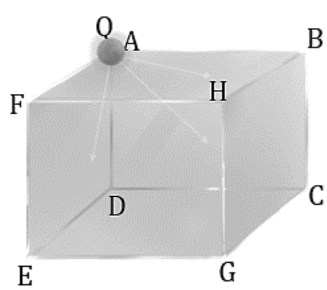
Q.8 Figure shows an imaginary cube of side **a**. A uniformly charged rod of length **a** moves towards right at a constant speed**v**. At $\mathbf{t = 0}$, the right end of the rod just touches the left face of the cube. Which of the following represents the correct graph between electric fluxes passing through the cube with time?

(A) 
(B) 

(C) 
(D) 

Q.9 A charge **Q** is kept at the corner of a cube. If the net flux through the cube is $\boldsymbol{\phi}$, the electric flux passing through one of those faces not touching the charge will be

(A) $\frac{\phi}{3}$ (B) $\frac{\phi}{6}$ (C) $\frac{\phi}{4}$ (D) $\frac{\phi}{8}$



Q.10 The intensity of an electric field depends only on the coordinates **x** and **y** as follows:

$$\mathbf{E} = \frac{\mathbf{a(x\hat{i} + y\hat{j})}}{\mathbf{x^2 + y^2}}$$

Where, a is a constant and $\hat{i}$ and $\hat{j}$ are the unit vectors of the x and y− axes. Find the charge within a sphere of radius R with the center at the origin.

(A) $2\pi\epsilon_0 aR$ (B) $4\pi\epsilon_0 aR$ (C) $\pi\epsilon_0 aR$ (D) $-2\pi\epsilon_0 aR$

WORK SHEET

Q.1 A string breaks under the load of **50 kg**. A mass of **1 kg** is attached to one end of the string **10 m** long is rotated in a horizontal circle while the other end is attached to the ceiling. Calculate the greatest number of revolutions that the mass can make per second without breaking the string. (Take $\mathbf{g = 10\ m/s^2}$)

(A) $\frac{100}{\pi}$ Revolutions per second **(B)** $\frac{10\sqrt{2}}{\pi}$ revolutions per second

(C) $\frac{100}{\sqrt{\pi}}$ Revolutions per second **(D)** $\frac{\sqrt{50}}{2\pi}$ revolutions per second

Q.2 A syringe of diameter **1 cm** having a nozzle of diameter **1 mm**, is placed horizontally at a height **5 m** from the ground. An incompressible, non-viscous liquid is filled in the syringe and the liquid is compressed by moving the piston at a speed of $\mathbf{0.5\ ms^{-1}}$. The horizontal distance travelled by the liquid jet is ($\mathbf{g = 10\ ms^{-2}}$)

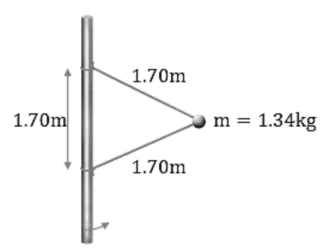
(A) 12.5 m **(B)** 25 m **(C)** 50 m **(D)** 67.5 m

Q.3 A boy whirls a stone in a horizontal circle of radius **1.5 m** and at height **2.0 m** above ground level. The string breaks, and the stone flies off horizontally and strikes the ground after travelling a horizontal distance of **10 m**. What is the magnitude of the centripetal acceleration of the stone during the circular motion?

(A) $166.7\ m/s^2$ **(B)** $176.7\ m/s^2$ **(C)** $156.7\ m/s^2$ **(D)** $146.7\ m/s^2$

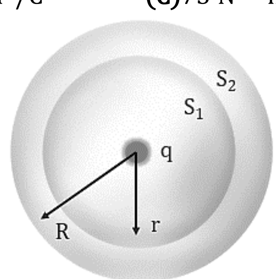
Q.4 In the shown figure, the strings are massless. If the vertical rod is rotated the tension in the upper string is **35 N** then the speed of the ball is

(A) 5.4 m/s **(B)** 4.4 m/s **(C)** 3.4 m/s **(D)** 6.4 m/s



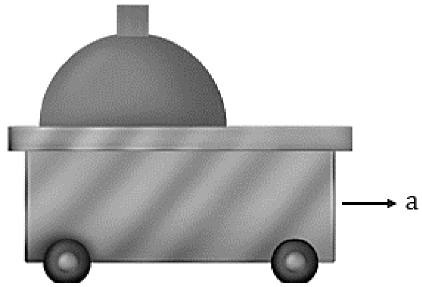
Q.5 Electric charges are distributed in a small volume. The flux of the electric field through a spherical surface of radius **10 cm** surrounding the total charge is $\mathbf{25\ N-m^2/C}$. T

(A) $25\ N-m^2/C$ **(B)** $50\ N-m^2/C$ **(C)** $75\ N-m^2/C$ **(D)** $100\ N-m^2/C$



Q.6 A vertical frictionless semicircular track of radius **1 m** is fixed on the edge of a movable trolley (figure). Initially the system is at rest and a mass **m** is kept at the top of the track. The trolley starts moving to the right with a uniform horizontal acceleration $\mathbf{a} = \frac{2g}{9}$. The mass slides down the track, eventually losing contact with it and dropping onto the floor. Calculate the angle $\boldsymbol{\theta}$ at which it loses contact with the trolley and the track.

(A) 30° (B) 37° (C) 53° (D) 60°

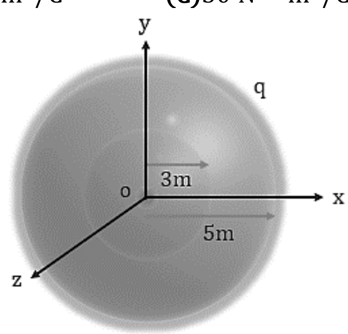


Q.7 One-dimensional steady state heat conduction takes place through a solid whose cross-sectional area varies linearly in the direction of heat transfer. Assume there is no heat generation (or absorption and dissipation) in the solid and the thermal conductivity of the material is constant and independent of temperature. The temperature distribution in the solid is

(A) Quadratic (B) Logarithmic (C) Linear (D) Exponential

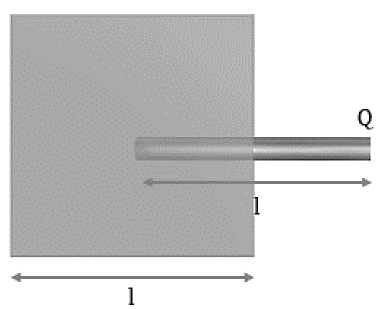
Q.8 $\mathbf{1\mu C}$ charge is uniformly distributed on a spherical shell given by equation $\mathbf{x^2 + y^2 + z^2 = 25}$. What will be the flux through an imaginary sphere of radius **3 m** and center at origin?

(A) $5\ \mathrm{N - m^2/C}$ (B) $25\ \mathrm{N - m^2/C}$ (C) $50\ \mathrm{N - m^2/C}$ (D) Zero



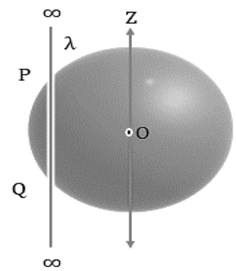
Q.9 A charge **Q** is uniformly distributed over a rod of length **l** held perpendicular to the face of a hypothetical cube of side length **l** with the centre of the cube at one end of the rod as shown in the figure below. Find the flux of the electric field through the entire surface of the cube.

(A) $\frac{Q}{2\epsilon_0}$ (B) $\frac{Q}{\epsilon_0}$ (C) $\frac{Q}{4\epsilon_0}$ (D) $\frac{Q}{6\epsilon_0}$



Q.10 An infinitely long thin non-conducting wire is parallel to the **z** - axis and carries a uniform charge of line charge density $\boldsymbol{\lambda}$. It pierces a thin non-conducting spherical shell of radius **R** in such a way that the arc **PQ** subtends an angle of $\mathbf{120}°$ at the center **O** of the spherical shell as shown in the figure. The electric flux through the shell is

(A)$\sqrt{3}R\frac{\lambda}{\epsilon_0}$ (B)$\sqrt{2}R\frac{\lambda}{\epsilon_0}$ (C)$\sqrt{5}R\frac{\lambda}{\epsilon_0}$ (D)$\sqrt{6}R\frac{\lambda}{\epsilon_0}$

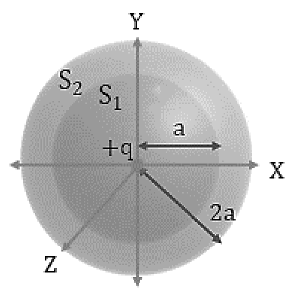


Q.11 A ray of light is incident on one face of a rectangular glass slab of thickness $\mathbf{0.1\ m}$ and refractive index $\mathbf{1.5}$ at an angle of $\mathbf{60}°$ with the normal. Calculate the lateral shift produced.

(A)0.0234m (B)0.0316m (C)0.0452m `(D)0.0513m

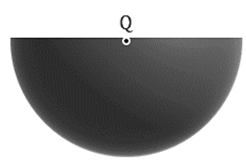
Q.12 Consider two concentric spherical surfaces $\mathbf{S_1}$ with radius **a** and $\mathbf{S_2}$ with radius **2a**, both centered on the origin. There is a charge **+q** at the origin, and no other charges. Compare the flux $\boldsymbol{\phi_1}$ through $\mathbf{S_1}$ with flux $\boldsymbol{\phi_2}$ through $\mathbf{S_2}$

(A)$\phi_1 = 4\phi_2$ (B)$\phi_1 = 2\phi_2$ (C)$\phi_1 = \phi_2$ (D)$\phi_1 = \frac{\phi_2}{2}$



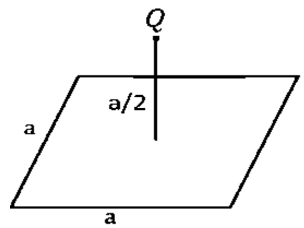
Q.13 A charge **Q** is placed at the centre of an imaginary hemispherical surface. Using symmetry arguments and Gauss's law, find the flux of the electric field due to this charge through the curved surface of the hemisphere as shown in the figure.

(A)$\frac{Q}{\varepsilon_0}$ (B)$\frac{Q}{2\varepsilon_0}$ (C)$\frac{2Q}{\varepsilon_0}$ (D)$\frac{Q}{3\varepsilon_0}$



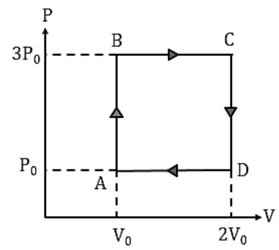
Q.14 A charge **Q** is placed at a perpendicular distance $\frac{\mathbf{a}}{\mathbf{2}}$above the center of the horizontal, square surface of edge length **a** as shown in figure. Find the flux of the electric field through the square surface.

(A)$\frac{Q}{\varepsilon_0}$ (B)$\frac{Q}{6\varepsilon_0}$ (C)$\frac{Q}{3\varepsilon_0}$ (D)$\frac{Q}{2\varepsilon_0}$



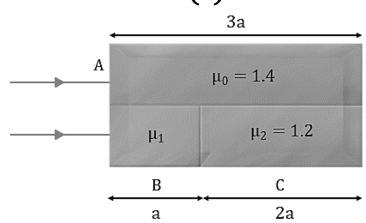
Q.15 An ideal monatomic gas undergoes the cyclic process **ABCDA** as shown in the figure. The efficiency of the cycle is

(A)28.6% **(B)**19.04% **(C)**46.8% **(D)**62.3%



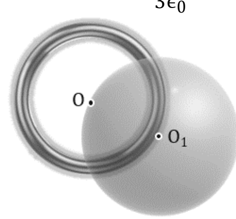
Q.16 A slab of transparent material is made as shown in the figure. The thickness of **C** is twice the thickness of **B.** If the number of waves in **A** is equal to the number of waves in combination of **B** and**C**, then the refractive index of **B** is

(A)1.33 **(B)**1.8 **(C)**1.6 **(D)**1.4



Q.17 A charge **Q** is distributed uniformly on a ring of radius **r**. A sphere of equal radius **r** is constructed with it's center at the periphery of the ring. Find the flux of the electric field through the surface of the sphere.

(A)$\frac{Q}{\epsilon_0}$ **(B)**$\frac{Q}{2\epsilon_0}$ **(C)**$\frac{Q}{3\epsilon_0}$ **(D)**$\frac{Q}{4\epsilon_0}$



Q.18 A thin rod of negligible mass, length $\mathbf{0.5\ m}$ and area of cross-section$\mathbf{4 \times 10^{-6}\ m^2}$, suspended vertically from one end. The rod is cooled down and it can contract by $\mathbf{5 \times 10^{-4}\ m}$ but is prevented from contracting by attaching a mass at the lower end. Choose the correct option(s).(Given: Take young's modulus of rod $\mathbf{Y = 10^{11}\ N/m^2,\ g = 10\ m/s^2}$)

(A) Value of mass is 80 kg**(B)**Value of mass is 40 kg

(C) Energy stored in the rod is 0.1 J **(D)**Energy stored in the rod is 0.2 J

Q.19 Charges $\mathbf{Q_1}$ and $\mathbf{Q_2}$ lie inside and outside respectively of a closed surface**S.** Let **E** be the field at any point on **S** and **ϕ** be the flux of **E** over **S**. Choose the correct statement (s).

(A) If Q_1 changes in magnitude, both E and ϕ will change
(B) If Q_2 changes in magnitude, E will change but ϕ will not change
(C) If $Q_1 = 0$ and $Q_2 \neq 0$, then $E \neq 0$ but $\phi = 0$
(D) If $Q_1 \neq 0$ and $Q_2 = 0$, then $E = 0$ but $\phi \neq 0$

Q.20 Mark the correct options about electric fields and Gauss's law in a region of space:
(A) Gauss's law is valid only for uniform charge distributions
(B) Gauss's law is valid only for charges placed in vacuum
(C) The electric field calculated by Gauss's law is the field due to all the charges
(D) The flux of the electric field through a closed surface due to all the charges is equal to

ANSWER KEY

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