Q.1 A point charge $q_A = +100\ \mu C$ is placed at point A(1,0,2) m and another point charge $q_B = +200\ \mu C$ is placed at point B(4,4,2) m. The magnitude of electrostatic force acting between them is:

(A) 10 N **(B)** 8.5 N **(C)** 7.2 N **(D)** 1.5 N

Q.2 Find out the electric force experienced by $+1\ \mu C$ charge at point A(0,1,2) m due to a point charge $-20\ \mu C$ situated at point B$(\sqrt{2}, 0, 1)$ m.

(A) $22.5 \times 10^3(-\sqrt{2}\hat{i} + \hat{j} + \hat{k})$ N **(B)** $-22.5 \times 10^{-3}(-\sqrt{2}\hat{i} + \hat{j} + \hat{k})$ N

(C) $44.5 \times 10^{-3}(\hat{i} + \sqrt{2}\hat{j} - \hat{k})$ N **(D)** $25 \times 10^{-3}(\hat{i} - \hat{j} + \hat{k})$ N

Q.3 Two-point charges placed at a distance r in air exert a force F on each other. What will be the distance at which they will experience force 4F, when placed in a medium of dielectric constant 16?

(A) r **(B)** $\frac{r}{4}$ **(C)** $\frac{r}{8}$ **(D)** 2r

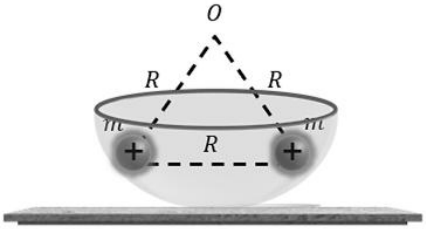
Q.4 Two points charges Q_1 and Q_2 are placed at separation d in vacuum and force acting between them is F. Now a dielectric slab of thickness $\frac{d}{2}$ and dielectric constant $K = 4$ is placed between them. The new force between the charges will be

(A) $\frac{4F}{9}$ **(B)** $\frac{2F}{9}$ **(C)** $\frac{F}{9}$ **(D)** $\frac{5F}{9}$

Q.5 Two-point charges q_1 and q_2 are placed at a distance of 50 m from each other in air, interact with a certain electrostatic force. If the medium is replaced with oil whose relative permittivity is 5, then the interaction force between them is still the same. Now the separation between them is

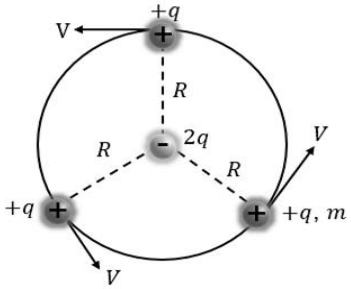
(A) 16.6 m **(B)** 22.3m **(C)** 28.4 m **(D)** 25.0 m

Q.6 Two identical beads, each have a mass m and charge q. When placed at a distance R apart in a hemispherical bowl of radius R with frictionless, non-conducting walls, the beads are at equilibrium as shown in figure. Determine the charge on each bead, if $m = 0.001$ kg and $R = 0.001$ m



(A) 2×10^{-10} C **(B)** 4×10^{-10} C **(C)** 6×10^{-10} C **(D)** 8×10^{-10} C

Q.7 Three equal point charges with charge +q each are moving along a circle of radius R and a fixed-point charge $-2q$ is placed at the centre of the circle. If +q charges are revolving at constant speed around $-2q$ as shown, then the speed of charges is (Assume that charges (+q) form vertices of equilateral triangle)



(A) $\frac{kq^2}{\sqrt{3}Rm}$ **(B)** $\sqrt{\frac{kq^2}{Rm}\left(2 - \frac{1}{\sqrt{3}}\right)}$ **(C)** $\sqrt{\frac{kq^2}{Rm}(\sqrt{2} + 1)}$ **(D)** $\frac{kq^2}{2Rm}$

Q.8 An isolated charge q_1 of mass m is suspended freely by a thread of length l. Another charge q_2 is brought near it ($r >> l$). When q_1 is in equilibrium, tension in thread will be

(A) mg **(B)** $>$ mg **(C)** $<$ mg **(D)** None of these

Q.9 Two equal positive point charges are separated by a distance $2a$. A point test charge is located in a plane which is normal to the line joining these charges and midway between them. Calculate the radius r of the circle of symmetry in this plane for which the force on the test charge has a maximum value.

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

Q.10 Two identical balls each having a density ρ are suspended in vaccum from a common point by two insulating strings of equal length. Both the balls have equal mass and charge. In equilibrium each string makes an angle θ with vertical. Now both the balls are immersed in a liquid, as a result the angle θ does not change. If the density of the liquid is σ, then find the dielectric constant of the liquid.

(A) $\frac{\sigma}{\rho-\sigma}$ **(B)** $\frac{\rho}{\rho-\sigma}$ **(C)** $\frac{\sigma}{\sigma+\rho}$ **(D)** $\frac{\sigma}{\sigma+\rho}$

WORK SHEET

Dimensional Analysis

Q.1 Refractive index μ is given as $\mu = A + \frac{B}{\lambda^2}$, where A and B are constants and λ is wavelength then dimension of B is same as that of

(A) Wavelength **(B)** Volume **(C)** Pressure **(D)** Area

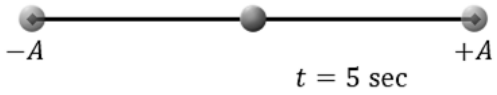
Screw Gauge

Q.2 Screw gauge of pitch 0.1 cm and 50 divisions on circular scale measures thickness of an object. Which of the following measurement is possible for thickness?

(A) 2.123 cm **(B)** 2.124 cm **(C)** 2.125 cm **(D)** 2.127 cm

Potential Energy

Q.3 The potential energy of a particle executing SHM changes from maximum to minimum is 5 *sec*. Then the time period of SHM is

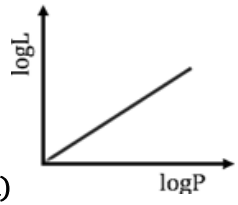


(A) 5 s **(B)** 10 s **(C)** 15 s **(D)** 20 s

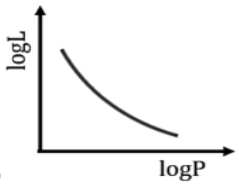
Angular Momentum

Q.4 If L represents angular momentum and P represents linear momentum then the variation of logL and logP is correctly shown by

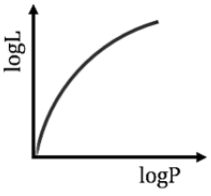
(A)



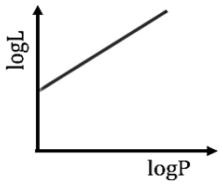
(B)



(C)

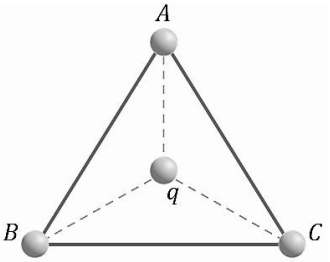


(D)



Principle of Superposition

Q.5 Three charges each of magnitude q are placed at the vertices of an equilateral triangle having side l. The electrostatic force on an identical charge placed at the centroid of the triangle is



(A) Zero **(B)** $\frac{1}{4\pi\epsilon_0}\frac{q^2}{l^2}$ **(C)** $\frac{1}{4\pi\epsilon_0}\frac{3q^2}{l^2}$ **(D)** $\frac{1}{12\pi\epsilon_o}\frac{q^2}{l^2}$

Phase Difference

Q.6 Two simple harmonic motions are represented by equations, $y_1 = 4\sin(10t + \phi)$ and $y_2 = 5\cos 10t$. What is the phase difference between their velocities?

(A) ϕ **(B)** $-\phi$ **(C)** $\phi + \frac{\pi}{2}$ **(D)** $\phi - \frac{\pi}{2}$

Buoyant Force

Q.7 A wooden cube just floats inside water with a 200 g mass placed on it. When the mass is removed, the cube floats with its top surface 2 cm above water level. What is the side of the cube?

(A) 6 cm **(B)** 8 cm **(C)** 10 cm **(D)** 12 cm

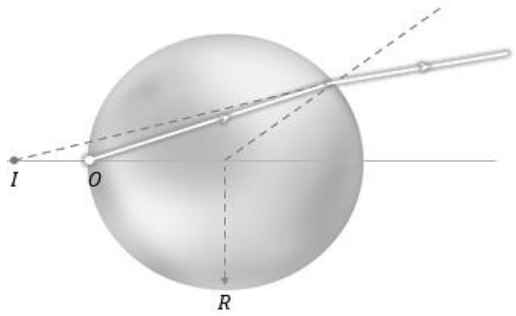
Refractive Index

Q.8 A ball is dropped from a height of 20m above the surface of water in a lake. The refractive index of water is $\frac{4}{3}$. A fish inside the lake, in the line of fall of the ball, is looking at the ball. At an instant, when the ball is 12.8m above the water surface, the fish sees the speed of ball as

(A) $9 ms^{-1}$ **(B)** $12 ms^{-1}$ **(C)** $16 ms^{-1}$ **(D)** $21.33 ms^{-1}$

Refraction at a Spherical Surface

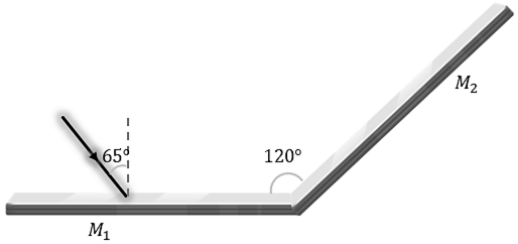
Q.9 A small object stuck on the surface of a glass sphere (n = 1.5) is viewed from the diametrically opposite position. Find transverse magnification if the surrounding medium is air.



(A) 3 **(B)** –2.5 **(C)** 2 **(D)** 2.5

Reflection of Light

Q.10 Find the value of angle of reflection at plane mirror M_2, when a ray of light is incident at M_1 as shown in figure.



(A) 45° **(B)** 55° **(C)** 65° **(D)** 75°

Coulomb's law

Q.11 Two-point charges q_1 and q_2 are placed at a distance of 50 m from each other in air, and interact with a certain force F. The same charges at same separation distance are now placed in oil whose relative permittivity is 5.0. Find the new force of interaction between them:

(A) F **(B)** $\frac{F}{S}$ **(C)** 5F **(D)** $\frac{F}{\sqrt{5}}$

Q.12 Which of the following options represents correct dimensions of ϵ_o?

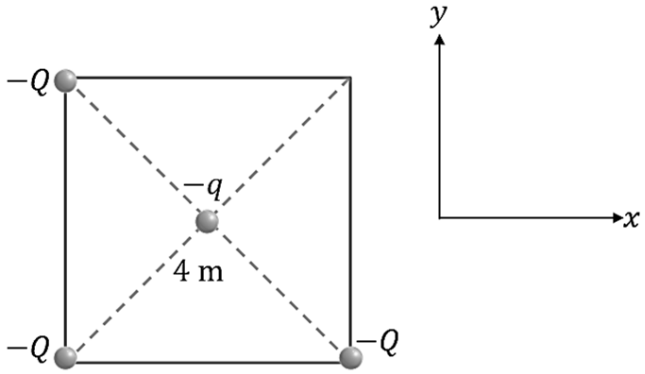
(A) $[M^{-1}L^{-3}T^4A^2]$ **(B)** $[M^0L^{-3}T^3A^3]$ **(C)** $[M^{-1}L^{-3}T^3A]$ **(D)** $[M^{-1}L^{-3}TA^2]$

Q.13 Three charges each of magnitude q are placed at the vertices of an equilateral triangle having side l. The electrostatic force on an identical charge placed at the centroid of the triangle is

(A) Zero **(B)** $\frac{1}{4\pi\epsilon_o}\frac{q^2}{l^2}$ **(C)** $\frac{1}{4\pi\epsilon_o}\frac{3q^2}{l^2}$ **(D)** $\frac{1}{12\pi\epsilon_o}\frac{q^2}{l^2}$

Principle of Superposition

Q.14 Three-point charges are placed at the vertices of a square of diagonal $4\ m$ as shown in figure. What will be the net force experienced by a charge $-q$ placed at centre of a square?



(A) $\frac{kQq}{4}(\hat{i}+\hat{j})$ **(B)** $\frac{kQq}{4}(\hat{i}-\hat{j})$ **(C)** $\frac{kQq}{4\sqrt{2}}(\hat{i}-\hat{j})$ **(D)** $\frac{kQq}{4\sqrt{2}}(\hat{i}+\hat{j})$

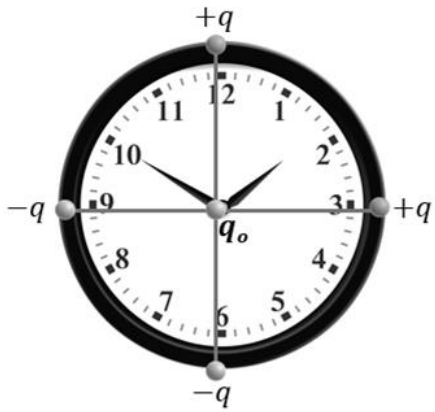
Coulomb's law

Q.15 The force per unit charge is known as

(A) Electric flux **(B)** Electric field **(C)** Electric potential **(D)** Electric current

Principle of Superposition

Q.16 Four charges are placed at the circumference of a dial clock as shown in the figure. If the clock has only hour hand, then the resultant force on a charge $+q_0$ placed at the centre, points in the direction which shows the time as



(A) 1 : 30 **(B)** 7: 30 **(C)** 4: 30 **(D)** 10: 30

Reanalysing Permittivity

Q.17 Two equal charges are suspended with non-conducting wires of equal length from the same point. Now, the whole system is taken inside a liquid (water). If the angle between the threads remains same, then calculate the relative permittivity of water. Relative density of both charged particles is σ.

(A) $\frac{\sigma}{\sigma-1}$ **(B)** $\frac{\sigma}{1+\sigma}$ **(C)** $\frac{1-\sigma}{\sigma}$ **(D)** $\frac{1}{\sigma-1}$

Q.18 Two small spheres with mass m_1 and m_2 hang from massless insulating threads of length l_1 and l_2. The two spheres carry charges q_1 and q_2 respectively. The spheres hang such that they are on the same horizontal level and the threads are inclined to the vertical at angles θ_1 and θ_2. Which of the conditions is required if $\theta_1 = \theta_2$?

(A) $m_1 = m_2$ **(B)** $|q_1| = |q_2|$ **(C)** $l_1 = l_2$ **(D)** $\frac{q_1}{m_1} = \frac{q_2}{m_2}$

Principle of Superposition

Q.19 Two identical non-conducting solid spheres of same mass and charge are suspended in air from a common point by two non-conducting, massless strings of same length. At equilibrium, the angle between the strings is α. The spheres are now immersed in a dielectric liquid of density 800 kgm^{-3} and dielectric constant 21. If the angle between the strings remains the same after the immersion, then

(A) Electric force between the spheres changes

(B) Mass density of the spheres is 8400 kgm^{-3}

(C) Mass density of the spheres is 840 kgm^{-3}

(D) The tension in the strings holding the spheres remains unchanged

Coulomb's Law - Vector Form

Q.20 The figure shows four charges fixed on the vertex of a square in the horizontal plane. A charged bead is constrained to move along a wire passing through the centre of the square. Mark the correct statement(s).

(A) In gravity free space, a positively charged bead cannot be in equilibrium at any position.

(B) In gravity free space, a negatively charged bead cannot be in equilibrium at any position.

(C) In the presence of gravity, a negatively charged bead can be in equilibrium position above the plane of fixed charges.

(D) In the presence of gravity, a positively charged particle can be in equilibrium above the plane of the fixed charges.

ANSWER KEY

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