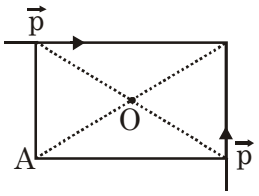
CLASS TEST

PHYSICS | CLASS TEST # 14

SECTION-I

Single Correct Answer Type — 6 Q. [3 M (–1)]

1. Two short electric dipoles of dipole moment $\vec{p}$ each are placed at two corners of a square as shown in figure. What is ratio of magnitudes of electric field at two point O and A :-



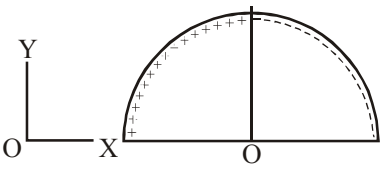
(A) 2 (B) $2\sqrt{2}$

(C) 1 (D) $\sqrt{2}$

2. Three equal charges Q are placed at the vertices of an equilateral triangle. What should be the value of a charge so that when placed at the centroid, self energy of the system becomes zero. (excluding the self energies of point charges)

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

3. A wire, of length L(= 20 cm), is bent into a semi-circular arc. If the two equal halves, of the arc, were each to be uniformly charged with charges ±Q, [$|Q| = 10^3\ \varepsilon_0$ Coulomb where ε_0 is the permittivity (in SI units) of free space] the net electric field at the centre O of the semi-circular arc would be :-

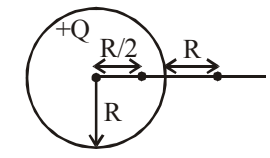


(A) $(50\times10^3\ \text{N/C})\ \hat{j}$ (B) $(50\times10^3\ \text{N/C})\ \hat{i}$ (C) $(25\times10^3\ \text{N/C})\ \hat{i}$ (D) $(25\times10^3\ \text{N/C})\ \hat{j}$

4. Two planes of charge with no thickness, A and B, are parallel and vertical. The electric field in region–1 to the left of plane A has magnitude $\frac{3\sigma}{2\varepsilon_0}$ and points to the left. The electric field in region–2 to the right of B has magnitude $\frac{3\sigma}{2\varepsilon_0}$ and points to the right. The electric field in region–3 between the two planes has magnitude $\frac{\sigma}{2\varepsilon_0}$ and points to the right. The surface charge density on planes A and B respectively is :-

(A) $-\frac{\sigma}{2}, \sigma$ (B) $+\frac{\sigma}{2}, \sigma$ (C) $\sigma, -\frac{\sigma}{2}$ (D) $2\sigma, \sigma$

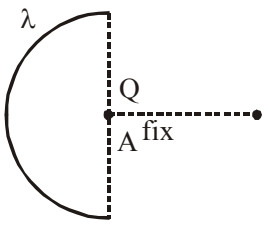
5. A point charge (+q) of mass m is released from a distance $\left(\frac{R}{2}\right)$ from the centre of a solid sphere of radius R and charge Q (uniformly charged in volume). The speed of the point charge when it reaches a distance R from the surface of the sphere (there is no interaction between sphere and point charge other than electrostatic). $k = \frac{1}{4\pi\in_0}$



fixed solid sphere

(A) $\sqrt{\frac{7kQq}{16mR}}$ (B) $\sqrt{\frac{7kQq}{4mR}}$ (C) $\sqrt{\frac{5kQq}{16mR}}$ (D) $\sqrt{\frac{3kQq}{4mR}}$

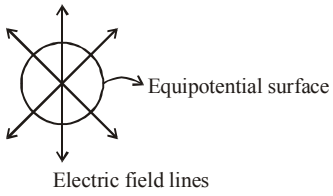
6. A charge is kept fixed at point A as shown in the figure in a gravity free space. A semicircular ring of linear charge density λ, mass m & radius R is released from rest. Initially centre of semicircular ring coincides with the fixed charge. The initial acceleration of the semicircular ring is :-

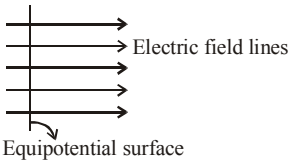


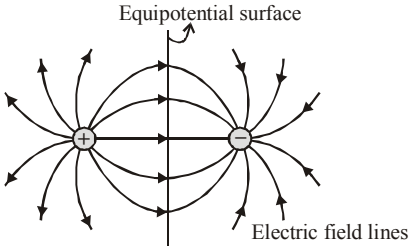
(A) $\frac{2K\lambda Q}{mR}$ (B) $\frac{K\lambda Q}{2mR}$ (C) $\frac{K\lambda Q}{mR}$ (D) 0

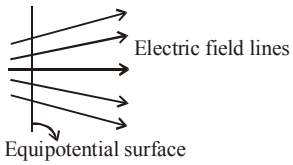
Multiple Correct Answer Type 5 Q. [4 M (–1)]

7. If we move in the direction perpendicular to the electric field, work done by the electric field will be zero and surface thus generated is called equipotential surface. Choose the correct matching :-

(A) 

(B) 

(C) 

(D) 

8. Consider a non-conducting sphere of radius a carrying uniformly distributed charge q surrounded by a spherical shell of radius 2a. The region between $a \le r \le 2a$ is filled with charge density $\rho = \frac{C}{r}$, where r is the distance from the centre. If the magnitude of electric field in the region $a \le r \le 2a$ is constant, then:

(A) $C = \frac{q}{2\pi a^2}$

(B) Magnitude of charge in the volume $a \le r \le 2a$ will be 3q.

(C) Electric field outside the spherical shell remains constant.

(D) $C = \frac{q}{\pi a^2}$

9. A non-conducting solid sphere of radius 30 cm and relative permittivity 1 has the volume charge density $\rho = \left(\frac{5}{2\pi}\mu C/m^3\right)\left(1 - \frac{r}{30cm}\right)$, where r (in cm) is the radial distance of any point in the space from the centre of the sphere. Then choose the correct statement(s).

(A) Density of electric field lines is maximum at r = 25 cm

(B) Density of electric field lines is maximum at r = 20 cm

(C) Electrical energy stored in the space r = 30 cm to $r \to \infty$, is same as that of a solid non-conducting sphere carrying charge of 0.0225 μC and radii 30 cm having uniform volume charge density in the same space r = 30 cm to $r \to \infty$.

(D) Variation of magnitude of electric field due to the sphere with respect to radial distance r is rectangular hyperbola in the region r = 30 to $r \to \infty$.

10. In a solid sphere of radius R = 2m charge density varies as

$$\rho = \frac{A}{r^2} - \frac{B}{r} \qquad 0 < r \le R$$

where A = 1 C/m and B = 1 C/m^2. For this sphere

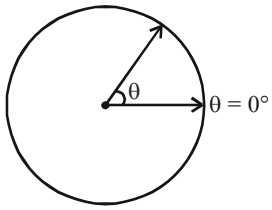
(A) Flux of electric field linked with a sphere of radius r ($0 < r \le R$), increases as r increases

(B) Flux of electric field linked with a sphere of radius r ($0 < r \le R$), first increases and then decreases as r increases

(C) Magnitude of electric field intensity continuously decreases as r increases from $r > 0$ to $r = R$.

(D) Forces experienced by two point charges placed at distance 3m and 4m from centre of sphere are same.

11. The linear charge density on a non conducting ring of radius R is varying with θ as $\lambda = \lambda_0 \cos\theta$:-



(A) Electric field at the center of the ring is zero

(B) Electric field at center of ring is towards left

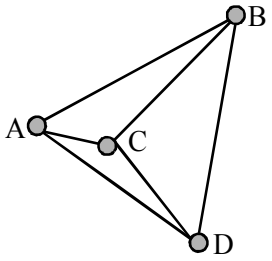
(C) Electric field on a line perpendicular to the plane of the ring and passing through the center of the ring is zero

(D) Electric field on a line perpendicular to the plane of the ring and passing through the center of the ring is non-zero.

Linked Comprehension Type (1 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Question Nos. 12 to 14

Four charged particles (A, B, C, D), of mass m and charge q each are connected by light silk threads of length d forming a tetrahedron floating in outer space. The thread connecting particles A and B suddenly snaps.



12. Mark the **CORRECT** statement :-

(A) Displacement of centre of mass of system of particles is $\frac{d}{\sqrt{3}}$

(B) Angular momentum of system about CM is $\frac{4Md^2}{\sqrt{3}}\omega$, where ω is maximum angular velocity of particles about centre of mass.

(C) When particles attain maximum speed direction of motion of particles C and D is opposite to that of A and B.

(D) When particles attain maximum speed direction of motion of all the particles is in same direction

13. The potential energy of particle A and B when the maximum speed is attained by charged particles :-

(A) $U = \frac{q^2}{4\pi\epsilon_0\left(d\sqrt{2}\right)}$ (B) $U = \frac{q^2}{4\pi\epsilon_0\left(d\sqrt{3}\right)}$

(C) $U = \frac{q^2}{4\pi\epsilon_0 d}\left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)$ (D) $U = \frac{q^2}{4\pi\epsilon_0 d}\left(\frac{\sqrt{3}-1}{\sqrt{3}}\right)$

14. Maximum speed of particles is :-

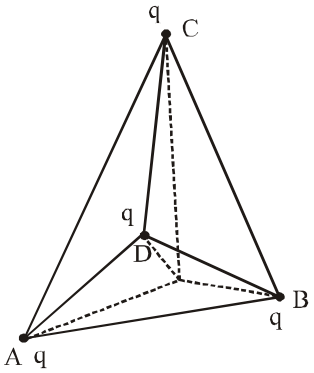
(A) $v = \sqrt{\frac{q^2}{8\pi\epsilon_0 md}\left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)}$ (B) $v = \sqrt{\frac{q^2}{8\pi\epsilon_0 md}\left(\frac{\sqrt{3}-1}{\sqrt{3}}\right)}$

(C) $v = \sqrt{\frac{q^2}{8\pi\epsilon_0 md}\left(\frac{1}{\sqrt{2}}\right)}$ (D) $v = \sqrt{\frac{q^2}{8\pi\epsilon_0 md}\left(\frac{1}{\sqrt{3}}\right)}$

Matching List Type (4 × 4) 1Q.[3 M (–1)]

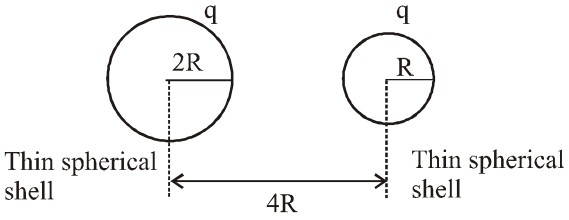
15. List-I shows different configurations of charge distribution. List-II gives the corresponding expressions of physical quantities mentioned in list-I :-

List-I **List-II**

(P) 

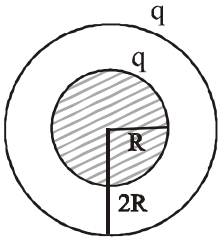
Four point charges are kept at the vertices of a regular tetrahedron of side R.Total electrostatics energy of the configuration.

(1) $\frac{6kq^2}{R}$

(Q) 

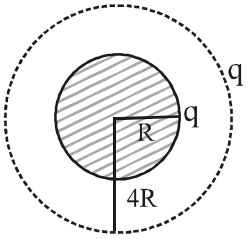
Two thin spherical uniformly charged shells having charge q are separated by distance 4R. Total electrostatics energy of the configuration.

(2) $\frac{6kq^2}{R}\left(\frac{9}{40}\right)$

(R) 

A solid non-conducting sphere of radius R having uniform charge q is kept inside a thin spherical non-conducting shell of radius 2R having uniform charge q. Total electrostatics energy of the configuration.

(3) $\frac{6kq^2}{6R}$

(S) 

Work done in contracting the sphere having uniform charge q from radius 4R to R

(4) $\frac{6kq^2}{40R}$(3)

Codes :

	P	Q	R	S
(A)	1	3	4	2
(B)	4	2	3	1
(C)	3	2	1	4
(D)	1	3	2	4

SECTION-II

Numerical Answer Type Question 1Q.[3(0)]
(upto second decimal place)

1. In a 2-D region of x-y space, a uniform electric field exists, given by : E = (2 V/m) (3i + 4j). A charged particle of mass 10^{-2} g and charge 10^{-5} C is fired from the origin with initial velocity 20 m/s, directed along the negative y-direction. Find the minimum speed (in m/s) of the particle during its subsequent motion. Neglect gravity.

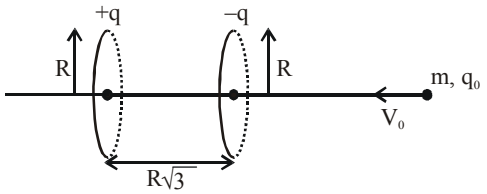
SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 3 Q. [4 M (0)]

1. Two point charges 2 μC and 8 μC are placed at position x = 0 and x = 4 m respectively. The distance of the neutral point form the smaller charge is found to be at x= α/β. Find the value of $(\alpha+\beta)$.

2. A positive charged particle q_0, when launched with some velocity $\vec{v}_0$ in a uniform field is found to deviate by 60º in a certain time, such that its speed is halved. If –ve charged particle $-2q_0$, is launched with the same velocity $\vec{v}_0$ in the same field then after same time its speed is v_2. Mass of both particles is same then $\frac{v_2^2}{v_0^2}$ would be :-

3. Two uniformly charged co-axial, identical rings (Radius R) are fixed as shown. A point charge q_0 is projected with speed V_0 along common axis of rings from large distance. Minimum value of V_0 for which the charge particle can just pass through both rings is given as $V_0 = \sqrt{\frac{kqq_0}{nmR}}$. Find $n\left(k = \frac{1}{4\pi\in_0}\right)$.



CLASS TEST # 14 **ANSWER KEY**

SECTION-I

Single Correct Answer Type **6 Q. [3 M (–1)]**

1. Ans. (B) **2. Ans. (D)** **3. Ans. (C)** **4. Ans. (D)** **5. Ans. (B)** **6. Ans. (A)**

Multiple Correct Answer Type **5 Q. [4 M (–1)]**

7. Ans. (A,B,C) **8. Ans. (A,B)** **9. Ans. (B,C)** **10. Ans. (B,C,D)** **11. Ans. (B, D)**

Linked Comprehension Type (1 Para × 3Q.) [3 M (-1)]

(Single Correct Answer Type)

12. Ans. (C) **13. Ans. (B)** **14. Ans. (B)**

Matching List Type (4 × 4) **1Q.[3 M (–1)]**

15. Ans. (D)

SECTION-II

Numerical Answer Type Question (upto second decimal place) **1Q.[3(0)]**

1. Ans. 12.00

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **3 Q. [4 M (0)]**

1. Ans. 7 **2. Ans. 7** **3. Ans. 1**