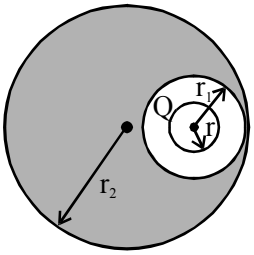
CLASS TEST

PHYSICS | CLASS TEST # 17

SECTION-I

Single Correct Answer Type **5 Q. [3 M (–1)]**

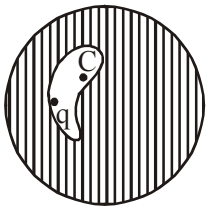
1. Charge Q is distributed on a small hollow conducting sphere (radius r) as shown inside a spherical cavity of radius r_1 made inside a solid conducting sphere of radius r_2 as shown in the figure. The total energy of the system is :-



(A) $kQ^2\left(\frac{1}{2r_2}-\frac{1}{2r_1}+\frac{1}{2r}\right)$ (B) $kQ^2\left(\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{2r}\right)$

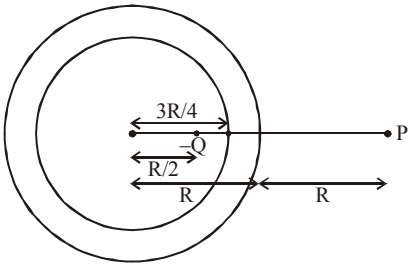
(C) $kQ^2\left(\frac{1}{2r_1}+\frac{1}{4r_2}+\frac{1}{2r}\right)$ (D) $kQ^2\left(\frac{1}{4r_1}+\frac{1}{2r_2}+\frac{1}{2r}\right)$

2. The figure shows a charge q placed inside a cavity in an uncharged conductor. Now if an external electric field is switched on then :



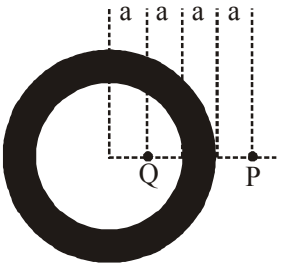
(A) only induced charge on outer surface will redistribute
(B) only induced charge on inner surface will redistribute
(C) Both induced charge on outer and inner surface will redistribute
(D) force on charge q placed inside the cavity will change

3. There are two conducting concentric spherical thin shells of radius $\frac{3R}{4}$ and R. Thin shell of radius R is given a charge 4 Q. A point charge –Q is also placed in the cavity at a distance R/2 from the centre as shown in figure. Find the electric potential at a distance 2R from the centre of concentric spherical shells along the line joining point charge :



(A) $\frac{1}{8\pi\varepsilon_0}\frac{5Q}{R}$ (B) $-\frac{1}{8\pi\varepsilon_0}\frac{5Q}{R}$ (C) $\frac{1}{8\pi\varepsilon_0}\frac{3Q}{R}$ (D) $\frac{1}{2\pi\in_0}\frac{Q}{3R}$

4. A solid uncharged conducting sphere has radius 3a contains a hollowed spherical region of radius 2a. A point charge +Q is placed at a position a distance a from the common center of the spheres. What is the magnitude of the electric field at the position r = 4a from the center of the spheres as marked in the figure by P? $\left(k=\frac{1}{4\pi\in_0}\right)$:-



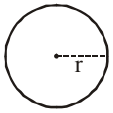
(A) 0 (B) $\frac{kQ}{16a^2}$ (C) $\frac{3kQ}{16a^2}$ (D) $\frac{kQ}{9a^2}$

5. An isolated and charged spherical soap bubble has a radius 'r' and the pressure inside is 1 atmosphere. If 'T' is the surface tension of soap solution, then charge on the soap bubble is :-

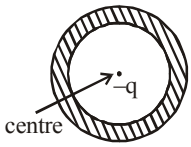
(A) $2\sqrt{\frac{2rT}{\in_0}}$ (B) $8\pi r\sqrt{2rT\in_0}$ (C) $8\pi r\sqrt{rT\in_0}$ (D) $8\pi r\sqrt{\frac{2rT}{\in_0}}$

Multiple Correct Answer Type 3 Q. [4 M (–1)]

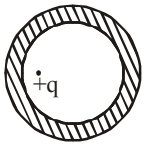
6. In which of the cases we will get uniform charge distribution of (+q) on external spherical surface. Given every object is a conductor :

(A) 

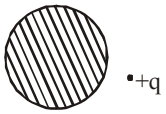
thin shell having net charge +q

(B) 

thick shell having net charge zero

(C) 

thick shell having net charge zero

(D) 

solid sphere having net charge +q

7. A long thin straight wire with linear charge density λ runs along axis of a thin hollow metal cylinder of radius R. The cylinder has a net linear charge density 2λ. Assume λ is positive. Mark correct options:-

(A) $\vec{E}(r > R) = \frac{3\lambda}{2\pi\epsilon_0}\frac{\hat{r}}{r}$

(B) $\vec{E}(r < R) = \frac{3\lambda}{2\pi\epsilon_0}\frac{\hat{r}}{r}$

(C) Linear charge density on inner surface of cylinder is $-\lambda$

(D) Linear charge density on outer surface of cylinder is 3λ

8. A point charge q is placed at P(0, 0, a). Then :-

(A) Flux through surface formed by joining points (0, 0, 0) ; (0, a, 0) ; (a, 0, 0) is greater than $\frac{q}{48\varepsilon_0}$

(B) Flux through surface formed by joining points (0, a, 0) ; (a, 0, 0) ; (a, a, 0) is greater than $\frac{q}{24\varepsilon_0}$

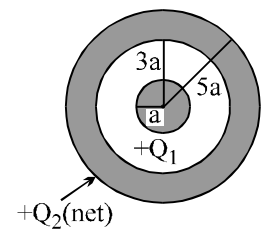
(C) Flux through surface formed by joining points (0, a, 0); (0, –a, 0); (–a, –a, 0); (–a, a, 0) is equal to $\frac{q}{12\varepsilon_0}$

(D) Flux through surface formed by joining points (0, 0, 0) ; (0, 0, a) ; (0, a, a) ; (0, a, 0) is equal to $\frac{q}{48\varepsilon_0}$

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

Paragraph for Question No. 9 to 11

A spherical insulator of radius a is concentric with a conducting spherical shell having inner radius 3a and outer radius 5a as shown in the figure. The charge $+Q_1$ is uniformly distributed throughout the volume of the insulator, and the net charge on the conductor is $+Q_2$.



9. What is the magnitude of the electric field a distance of 2a from the center of the insulator?

(A) $(Q_1 + Q_2)/4\pi\varepsilon_0 a^2$ (B) $Q_1/16\pi\varepsilon_0 a^2$ (C) $Q_1/4\pi\varepsilon_0 a^2$ (D) None of these

10. What is the flux of the electric field through a Gaussian sphere of radius $4a$ that is concentric with both the insulator and conducting shell?

(A) 0 (B) Q_1/ε_0 (C) $(Q_1+Q_2)/\varepsilon_0$ (D) None of these

11. What is the surface charge density on the outer surface of the conductor?

(A) $Q_2/100\pi a^2$ (B) $(Q_1 + Q_2)/100\pi a^2$

(C) $3(Q_1 + Q_2)/100\pi a^2$ (D) None of these

Matching list based comprehension Type (4 × 4 × 4) 1 Table × 3 Q. [3(–1)]

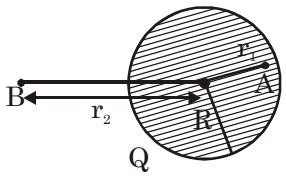
Single option correct (Three Columns and Four Rows)

Answer Q.12, Q.13 and Q.14 by appropriately matching the information given in the three columns of the following table.

Column-I & II represents the magnitude of electric field at points A & B respectively. Column-III represents the magnitude of potential difference between the two points. (Take potential at infinity to be zero) $\left(k=\frac{1}{4\pi\varepsilon_0}\right)$

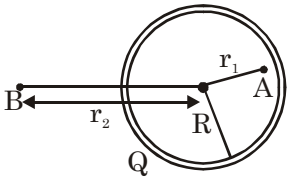
	Column–I Electric field at point A		**Column-II Electric field at point B**		**Column-III Potential difference between two points**
(I)	$\frac{\rho r_1}{2\varepsilon_0}$	(i)	$\frac{\rho R^2}{4\varepsilon_0 r_2}$	(P)	$\lvert V_A - V_B\rvert = \frac{kQ}{2R}\left(3-\frac{r_1^2}{R^2}\right)-\frac{kQ}{r_2}$
(II)	$\frac{kQr_1}{R^3}$	(ii)	$\frac{\rho R^2}{2\varepsilon_0 r_2}$	(Q)	$\lvert V_A - V_B\rvert = \frac{3kQ}{2R}-\frac{kQ}{r_2}$
(III)	0	(iii)	$\frac{kQ}{r_2^2}$	(R)	$\lvert V_C - V_B\rvert = \frac{\rho R^2}{2\varepsilon_0}\ell n\left(\frac{r_3}{r_2}\right)$
(IV)	$\frac{\rho r_1}{4\varepsilon_0}$	(iv)	$\frac{kQr_2}{R^3}$	(S)	$\lvert V_A - V_B\rvert = \frac{kQ}{R}-\frac{kQ}{r_2}$

12. Which of the following combination represents the situation due to a uniformly charged non-conducting solid sphere having total charge Q & radius R :-



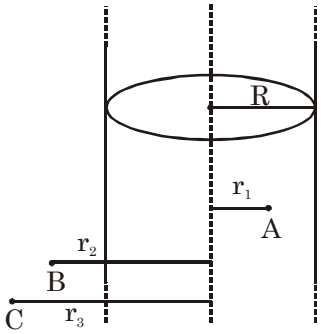
(A) (II) (iii) (Q) (B) (III) (iii) (S) (C) (II) (iii) (P) (D) (III) (iv) (P)

13. Which of the following combination represents the situation due to a uniformly charged non-conducting hollow thin sphere having total charge Q & radius R.



(A) (III) (iii) (S) (B) (II) (iii) (P) (C) (III) (iv) (Q) (D) (II) (iv) (S)

14. Which of the following combination represents the situation due to a uniformly charged infinite solid cylinder of radius R and charge density ρ.



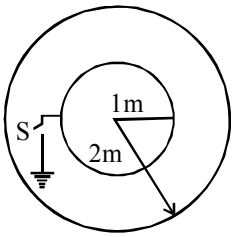
(A) (III) (i) (P) (B) (I) (i) (R) (C) (IV) (ii) (P) (D) (I) (ii) (R)

SECTION-III

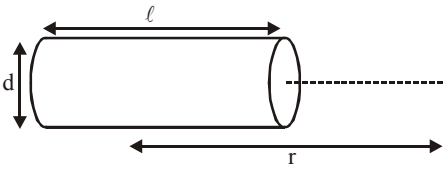
Numerical Grid Type (Ranging from 0 to 9) 5 Q. [4 M (0)]

1. An arrangement of source charges produces the electric potential $V = 5000\ x^2$ along the x-axis, where V is in volts and x is in meters. If a charge particle of mass 1g and charge 1nC is present in this field and its turning points are at ± 8.0 cm? What is the particle's maximum speed (in mm/s).

2. Figure shows two concentric spherical shell having radii 1 m and 2 m respectively. Outer spherical surface has charge -3.2×10^{-15} Coulomb. If inner surface is now earthed by closing the switch then $x \times 10^{+y}$ number of electron move towards earth, then x + y will be (x, y ∈ I, 0 ≤ x,y ≤ 9).

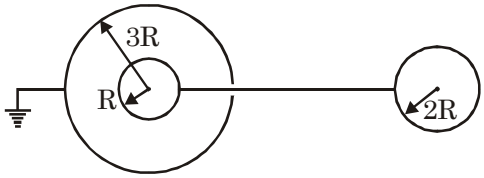


3. Figure shows a cylindrical conducting rod of diameter d and length $\ell >> d$ uniformly charged in vacuum such that electric field near its surface and far from its ends is E_0. Electric field at $r >> \ell$ on the axis of the cylinder is $\frac{3E_0\ell d}{2Nr^2}$. Then find the value of N.



4. A spherical conductor of radius 4cm carries a charge of $\frac{10}{9}\times10^{-10}\,C$. At what distance (in cm) from of sphere should a point charge of $\frac{40}{9}\times10^{-10}\,C$ should be placed so that the potential of the conductor becomes 75 V. Assume potential is zero at infinity.

5. Two metal balls of radii R and 2R are connected to a long thin conducting wire and has total charge Q = 21 μC. Then the ball of radius R is placed inside a grounded metal sphere of radius 3R as shown. What charge (in μC) will flow through the thin wire in this process ?



CLASS TEST # 17	ANSWER KEY

SECTION-I

Single Correct Answer Type **5 Q. [3 M (–1)]**

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

Multiple Correct Answer Type **3 Q. [4 M (–1)]**

6. Ans. (A, C) **7. Ans. (A, C, D)** **8. Ans. (A,C)**

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

9. Ans. (B) **10. Ans. (A)** **11. Ans. (B)**

Matching list based comprehension Type (4 × 4 × 4) **1 Table × 3 Q. [3(–1)]**
Single option correct (Three Columns and Four Rows)

12. Ans. (C) **13. Ans. (A)** **14. Ans. (D)**

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **5 Q. [4 M (0)]**

1. Ans. 8 **2. Ans. 5** **3. Ans. 6** **4. Ans. 8**
5. Ans. 2