Additional Problems For Self Practice (APSP)

PART-I : PRACTICE TEST PAPER

Max. Marks : 120 **Max. Time : 1 Hr.**

Important Instructions :

1. The test is of **1 hour** duration and max. marks 120.
2. The test consists **30** questions, **4 marks** each.
3. Only one choice is correct **1 mark** will be deducted for incorrect response. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
4. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 3 above.

1. A flat circular fixed disc has a charge +Q uniformly distributed on the disc. A charge +q is thrown with kinetic energy K, towards the disc along its axis. The charge q :
(1) may hit the disc at the centre
(2) may return back along its path after touching the disc
(3) may return back along its path without touching the disc
(4) any of the above three situations is possible depending on the magnitude of K

2. A 5 coulomb charge experiences a constant force of 2000 N when moved between two points separated by a distance of 2 cm in a uniform electric field. The potential difference between these two points is:
(1) 8 V (2) 200 V (3) 800 V (4) 20,000 V

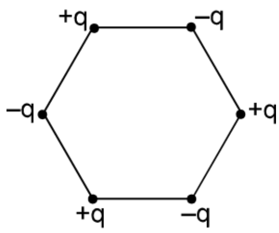
3. An equipotential surface and an electric line of force :
(1) never intersect each other (2) intersect at 45º
(3) intersect at 60º (4) intersect at 90º

4. A hollow uniformly charged sphere has radius r. If the potential difference between its surface and a point at distance 3r from the centre is V, then the electric field intensity at a distance 3r from the centre is:
(1) V/6r (2) V/4r (3) V/3r (4) V/2r

5. A hollow sphere of radius 5 cm is uniformly charged such that the potential on its surface is 10 volts then potential at centre of sphere will be :
(1) Zero
(2) 10 volt
(3) Same as at a point 5 cm away from the surface
(4) Same as at a point 25 cm away from the centre

6. A particle of mass 2 g and charge 1μC is held at rest on a frictionless horizontal surface at a distance of 1 m from a fixed charge of 1 mC. If the particle is released it will be repelled. The speed of the particle when it is at distance of 10 m from the fixed charge is:
(1) 100 m/s (2) 90 m/s (3) 60 m/s (4) 45 m/s

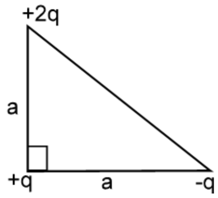
7. Six charges of magnitude + q and –q are fixed at the corners of a regular hexagon of edge length a as shown in the figure. The electrostatic potential energy of the system of charged particles is :



(1) $\frac{q^2}{\pi \epsilon_0 a}\left[\frac{\sqrt{3}}{8}-\frac{15}{4}\right]$ (2) $\frac{q^2}{\pi \epsilon_0 a}\left[\frac{\sqrt{3}}{2}-\frac{9}{4}\right]$

(3) $\frac{q^2}{\pi \epsilon_0 a}\left[\frac{\sqrt{3}}{4}-\frac{15}{2}\right]$ (4) $\frac{q^2}{\pi \epsilon_0 a}\left[\frac{\sqrt{3}}{2}-\frac{15}{8}\right]$

8. Three charges +q, –q, and + 2q are placed at the vertices of a right angled triangle (isosceles triangle) as shown. The net electrostatic energy of the configuration is :



(1) $-\frac{K\ q^2}{a}(\sqrt{2}+1)$ (2) $\frac{Kq^2}{a}(\sqrt{2}+1)$

(3) $-\frac{K\ q^2}{a}(\sqrt{2}-1)$ (4) None of these

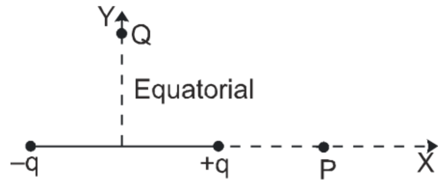
9. A sphere of radius 1 cm has potential of 8000 V. The energy density near the surface of sphere will be:
(1) 64×10^5 J/m^3 (2) 8×10^3 J/m^3 (3) 32 J/m^3 (4) 2.83 J/m^3

10. Four positive charges $(2\sqrt{2}-1)$ Q are arranged at corner of a square. Another charge q is placed at the centre of the square. Resultant force acting on each corner is zero If q is
(1) – 7Q/4 (2) – 4Q/7 (3) -Q (4) None

11. The electric potential V as a function of distance x (in metre) is given by
$V = (5x^2 + 10x - 9)$ volt.
The value of electric field at x = 1 m would be :
(1) – 20 volt/m (2) 6 volt/m (3) 11 volt/m (4) –23 volt/m

12. If uniform electric field $\vec{E} = E_0\ \hat{i} + 2\ E_0\ \hat{j}$, where E_0 is a constant, exists in a region of space and at (0, 0) the electric potential V is zero, then the potential at $(x_0, 0)$ will be :
(1) zero (2) $-E_0 x_0$ (3) $-2 E_0 x_0$ (4) $-\sqrt{5}\ E_0 x_0$

13. Due to an electric dipole shown in fig., the electric field intensity is parallel to dipole axis



(1) at P only
(2) at Q only
(3) both at P and at Q
(4) neither at P nor at Q

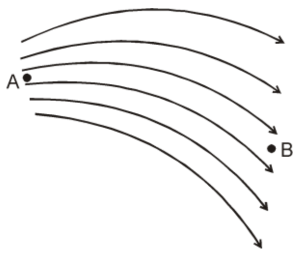
14. Dipole is placed parallel to the electric field. If W is the work done in rotating the dipole by 60°, then work done in rotating it by 180° is :
(1) 2W (2) 3W (3) 4W (4) W/2

15. Two opposite and equal charges of magnitude 4×10^{-8} coulomb each when placed 2×10^{-2} cm apart form a dipole. If this dipole is placed in an external electric field of 4×10^8 N/C, the value of maximum torque and the work required in rotating it through 180º from its initial orientation which is along electric field will be : (Assume rotation of dipole about an axis passing through centre of the dipole):
(1) 64×10^{-4} N-m and 44×10^{-4} J (2) 32×10^{-4} N-m and 32×10^{-4} J
(3) 64×10^{-4} N-m and 32×10^{-4} J (4) 32×10^{-4} N-m and 64×10^{-4} J

16. At a point on the axis (but not inside the dipole and not at infinity) of an electric dipole
(1) The electric field is zero
(2) The electric potential is zero
(3) Neither the electric field nor the electric potential is zero
(4) The electric field is directed perpendicular to the axis of the dipole

17. The force between two short electric dipoles separated by a distance r is directly proportional to :
(1) r^2 (2) r^4 (3) r^{-2} (4) r^{-4}

18. The figure shows the electric lines of force emerging from a charged body. If the electric fields at A and B are E_A and E_B respectively and if the distance between A and B is r, then



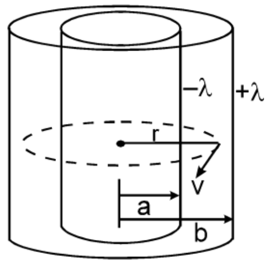
(1) $E_A < E_B$ (2) $E_A > E_B$

(3) $E_A = \frac{E_B}{r}$ (4) $E_A = \frac{E_B}{r^2}$

19. An electric dipole is placed at the centre of a sphere. Mark the correct options.

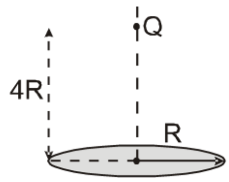
(1) The electric field is zero at every point of the sphere.
(2) The flux of the electric field through the sphere is non-zero.
(3) The electric field is zero on a circle on the sphere.
(4) The electic field is not zero anywhere on the sphere.

20. Figure shows two large cylindrical shells having uniform linear charge densities $+\lambda$ and $-\lambda$. Radius of inner cylinder is 'a' and that of outer cylinder is 'b'. A charged particle of mass m, charge q revolves in a circle of radius r. Then, its speed 'v' is : (Neglect gravity and assume the radii of both the cylinders to be very small in comparison to their length.)



(1) $\sqrt{\frac{\lambda q}{2\pi \epsilon_0 m}}$ (2) $\sqrt{\frac{2\lambda q}{\pi \epsilon_0 m}}$
(3) $\sqrt{\frac{\lambda q}{\pi \epsilon_0 m}}$ (4) $\sqrt{\frac{\lambda q}{4\pi\varepsilon_0 m}}$

21. A charge Q is placed at a distance of 4R above the centre of a disc of radius R. The magnitude of flux through the disc is φ. Now a hemispherical shell of radius R is placed over the disc such that it forms a closed surface. The flux through the curved surface (taking direction of area vector along outward normal as positive), is



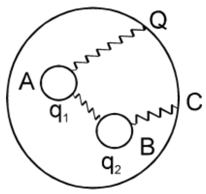
(1) zero (2) φ (3) $-\varphi$ (4) 2φ

22. A positive point charge q is brought near a neutral metal sphere.
(1) The sphere becomes negatively charged.
(2) The sphere becomes positively charged.
(3) The interior remains neutral and the surface gets non-uniform charge distribution.
(4) The interior becomes positively charged and the surface becomes negatively charged.

23. Three concentric conducting spherical shells carry charges as follows : + 4Q on the inner shell, - 2 Q on the middle shell and – 5 Q on the outer shell. The charge on the inner surface of the outer shell is:
(1) 0 (2) 4 Q (3) - Q (4) - 2 Q

24. A charge q is uniformly distributed over a large plastic plate. The electric field at a point P close to the centre and just above the surface of the plate is 50 V/m. If the plastic plate is replaced by a copper plate of the same geometrical dimensions and carrying the same uniform charge q, the electric field at the point P will become :
(1) zero (2) 25 V/m (3) 50 V/m (4) 100 V/m

25. Two small conductors A and B are given charges q_1 and q_2 respectively. Now they are placed inside a hollow metallic conductor (C) carrying a charge Q. If all the three conductors A, B and C are connected by conducting wires as shown, the charges on A, B and C will be respectively:

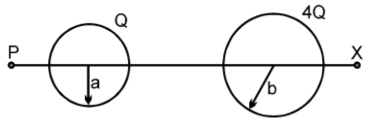


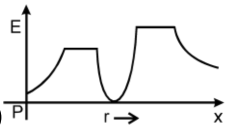
(1) $\frac{q_1+q_2}{2}, \frac{q_1+q_2}{2}, Q$ (2) $\frac{Q+q_1+q_3}{3}, \frac{Q+q_1+q_2}{3}, \frac{Q+q_1+q_2}{3}$
(3) $\frac{q_1+q_2+Q}{2}, \frac{q_1+q_2+Q}{2}, 0$ (4) 0, 0, $Q + q_1 + q_2$

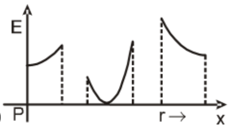
26._ Two uniformly charged non-conducting hemispherical shells each having uniform charge density σ and radius R form a complete sphere (not stuck together) and surround a concentric spherical conducting shell of radius R/2. If hemispherical parts are in equilibrium then minimum surface charge density of inner conducting shell is:

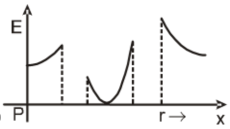
(1) -2σ (2) $-\sigma/2$ (3) $-\sigma$ (4) 2σ

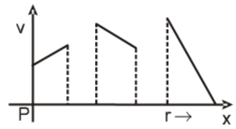
27. For the spherical isolated charged spherical conductors shown in the figure, if one moves from P to X, which of the following graphs is correct (approximately) ?



(1) 

(2) 

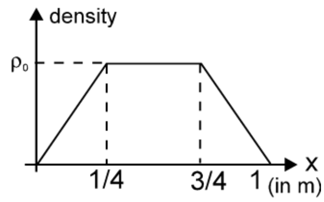
(3) 

(4) 

28. A particle A has charge +q and particle B has charge + 4q with each of them having the same mass m. When allowed to fall from rest through same electrical potential difference, the ratio of their speed $v_A : v_B$ will be :

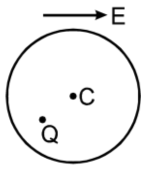
(1) 2 : 1 (2) 1 : 2 (3) 4 : 1 (4) 1 : 4

29. The volume charge density as a function of distance X from one face inside a unit cube is varying as shown in the figure. Then the total flux (in S.I. units) through the cube if ($\rho_0 = 8.85 \times 10^{-12}$ C/m^3) is:



(1) 1/4 (2) 1/2
(3) 3/4 (4) 1

30. A positive point charge Q is kept (as shown in the figure) inside a neutral conducting shell whose centre is at C. An external uniform electric field E is applied. Then :



(1) Force on Q due to E is zero
(2) Net force on Q is zero
(3) Net force acting on Q and conducting shell considered as a system is zero
(4) Net force acting on the shell due to E is zero.

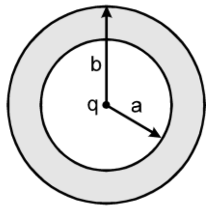
Practice Test (JEE-Main Pattern)

OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22	23	24	25	26	27	28	29	30
Ans.										

PART - II : PRACTICE QUESTIONS

1. A point charge q is brought from infinity (slowly so that heat developed in the shell is negligible) and is placed at the centre of a conducting neutral spherical shell of inner radius a and outer radius b, then work done by external agent is:



(1) 0 (2) $\frac{kq^2}{2b}$

(3) $\frac{kq^2}{2b} - \frac{kq^2}{2a}$ (4) $\frac{kq^2}{2a} - \frac{kq^2}{2b}$

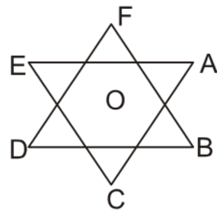
2. A solid sphere of radius R has a volume charge density $\rho = \rho_0 r^2$ (Where ρ_0 is a constant and r is the distance from centre). At a distance x from its centre (for x < R), the electric field is directly proportional to :

(1) $1/x^2$ (2) $1/x$ (3) x^3 (4) x^2

3. A total charge of 20 μC is divided into two parts and placed at some distance apart. If the charges experience maximum coulombian repulsion, the charges should be :

(1) 5 μC, 15μC (2) 10 μC, 10 μC (3) 12 μC, 8 μC (4) $\frac{40}{3}\mu C, \frac{20}{3}\mu C$

4. The magnitude of electric force on 2 μ c charge placed at the centre O of two equilateral triangles each of side 10 cm, as shown in figure is P. If charge A, B, C, D, E & F are 2 μ c, 2 μ c, 2 μ c, -2 μc, - 2 μ c, - 2 μ c respectively, then P is:



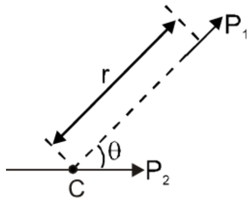
(1) 21.6 N (2) 64.8 N

(3) 0 (4) 43.2 N

5. A charge Q is kept at the centre of a conducting sphere of inner radius R_1 and outer radius R_2. A point charge q is kept at a distance r (> R_2) from the centre. If q experiences an electrostatic force 10 N then assuming that no other charges are present, electrostatic force experienced by Q will be:

(1) – 10 N (2) 0 (3) 20 N (4) none of these

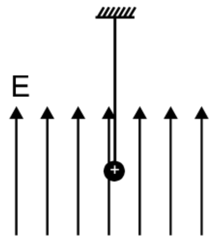
6. Two short electric dipoles are placed as shown (r is the distance between their centres). The energy of electric interaction between these dipoles will be:
(C is centre of dipole of moment P_2)



(1) $\frac{2k\ P_1P_2\ \cos\theta}{r^3}$ (2) $\frac{-2k\ P_1P_2\ \cos\theta}{r^3}$

(3) $\frac{-\ 2k\ P_1P_2\ \sin\theta}{r^3}$ (4) $\frac{-\ 4k\ P_1P_2\ \cos\theta}{r^3}$

7. A positively charged pendulum is oscillating in a uniform electric field as shown in Figure. Its time period of SHM as compared to that when it was uncharged. (mg > qE)



(1) Will increase
(2) Will decrease
(3) Will not change
(4) Will first increase then decrease

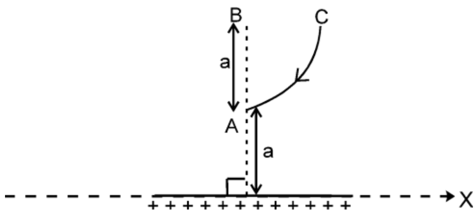
8. A solid metallic sphere has a charge +3Q. Concentric with this sphere is a conducting spherical shell having charge –Q. The radius of the sphere is a and that of the spherical shell is b(>a). What is the electric field at a distance r(a < r < b) from the centre?

(1) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$ (2) $\frac{1}{4\pi\varepsilon_0}\frac{3Q}{r}$ (3) $\frac{1}{4\pi\varepsilon_0}\frac{3Q}{r^2}$ (4) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$

9. A solid conducting sphere having a charge Q is surrounded by an uncharged concentric conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge –3Q, the new potential difference between the same two surfaces is :

(1) V (2) 2V (3) 4V (4) –2V

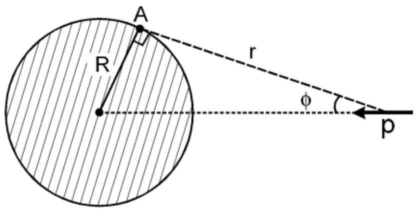
10. For an infinite line of charge having charge density λ lying along x-axis, the work required in moving charge q from C to A along arc CA is :



(1) $\frac{q\lambda}{\pi\varepsilon_0}\log_e\sqrt{2}$ (2) $\frac{q\lambda}{4\pi\varepsilon_0}\log_e\sqrt{2}$

(3) $\frac{q\lambda}{4\pi\varepsilon_0}\log_e 2$ (4) $\frac{q\lambda}{2\pi\varepsilon_0}\log_e\frac{1}{2}$

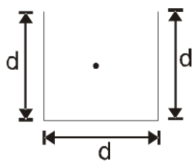
11. A dipole having dipole moment p is placed in front of a solid uncharged conducting sphere as shown in the diagram. The net potential at point A lying on the surface of the sphere is :



(1) $\frac{kp\cos\phi}{r^2}$ (2) $\frac{kp\cos^2\phi}{r^2}$

(3) zero (4) $\frac{2kp\cos^2\phi}{r^2}$

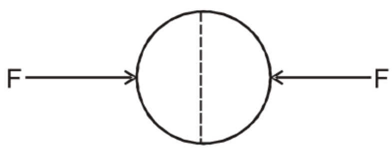
12. A charge q is placed at the centre of the cubical vessel (with one face open) as shown in figure. The flux of the electric field through the surface of the vessel is



(1) zero (2) q/ε_0

(3) $\frac{q}{4\varepsilon_0}$ (4) $5q/6\varepsilon_0$

13. A uniformly charged thin spherical shell of radius R carries uniform surface charge density of σ per unit area. It is made of two hemispherical shells, held together by pressing them with force F (see figure). F is proportional to



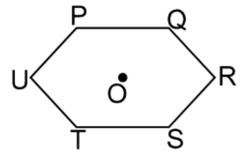
(1) $\frac{1}{\varepsilon_0}\sigma^2R^2$ (2) $\frac{1}{\varepsilon_0}\sigma^2R$

(3) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R}$ (4) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R^2}$

14. A tiny spherical oil drop carrying a net charge q is balanced in still air with a vertical uniform electric field of strength $\frac{81\pi}{7}\times10^5$ Vm^{-1}. When the field is switched off, the drop is observed to fall with terminal velocity 2×10^{-3} m s^{-1}. Given g = 9.8 m s^{-2}, viscosity of the air = 1.8×10^{-5} Ns m^{-2} and the density of oil = 900 kg m^{-3}, the magnitude of q is :

(1) 1.6×10^{-19} C (2) 3.2×10^{-19} C (3) 4.8×10^{-19} C (4) 8.0×10^{-19} C

15. Six charges q,q,q, – q, –q and –q are to be arranged on the vertices of a regular hexagon PQRSTU such that the electric field at centre is double the field produced when only charge 'q' is placed at vertex R. The sequence of the charges from P to U is :



(1) q, –q, q, q, –q, –q (2) q, q, q, –q, –q, –q

(3) –q, q, q, –q, –q, q (4) –q, q, q, q, –q, –q

16. A $+q_1$ charge is at centre of an imaginary spherical Gaussion surface 'S' and $-q_1$ charge is placed nearby this $+q_1$ charge inside 'S'. A charge $+q_2$ is located outside this Gaussian surface. Then, electric field on Gaussian surface will be :

(1) due to $-q_1$ & q_2 (2) uniform

(3) due to all charges (4) zero

APSP Answers

PART- I

1.	(4)	**2.**	(1)	**3.**	(4)	**4.**	(1)	**5.**	(2)	**6.**	(2)	**7.**	(4)
8.	(3)	**9.**	(4)	**10.**	(1)	**11.**	(1)	**12.**	(2)	**13.**	(3)	**14.**	(3)
15.	(4)	**16.**	(3)	**17.**	(4)	**18.**	(2)	**19.**	(4)	**20.**	(1)	**21.**	(3)
22.	(3)	**23.**	(4)	**24.**	(3)	**25.**	(4)	**26.**	(1)	**27.**	(2)	**28.**	(2)
29.	(3)	**30.**	(4)										

PART- II

1.	(3)	**2.**	(3)	**3.**	(2)	**4.**	(4)	**5.**	(2)	**6.**	(2)	**7.**	(1)
8.	(3)	**9.**	(1)	**10.**	(1)	**11.**	(2)	**12.**	(4)	**13.**	(1)	**14.**	(4)
15.	(1)	**16.**	(3)										