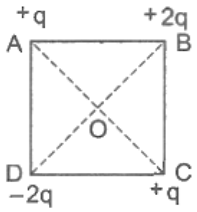
ACUMEN

JEE MAIN - PHYSICS

Test 1

Time Allowed: 1 hour **Maximum Marks: 100**

1. Four charges are arranged at the corners of a square ABCD as shown in the figure. The force on the charge kept at the centre is: **[4]**



a) perpendicular to side AB
b) along the diagonal AC
c) along the diagonal BD
d) zero

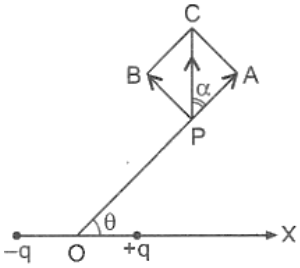
2. A particle of charge q and mass m is subjected to an electric field $E = E_0 (1 - ax^2)$ in the x-direction, where a and E_0 are constants. Initially, the particle was at rest at x = 0. Other than the initial position the kinetic energy of the particle becomes zero when the distance of the particle from the origin is: **[4]**

a) $\sqrt{\frac{1}{a}}$
b) $\sqrt{\frac{2}{a}}$
c) a
d) $\sqrt{\frac{3}{a}}$

3. Two electric dipoles of moments p and 64p are placed in opposite direction on a line at a distance of 25 cm. The electric field will be zero at a point between the dipoles whose distance from the dipole of moment p is: **[4]**

a) $\frac{25}{9}$ cm
b) $\frac{4}{13}$ cm
c) 5 cm
d) 10 cm

4. An electric dipole of moment $\vec{p}$ is placed at the origin along the x-axis. The electric field at a point P, whose position vector makes an angle θ with the x-axis, will make an angle: with the x-axis, where $\tan \alpha = \frac{1}{2} \tan \theta$. **[4]**



a) $2\theta + \alpha$
b) $\theta + \alpha$
c) α
d) θ

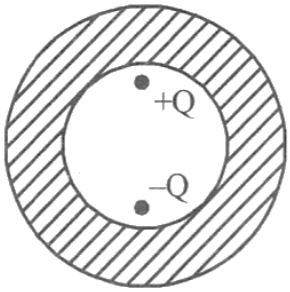
5. Under the action of a given Coulombic force, the acceleration of an electron is 2.5×10^{22} **[4]**

m/sec^2. Then, the magnitude of the acceleration of a proton under the action of same force is nearly:

a) 1.6×10^{27} m/sec^2 b) 9.1×10^{31} m/sec^2

c) 1.5×10^{19} m/sec^2 d) 1.6×10^{-19} m/sec^2

6. Shown in the figure are two point charges +Q and -Q inside the cavity of a spherical shell. The charges are kept near the surface of the cavity on opposite sides of the centre of the shell. If σ_1 is the surface charge on the inner surface and Q_1 net charge on it and σ_2 the surface charge on the outer surface and Q_2 net charge on it then: **[4]**



a) $\sigma_1 \neq 0, Q_1 \neq 0$
$\sigma_2 \neq 0, Q_2 \neq 0$

b) $\sigma_1 = 0, Q_1 = 0$
$\sigma_2 = 0, Q_2 = 0$

c) $\sigma_1 \neq 0, Q_1 = 0$
$\sigma_2 \neq 0, Q_2 = 0$

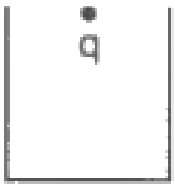
d) $\sigma_1 \neq 0, Q_1 = 0$
$\sigma_2 = 0, Q_2 = 0$

7. Among two discs A and B, first have radius 10 cm and charge 10^{-6} C and second have radius 30 cm and charge 10^{-5} C. When they are touched, charge on both q_A and q_B respectively will, be: **[4]**

a) $q_A = 2.75\ \mu C, q_B = 3.15\ \mu C$ b) None of these

c) $q_A = 1.09\ \mu C, q_B = 1.53\ \mu C$ d) $q_A = q_B = 5.5\ \mu C$

8. A charge q is placed at the centre of the open end of a cylindrical vessel (figure). The flux of the electric field through the surface of the vessel is: **[4]**



a) $\frac{q}{2\varepsilon_0}$ b) $\frac{2q}{\varepsilon_0}$

c) Zero d) $\frac{q}{\varepsilon_0}$

9. An electric dipole is placed at an angle of 30^o with an electric field of intensity 2×10^5 NC^{-1}. It experiences a torque equal to 6 Nm. The charge on the dipole if the dipole length is 3 cm is: **[4]**

a) 2×10^{-3} C b) 3×10^{-3} C

c) 1×10^{-3} C d) 6×10^{-3} C

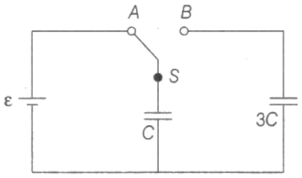
10. Two point dipoles of dipole moment $\overrightarrow{p_1}$ and $\overrightarrow{p_2}$ are at a distance x from each other and $\vec{p}_1 \| \vec{p}_2$. **[4]**

The force between the dipoles is:

a) $\frac{1}{4\pi\varepsilon_0}\frac{3p_1p_2}{x^3}$ b) $\frac{1}{4\pi\varepsilon_0}\frac{6p_1p_2}{x^4}$

c) $\frac{1}{4\pi\varepsilon_0}\frac{8p_1p_2}{x^4}$ d) $\frac{1}{4\pi\varepsilon_0}\frac{4p_1p_2}{x^4}$

11. In the figure shown, after the switch S is turned from position A to position B, the energy dissipated in the circuit in terms of capacitance C and total charge Q is **[4]**



a) $\frac{1}{8}\cdot\frac{Q^2}{C}$ b) $\frac{3}{4}\cdot\frac{Q^2}{C}$

c) $\frac{5}{8}\cdot\frac{Q^2}{C}$ d) $\frac{3}{8}\cdot\frac{Q^2}{C}$

12. A uniform vertical electric field E is established in the space between two large parallel plates. A small conducting sphere of mass m is suspended in the field from a string of length L. If the sphere is given a + q charge and the lower plate is charged positively, the period of oscillation of this pendulum is: **[4]**

a) $2\pi\sqrt{\frac{L}{g+(\frac{qE}{m})}}$ b) $2\pi\sqrt{\frac{L}{g}}$

c) $2\pi\sqrt{\frac{L}{g-(\frac{qE}{m})}}$ d) $2\pi\sqrt{\frac{L}{\left[g^2+(\frac{qE}{m})^2\right]^{\frac{1}{2}}}}$

13. A force of 2.56 N acts on a charge of 16×10^{-4} C. The intensity of electric field at that point is: **[4]**

a) 16 NC^{-1} b) 1600 NC^{-1}

c) 1.5 NC^{-1} d) 150 NC^{-1}

14. Which of the following statements about dipole moment is not true? **[4]**

a) The unit of dipole moment is Cm^{-1}.

b) The dimensions of dipole moment are $[L^1T^0A^0]$.

c) Dipole moment is a scalar quantity and has a magnitude charge equal to the potential of separation between charges.

d) Dipole moment is vector quantity and directed from negative to positive charge.

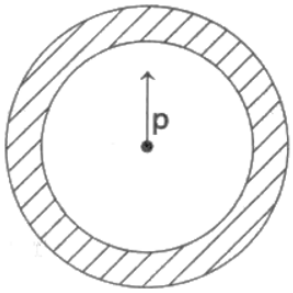
15. The electrostatic force between two point charges is directly proportional to the: **[4]**

a) product of the charges b) sum of the charges

c) permittivity of the medium d) distance between the charges

16. Shown in the figure is a shell made of a conductor. It has inner radius a and outer radius a and outer radius b and carries charges Q. At its centre is a dipole $\vec{p}$ as shown. **[4]**

In this case,



a) electric field outside the shell is the same as that of a point charge at the centre of the shell

b) surface charge density on the inner surface is uniform and equal to $\frac{\left(\frac{Q}{2}\right)}{4\pi a^2}$

c) surface charge density on the inner surface of the shell is zero everywhere

d) surface charge density on the outer surface depends on $|\vec{p}|$

17. What is the angle between the electric dipole moment and the electric field strength due to it on the axial line? **[4]**

a) 90^o

b) 0^o

c) 180^o

d) 45^o

18. Three equal charges are placed on the three corners of a square. If the force between q_1 and q_2 is F_{12} and that between q_1 and q_3 is F_{13}, the ratio of magnitudes $\frac{F_{12}}{F_{13}}$ is: **[4]**

a) 0.5

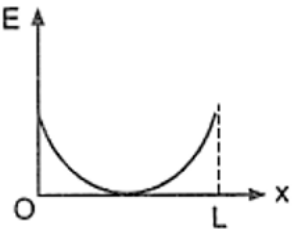
b) 1

c) 2

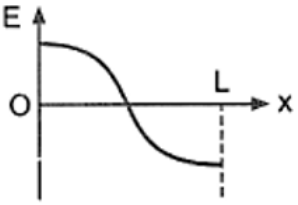
d) 1.5

19. Two identical point charges are placed at a separation of l. P is a point on the line joining the charges, at a distance x from any one charge. The field at P is E. E is plotted against x for values of x from close to zero to slightly less than l. Which of the following best represents the resulting curve? **[4]**

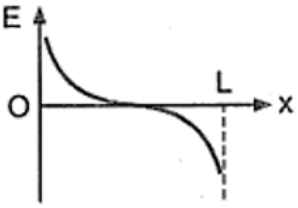
a)



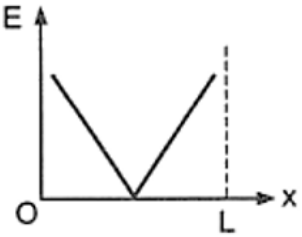
b)



c)

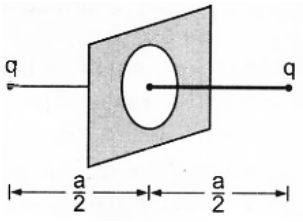


d)



20. Two equal positive point charges q are held at a fixed distance a apart. A point test charge is located in a plane that is normal to the line joining these charges and midway between them. What is the radius r of the circle in this plane for which the force on the test particle has **[4]**

maximum value?



a) $\frac{a}{2\sqrt{2}}$ b) $\frac{a}{2}$

c) $\frac{a}{\sqrt{2}}$ d) $\sqrt{2}a$

21. The voltage of cloud is 4×10^6 volt with respect to ground. In a lightning strike lasting 100 m/sec, a charge of 4 coulomb is delivered to the ground. The power of the lightning strike is: **[4]**

22. A point charge of 2 C experiences a constant force of 1000 N when moved between two points separated by a distance of 2 cm in a uniform electric field. The potential difference between the two points is : **[4]**

23. If 20 J of work has to be done to move an electric charge of 4 C from a point, where potential is 10 V to another point, where potential is V volt, find the value of V: **[4]**

24. Two positive point charges of 12 and 5 microcoulombs, are placed 10 cm apart in air. The work needed to bring them 4 cm closer is: **[4]**

25. A positive charge +Q is fixed at a point A. Another positively charged particle of mass m and charge +q is projected from a point B with velocity u as shown in the +Q figure. Point B is at a large distance from A and at distance d from the line AC. The initial velocity is parallel to the line AC. Point C is at a very large distance from A. If the minimum distance (in metre) of +q from +Q during motion. **[4]**
[Take $Qq = 4\pi\varepsilon_0 mu^2 d$] is $d(1+\sqrt{x})$, then find the value of x.