

Electric Charges and Fields — NEET Physics PYQ (2006–2021)

Class 12 Physics · 16 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2021

1. Polar molecules are the molecules :

- (A) having zero dipole moment.
- (B) acquire a dipole moment only in the presence of electric field due to displacement of charges.
- (C) acquire a dipole moment only when magnetic field is absent.
- (D) having a permanent electric dipole moment.

NEET 2020 · Q151

2. A spherical conductor of radius 10 cm has a charge of 3.2×10^{-7} C distributed uniformly. What is the magnitude of electric field at a point 15 cm from the centre of the sphere ? ($1/4\pi\epsilon_0 = 9 \times 10^9 \text{ N m}^2/\text{C}^2$)

- (A) $1.28 \times 10^4 \text{ N/C}$
- (B) $1.28 \times 10^5 \text{ N/C}$
- (C) $1.28 \times 10^6 \text{ N/C}$
- (D) $1.28 \times 10^7 \text{ N/C}$

NEET 2019 · Q25

3. A hollow metal sphere of radius R is uniformly charged. The electric field due to the sphere at a distance r from the centre:

- (A) increases as r increases for $r < R$ and for $r > R$
- (B) zero as r increases for $r < R$, decreases as r increases for $r > R$
- (C) zero as r increases for $r < R$, increases as r increases for $r > R$
- (D) decreases as r increases for $r < R$ and for $r > R$

NEET 2019 · Q36

4. Two parallel infinite line charges with linear charge densities $+\lambda \text{ C/m}$ and $-\lambda \text{ C/m}$ are placed at a distance of $2R$ in free space. What is the electric field mid-way between the two line charges?

- (A) zero
- (B) $2\lambda/(\pi\epsilon_0 R) \text{ N/C}$
- (C) $\lambda/(\pi\epsilon_0 R) \text{ N/C}$
- (D) $\lambda/(2\pi\epsilon_0 R) \text{ N/C}$

NEET 2019 · Q37

5. Two point charges A and B, having charges $+Q$ and $-Q$ respectively, are placed at certain distance apart and force acting between them is F. If 25% charge of A is transferred to B, then force between the charges becomes:

- (A) F
- (B) $9F/16$
- (C) $16F/9$
- (D) $4F/3$

NEET 2018 · Q22

6. An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is

- (A) 10 times greater
- (B) 5 times greater
- (C) smaller
- (D) equal

7. An electric dipole is placed at an angle of 30° with an electric field intensity $2 \times 10^5 \text{ N/C}$. It experiences a torque equal to 4 N m . The charge on the dipole, if the dipole length is 2 cm , is

- (A) 8 mC
- (B) 2 mC
- (C) 5 mC
- (D) $7 \mu\text{C}$

8. Two identical charged spheres suspended from a common point by two massless strings of lengths l , are initially at a distance d ($d \ll l$) apart because of their mutual repulsion. The charges begin to leak from both the spheres at a constant rate. As a result, the spheres approach each other with a velocity v . Then v varies as a function of the distance x between the spheres, as:

- (A) $v \propto x^{(1/2)}$
- (B) $v \propto x$
- (C) $v \propto x^{(-1/2)}$
- (D) $v \propto x^{(-1)}$

9. The electric field in a certain region is acting radially outward and is given by $E = Ar$. A charge contained in a sphere of radius ' a ' centred at the origin of the field, will be given by:

- (A) $\epsilon_0 Aa^3$
- (B) $4\pi\epsilon_0 Aa^2$
- (C) $A\epsilon_0 a^2$
- (D) $4\pi\epsilon_0 Aa^3$

10. Two pith balls carrying equal charges are suspended from a common point by strings of equal length; the equilibrium separation between them is r . Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now becomes

- (A) $(1/\sqrt{2})^2$
- (B) $r/\sqrt[3]{2}$
- (C) $2r/\sqrt{3}$
- (D) $2r/3$

11. What is the flux through a cube of side a if a point charge of q is at one of its corners?

- (A) $(q/2\epsilon_0)6a^2$
- (B) $2q/\epsilon_0$
- (C) $q/(8\epsilon_0)$
- (D) q/ϵ_0

12. A charge Q is enclosed by a Gaussian spherical surface of radius R . If the radius is doubled, then the outward electric flux will

- (A) Be doubled
- (B) Increase four times
- (C) Be reduced to half
- (D) Remain the same

13. The electric field at a distance $3R/2$ from the centre of a charged conducting spherical shell of radius R is E . The electric field at a distance $R/2$ from the centre of the sphere is

- (A) Zero
- (B) E
- (C) $E/2$
- (D) $E/3$

14. Two positive ions, each carrying a charge q , are separated by a distance d . If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge on an electron)

- (A) $4\pi\epsilon_0 Fd^2/q^2$
- (B) $4\pi\epsilon_0 Fd^2/e^2$
- (C) $\sqrt{4\pi\epsilon_0 Fe^2/d^2}$
- (D) $\sqrt{4\pi\epsilon_0 Fd^2/e^2}$

15. A square surface of side L meter in the plane of the paper is placed in a uniform electric field E (volt/m) acting along the same plane at an angle θ with the horizontal side of the square. The electric flux linked to the surface, in units of volt-m, is

- (A) Zero
- (B) EL^2
- (C) $EL^2 \cos \theta$
- (D) $EL^2 \sin \theta$

16. An electric dipole of moment $\vec{p}$ is lying along a uniform electric field E . The work done in rotating the dipole by 90° is :

- (A) $\sqrt{2} pE$
- (B) $pE/2$
- (C) $2pE$
- (D) pE

Answer key and explanations

1. Answer: (D) having a permanent electric dipole moment.

In polar molecules such as H_2O and HCl the centres of positive and negative charge do not coincide, so they have a permanent dipole moment even without an external field. Acquiring a dipole only in an applied field describes non-polar molecules (induced dipoles).

2. Answer: (B) $1.28 \times 10^5 \text{ N/C}$

Outside the sphere it acts like a point charge: $E = kq/r^2 = 9 \times 10^9 \times 3.2 \times 10^{-7} / (0.15)^2 = 2880/0.0225 = 1.28 \times 10^5 \text{ N/C}$. Using 10 cm (the radius) instead of 15 cm, or forgetting to convert cm to m, gives the other powers of ten.

3. Answer: (B) zero as r increases for $r < R$, decreases as r increases for $r > R$

By Gauss's law the field inside a charged conducting shell is zero, and outside it falls as kQ/r^2 . A field increasing outside the sphere would contradict the inverse-square dependence.

4. Answer: (C) $\lambda/(\pi\epsilon_0 R) \text{ N/C}$

Each line gives $E = \lambda/(2\pi\epsilon_0 R)$ at distance R . At the midpoint the field of $+\lambda$ points away from it and that of $-\lambda$ points toward it, i.e. in the same direction, so they add: $\lambda/(\pi\epsilon_0 R)$. Zero would hold only for like charges.

5. Answer: (B) $9F/16$

Transferring $Q/4$ from A to B leaves A with $+3Q/4$ and B with $-Q + Q/4 = -3Q/4$. Force $\propto$ product of charges, so $F' = (9/16)F$. $16F/9$ inverts the ratio.

6. Answer: (C) smaller

In both cases the electric force is downward with magnitude eE , so each accelerates at $a = eE/m$ (plus g). Since $t = \sqrt{2h/a}$ and the electron's mass is far smaller, its acceleration is much larger and its time of fall is smaller. The times are not equal because the masses differ.

7. Answer: (B) 2 mC

$\tau = pE \sin\theta = q(2a)E \sin\theta$, so $4 = q \times 0.02 \times 2 \times 10^5 \times 0.5 = 2000q$, giving $q = 2 \times 10^{-3} \text{ C} = 2 \text{ mC}$. Using $\sin 30^\circ$ as 1 by mistake gives 1 mC, and forgetting to convert cm to m gives a far smaller charge.

8. Answer: (C) $v \propto x^{(-1/2)}$

For small angles, equilibrium gives $kq^2/x^2 = mg \cdot (x/2l)$, so $q^2 \propto x^3$ and $q \propto x^{(3/2)}$. Differentiating, $dq/dt \propto x^{(1/2)} \cdot dx/dt$; since dq/dt is constant, $v = dx/dt \propto x^{(-1/2)}$. The speed therefore increases as the spheres come closer, ruling out $v \propto x^{(1/2)}$ and $v \propto x$.

9. Answer: (D) $4\pi\epsilon_0 Aa^3$

At $r = a$ the field is Aa , radial, so the flux through the sphere is $Aa \times 4\pi a^2 = 4\pi Aa^3$. By Gauss's law $q = \epsilon_0 \times \text{flux} = 4\pi\epsilon_0 Aa^3$. Forgetting the 4π gives $\epsilon_0 Aa^3$.

10. Answer: (B) $r^{3/2}$

For a ball at equilibrium, $\tan \theta = F/mg$; with small angles $\tan \theta \approx (r/2)/L$, so $(r/2)/L = kq^2/(r^2 mg)$, giving $r^3 \propto L$. Clamping at half the height halves the effective length, so $r'^3 = r^3/2$ and $r' = r/\sqrt[3]{2}$.

11. Answer: (C) $q/(8\epsilon_0)$

A charge at a corner can be enclosed symmetrically by 8 identical cubes, so each cube receives 1/8 of the total flux q/ϵ_0 , i.e. $q/(8\epsilon_0)$. q/ϵ_0 would apply only if the charge were inside the cube.

12. Answer: (D) Remain the same

By Gauss's law, the total flux through any closed surface is $q(\text{enclosed})/\epsilon_0$. The enclosed charge is still Q when the radius doubles, so the flux remains the same; the field falls as $1/r^2$ but the area grows as r^2 .

13. Answer: (A) Zero

All the charge of a conducting shell sits on its surface, and by Gauss's law the enclosed charge for any point inside ($r = R/2$) is zero, so the field there is zero. The value E at $3R/2$ only describes points outside the shell and does not scale down inside.

14. Answer: (D) $\sqrt{(4\pi\epsilon_0 Fd^2/e^2)}$

Each ion has charge $q = ne$. $F = (ne)^2/(4\pi\epsilon_0 d^2)$, so $n^2 = 4\pi\epsilon_0 Fd^2/e^2$ and $n = \sqrt{(4\pi\epsilon_0 Fd^2/e^2)}$. The same expression without the square root gives n^2 , not n .

15. Answer: (A) Zero

Flux = $E \cdot A \cos(\text{angle between } E \text{ and the area vector})$. The area vector is normal to the paper, while E lies in the plane of the paper, so the angle is 90° and the flux is zero for any θ . $EL^2 \cos \theta$ wrongly treats θ as the angle with the normal.

16. Answer: (D) pE

Work done in rotating a dipole in a uniform field is $W = pE(\cos \theta_1 - \cos \theta_2)$. From $\theta = 0^\circ$ to 90° , $W = pE(1 - 0) = pE$. The value $2pE$ applies to rotating it through 180° .

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