PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

POTENTIAL AND FIELD DUE TO A DIPOLE

Example

1. ABC is a small , isosceles right angled-triangle of hypotenuse 1 cm . A charge of $+4pC$ (picocoulomb) is placed at the right-angled corner A and -20 pC and -20pC at B and C respectively . Show that this system of charges may be treated as a dipole for all external points at large distances . Calculate the potential due to this system of charges of charges at a point on the prolongation of the side AC at a distance 40 cm from A .

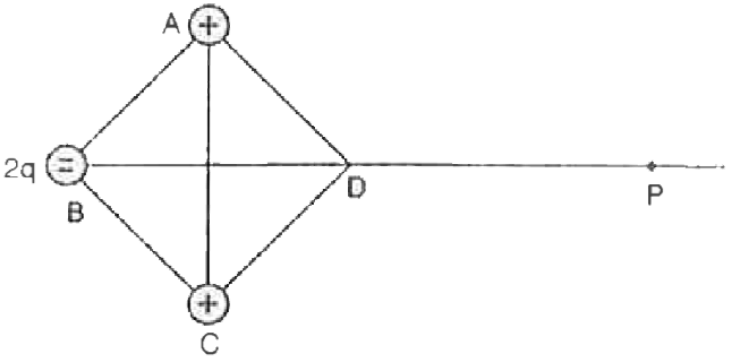
Watch Video Solution

2. Calculate the binding energy of a dipole consisting of two charges $+4pC$ and -4 pC separated by a distance 20μ (micron) .

Watch Video Solution

3. A system consists of two identical dipoles placed along the sides of a square ABCD in such a way that $+q$ and $+q$ lie at the corner A and C and $-q$ and $-q$ at the corner B . Calculate the potential due to the system on

the diagonal BD at a distance r from the intersection of the diagonals of the square . The length of each diagonal is 2a .



Watch Video Solution

4. In a certain region of space, electric field is along the z-direction throughout. The magnitude of electric field is , however, not

constant but increases uniformly along the positive z-direction. At the rate of $10^5 NC^{-1}m^{-1}$. What are the force and torque experienced by system having a total dipole moment equal to 10^{-7}Cm in the negative z-direction?

Watch Video Solution

5. A dipole of moment $\overrightarrow{p} = 10^{-7}\left(5\hat{i} + \hat{j} - 2\hat{k}\right)$ C is placed in an

electric field $\vec{E} = 10^7\left(\hat{i} + \hat{j} + \hat{k}\right)Vm^{-1}$.

Find the torque experienced .

Watch Video Solution

Exercise

1. ABC is a very small equilateral triangles of side 0.5×10^{-3} m . A charge of $+20$ aC (attocoulomb) is placed at the corner A and two charges , each of -10aC , at B and C . Calculate the potential at a point on the

prolongation of AC 2 cm away from A .

[Hint: 1 aC (attocoulomb = 10^{-18} coulomb]

Watch Video Solution

2. An electric dipole consists of two opposite charges of magnitude $1\mu C$ (micro-coulomb) separated by a distance of 2 cm . The dipole is placed in an electric field of $10^5 Vm^{-1}$. (a) What maximum torque does the field exert on the dipole ? (b) How much work must an external agent do to turn the dipole end for

end , starting from a position of alignment $\theta = 0$?

Watch Video Solution

3. Show that the potential at a point of coordinates (x,y) with reference to the axis of the dipole as x -axis and the line perpendicular to the axis and passing through the centre of the dipole as y-axis is $V = \frac{1}{4\pi\varepsilon_0}, \frac{px}{(x^2+y^2)^{3/2}}$ and hence show that the components of the field along x- and

y- axis are given by ,

$$E_x = \frac{q}{4\pi\varepsilon_0}, \frac{2x^2 - y^2}{(x^2 + y^2)^{5/2}}$$

$$E_y = \frac{p}{4\pi\varepsilon_0}, \frac{3xy}{(x^2 + y^2)^{5/2}}$$

[Hint : Find the value of cos θ and r in terms of x and y and substitute their values in the standard formula $E_x = -\frac{\partial V}{\partial x} \text{and} E_y = -\frac{\partial V}{\partial y}$]

Watch Video Solution

4. A dipole of moment 4×10^{-14} C m is placed with the its centre at one correct of a cube of

sidelength 20 cm and its axis coinciding with one of the edges at that corner . Calculate the potential and field at the diagonally opposite corner .

Watch Video Solution

5. Two dipole of moment 5×10^{-12} C m form a cross with their axes $(-\text{to}+)$ along the coordinate axes . Calculate the potential at a point 20 cm away in a directioin making an angle 30° with the x-axis .

Watch Video Solution

6. Find the locus of points where the electric field due to a dipole is (i) perpendicular to its axis , (ii) anti-parallel to the axis .

[Hint : $\tan\alpha = \frac{\tan\theta}{2}$]

Watch Video Solution

7. Find the locus of points where the electric field (resultant) will always have a bearing of 45° with the axis of the dipole .

Watch Video Solution

8. A dipole consisting of $+10$ nC (nanocoulomb) and -10 nC separted by 2 cm oscillates in an electric field of strength $60000Vm^{-1}$. Calculate the frequency of vibration of the dipole if its moment of inertia about the axis of oscillation is $3 \times 10^{-10}kgm^2$

.

[Hint : t = $2\pi\sqrt{\frac{I}{pE}}$ a formula similar to t = $2\pi\sqrt{\frac{I}{mB}}$ in magnetism.]

Watch Video Solution

9. A system consists of charges +q and +q at the opposite corners of a square of sides 2a and $-q$ and $-q$ at the other two corners . Calculate the potential and field at a distance r from the centre of the square along a line parallel to the two sides of the square . Assume a $<<$ r .

Watch Video Solution

10. Two identical dipoles have their axes at right angles to each other and also bisecting each other . Calculate the field at a distance r from the point of intersection of their axes in a direction θ with the axis of one of the dipoles . The dipole moment of each dipole is equal to p .

Watch Video Solution

11. A system consists of charges +q and +q at the opposite corners of a square of sides 2a and $-q$ and $-q$ at the other two corners . Calculate the potential and field at a distance r from the centre of the square along a line parallel to the two sides of the square . Assume a $<<$ r .

Watch Video Solution

12. Two electric dipoles , each of dipole moment $p = 6.2 \times 10^{-30}$ C m are placed with their axes along the same line their centre a distance $d = 10^{-8}$ m apart . Calculate the force of attraction between the dipoles .

Watch Video Solution

13. A point electric dipole with a moment p is placed in the external uniform electric field whose strength equals E_0. With $p \uparrow \uparrow E_0$. In

this case one of the equipotential surfaces enclosing the dipole from a sphere. Find the radius of this sphere.

Watch Video Solution

14. Calculate the energy released in the formation of 1 kg hydrogen chloride , given that the dipole moment of hydrogen chloride molecules is 3.44×10^{-30} C m and the separation between hydrogen and chlorine

atoms in the equilibrium position is 1.01×10^{-10} m .

Watch Video Solution

15. A dipole of electric moment p is located at a distance r from a long thread charged with a linear density λ . Find the force on the dipole if (a) if is placed parallel to the thread , (b) perpendicular to the thread .

[Hint : Field due to long thread = $\frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$]

Watch Video Solution