ÇANKAYA UNIVERSITY

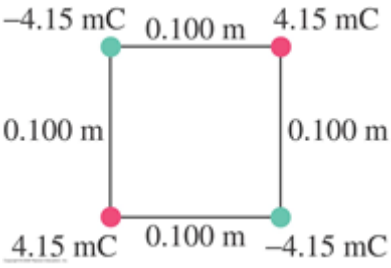
PHYS 132 – PHYSICS II

CHAPTER 22

ELECTRIC FIELDS

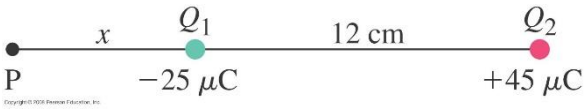
PROBLEM SET

1) Two negative and two positive point charges $\left(\text{magnitude } Q = 4.15 \text{ mC}\right)$ are placed on opposite corners of a square as shown in Fig. 21–54. Determine the magnitude and direction of the electric field on each charge. .**[Answer: 3.42×10^9 N/C, $\theta = 225^0$ from the *x*-direction, or exactly towards the center of the square.]**



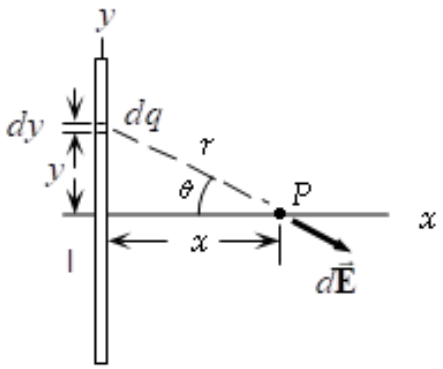
2) Two point charges, $Q_1 = -25\ \mu C$ and $Q_2 = +45\ \mu C$ are separated by a distance of 12 cm. The electric field at the point P (see Fig. 21–58) is zero. How far from Q_1 is P?

[Answer: x=35 cm]



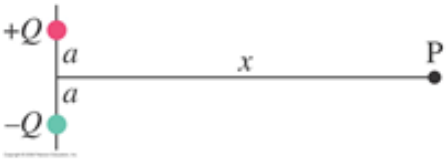
3) The uniformly charged straight wire in Fig. 21–29 has the length ***l***, where point 0 is at the midpoint. Find the field at point P where λ is the charge per unit length.

[Answer: below]



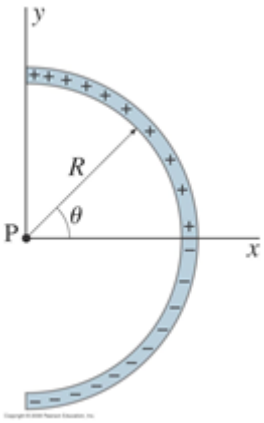
$$\frac{\lambda}{2\pi\varepsilon_0}\frac{\ell}{x\left(4x^2+\ell^2\right)^{1/2}}$$

4) ***Determine the direction and magnitude of the electric field at the point P shown in Fig. 21–64. The two charges are separated by a distance of $2a$. Point P is on the perpendicular bisector of the line joining the charges, a distance x from the midpoint between them. Express your answers in terms of Q, x, a, and k.**[Answer: below]**



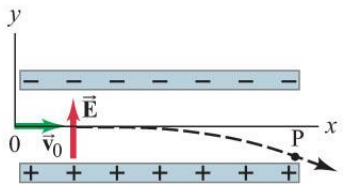
$\dfrac{2kQa}{\left(x^2+a^2\right)^{3/2}}$ in the negative y direction

5) ***A thin glass rod is a semicircle of radius R, Fig. 21–66. A charge is nonuniformly distributed along the rod with a linear charge density given by $\lambda = \lambda_0 sin\theta$ where λ_0 is a positive constant. Point P is at the center of the semicircle. (a) Find the electric field $\vec{\mathbf{E}}$ (magnitude and direction) at point P. [*Hint*: Remember $\sin(-\theta) = -sin\theta$ so the two halves of the rod are oppositely charged.] (b) Determine the acceleration (magnitude and direction) of an electron placed at point P, assuming $R = 1.0\,\text{cm}$ and $\lambda_0 = 1.0\,\mu C/m$. **[Answer: a) $\vec{E} = -\frac{\lambda_0}{8\varepsilon_0 R}\hat{\mathbf{j}}$, b) $\vec{a} = \mathbf{2.5 \times 10^{17}\ m/s^2\hat{j}}$]**

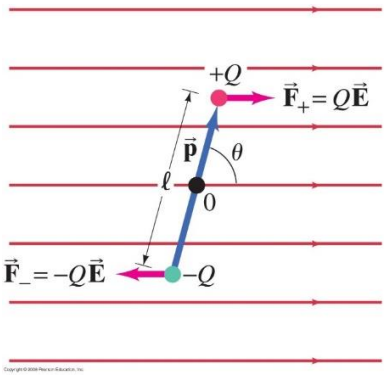


6) At what angle will the electrons in Example 21–16 leave the uniform electric field at the end of the parallel plates (point P in Fig. 21–41)? Assume the plates are 4.9 cm long and $E = 5.03\ 10^3$ N/C., and $v_0 = 1.00 \times 10^7\ m/s$. Ignore fringing of the field.

[Answer: $\boldsymbol{\theta = -23^0}$]



7) An electric dipole, of dipole moment *p* and moment of inertia *I*, is placed in a uniform electric field $\vec{\mathbf{E}}$. (*a*) If displaced by an angle θ as shown in Fig. 21–44 and released, under what conditions will it oscillate in simple harmonic motion? (*b*) What will be its frequency?**[Answer: a) If θ is small, so that** $\sin\theta \approx \theta$, **b)** $\boldsymbol{f = \frac{1}{2\pi}\sqrt{\frac{pE}{I}}}$ **]**



8) A positive point charge $Q_1 = 2.5 \times 10^{-5}\ C$ is fixed at the origin of coordinates, and a negative point charge $Q_2 = -5.0 \times 10^{-6}\ C$ is fixed to the *x* axis at x = +2.0 m . Find the location of the place(s) along the *x* axis where the electric field due to these two charges is zero. **[Answer: 1.6 m from $\boldsymbol{Q_2}$, 3.6 m from $\boldsymbol{Q_1}$]**

9) ***A large electroscope is made with "leaves" that are 78-cm-long wires with tiny 24-g spheres at the ends. When charged, nearly all the charge resides on the spheres. If the wires each make a 26° angle with the vertical (Fig. 21–72), what total charge *Q* must have been applied to the electroscope? Ignore the mass of the wires.[**Answer:** $\boldsymbol{Q = 4.9 \times 10^{-6}\ C}$ **]**

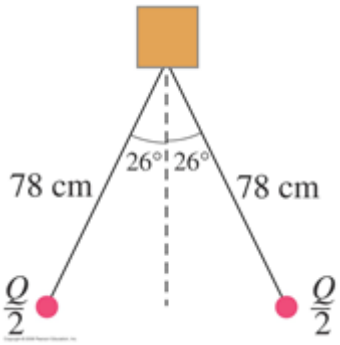


Fig. 21–72

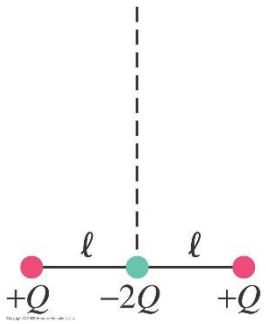


Fig. 21–74

10) One type of *electric quadrupole* consists of two dipoles placed end to end with their negative charges (say) overlapping; that is, in the center is $-2\boldsymbol{Q}$ flanked (on a line) by a $+\boldsymbol{Q}$ to either side (Fig. 21–74). Determine the electric field $\vec{\mathbf{E}}$ at points along the perpendicular bisector and show that *E* decreases as $1/r^4$. Measure *r* from the $-2\boldsymbol{Q}$ charge , assume r >> *l* **[Answer:** $-\frac{3Q\ell^2}{4\pi\varepsilon_0 r^4}$ **]**