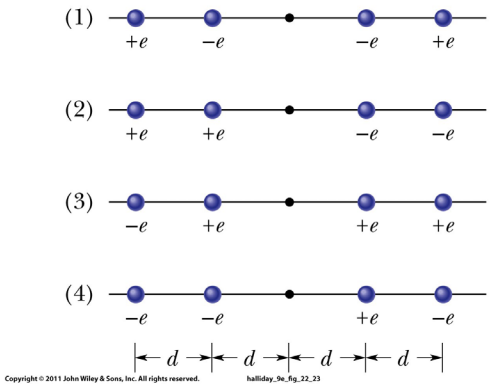
Homework for Chapter 22

(Due 9/15/22)

Questions: 4, 8, 10
Exercises & Problems: 7, 21, 28, 31, 37, 45, 48, 54, 77

Question 4

Figure 22-23 shows four situations in which four charged particles are evenly spaced to the left and right of a central point. The charge values are indicated. Rank the situations according to the magnitude of the net electric field at the central point, greatest first.



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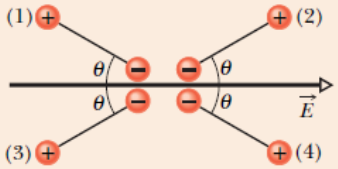
Question 8

(a) In the Checkpoint of Section 22-9, if the dipole rotates from orientation 1 to orientation 2, is the work done on the dipole by the field positive, negative, or zero? (b) If, instead, the dipole rotates from orientation 1 to orientation 4, is the work done by the field more than, less than, or the same as in (a)?

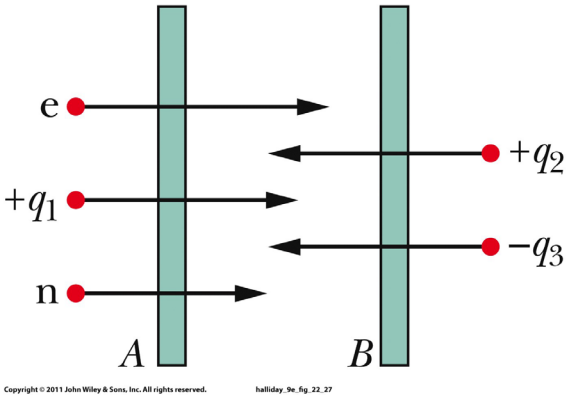
CHECKPOINT 4

The figure shows four orientations of an electric dipole in an external electric field. Rank the orientations according to (a) the magnitude of the torque on the dipole and (b) the potential energy of the dipole, greatest first.



Question 10

In Fig. 22-27, an electron e travels through a small hole in plate *A* and then toward plate *B*. A uniform electric field in the region between the plates then slows the electron without deflecting it. (a) What is the direction of the field? (b) Four other particles similarly travel through small holes in either plate *A* or plate *B* and then into the region between the plates. Three have charges $+q_1$, $+q_2$, and $-q_3$. The fourth (labeled n) is a neutron, which is electrically neutral. Does the speed of each of those four other particles increase, decrease, or remain the same in the region between the plates?



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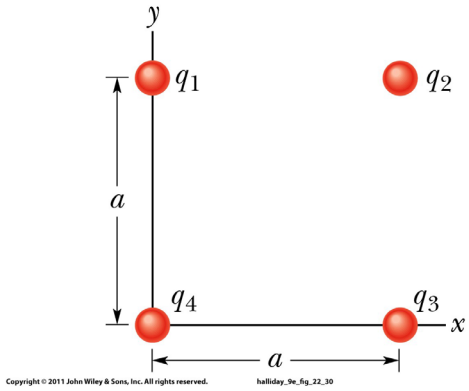
Problem 7

In Fig. 22-30, the four particles form a square of edge length a = 5.00 cm and have charges q_1 = +10.0 nC, q_2 = -20.0 nC, q_3 = +20.0 nC, and q_4 = -10.0 nC. In unit-vector notation, what net electric field do the particles produce at the square's center?

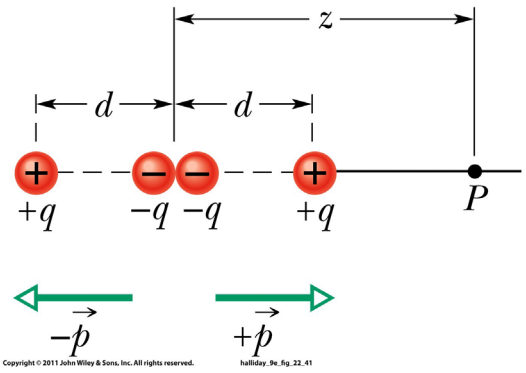


Problem 21

Figure 22-41 shows an electric quadrupole. It consists of two dipoles with dipole moments that are equal in magnitude but opposite in direction. Show that the value of E on the axis of the quadrupole for a point P a distance z from its center (assume $z >> d$) is given by

$$E = \frac{3Q}{4\pi\varepsilon_0 z^4}$$

in which Q (= $2qd^2$) is known as the *quadrupole moment* of the e distribution.

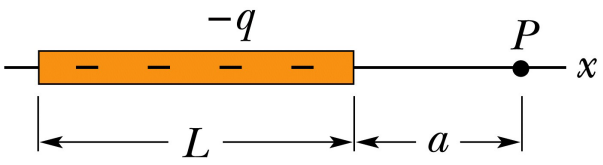


Problem 28

Charge is uniformly distributed around a ring of radius R = 2.40 cm, and the resulting electric field magnitude E is measured along the ring's central axis (perpendicular to the plane of the ring). At what distance from the ring's center is E maximum?

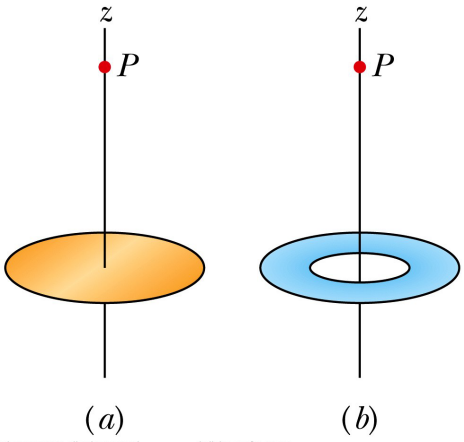
Problem 31

In Fig.22-49, a nonconducting rod of length L = 8.15 cm has a charge $-q$ = -4.23 fC uniformly distributed along its length. (a) What is the linear charge density of the rod? What are the (b) magnitude and (c) direction (relative to the positive direction of the x axis) of the electric field produced at point P, at distance a = 12.0 cm from the rod? What is the electric field magnitude produced at distance a = 50 m by (d) the rod and (e) a particle of charge $-q$ = -4.23 fC that replaces the rod?



Problem 37

Suppose you design an apparatus in which a uniformly charged disk of radius R is to produce an electric field. The field magnitude is most important along the central perpendicular axis of the disk, at a point P at distance 2.00R from the disk (Fig. 22-52a). Cost analysis suggests that you switch to a ring of the same outer radius R but with inner radius R/2.00 (Fig. 22-52b). Assume that the ring will have the same surface charge density as the original disk. If you switch to the ring, by what percentage will you decrease the electric field magnitude at P?

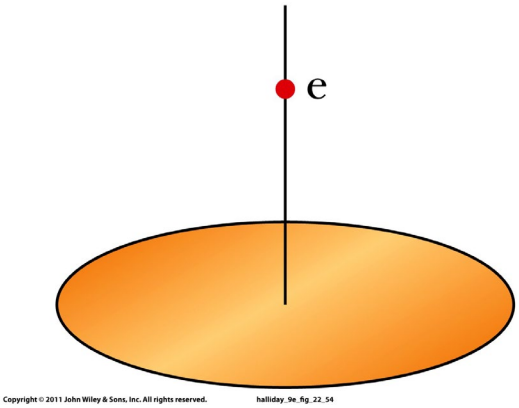


Problem 45

An electron on the axis of an electric dipole is 25 nm from the center of the dipole. What is the magnitude of the electrostatic force on the electron if the dipole moment is 3.6×10^{-29} C-m? Assume that 25 nm is much larger than the dipole charge separation.

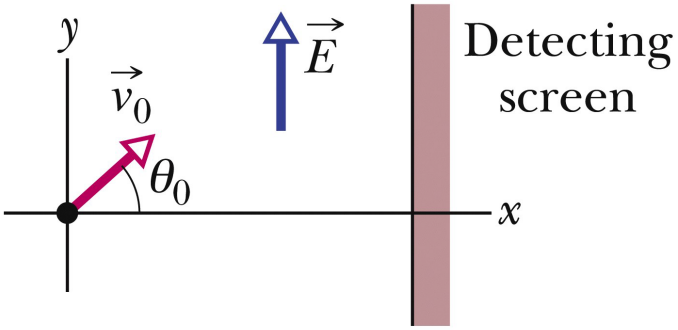
Problem 48

In Fig. 22-54, an electron (e) is to be released from rest on the central axis of a uniformly charged disk of radius R. The surface charge density on the disk is $+4.00\ \mu C/m^2$. What is the magnitude of the electron's initial acceleration if it is released at a distance (a) R, (b) $R/100$, and (c) $R/1000$ from the center of the disk? (d) Why does the acceleration magnitude increase only slightly as the release point is moved closer to the disk?



Problem 54

In Fig. 22-56, an electron is shot at an initial speed of $v_0 = 2.00 \times 10^6$ m/s, at angle $\theta_0 = 40.0°$ from an x axis. It moves through a uniform electric field $E = (5.00\ N/C)\hat{j}$. A screen for detecting electrons is positioned parallel to the y axis, at distance $x = 3.00$ m. In unit-vector notation, what is the velocity of the electron when it hits the screen?



Problem 77

A particle of charge $-q_1$ is at the origin of an x axis. (a) At what location on the axis should a particle of charge $-4q_1$ be placed so that the net electric field is zero at $x = 2.0$ mm on the axis? (b) If, instead, a particle of charge $+4q_1$ is placed at that location, what is the direction (relative to the positive direction of the x axis) of the net electric field at x = 2.0 mm?