Physics NINJA

Physics 1302B/1402B

Electric Fields and Forces

Electric Fields and Forces

- Chapter Review
- Submitted Questions
- Conceptual Questions
- Problems and Solutions

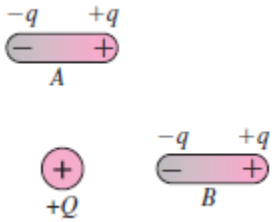
Chapter Review

- Electric fields produced by point charges, lines of charge, sheets of charge.

Submitted Questions

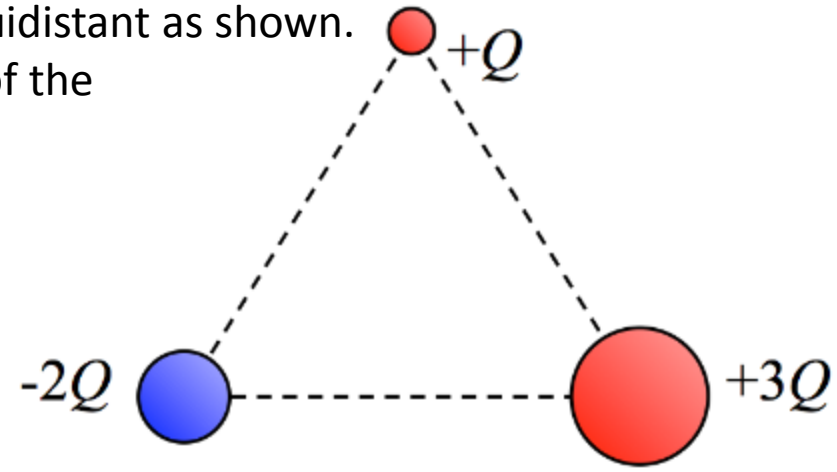
Conceptual Questions

1) Is the electric force on a charged particle always in the direction of the field? Explain.
2) Why does a dipole, which has no net charge, produce an electric field?
3) Why should there be a force between two dipoles, which each have zero net charge?
4) Dipoles *A* and *B* are both located in the field of a point charge *Q*, as shown below. Does either experience a net torque? A net force? If each dipole is released from rest, describe qualitatively its subsequent motion.



Problems and Solutions

Problem 1: Three point charges are placed equidistant as shown. Which vector best describes the net direction of the Electric force acting on the $+Q$ charge?



a.

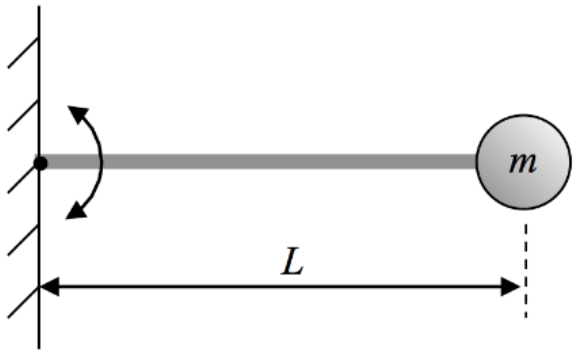
b.

c.

d.

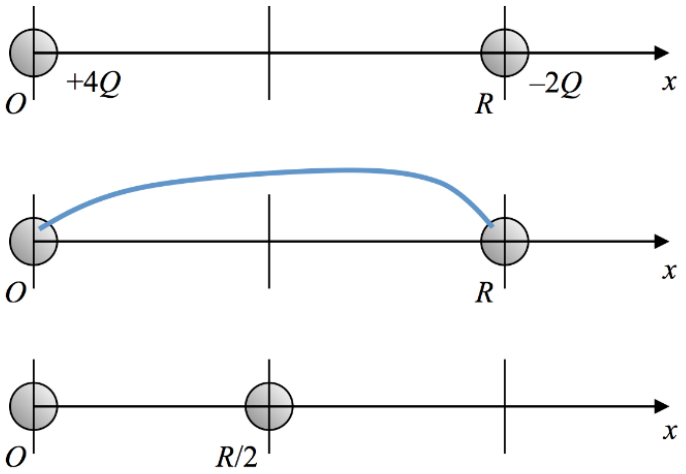
Problem 2: A light, rigid rod of length L is free to rotate vertically about a horizontal axis at one end. At the other end of the rod, a charged sphere of mass m and charge $-Q$ is mounted. What magnitude and direction of electric field Is required to maintain the sphere-rod in the horizontal orientation.

a. mg/Q, up
b. mg/Q, down
c. mgL/Q, up
d. mgL/Q, down
e. mg/LQ, up

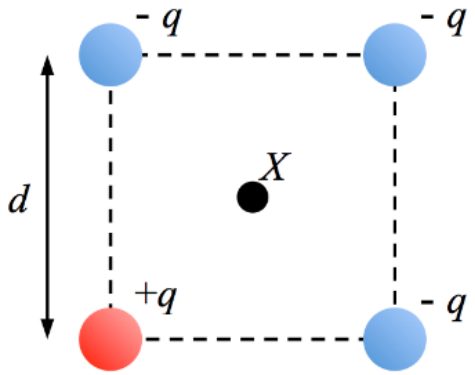


Problem 3: Two identical, isolated conducting spheres are separated by a distance R as shown above. The sphere at the origin as a charge $+4Q$, while the other sphere at position $+R$ has a charge of $-2Q$, and the magnitude of the force between them is $\mathbf{F_0}$. The two spheres are connected to each other by a conducting wire for a moment which is then removed. When the sphere at distance R is relocated to a distance $R/2$, the vector force it experiences due to the sphere at the origin is:

a. $+\mathbf{F_0}/4$
b. $+\mathbf{F_0}/2$
c. $+2\mathbf{F_0}$
d. $-2\mathbf{F_0}/4$
e. $+4\mathbf{F_0}$



Problem 4: Four charges are placed at the corners of a square with sides of length d as shown above. The electric field at point X in the center of the square is:



a. $\frac{4kq}{d^2}$, to the upper right

b. $\frac{4kq}{d^2}$, to the lower left

c. $\frac{3kq}{d^2}$, to the upper right

d. $\frac{2kq}{d^2}$, to the upper right

e. $\frac{2kq}{d^2}$, to the lower left

Problem 5: Two spheres, one with a charge of $-Q$ and the other with a charge of $+2Q$ are separated by a distance R, and exert a force F on each other. The spheres are now altered so that the force between them is $2F$. Which of the following would have produced this result?

a. The charge on both spheres was doubled.
b. The charge on only one sphere was increased by a factor of 4.
c. The charge on both spheres was doubled, and the distance between them halved.
d. The charge on only one sphere was halved, and the distance between them halved.
e. The charge on both spheres was increased by a factor of 4, and distance between them doubled.

Problem 6:

Three point charges of $+Q$, $+2Q$, and $-Q$ are each located a distance r away from the origin, as shown above. The magnitude of the electric field at the origin due to these charges is:

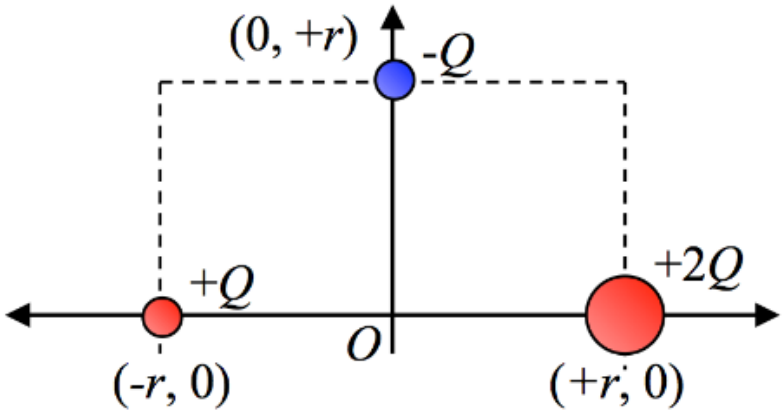
a. $\frac{2kQ}{r^2}$

b. $\frac{2kQ^2}{r^2}$

c. $\frac{2kQ}{r}$

d. $\frac{\sqrt{2}kQ}{r^2}$

e. $\frac{\sqrt{2}kQ}{2r^2}$

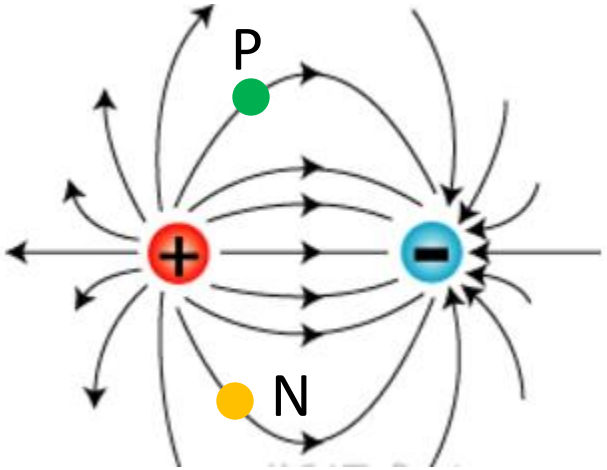


Problem 7: The electric field at a distance y above the center of a ring of charge is given by the formula

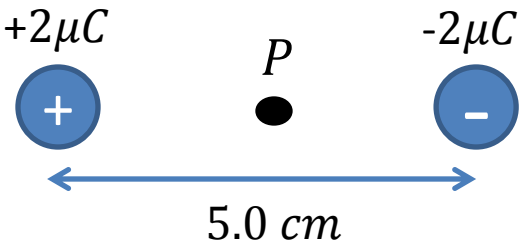
$$E = \frac{kQy}{(y^2 + R^2)^{3/2}}$$

where $Q$is the charge on the ring and R is the radius. If $Q = 25mC$ and $R = 3m$, find the force that a charge $q = 25/9\ nC$ would feel if it were placed at $y = 4m$.

Problem 8: A positive charge $+q$ is placed at the point labeled P in the field produced by a dipole. Describe the direction of the resulting electric force on the charge. Do the same for a negative charge, $-q$ placed at the point labeled N.



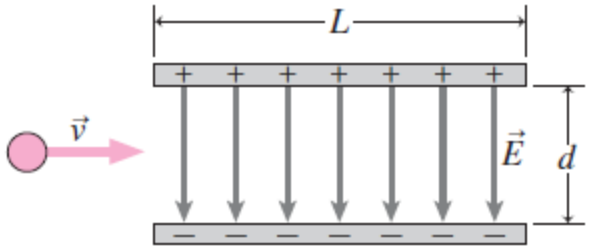
Problem 9: In the figure below, the point *P* is midway between the two charges. Find the electric field in the plane of the page (a) 5.0 cm to the left of *P*, (b) 5.0 cm directly above *P*, and (c) at *P*.



Problem 10: An electron is at the origin, and an ion with charge $+5e$ is at $x = 10nm$. Find a point where the electric field is zero.

Problem 11: A straight wire 10 m long carries $+25\mu C$ distributed uniformly over its length. (a) What's the line charge density on the wire? Find the electric field strength (b) 15 cm from the wire axis, not near either end, and (c) 350 m from the wire. Make suitable approximations in both cases.

Problem 12: You're working on the design of an ink-jet printer. Ink drops of mass *m*, speed *v*, and charge *q* will enter a region of uniform electric field *E* between two charged plates. The drops enter midway between the plates, and the electric field deflects them toward the correct place on the page. Find an expression for the maximum electric field for which drops can still get through without hitting either plate.



Problem 13: Three identical charges $+q$ and a fourth charge $-q$ form a square of side a.
(a) Find the magnitude of the electric force on a charge Q placed at the square's center.
(b) Describe the direction of this force.

Problem 14: Two $34\mu C$ charges are attached to opposite ends of a spring with spring constant 150N/m and equilibrium length 50 cm. By how much does the spring stretch?

Problem 15: Two identical small metal spheres initially carry charges q_1 and q_2 When they're $1.0m$ apart, they experience a 2.5N attractive force. Then they're brought together so charge moves from one to the other until they have the same net charge. They're again placed 1.0 m apart, and now they repel with a 2.5N force. What were the original charges q_1 and q_2.

Problem 16: Two small spheres with mass $m = 15.0g$ are hung by silk threads of length $L = 1.2m$ from a common point. When the spheres are given equal quantities of negative charge q each thread hangs at an angle $\theta = 25^o$. Find the magnitude of the charge q on each sphere. B) if both threads are shortened to length $L/2$, while the charge remains unchanged, what new angle will each thread make?