Chapter 5 Review Questions

Solutions can be found in Chapter 12.

Section I: Multiple Choice

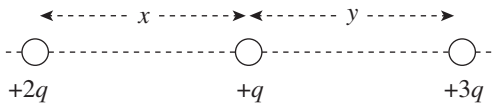
1. An experiment is conducted measuring the electrostatic force, F, on a test object at various distances, r. In order to create a plot with a straight line, what should be graphed?

   (A) F versus r^2
   (B) F versus r
   (C) F versus r^{-1}
   (D) F versus r^{-2}

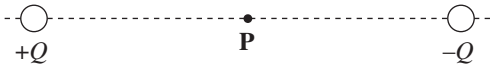
2. Two 1 kg spheres each carry a charge of magnitude 1 C. How does F_E, the strength of the electric force between the spheres, compare to F_G, the strength of their gravitational attraction?

   (A) $F_E < F_G$
   (B) $F_E = F_G$
   (C) $F_E > F_G$
   (D) If the charges on the spheres are of the same sign, then $F_E > F_G$; but if the charges on the spheres are of the opposite sign, then $F_E < F_G$.

3. The figure below shows three point charges, all positive. If the net electric force on the center charge is zero, what is the value of y/x ?



   (A) $\frac{4}{9}$
   (B) $\sqrt{\frac{2}{3}}$
   (C) $\sqrt{\frac{3}{2}}$
   (D) $\frac{3}{2}$



4. The figure above shows two point charges, $+Q$ and $-Q$. If the negative charge were absent, the electric field at Point P due to $+Q$ would have strength E. With $-Q$ in place, what is the strength of the total electric field at P, which lies at the midpoint of the line segment joining the charges?

   (A) 0
   (B) $\frac{E}{2}$
   (C) E
   (D) $2E$

5. A sphere of charge $+Q$ is fixed in position. A smaller sphere of charge $+q$ is placed near the larger sphere and released from rest. The small sphere will move away from the large sphere with

   (A) decreasing velocity and decreasing acceleration
   (B) decreasing velocity and increasing acceleration
   (C) increasing velocity and decreasing acceleration
   (D) increasing velocity and increasing acceleration

6. An object of charge $+q$ feels an electric force $\mathbf{F}_E$ when placed at a particular location in an electric field, $\mathbf{E}$. Therefore, if an object of charge $-2q$ were placed at the same location where the first charge was, it would feel an electric force of

   (A) $\frac{-\mathbf{F}_E}{2}$

   (B) $-2\mathbf{F}_E$

   (C) $-2q\mathbf{F}_E$

   (D) $\frac{-2\mathbf{F}_E}{q}$

7. A charge of $-3Q$ is transferred to a solid metal sphere of radius r. How will this excess charge be distributed?

   (A) $-Q$ at the center, and $-2Q$ on the outer surface

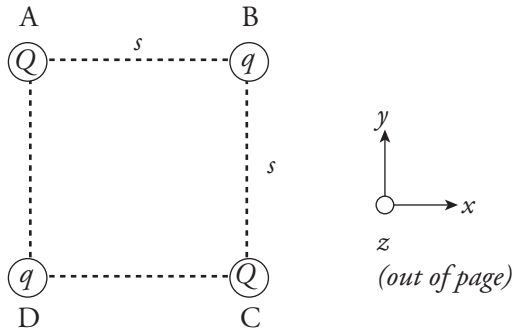
   (B) $-3Q$ at the center

   (C) $-3Q$ on the outer surface

   (D) $-Q$ at the center, $-Q$ in a ring of radius $\frac{1}{2}r$, and $-Q$ on the outer surface

Section II: Free Response

1. In the figure shown, four charges are situated at the corners of a square of side length s. The charges on opposite corners are equal to one another and are labeled Q for corners A and C and labeled q for corners B and D. The charge on Q is positive for all experiments.



(a) In a first experiment, it is found that the force on the charge at position C is 0 *N*.

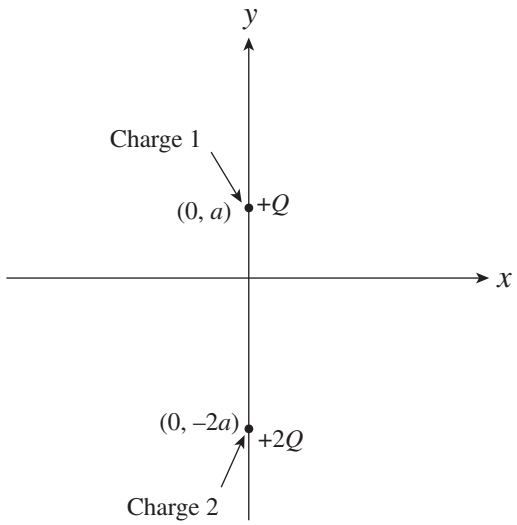
i. Justify the assertion that the charges q cannot have different magnitudes in this experiment.

ii. Derive an expression for the magnitude and sign of charge on q in this experiment.

(b) In a second experiment, the charge at point C is removed. If the charges q are positive, is there anywhere within the boundary square where the electric field could be 0 *N/C*?

(c) The charges are reassembled into their original positions. In a clear, coherent paragraph length response, explain why the electric field at the center of the square must be 0 *N/C* regardless of the magnitudes of the charges q or Q and regardless of their signs.

2. Two charges, $+Q$ and $+2Q$, are fixed in place along the y-axis of an xy-coordinate system as shown in the figure below. Charge 1 is at the point $(0, a)$, and Charge 2 is at the point $(0, -2a)$.



(a) Find the electric force (magnitude and direction) felt by Charge 1 due to Charge 2.

(b) Find the electric field (magnitude and direction) at the origin created by both Charges 1 and 2.

(c) Is there a point on the x-axis where the total electric field is zero? If so, where? If not, explain briefly.

(d) Is there a point on the y-axis where the total electric field is zero? If so, where? If not, explain briefly.