

## Graphical Analysis of the Electrostatic Force

In an experiment, small positive test charges ( $q$ ) are placed at a distance  $r$  around a large positive point charge  $Q$  (*the source charge*).

1. Sketch the graph  $|\mathbf{F}|$  vs.  $q$  where  $|\mathbf{F}|$  is the magnitude of the force acting on the test charge and  $q$  is the magnitude of the charge of the test charge.

Answer the following questions:

- a. What is the slope of the graph equal to?
  - b. Does the slope depend on  $Q$ ?  $r$ ?  $q$ ?
  - c. What is the physical meaning of the slope?
  - d. Does it matter where, exactly, the tests are placed in space as long as they are placed a distance  $r$  from  $Q$ ?
2. Using the graph constructed in question 1, use the same set of axes to sketch the graphs  $|\mathbf{F}|$  vs.  $q$  for different situations as described below. Clearly label which graph corresponds to which situation.
    - a. The test charges are placed at a distance  $2r$  from charge  $Q$ .
    - b. Charge  $Q$  is replaced by charge  $2Q$ , and the test charges are placed at a distance  $2r$  from charge  $2Q$ .
    - c. Another charge  $Q$  is placed a distance  $2r$  from the existing charge  $Q$ , and the test charges are placed halfway between charges  $Q$ .
    - d. Charge  $-Q$  is placed a distance  $2r$  from the existing charge  $Q$ , and the test charges are placed halfway between charges  $Q$ .