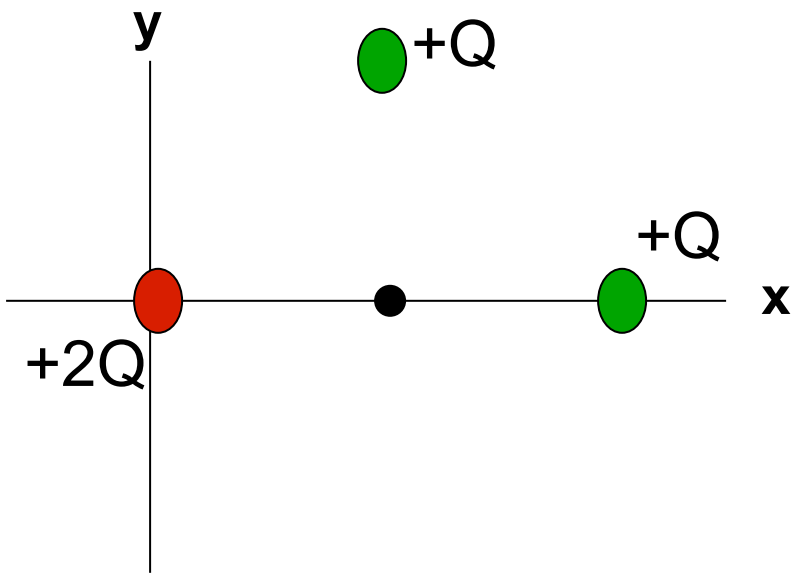
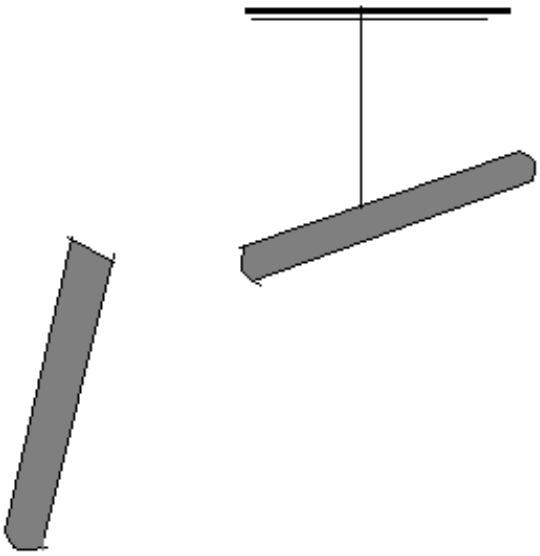
**Sample Question:** A point in empty space is near 3 charges as shown. The distances from the point to each charge are identical.

A. Draw a vector showing the direction the electric field points.




B. What is the angle between the electric field and the x-axis at the point?

C. If the distance to each charge is L, what is the magnitude of the electric field at the point?



*Charged glass rod*

**Sample Question:** A positively charged rod is brought near (but not touching) another rod suspended on a string.

A. If the suspended rod is repelled from the positive rod, what can you say about its total charge?

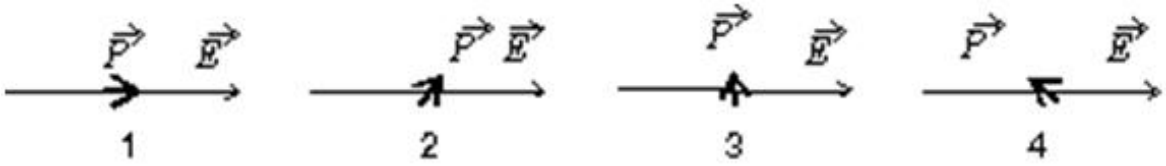
B. If the suspended rod is attracted to the positive rod, what can you say about its total charge?

C. Describe what happens if the rod is an uncharged insulator.

D. Describe what happens if the rod is an uncharged conductor.

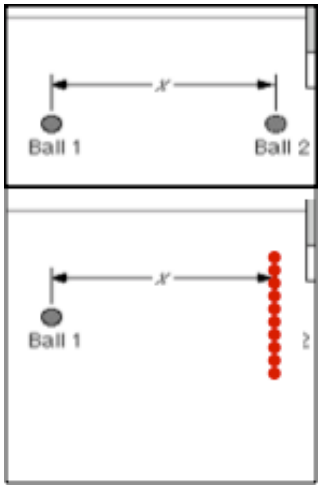
**Sample Question:**
A particle with charge $Q$ is on the $y$ axis a distance $a$ from the origin and a particle with charge $q$ is on the $x$ axis a distance $d$ from the origin. What is the value of $d$ for which the $x$ component of the force on the second particle is greatest?

**Sample Question:**
The diagrams show four possible orientations of an electric dipole in a uniform electric field. Draw the directions of the torques, and rank them according to the magnitude of the torque exerted on the dipole by the field, greatest (1) to least (4). If any of the torques have the same magnitude, give them the same ranking. Explain your answer.




**Sample Question:**
A point particle with charge $q$ is at the center of a Gaussian surface in the form of a cube. What is the electric flux through any one face of the cube? Explain your answer.

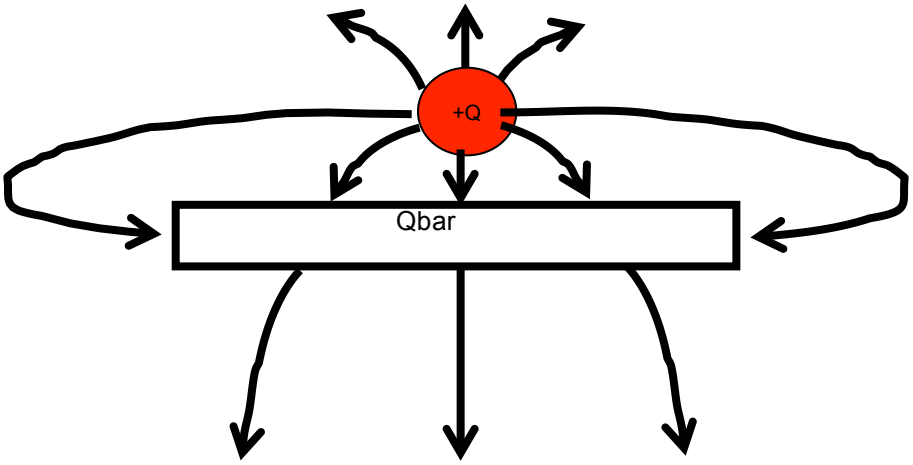
**Sample Question:**
Ball 2 has charge Q. Ball 2 is torn apart into a rod of 10 smaller balls each with charge Q/10.




A. How do the electric forces on Ball 1 from Ball 2 and the rod compare in magnitude?

B. Why? Draw a vector diagram to support your answer.

**Sample Question:**
A positive point charge sits near a metal bar, as shown below.



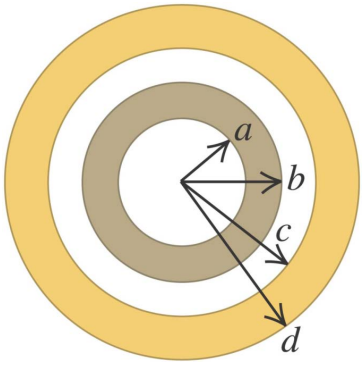

A. What can you say about the magnitude of the charge on the bar |Qbar|, compared to the magnitude of the charge Q of the point charge?

B. Sketch the distribution of charge on the bar.

C. Sketch the electric field lines in the bar corresponding to only the component of the field produced by the charge on the bar.

D. Sketch the electric field lines outside of the bar corresponding to only the component of the field produced by the charge on the bar.

**Sample Question**




Consider an infinitely long line of charge with linear charge density -λ surrounded by two infinitely long conducting cylinders. The inner cylinder, with inner radius *a* and outer

radius *b*, has a total linear charge density of 2λ. The outer cylinder, with inner radius *c* and outer radius *d*, has no net charge on it.

A. How does charge distribute itself on the inner and outer cylinders? Explain why in at least one sentence.

B. Find the electric field as a function of r, inside both cylinders, inside the inner conductor, between the two conductors, inside the outer conductor, and outside the outer conductor.

**Sample Question:** A spherical conducting shell with inner radius $R_1$ and outer radius $R_2$ has charge *Q*. A particle with charge *q* is placed at the center of the cavity.

A. What are the charge on the inner surface of the shell ($R_1$) and the charge on the outer surface of the shell ($R_2$), respectively?

B. What is the magnitude of the electric field for $r<R_1$?

C. What is the magnitude of the electric field for $r>R_2$?

D. What is the magnitude of the electric field inside the shell ($R_1 < r < R_2$)?

E. Sketch the electric field E(r) as a function of radius, with the convention that positive fields point outward, and negative fields point inward. Describe in at least one sentence why you drew it as you did.

F. Sketch the electric potential V(r), assuming $V(\infty) = 0$. Describe in at least one sentence why you drew it the way you did.

**Sample Question**

Calculate the electric potential V as a function of radius r from first principles [don't just write down an equation from your card] for a sphere of radius R with a total charge Q uniformly distributed throughout the sphere (neglect any polarization - assume charge is perfectly fixed, and assume the potential at infinity is zero).