Chapter-22

1. Two small beads having charges q1 and q2 of the same sign are fixed at the opposite ends of a horizontal insulating rod of length d. The bead with charge q1 is at the origin. As shown in Figure P22.8, a third small, charged bead is free to slide on the rod. (a) At what position x is the third bead in equilibrium? (b) Can the equilibrium be stable?

**Ans:** (a) Let the third bead have charge *Q* and be located distance *x* from the left end of the rod. This bead will experience a net force given by



The net force will be zero if 

 because *d* > *x.* Thus,



(b)  The equilibrium would be stable because if charge *Q* were displaced either to the left or right on the rod, the new net force would be opposite to the direction *Q* has been displaced, causing it to be pushed back to its equilibrium position.

1. Two charged particles are located on the x axis. The first is a charge +Q at x = -a. The second is an unknown charge located at x = +3a. The net electric field these charges produce at the origin has a magnitude of 2keQ /a2. Explain how many values are possible for the unknown charge and find the possible values.

Ans:



**ANS. FIG. P22.18**

The first charge creates at the origin a field  to the right. Both charges are on the *x* axis, so the total field cannot have a vertical component, but it can be either to the right or to the left. If the total field at the origin is to the right, then *q* must be negative:



In the alternative, if the total field at the origin is to the left,



1. A proton moves at 4.50 X 105 m/s in the horizontal direction. It enters a uniform vertical electric field with a magnitude of 9.60 X 103 N/C. Ignoring any gravitational effects, find (a) the time interval required for the proton to travel 5.00 cm horizontally, (b) its vertical displacement during the time interval in which it travels 5.00 cm horizontally, and (c) the horizontal and vertical components of its velocity after it has traveled 5.00 cm horizontally

Ans:  is directed along the *y* direction; therefore, *ax* = 0 and *x* = *vxit*.

(a) 

(b) 





(c) 



