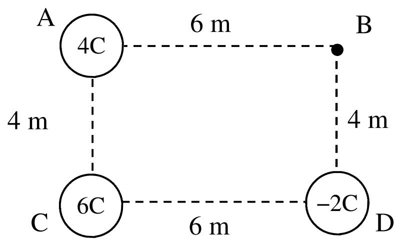
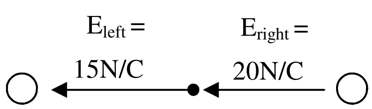
PreAP Electrostatics 9

Cover up the answers on the right side of the page.

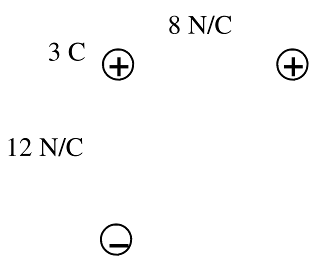


1. Three charges are situated as shown at the left.
   A. What produces the net electric field at point B?
   B. What produces the net electric field at point D?
   C. Set up the equation for the electric field at point C from point A (don't solve):
   D. Simplify your expression.
   E. Calculate "r " for the electric field at point B due to point C.
   F. What is the direction of E_{net} at point C (roughly)?
   G. If the 6C charge was fixed and the others could be moved, would the 4C or −2C be harder to remove and why?

2. What are the two ways you could increase the electric field emanating from a charge?

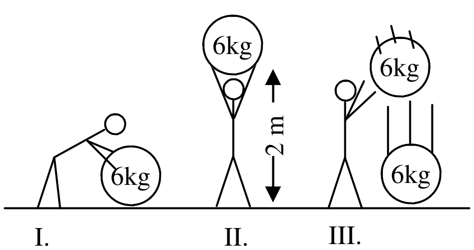


3. Two unknown charges are fixed (can't move). The electric fields due to these charges are shown.
   A. Label the signs of the charges in the circles.
   B. If the two charges have equal magnitudes, how is it that the right electric field is stronger?
   C. Calculate the net electric field.



4. The individual electric fields shown are on the 3 C charge.
   A. Draw the directions of the electric fields.
   B. Calculate the magnitude and direction of the net electric field on the 3 C charge.
   C. Calculate the force on the 3C charge.

5. Ever eager, Slim Jim helps us with an energy demo.



A. How much energy does the ball have in picture I?
B. What kind of energy does the ball have in picture II?
C. How much energy does the ball have in picture II?
D. How much work was necessary to lift the ball up?
E. How much kinetic energy does the ball have just before it hits the ground?
F. How fast is the ball moving at the ground?
G. So the amount of potential energy equals the amount of _______ done on it and equals the amount of _______ _________ after it is let go.

And this is the same for electrostatics: the PE gained by a charge equals the W done to get the charge to a position and equals the KE it will have if released.

1.

A. The charges at A, C, and D (the 3 charges)

B. Charges at A and C

C. $E = k\frac{4}{4^2}$

D. E = k/4

E. Pyth theorem using 4 and 6.

F. 4th Q

G. −2C it is attracted to the other ones. The 4C feels repulsion, so would be easy to remove.

2. increase q (more charge) or decrease r (get closer)

3A. Neg on left (pull) Pos on right (push)

3B. mag same means q same, so r must be smaller or closer

3C. 35 N/C to the left or at 180°

4A. Neg pulls, + pushes, so Enet = 3rdQ

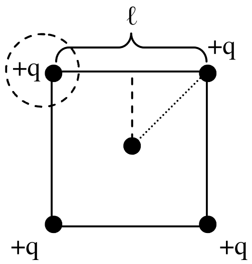
4B. Pyth theor of 8 and 12 for mag = 14.4 N/C

Inv tan of −12/−8 = 56.3°. But +180° for 3rdQ = 236.3°

4C. N/C times C = N So, 14.4(3) = 43.2 N at 236.3°

5A none
5B. PE (U)
5C. 120 J
5D. 120 J
5E. 120 J
5F. Mgh = ½mv^2 = v = 6.3 m/s
5G. Work, KE

The following is to help you with the bonus question on the test (which is still a long way off). Everyone should be able to do Parts A, E and F. The rest is more challenging and optional.



A. Draw the direction of E_{net} at the upper left hand corner. (*Pretend the upper left q is not there. Put together all of the E's from the other q's and find E_{net}.*)

B. What is the length of the dashed vertical line (from the top line to the center)?

C. Now that you have a right triangle, calculate the distance (r) from the center of the square to one of the corners.

You just found "r" from the dot to each of the q's.

D. Write an expression for the electric field at the center due to one of the corners (and simplify).

E. Calculate the net electric field at the center of the square.

F. Calculate the net potential (voltage) at the center of the square.

1.A. 2nd Q (the other +q's all push)

B. ℓ/2

C.

$$r = \sqrt{\left(\frac{\ell}{2}\right)^2 + \left(\frac{\ell}{2}\right)^2}$$

$$r = \sqrt{2\left(\frac{\ell}{2}\right)^2} = \frac{\ell}{2}\sqrt{2}$$

D.

$$E = \frac{kq}{\left(\frac{\ell}{2}\sqrt{2}\right)^2} = \frac{kq}{\left(\frac{2\ell^2}{4}\right)}$$

$$E = \frac{kq}{\left(\frac{\ell^2}{2}\right)} = \frac{2kq}{\ell^2}$$

E. 0 N/C (by symmetry). They all push, so they all cancel.

F. $V_{net} = V_1 + V_2 + \ldots$ (scalars, direction doesn't matter). So ΣV = kq/r for each of them for a total of 4kq/r. Putting in what we know for r:

$$\Sigma V = \frac{4kq}{r} = \frac{4kq}{\left(\frac{\ell\sqrt{2}}{2}\right)}$$

multiply by the reciprocal

$$= \frac{4kq}{1}\left(\frac{2}{\ell\sqrt{2}}\right) = \frac{8kq}{\ell\sqrt{2}}$$