Electrostatics: Electrostatic Force and Field (Chapter 18)

May Contain Tree Nuts. But Probably Not.

1. Find the force experienced by a 6.0µC point charge and a -4.0µC point charge separated by 1.6x10-2m.

2. A proton and an electron experience a 2.2x10-11N attractive force. What is the distance between the charges?

3. Three charges are arranged as shown below. The rectangle measures 3.00cm by 4.00cm.

+2.50µC P

+3.00µC -2.00µC

a. Find the force experienced by the 2.50µC charge

b. Find the force experienced by the -2.00µC charge

c. Find the force experienced by the +3.00µC charge

4. Three charges are placed on a straight line. Charge 1 is 4.00 µC, Charge 2 is -3.00 µC and is 2.00cm to the right of charge 1. Charge 3 is 6.00µC and is 5.00cm to the right of **charge 1**. Find the electrostatic force on Q2.

5. A +2.0nC charge is placed at a point where it feels an electrostatic force of 4.0x10-6N left. What is the electric field at that point?

6. A -2.0nC charge is placed at a point where it feels an electrostatic force of 4.0x10-6N left. What is the electric field at that point?

7. Find the electric field 1.00mm to the left of a proton.

8. Find the electric field 1.00mm to the left of an electron.

9. Find the electric field midway between two protons separated by 2.00mm.

10. Find the electric field midway between two electrons separated by 2.00mm.

11. Find the electric field midway between a proton and an electron separated by 2.00mm.

12.

12.0nC

A

3.00cm

4.0nC

B

6.00cm

Find the electric field at point A and point B.

13. A 29g balloon is suspended from a string. The balloon has been charged by rubbing it on a human head. The human head has hair. A spherical charged object is brought close to the balloon, causing it to move to the position shown, where it is held in equilibrium.

A. Find the charge on the balloon.

B. How many electrons were transferred to/from the balloon? 66o

18μC

16cm

Electrostatics: Charges in Uniform Electric Fields

Classical Mechanics Applied to Tiny Invisible Objects.

1. A proton accelerates from rest to 3.0x107m/s (10% the speed of light) in 5.0s in a uniform electric field.
   1. How far does the proton travel?
   2. What is the magnitude of the field?
2. An electron accelerates from rest to 3.0x107m/s (10% the speed of light) in 5.0s in a uniform electric field.
   1. How far does the electron travel?
   2. What is the magnitude of the field?
3. A 1.00g small metal sphere is suspended between two charged parallel plates. The field between the plates is 1.00x104N/C down.
   1. Is the charge positive or negative?
   2. Which plate is positively charged?
   3. What is the charge on the sphere?
   4. How many electrons has the sphere GAINED or LOST?
4. +

3.0x105m/s

-

5.0cm

A proton is fired horizontally into a region of uniform upward electric field as shown. The speed of the proton as it leaves the plates is 5.0x105m/s. What is the field between the plates?

Consider the plates shown to the right: + -

The magnitude of the field between the plates is 2.5x105N/C B

A

1. Find the work to move an electron from A to B at constant speed.
2. Find the work to move a proton from A to B at constant speed.
3. Find the work to move an electron from B to A at constant speed. 2.0cm
4. Find the work to move a proton from B to A at constant speed.
5. A 2.00g sphere is suspended between two parallel conducting plates. The field between the pates is 3.00x103N/C downward.

a. What is the charge on the sphere?

b. The plates are now placed in an elevator. The elevator accelerates upward at 8.00m/s2. What must the field between the plates be to keep the sphere suspended?

**Electric Potential Energy, Electric Potential, Electric Potential Difference with Point Charges**

Can’t see it, can’t touch it, can’t smell it, can’t hear it, can’t taste it but believe you me, it’s there!

**1**. Find the electric potential energy of a 2.00nC charge and a 3.00nC charge separated by 1.20x10-5m.

**2**. Find the electric potential energy of a -2.00nC charge and a 3.00nC charge separated by 1.20x10-5m.

**3**. Find the electric potential energy of a -2.00nC charge and a -3.00nC charge separated by 1.20x10-5m.

**4**. Find the electric potential energy of a 2.00nC charge and a -3.00nC charge separated by 1.20x10-5m.

**5.** Find the electric potential 2.0m from a -4.0µC point charge.

**6.** Find the electric potential 25.0cm from a 5.00µC point charge.

**7. a.** Find the potential difference between point A, 1.00mm from an electron, and point B, 2.00mm from an electron.

**b.** Which point is at higher potential?

**8.** The potential at point X is 15.0V, the potential at point Y is -25.0V.

a. What is the change in potential as you move from X to Y.

b. A proton is released from rest midway between X and Y, toward which point will it accelerate?

c. An electron is released from rest midway between X and Y, toward which point will it accelerate?

**9.** Three charges are arranged as shown below. The rectangle measures 3.00cm by 4.00cm.

+2.50µC P

+3.00µC -2.00µC

**a.** Find the electric potential energy of this arrangement.

**b.** Find the electric potential at point P.

**c.** If an electron were placed at point P, how much electric potential energy would it have?

**10.** Point A has a potential of 240V. Point B has a potential of 190V. Charge 1 is a charged sphere with a charge of +2.0µC and a mass of 10.0g. Charge 2 is a charged sphere with a charge of -4.0µC and a mass of 30.0g.

**a.** What is the potential difference ΔVBA?

**b.** What is the potential difference ΔVAB?

**c.** In which direction will Charge 1 accelerate, A to B or B to A?

**d.** In which direction will Charge 2 accelerate, A to B or B to A?

**e.** Charge 1 is released from rest at either A or B (see part c.) and accelerates to B or A. What is the final speed?

**f.** Charge 2 is released from rest at either A or B (see part c.) and accelerates to B or A. What is the final speed?

**11.** Two protons are separated by 1.00nm and are at rest. The protons are released. How far apart are they when they reach a speed of 10.0km/s

**12.** Two electrons are separated by 1.00nm and are at rest. The electrons are released. How far apart are they when they reach a speed of 10.0km/s

**13.** A small charge has a mass of 2.0x10-12kg and a charge of +4.0μC. A second small charge has a mass of 4.0x10-12kg and a charge of -3.0μC. The two charges are initially at rest and separated by 6.0x10-2m. The charges are then simultaneously released from rest. What is the distance between them when the +4.0μC charge has a speed of 5.0x105m/s?

**14.** Two point charges are arranged on a straight line as shown below:

**+4.0nC -6.0nC**

**2.00mm**

Consider the position of the 4.0nC charge to be zero. Locate any points on the line (if any exist) at which the potential due to these 2 charges is zero.

**15.** Two point charges are arranged on a straight line as shown below:

**-4.0nC -6.0nC**

**2.00mm**

Consider the position of the -4.0nC charge to be zero. Locate any points on the line (if any exist) at which the potential due to these 2 charges is zero.

Electric Potential and Potential Energy, Uniform Fields. Fun for All Ages!

**For the following questions assume motion is parallel to the electric field, if not stated otherwise.**

1. It takes 8.0x10-7J of work to move a +4.0nC charge 2.00mm to the right (at constant speed) in a uniform electric field. Find the electric field in the region.

2. It takes 8.0x10-7J of work to move a -4.0nC charge 2.00mm to the right (at constant speed) in a uniform electric field. Find the electric field in the region.

3. The electric field in a region of space is uniform and **E**=24000N/C up.

61mm 19mm

A B

14mm

C D

Find: A. VA-VB  B. VB-VA

C. VA-VC D. VC-VA

E. VC-VD F. VD-VC

G. VB-VD H. VD-VB

I. VA-VD J. VD-VA

K. VB-VC L. VC-VB

4. Two parallel plates each have an area of 8.0x10-4m2. The plates are separated by 2.00mm, and are given equal charges of opposite polarities. The field between the plates is 975N/C from plate B to plate A.

A. Which plate is positively charged?

B. How much positive charge is on the positive plate?

C. How much charge is on the negative plate?

D. What is the potential difference VA-VB?

5. An electron is released from rest at the negative plate of a parallel plate capacitor. The electron exits through an itty-bitty-teeny-weeny hole in the positive plate at 2.5x106m/s. Each plate is a rectangle measuring 4.00cm by 3.00cm. And the plates are separated by 1.20mm.

A. Find the potential difference between the plates.

B. Find the charge stored on the plates.

C. How many excess electrons are on the negative plate?

D. Find the magnitude of the electric field between the plates.