Electricity Lecture Series

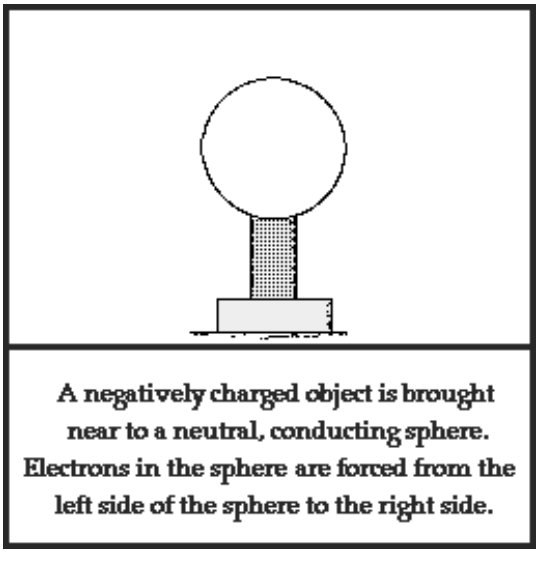
Assoc. Prof. Dr. J.J.

Electric Force & Electric Field

Applied Sciences Education Research Group (ASERG)
Faculty of Applied Sciences
Universiti Teknologi MARA
email: drjjlanita@hotmail.com jjnita@salam.uitm.edu.my;
http://www3.uitm.edu.my/staff/drjj/

 1

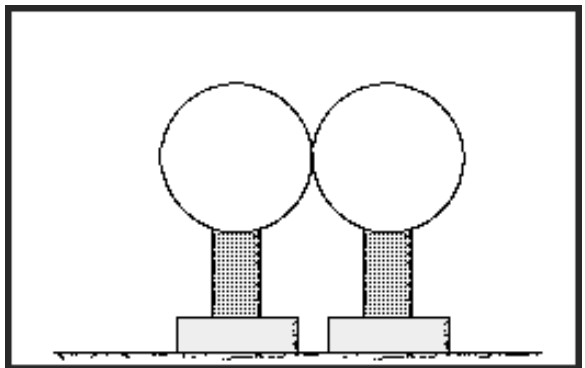
Charges, charging, electrical force & discharging



A negatively charged object is brought near to a neutral, conducting sphere. Electrons in the sphere are forced from the left side of the sphere to the right side.

2

Charges, charging, electrical force & discharging



Two neutral conducting spheres are touching one another, thus allowing for the free movement of electrons between them.

3

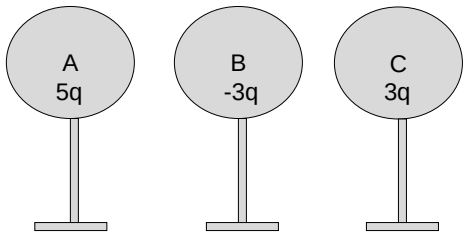
Charge Conservation

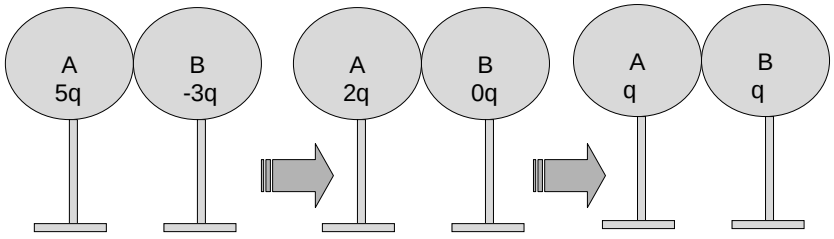
Shown are conducting spheres each of charges 5q, -3q and 5q

What is the total charge on the spheres?

Sphere A touches sphere B and then separated.

After the process above, what is the total charge & the charge on each individual sphere?





4

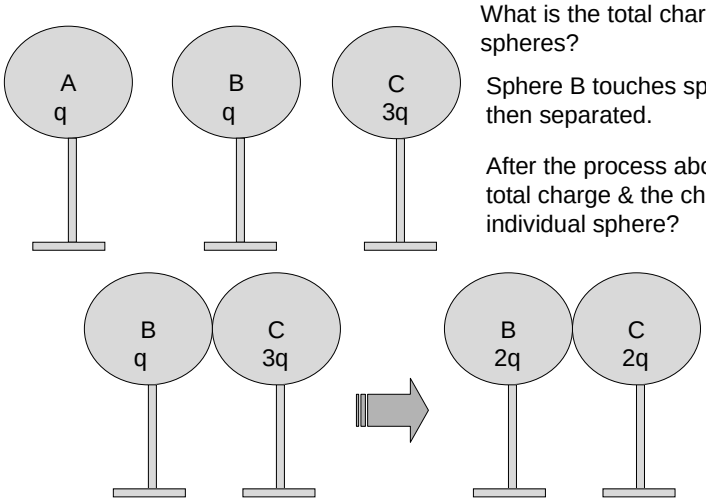
Charge Conservation

Shown are conducting spheres each of charges 5q, -3q and 5q

What is the total charge on the spheres?

Sphere B touches sphere C and then separated.

After the process above, what is the total charge & the charge on each individual sphere?



5

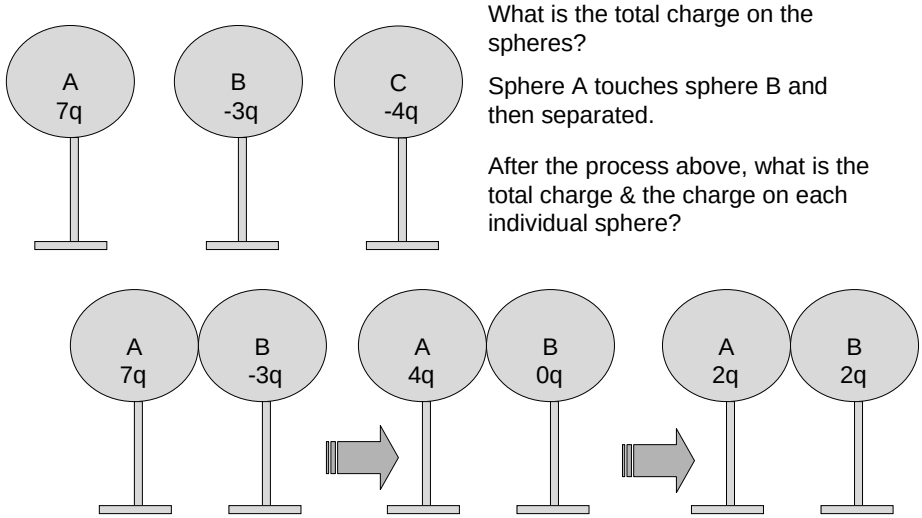
Charge Conservation

Shown are conducting spheres each of charges 7q, -3q and -4q

What is the total charge on the spheres?

Sphere A touches sphere B and then separated.

After the process above, what is the total charge & the charge on each individual sphere?



6

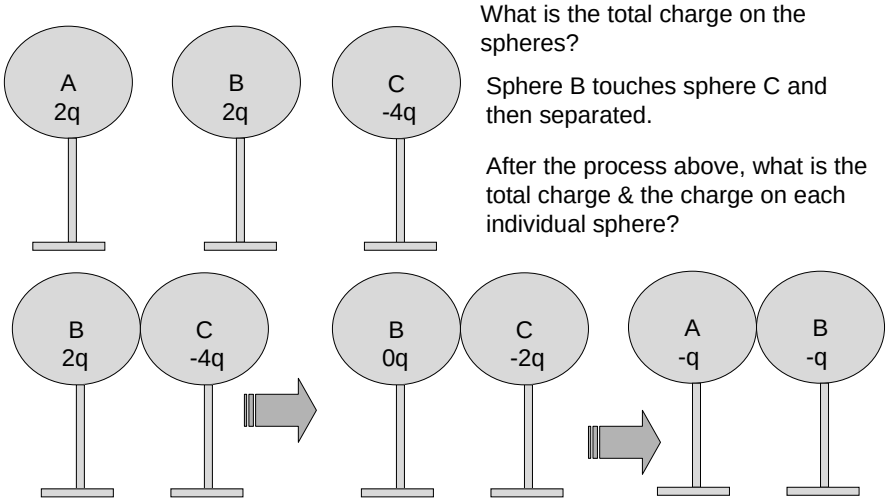
Charge Conservation

Shown are conducting spheres each of charges 2q, 2q and -4q

What is the total charge on the spheres?

Sphere B touches sphere C and then separated.

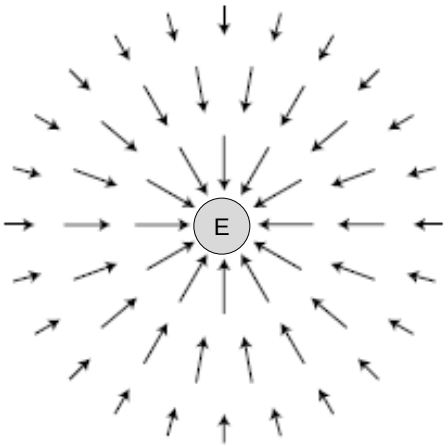
After the process above, what is the total charge & the charge on each individual sphere?



7

PHY407
Lecture 2:Electrical force & Electrical Field

Why do things fall to the ground???



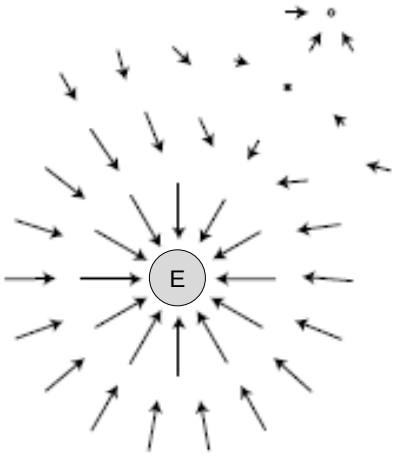
The gravitational field surrounding a clump of mass such as the earth. On earth, the gravitational field is $\mathbf{g}=\mathbf{F}/m_t$ where m_t is the objects's mass.

Objects don't fall, but are attracted to the center of the earth due to he presence of gravitational field, **g**

8

PHY407
Lecture 2:Electrical force & Electrical Field

Why do things fall to the ground???



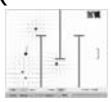
The gravitational fields of the earth and moon superpose. Note how the fields cancel at one point, and how there is no boundary between the interpenetrating fields surrounding the two bodies

PHY407
Lecture 2: Introduction

REFERENCE: http://phet.colorado.edu/web-pages/simulations-base.html

Activity 1-Electrical (Coulomb) Force

2.1 Electrons falling into proton
Reference: Physics 2000-force



2.2 Forces on charges
Reference: PHET electric field hockey

Activity 2-Resultant Force

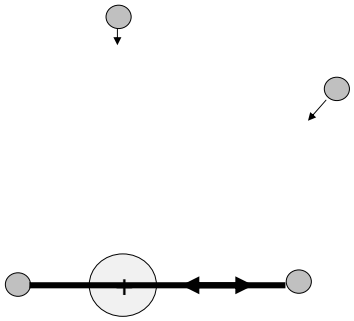
2.3 Addition of forces: PHET vector addition

Activity 3-Electric Field

2.4 Electric field
Reference: PHET charges & field

PHY407
Lecture 2: Introduction

Activity 1-Electrical (Coulomb) Force



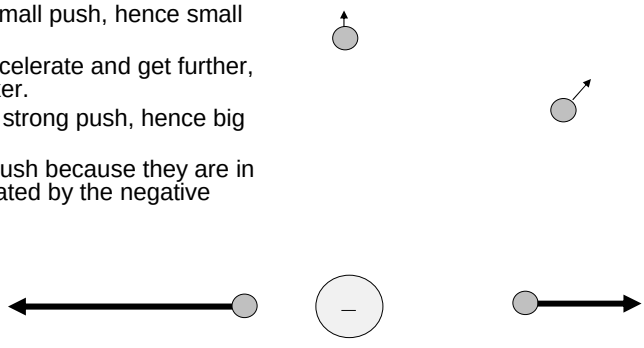
- Electrons move towards proton
- Far electrons feel small pull, hence small initial acceleration
- As the electrons accelerate and get closer, the pull gets stronger.
- Near electrons feel strong pull, hence big initial acceleration.
- Electrons feel the pull because they are in an electric field created by the proton

11

PHY407
Lecture 2: Introduction

Activity 1-Electrical (Coulomb) Force

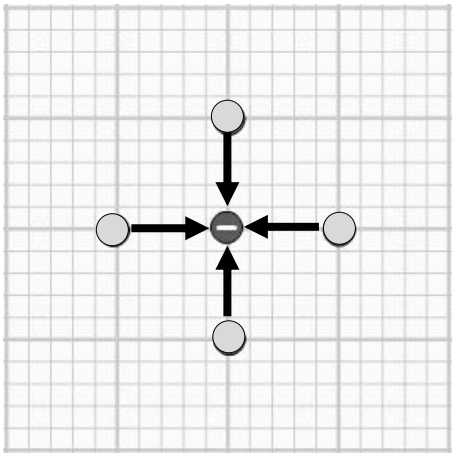
- Electrons move away from negative particle
- Far electrons feel small push, hence small initial acceleration
- As the electrons accelerate and get further, the push gets weaker.
- Near electrons feel strong push, hence big initial acceleration.
- Electrons feel the push because they are in an electric field created by the negative particle



12

PHY407
Lecture 2: Introduction

Activity 1-Electrical (Coulomb) Force on central electron

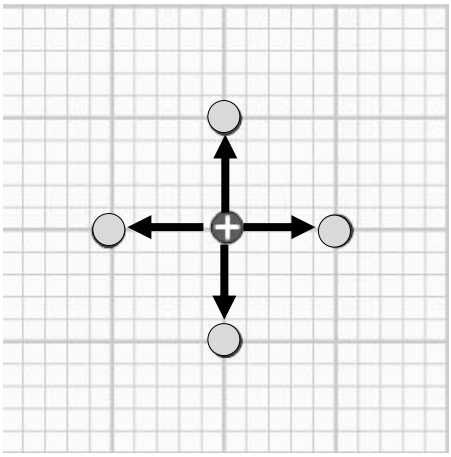


- Right electron push central electron to the left.
- Left electron push central electron to the right.
- Top electron push central electron to the bottom.
- Bottom electron push central electron to the top.

13

PHY407
Lecture 2: Introduction

Activity 1-Electrical (Coulomb) Force

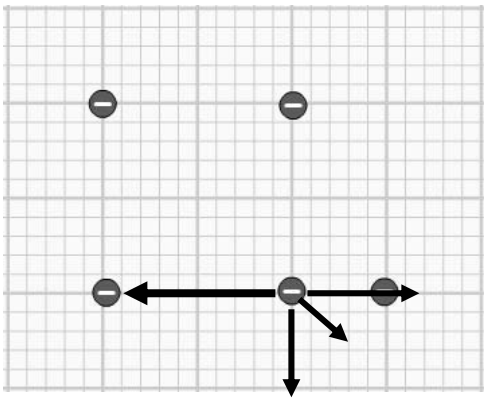


- Right electron pull central proton to the right.
- Left electron pull central proton to the left.
- Top electron pull central proton to the top.
- Bottom electron pull proton to the bottom.

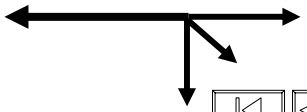
14

PHY407
Lecture 2: Introduction

Activity 1-Electrical (Coulomb) Force



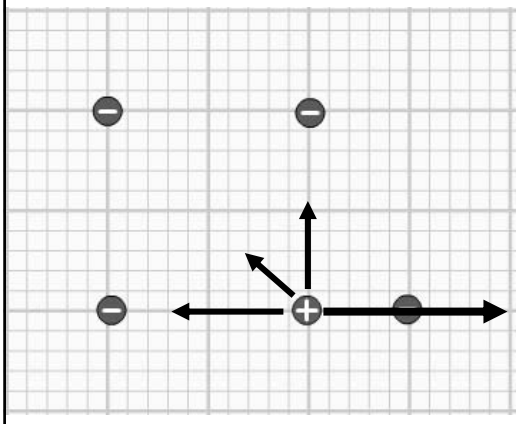
- Right electron pushes central electron to the left.
- Left electron pushes central electron to the right with a smaller force than the electron on the right.
- Top electron pushes central electron to the bottom with the same force that the left electron exerts on the central electron.
- Top left corner electron pushes central electron to the bottom right corner.



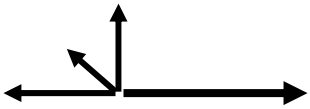
15

PHY407
Lecture 2: Introduction

Activity 1-Electrical (Coulomb) Force



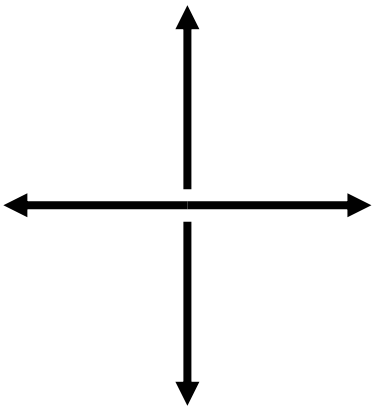
- Right electron pulls the proton to the right.
- Left electron pulls the proton to the left with a smaller force than the electron on the right.
- Top electron pulls the proton up with the same force that the left electron exerts on the central electron.
- Top left corner electron pulls the proton to the top left corner.



16

PHY407
Lecture 2: Introduction

Activity 2-Resultant Force



PULLING of PROTON

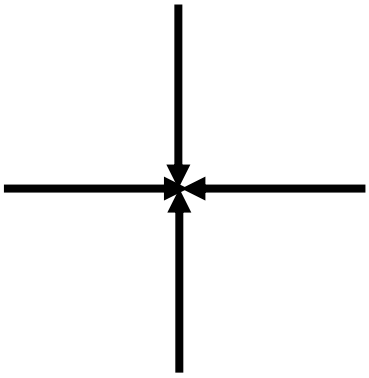
- Sum of force to the right (+ve) is equal to the sum of the force to the left (-ve).
- Sum of force to the top (+ve) is equal to the sum of the force to the bottom (-ve).

- Top electron push central electron to the bottom.
- Bottom electron push central electron to the top.

17

PHY407
Lecture 2: Introduction

Activity 2-Resultant Force



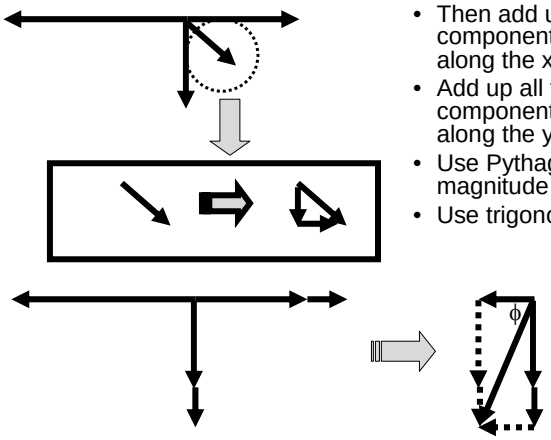
PUSHING of ELECTRON

- Sum of force to the right (+ve) is equal to the sum of the force to the left (-ve).
- Sum of force to the top (+ve) is equal to the sum of the force to the bottom (-ve).

18

PHY407
Lecture 2: Introduction

Activity 2-Resultant Force



- Break the forces into its x and y components. Use trigonometry to find the values.
- Then add up all the +ve & the –ve x components to get the sum of forces along the x.
- Add up all the +ve & the –ve y components to get the sum of forces along the y.
- Use Pythagoras theorem to determine the magnitude of the resultant force.
- Use trigonometry to find the direction

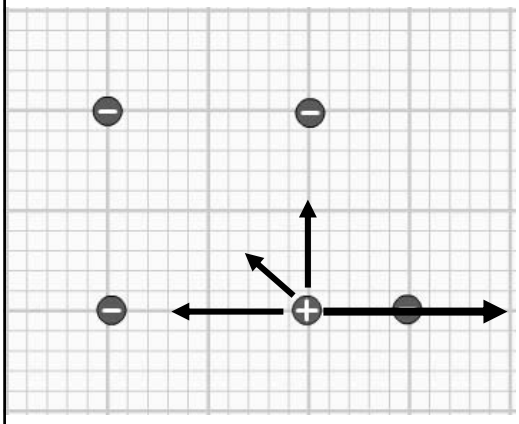
$$F^2 = F_x^{\ 2} + F_y^{\ 2}$$

$$tan\Phi = \frac{F_y}{F_x}$$

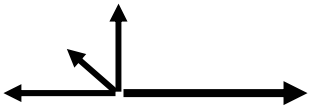
19

PHY407
Lecture 2: Introduction

Activity 1-Electrical (Coulomb) Force



- Right electron pulls the proton to the right.
- Left electron pulls the proton to the left with a smaller force than the electron on the right.
- Top electron pulls the proton up with the same force that the left electron exerts on the central electron.
- Top left corner electron pulls the proton to the top left corner.



20