Lecture 3

Fri: Turn in HW /surveys

Mon: Warm Up 2 due by 9am

Tues: Discussion /quiz

* Do following before class Supp 7, 8, 9, 10ab
  Ch 20 Probs 17, 59
* Bring to class – discuss /work in groups
* No turn in
* Quiz 5-10 min at end of class

Coulomb's Law

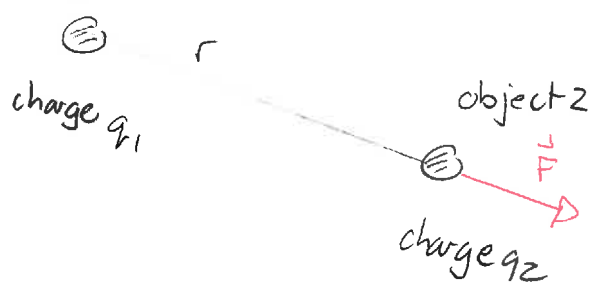
Coulomb's law provides the basic rule for a force exerted by a stationary charged particle:

a) The magnitude of the force exerted by 1 on 2 is

$$F_{1 on 2} = k \frac{|q_1||q_2|}{r^2}$$

where

$$k = 8.99 \times 10^9 \, Nm^2/C^2$$



b) the direction is determined by the repel / attract rule and is along the straight line between the particles

It should be stressed that charge and forces are very distinct quantities. We can illustrate these via various analogous

Electrostatics	Gravity	Money
Charge = innate property of an object electron $q = -1.6\times10^{-19}$C	Mass = innate property of an object electron $m = 9.11\times10^{-31}$ kg	Value of money = inherent property  =$0.25
Charge describes ability of particle to exert + feel electric force	Mass describes ability of particle to exert + feel gravitational force	Value of coin describes ability of token (coin) to acquire goods / services
Force describes interaction between two charged objects	Force describes interaction between two objects with mass	
An isolated charged particle has charge but does not have force	An isolated massive particle has mass but no force.	

Quiz 1

Quiz 2

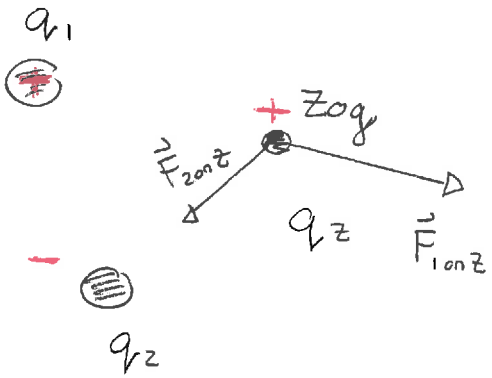
Note that the charge of an object only partly determines the force that it exerts (or feels). Other factors are

1) the charge of the particle with which it interacts
2) " distance to " " " " " "

Multiple charge particles

Suppose that a charged particle of interest, Zog, is in the vicinity of several other charged particles. If we are interested in the motion of Zog then we need the net force on Zog. Then a general rule is:

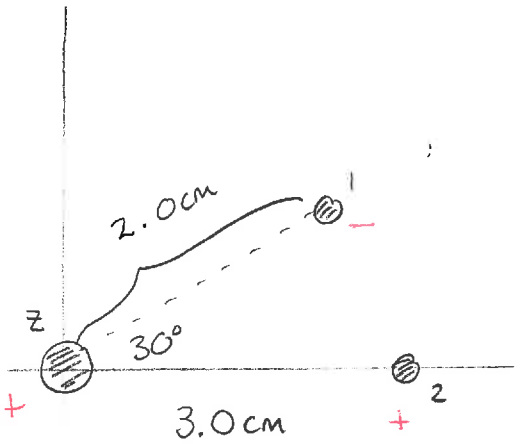
$$\vec{F}_{\text{net on Z}} = \vec{F}_{1\text{ on Z}} + \vec{F}_{2\text{ on Z}}$$



and an important rule is that each of the individual forces could be calculated as if the other charges were not present.

Quiz 3

Example: Consider the three charges as illustrated



$q_1 = -5.0 \times 10^{-6}\,C$

$q_2 = +5.0 \times 10^{-6}\,C$

$q_Z = +2.0 \times 10^{-6}\,C$

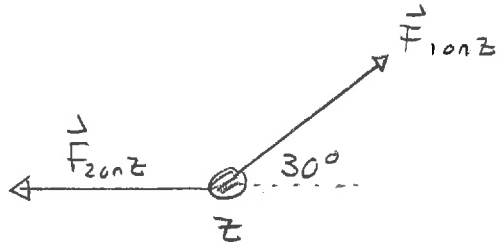
Determine the net force vector on particle Z.

Answer: Scheme

Sketch individual force vectors → Determine magnitudes + directions of individual force vectors → ADD VECTORS using components

Step 1 Individual forces

The diagram indicates directions



Step 2 Plan: $\vec{F}_{net} = \vec{F}_{1on2} + \vec{F}_{2on2}$

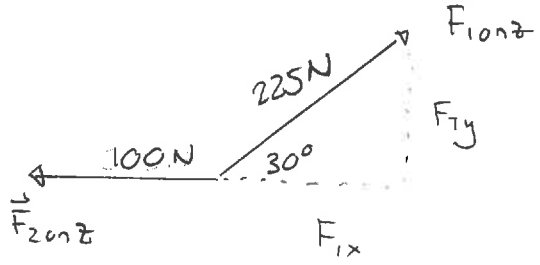
Step 3 Magnitudes

$$F_{1on2} = k\frac{|q_1||q_2|}{r^2} = 8.99\times10^9 \frac{Nm^2}{C^2}\frac{|-5.0\times10^{-6}C||2.0\times10^{-6}C|}{(2.0\times10^{-2}m)^2} = 225\,N$$

$$F_{2on2} = k\frac{|q_2||q_2|}{r^2} = 8.99\times10^9 \frac{Nm^2}{C^2}\frac{|+5.0\times10^{-6}C||2.0\times10^{-6}C|}{(3.0\times10^{-2}m)^2} = 100N$$

Step 4 Add vectors via components.

We need the components for $\vec{F}_{1on2}$



$F_{1x} = F_{1on2}\cos30° = 225N\cos30° = 195N$

$F_{1y} = F_{1on2}\sin30° = 225N\sin30° = 113N$

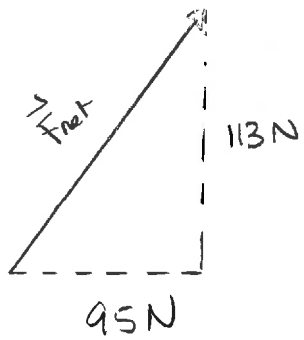
Vector	x comp	y comp
$\vec{F}_{1on2}$	195 N	113 N
$\vec{F}_{2on2}$	−100 N	0
	95 N	113 N

Then

$F_{net\,x} = F_{1x} + F_{2x} = 195N - 100N = 95N$

$F_{net\,y} = F_{1y} + F_{2y} = 113N + 0N = 113N$

We can construct the net force vector and this has magnitude



$$F_{net} = \sqrt{F_{net_x}^2 + F_{net_y}^2}$$

$$= \sqrt{(95N)^2 + (113N)^2}$$

$$= 150N$$

Note that we cannot just add or subtract the magnitudes of $\vec{F}_{1on2}$ and $\vec{F}_{2on2}$ to get $\vec{F}_{net}$. We have to take the vector directions into account.

When combining force vectors, remember to add vectors using components