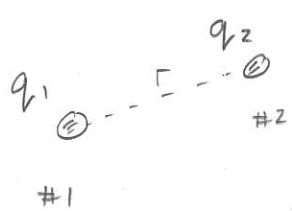
Fri. Labs

Mon: HW by 5pm
Phys 132 Exercises 8, 10, 11, 12, 13, 14, 15, 16
Turn in – Paper preferably
– Alternative D2L

Tues: Lecture

Coubmb's Law

Electrostatics considers forces that are exerted by charges at rest. The basic force law that governs all these situations describes the force exerted by one charged particle on another. This is Coulomb's Law:



The force exerted by charge 1 on charge 2:

a) has magnitude

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

b) has direction along the line of interaction according to repel/attract

Here Coulomb's constant is

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

and is sometimes written as

$$k = \frac{1}{4\pi\epsilon_0} \qquad \epsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$$

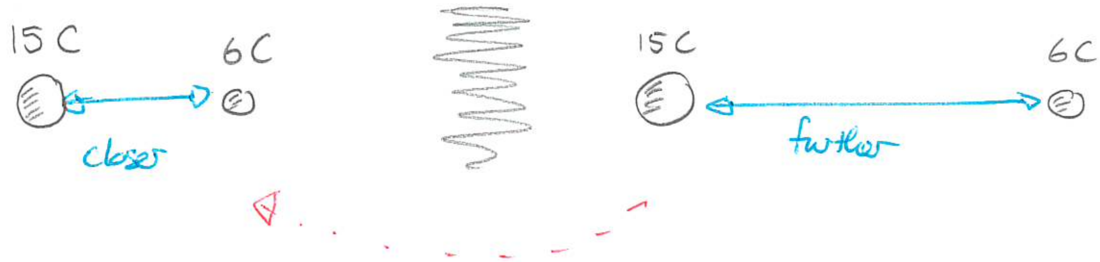
Charge refers to an inherent property of an object / particle, in the same way that mass does. In physics the role of charge is to <u>partly</u> determine the force exerted or experienced. In both cases

Collection of objects with inherent mass or charge

Actual arrangement of objects in space

— Both / Determine →

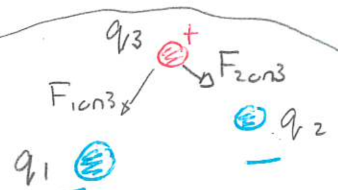
Forces objects exert / experience



same charges different forces

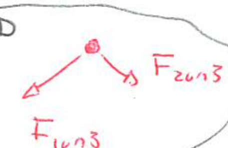
Quiz 1 30% - 90%

Coulomb's Law allows one to use classical physics as:



Choose object of interest + specify forces

→ Draw FBD



→ Coulomb's Law gives magnitude of each force

→ Determine net force

$\vec{F}_{net} = \sum \vec{F}_i$

ADD VECTORS

↓

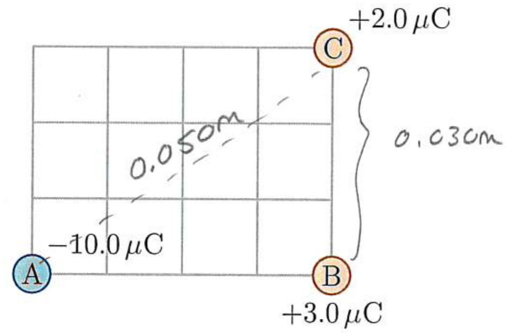
Newton's 2nd Law gives acceleration

$\vec{F}_{net} = m\vec{a}$

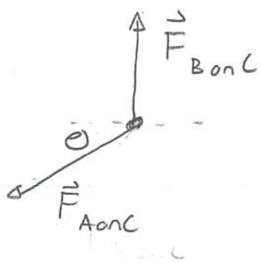
mass charge 3

17 Two dimensional charge arrangements: force, 3

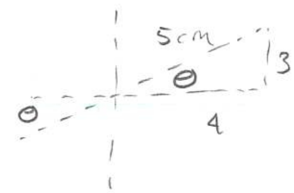
Three charged particles are held fixed as illustrated; the grid units are each 0.010 m. Determine the magnitude and direction of the net force on charge C. *(132S22 Class)*



Answer: ① Draw FBD



get θ via



$\tan\theta = 3/4$ $\theta = \tan^{-1}(3/4) = 36.9°$

② Magnitudes of forces

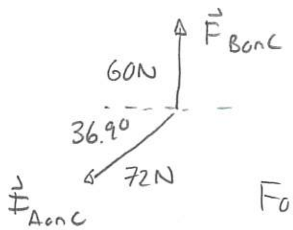
$$F_{B\,on\,C} = k\frac{|q_B||q_C|}{r^2} = 8.99\times10^9\,\frac{Nm^2}{C^2}\,\frac{3.0\times10^{-6}C \times 2.0\times10^{-6}C}{(0.030m)^2} = 60N$$

$$F_{A\,on\,C} = k\frac{|q_A||q_C|}{r^2} = 8.99\times10^9\,\frac{Nm^2}{C^2}\,\frac{10.0\times10^{-6}C \times 2.0\times10^{-6}C}{(0.050m)^2} = 72N$$

Distance from A to C → r^2

not component of vector from A to C

③ Add vectors



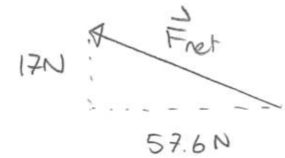
	x comp	y comp
$F_{B\,on\,C}$	0	60N
$F_{A\,on\,C}$	−57.6N	−43N

For $F_{A\,on\,C}$

x comp $= -72N\cos 36.9° = -57.6N$

y comp $= -72N \sin 36.9° = -43N$

$\vec{F}_{net} = -57.6N\,\hat{i} + 17N\,\hat{j}$



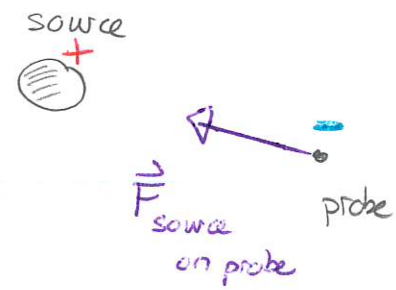
Quiz 2

Electric field

We now present an alternative way to describe the force that one charge exerts on another. This involves an intermediate quantity, the electric field.

Consider two point charges. One is fixed and will exert the force; this is the "source". The other feels the force; this is the "probe".

Then Coulomb's Law gives that the magnitude of the force exerted by the source on the probe is:



$$F_{\text{source on probe}} = k \frac{|q_{\text{source}}|\,|q_{\text{probe}}|}{r^2}$$

$$\Rightarrow \quad F_{\text{source on probe}} = |q_{\text{probe}}| \; k \frac{|q_{\text{source}}|}{r^2}$$

$|q_{\text{probe}}|$: depends on probe only

$k \frac{|q_{\text{source}}|}{r^2}$: can be calculated at any location with information about the source only ~ electric field produce by source, $\vec{E}$

When constructed properly, in terms of vectors,

$$\boxed{\vec{F}_{\text{source on probe}} = q_{\text{probe}} \vec{E}}$$

where q_{probe} is the charge of the probe

$\vec{E}$ is the electric field produced by the source at the probe location