ch05/s4.html Concept Q

a) Bring into contact when both are originally neutral.
  i) Touch one object with charged rod ? unclear
  ii) Bring charged rod near one object

b) Touch charged rod to one object. Then bring the two objects into contact

Coulomb's Law

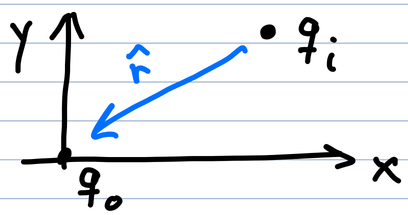
$F_{electric} \propto \left| \frac{q_1 q_2}{r^2} \right|$ constant of proportionality $k = \frac{1}{4\pi\epsilon_0} \sim 9 \cdot 10^9 \frac{Nm^2}{C^2}$

example $+4q, +4q$ where $q = 1.60 \cdot 10^{-19}C$ $r = 20pm$

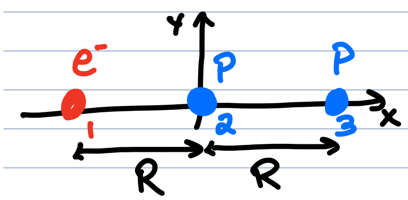
$\Rightarrow F = 92 \cdot 10^{-6} N$ (don't forget to include the factor of $1.6 \cdot 10^{-19}$ twice)

Principle of superposition : add up all the contributions

$$\vec{F}_{total\ on\ q_0} = \sum_{i=1}^{N} \vec{F}_{q_i\ on\ q_0} = \sum_{i=1}^{N} \frac{k q_0 q_i}{r_i^2} \hat{r}_i$$



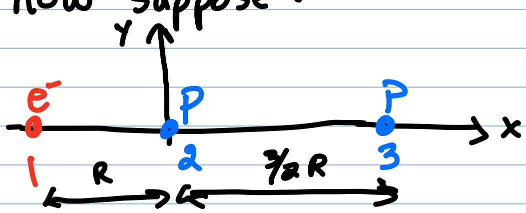
example what is the net electrostatic force on the central proton?



$$\vec{F}_{total\ on\ 2} = \vec{F}_{1on2} + \vec{F}_{3on2} = \frac{ke^2(-\hat{\imath})}{R^2} + \frac{ke^2(-\hat{\imath})}{R^2}$$

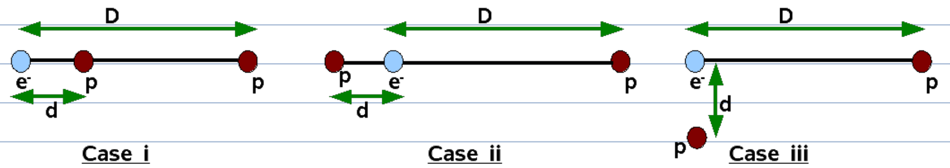
$$= \boxed{\frac{-2ke^2(\hat{\imath})}{R^2}}$$

now suppose :



$$\vec{F}_{total\ on\ 2} = \vec{F}_{1on2} + \vec{F}_{3on2}$$

$$= \frac{ke^2(-\hat{\imath})}{R^2} + \frac{ke^2(-\hat{\imath})}{\frac{9}{4}R^2} = \frac{-13}{9}\frac{ke^2(\hat{\imath})}{R^2}$$



Rank the arrangements according to the magnitude of the net electrostatic force on the electron due to the protons.

a) i>ii>iii
b) i>iii>ii
c) ii>i>iii
d) ii>iii>i
e) iii>i>ii
f) iii>ii>i

Case i $F_x = +\frac{k|e||-e|}{d^2} + \frac{k|e||e|}{D^2} = ke^2\left(\frac{1}{d^2}+\frac{1}{D^2}\right)$ $F_y = 0$

Case ii $F_x = -\frac{k|e||-e|}{d^2} + k|e||-e|/D^2$ $F_y = 0$

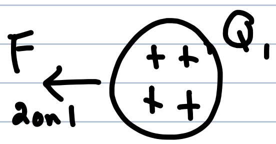
$\Rightarrow F_{net} = ke^2\left(\frac{1}{D^2} - \frac{1}{d^2}\right)$

Case iii $F_x = +\frac{k|e||-e|}{D^2}$ $F_y = -\frac{k|e||-e|}{d^2}$

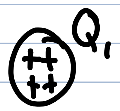
$F_{net} = \sqrt{\left(\frac{ke^2}{D^2}\right)^2 + \left(\frac{-ke^2}{d^2}\right)^2} = ke^2\sqrt{\frac{1}{D^4}+\frac{1}{d^4}}$

if $D=d=1$, then case i $ke^2 2$
case ii 0
case iii $ke^2\sqrt{2}$

Electric Field

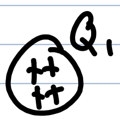


$\oplus q_2 \longrightarrow F_{1 on 2}$



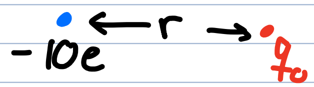
• Point "P" in space

imagine placing a test charge $+q_0$ at "P"



$\bullet q_0$ $\vec{E} = \frac{\vec{F}}{q_0}$

What is the electric field near a point charge of $-10e$?



$$\vec{F}_{on\ q_0} = \frac{k|q_0||-10e|}{r^2}(-\hat{r})$$

$$\Rightarrow \vec{E} = \frac{\vec{F}}{q_0} = \frac{k|-10e|(-\hat{r})}{r^2}$$

Compare gravity to electric force. Take 2 e^-s a distance r apart

$$\frac{F_e}{F_g} = \frac{k|e||-e|/r^2}{G m_e m_e/r^2} = 10^{42}$$