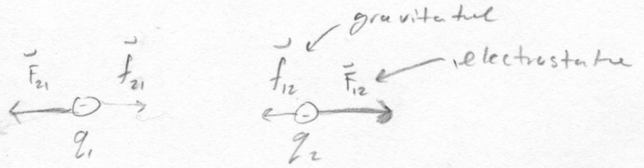
Quiz 1B Solutions



$\vec{f}_{12} = G\frac{m_1 m_2}{r^2}$ (towards the other) $\quad \vec{F}_{12} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}$ (away from each other if both are positive/negative)

$$|\vec{f}_{12}| = \left(\frac{20}{3}\right) \times 10^{-11} \left(9\times10^{-31}\right)^2 / \left(3\times10^{-2}\right)^2 \text{ N}$$

(↑ 6.67~)

$$= \left(\frac{2}{3}\right)(9)\,\frac{10^{-10}\,10^{-31\times2}}{10^{-4}} = \frac{18}{3}\,10^{-68} \text{ N}$$

← CRAZY SMALL!

$$|\vec{F}_{12}| = (9\times10^{9})\left(1.6\times10^{-19}\right)^2 / \left(3\times10^{-2}\right)^2 \text{ N}$$

$$\Rightarrow 10^{13-(19\times2)}(1.6)^2 = 2.56\times10^{-25} \text{ N}$$

Note $-25 >> -68$!

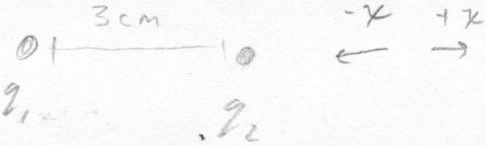
· We didn't have to calculate each individually, but it is good practice.

Anyway, the ratio, (ignoring the actual numbers and only consid. powers of 10)

$$\frac{|\vec{F}_{12}|}{|\vec{f}_{12}|} \simeq \frac{10^{-25}}{10^{-68}} = 10^{43} !!$$

$\vec{F}_{12}$ is WAY LARGER than $\vec{f}_{12}$ ✓

Now, let $|q_1| = |q_2| = q$



So, $\vec{F}_{21} = \frac{1}{4\pi\epsilon_0} \frac{q^2}{(3\times10^{-2})^2}$ (directed to the left or $-\hat{x}$ or $-\hat{i}$)

Should equal $-16\,N\,\hat{i}$. if q_1 wants to be repelled, they both are positively or negatively charged. either way, only $|q|$ is needed.

so,

$$16 = (9\times10^{9})\,q^2/9\times10^{-4} = q^2\times10^{13} \Rightarrow |q| = \sqrt{16\times10^{-13}}$$

$$\boxed{|q| = 4\times10^{-13/2}\ C}$$

or $4\times10^{-6.5}\ C$

Now, let $q_1 = -q_2 = 10\,C$ and recall $\vec{\tau} = \vec{p}\times\vec{E}$

with $p \Rightarrow (10)(3\times10^{-2}) = .3\,[C\cdot m]$ and $E = 5\times10^{5}\,[\frac{N}{C}]$

Now, if $\vec{p}\perp\vec{E}$ $\vec{p}\times\vec{E} = pE$ since $\vec{p}\times\vec{E} = pE\sin\phi = pE$ @ $\phi = \pi/2$ or 90

So, the net torque if $\vec{p}\perp\vec{E}$ is $\boxed{|\vec{\tau}| = (.3)(5\times10^{5}) = 1.5\times10^{5}\,[N\cdot m]}$

For the directn of the torque, use the right hand rule.

Conceptual Question

points ①
- hold a charged object close, without touching, to the ball surround by insulating material
- while a temporary charge seperation exists, ground one side. Since electrons carry charge, this means we can ground the ball to allow electrons to escape, leaving a net positive charge. ①
- This positive charge remains even when the object for induction is removed, as long as we unground the sphere again before we do so