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Welcome!

Physics 194 - Lecture 3

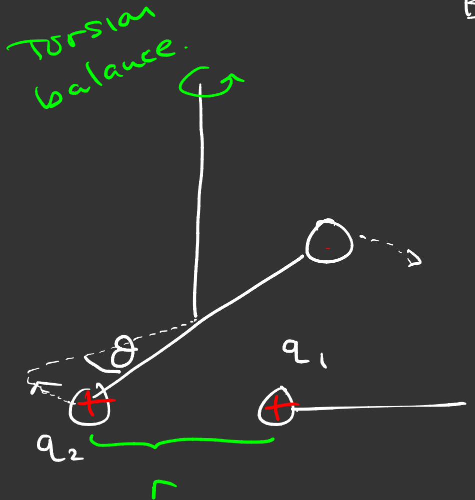
Have a question during class? Please ask it right away, even if it means interrupting in the middle of a thought. I want you to!

Agenda

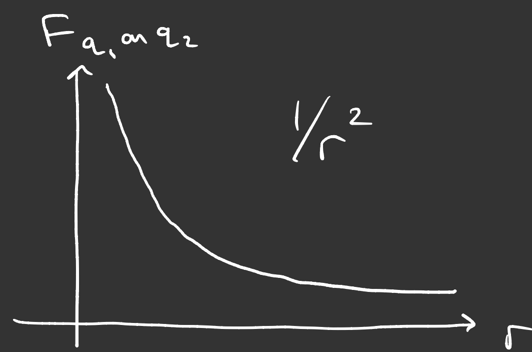
- Non-constant forces
- The electric field
- The superposition principle

Class starts @2:15 pm

Electric Force



Charles Coulomb's experiment



Double r and $F_{q_1 \text{ on } q_2}$ drops by $\frac{1}{4}$

Assumes...

- charges are spherical + not too close. (The distance between the objects is significantly greater than their size.

Coulomb's law

$$\underset{(N)}{F_{1 \text{ on } 2}} = K \frac{|q_1 q_2|}{r^2} \qquad \frac{(C)\,(C)}{(m^2)}$$

$\text{kg}\cdot\text{m/s}^2$

Coulomb's constant: $8.99\times10^{9} \frac{N\cdot m^2}{C^2}$

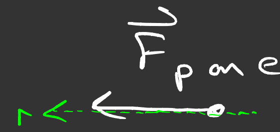
The unit of electric charge is the Coulomb (C)

electric charge quantum

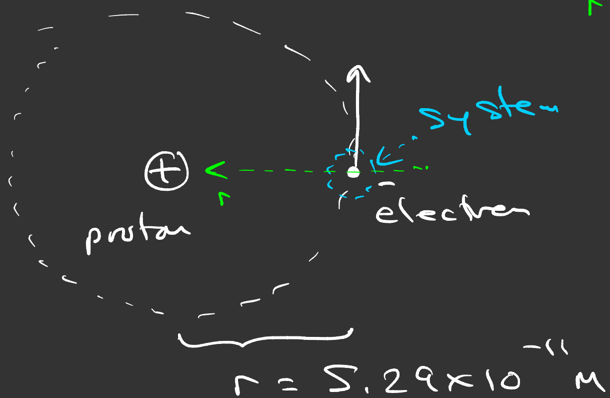
proton charge: $q_p = 1.6\times10^{-19}\,C = +e$

electron charge: $q_e = -1.6\times10^{-19}\,C = -e$

The hydrogen atom



How fast is the electron moving?



$$a_r = \frac{1}{m_e} \Sigma F_{on\ e,\ r}$$

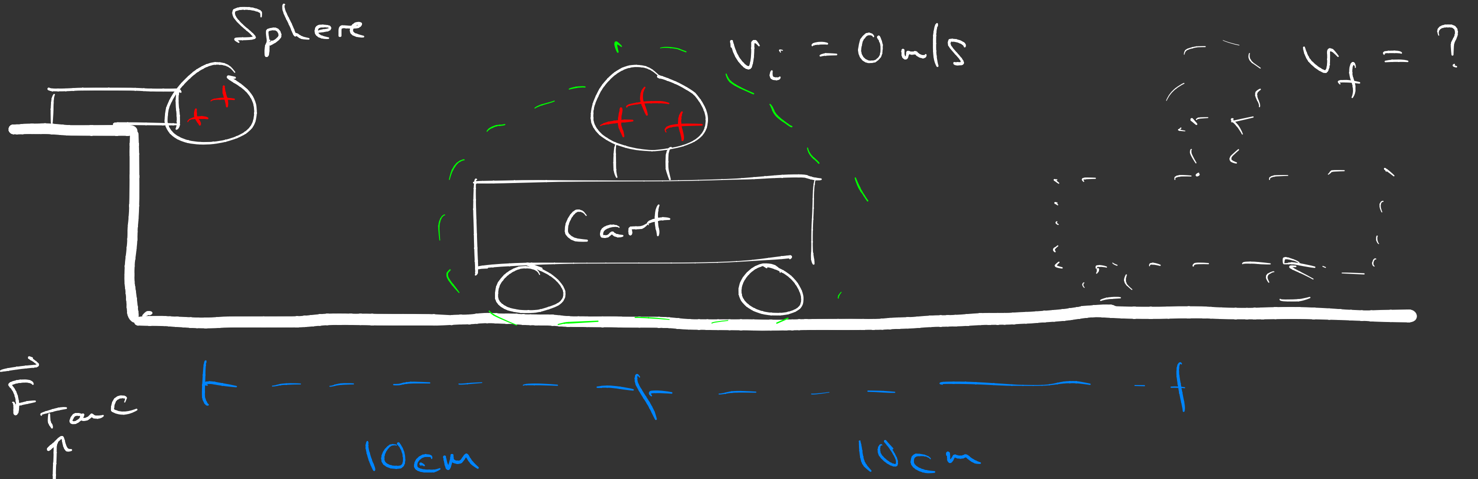
$$\frac{v^2}{\cancel{r}} = \frac{1}{m_e}\left(k \frac{|q_p q_e|}{r^{\cancel{2}}}\right)$$

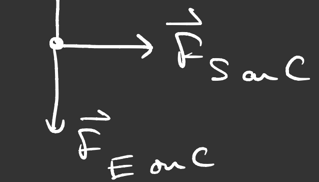
$$v^2 = \frac{1}{m_e}\left(k \frac{\overbrace{|(+e)(-e)|}^{e^2}}{r}\right)$$

$$v = \sqrt{\frac{ke^2}{m_e r}}$$

$$v = \sqrt{\frac{(9 \times 10^9\ Nm^2/C^2)(1.6 \times 10^{-19}\ C)^2}{(9.11 \times 10^{-31}\ kg)(5.29 \times 10^{-11}\ m)}} = 2.19 \times 10^6\ m/s$$

$$= 0.007\, \underset{3 \times 10^8\ m/s}{c}$$





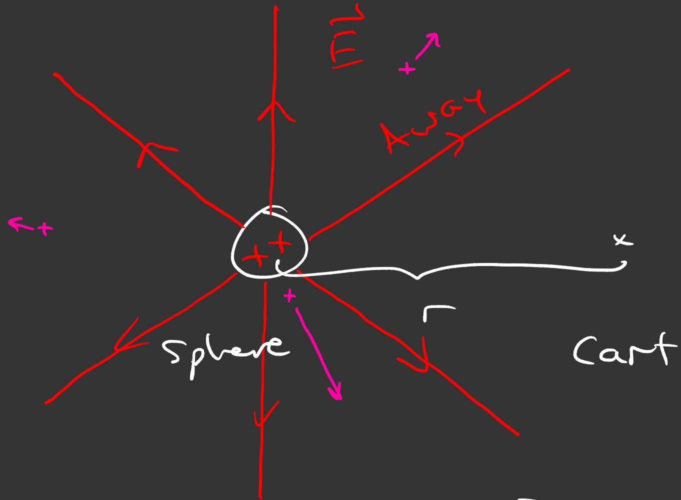
$$F_{S \text{ on } C} = k\frac{|q_s q_c|}{r^2}$$

$$a_x = \frac{1}{m}\sum F_{\text{on } C,x} = \frac{1}{m}\left(k\frac{|q_s q_c|}{r^2}\right)$$

$$v_f^2 = v_i^2 + 2a_x(x_f - x_i)$$

How do non-contact interactions work?

- Gravitational
- Electric
- Magnetic



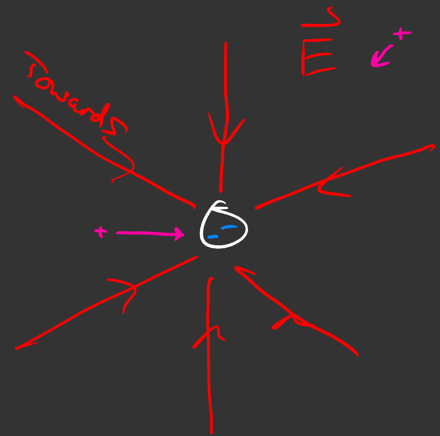
1) Charged objects create a disturbance called the electric field (E-field)

2) Other charged objects are "sensitive" to that field. The field at that object's location exerts a force on that object.

$$F_{s\,on\,c} = k\frac{|q_s q_c|}{r^2}$$

$$F_{s\,on\,c} = |q_c|\underbrace{\left(k\frac{|q_s|}{r^2}\right)}_{E_s}$$

$$\boxed{\underset{(N)}{F_{s\,on\,c}} = \underset{(C)}{|q_c|}\,\underset{(N/C)}{E_s}}$$



$$E = k\frac{|q|}{r^2}$$

E-field produced by a pointlike object.

$$\vec{F}_{\vec{E}\text{ on }q} = q\,\vec{E}_{@\,q\text{'s location}}$$