College Prep Physics II – Video Lecture Notes – Chapter 17

Video Lecture #1 – Chapter 17.1 - Introduction to the Law of Charges

Thank You, George Cholack, for these notes.

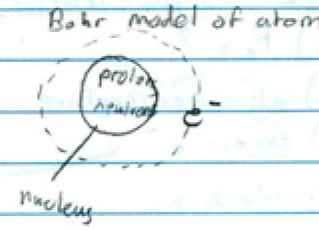
Law of Charges

unlike charges attract, like charges repel

positive and negative charges

electrons, e^- negative charge

proton positive charge



Video Lecture #2 – Chapter 17.1 - Introduction to the Quantization of Charge

1909 Oil Drop Experiment

Charge is quantized

$$Q = ne$$

n = integer

e = fundamental charge = $\pm 1.60 \times 10^{-19}$ c

c = coulombs

New unit

$m_e = 9.11 \times 10^{-31}$ kg

$m_p = 1.67 \times 10^{-27}$ kg

Video Lecture #3 – Chapter 17.1 - Definitions of Conductors, Insulators, Semi-Conductors and Super Conductors

conductor: electrons flow freely ex: gold, copper, aluminum, silver

insulator: electrons do not flow freely ex: fur, wool, silk

semi-conductor: in between

super conductor: no resistance to e^- flow perfect conductor 1 – 20 K, ~130 K

work at very low temperatures

Video Lecture #4 – Chapter 17.1 - Charging via Conduction, Induction and Polarization

Charging via conduction w/ touch

Charging via Induction No touch

Charge via polarization

Video Lecture #5 – Chapter 17.2 - Introduction to Coulomb's Force or the Electric Force

$$F_e = \frac{k q_1 q_2}{r^2}$$

$$k = 8.99 \times 10^9 \frac{N \cdot m^2}{c^2}$$

$$k = 8.99 \times 10^9 \frac{N \cdot m^2}{C^2}$$

$$F_g = \frac{G m_1 m_2}{r^2} \qquad G = 6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$$

F_g is negligible for atomic particles

μ micro

N nano

p pico

$1 \times 10^6\ \mu c = 1c$

$1 \times 10^9\ Nc = 1c$

$1 \times 10^{12}\ pc = 1C$

Video Lecture #6 – Chapter 17.2 - page 636 #1 Finding the Coefficient of Friction between a Cork and a table – A Coulomb's Force Problem

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$q_1 = +6.0\ \mu c \left(\frac{1\ c}{1 \times 10^6\ \mu c}\right) = 6 \times 10^{-6}\ C$ $\qquad r = 0.12 \qquad m_c = 1.1 g \left(\frac{1 kg}{1000 g}\right) = 1.1 \times 10^{-3}\ kg$

$q_2 = -4.3\ \mu c \left(\frac{1\ c}{1 \times 10^6\ \mu c}\right) = -4.3 \times 10^{-6}\ C$

a) $F_e = ?$ $\qquad F_e = \frac{k q_1 q_2}{r^2} = \frac{8.99 \times 10^9 (6 \times 10^{-6})(-4.3 \times 10^{-6})}{0.12^2} = -16.107$

b) attractive/repulsive $\qquad F_e \approx -16\ N$ — attractive

c) excess e^- → $Q = ne$

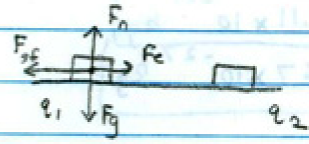
d) redundant

e) $\mu_s = ?$

$q_2 = ne \Rightarrow n = \frac{q_2}{e} = \frac{-4.3 \times 10^{-6}\ C}{-1.60 \times 10^{-19}\ C}$

$n = 2.687 \times 10^{13}$

$\approx 2.7 \times 10^{13}\ e^-$

e) 

$\Sigma F_x = F_e - F_{sf} = ma_x = m(0) = 0 \Rightarrow F_e = F_{sf}$

$F_e = \mu_s F_n$

$\Sigma F_y = F_n - F_g = ma_y = m(0) = 0 \Rightarrow F_n = F_g = mg$

$F_e = \mu_s mg$

$\mu_s = \frac{F_e}{mg} = \frac{+16.107}{(1.1 \times 10^{-3})(9.8)}$

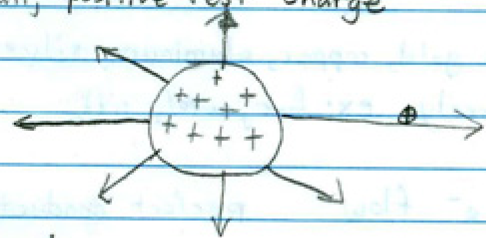
$\mu_s = 1494.16$

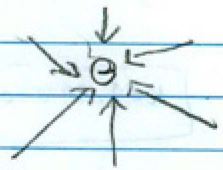
≈ 1500

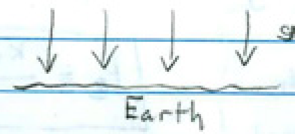
Video Lecture #7 – Chapter 17.3 - Introduction to the Electric Field

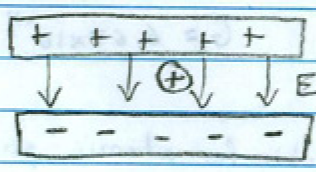
E field F_e is a field force

by a small, positive test charge









$$\boxed{E = \frac{F_e}{q}} \qquad \frac{N}{C}$$

Vectors!

$F_g = mg$

$g = \frac{F_g}{m}$

$E = \frac{F_e}{q} = \frac{1}{q} \cdot \frac{k q q_2}{r^2}$

around a point charge or spherical charge

$$\boxed{E = \frac{kq}{r^2}}$$

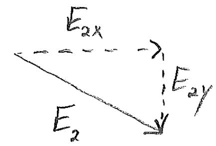
Video Lecture #8 has no lecture notes

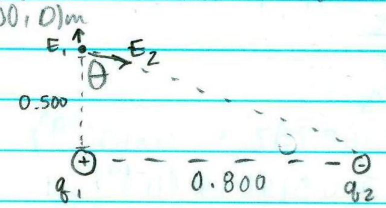
Thank You, Puja Patel, for these notes.

p.647 #11 $q_1 = 5.00\ \mu C$ $q_2 = -3.00\ \mu C$ $(0.800, 0)\ m$ $E = ??$ $(0.500, 0)\ m$

$E_1 = \frac{kq_1}{r_1^2}$

$E_1 = ($





$E_1 = \frac{kq_1}{r^2}$

$E_1 = \frac{(8.99\times10^9)(5\times10^{-6})}{(0.500)^2}$

$E_1 = 179{,}800\ \frac{N}{C}$

$q_1 = 5.00\ \mu C \cdot \frac{1C}{1\times10^6\ \mu C} = 5\times10^{-6}\ C$

$E_2 = \frac{kq_2}{r_2^2}$

$q_2 = -3.00\ \mu C \cdot \frac{1C}{1\times10^6\ \mu C} = -3\times10^{-6}\ C$

$E_2 = \frac{(8.99\times10^9)(3\times10^{-6})}{(0.500^2)+(0.800^2)}$

$r^2 = a^2 + b^2$

$\cos\theta = \frac{A}{H} = \frac{E_{2y}}{E_2}$

$E_2 = 30{,}303.37\ \frac{N}{C}$

$\tan\theta = \frac{O}{A} = \frac{0.8}{0.5}$

$E_{2y} = E_2\cos\theta$

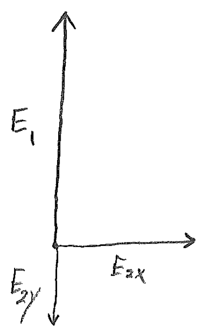
$\sin\theta = \frac{O}{H} = \frac{E_{2x}}{E_2}$

$\theta = 57.995°$

$E_{2y} = (30{,}303.37)\cos(57.995)$

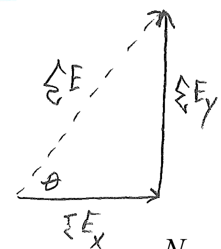
$E_{2y} = 16060.58211\ \frac{N}{C}$

$E_{2x} = E_2\sin\theta$
$E_{2x} = (30303.37)\sin(57.995)$
$E_{2x} = 25697.21$ N/C



$$\sum E_y = E_1 + E_{2y} = 179800 + (-16060.58) = +163739.41\frac{N}{C}$$

$$\sum E_x = E_{2x} = 25697.21\frac{N}{C}$$



$$\sum E = \sqrt{\left(\sum E_x\right)^2 + \left(\sum E_y\right)^2} = \sqrt{(25697.21)^2 + (163739.4179)^2} = 165743.61\frac{N}{C}$$

$$\tan\theta = \frac{O}{A} = \frac{\sum E_y}{\sum E_x} \Rightarrow \theta = \tan^{-1}\left(\frac{\sum E_y}{\sum E_x}\right) = \tan^{-1}\left(\frac{163739.42}{25697.21}\right) = 81.0808°$$

$\sum E = 166\frac{kN}{C} @ 81.1°$ above the positive x axis.

$E = \frac{F_e}{q} \Rightarrow F_e = qE = (1.6\times10^{-19})(165743.61) = 2.65190\times10^{-14}\ N @ 81.0808°$ above the positive x axis

$$\sum F = F_e = ma \Rightarrow a = \frac{F_e}{m_{proton}} = \frac{2.65190\times10^{-14}}{1.67\times10^{-27}} = 1.587963\times10^{13}\frac{m}{s^2}$$

$\Rightarrow a = 1.59\times10^{13}\frac{m}{s^2} @ 81.1°$ above the positive x axis ≠ uniformly accelerated motion!!!

As soon as it is no longer 0.500 m above q_1 the Electric Field changes, which means the Electric Force changes, which means the acceleration changes.