Notes on errors and uncertainties

average your three errors: $100 \times \frac{(q_{angle} - q_{pail})}{q_{pail}}$ #1

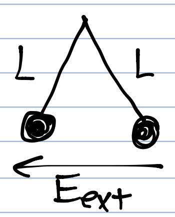
$\frac{100\,(q_{angle} - q_{pail})}{q_{pail}}$ #2

uncertainty on average error is $\sigma/\sqrt{3}$

Also, every # in the text and tables should have an uncert.

e.g. $q_{pail\ \#1}$ has uncert. of $\sim 0.5\,nC$ based on fluctuations on laptop read out

Ch 05 practice 2 oppositely charge balls, of magnitude 72.0 nC



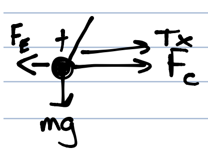
There's an external field E_{ext}

angle $\theta = 58.0°$ $L = 0.530\,m$

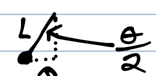
$m = 6.80\,mg$

a.) which is positive? $\vec{F}_{external\ E} = q E_{external} \Rightarrow$ left ball is +

b) what is $\vec{E}$?



$\Sigma F_y = 0$ $mg = T\cos\frac{\theta}{2}$ $\rightarrow T = \frac{mg}{\cos\theta/2}$



$r/2$ where $\sin\frac{\theta}{2} = \frac{1}{2}r/L$

$\Sigma F_x = 0$

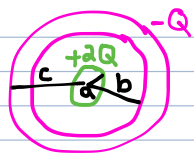
$\hookrightarrow \frac{kq^2}{r^2} + T\sin\frac{\theta}{2} - qE = 0$

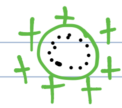
$\rightarrow E = \frac{\frac{kq^2}{(2L\sin\theta/2)^2} + mg\tan\theta/2}{q}$

More Gauss' Law

example solid conducting sphere inside a non-conducting shell with charge uniformly distributed throughout the shell

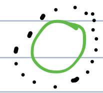
a) $r < a$



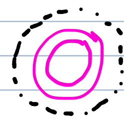


$Q_{encl} = 0 \Rightarrow E = 0$

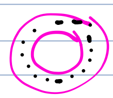
b) $a < r < b$ $\qquad Q_{encl} = 2Q \rightarrow E = \frac{k2Q}{r^2}$



c) $r > c$ $\qquad Q_{encl} = +1Q \rightarrow E = \frac{kQ}{r^2}$



d) $b < r < c$



$$Q_{enc} = 2Q + (\text{fraction of } -Q)$$

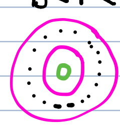
$$= 2Q + \frac{\frac{4\pi}{3}(r^3 - b^3)}{\frac{4\pi}{3}(c^3 - b^3)}(-Q) \equiv \beta$$

$$\int E\,dA = E 4\pi r^2 = \beta/\epsilon_0$$

$$\Rightarrow E = \frac{kQ}{r^2}\left[2 - \frac{r^3 - b^3}{c^3 - b^3}\right]$$

What if the shell were conducting?

d) $b < r < c$



We need $E = 0$ inside the shell

$\Rightarrow Q_{encl} = 0$ $\Rightarrow$ need $-2Q$ on inner surface of shell

$\Rightarrow +1Q$ on outer surface