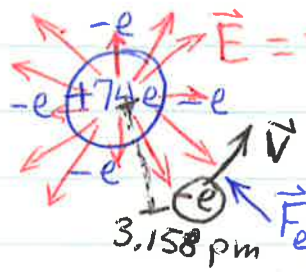
Phy. 203 HW#1

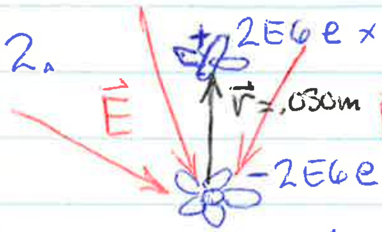
1. 

$$\vec{E} = \frac{k_c Q}{r^2} = \frac{9E9 \frac{Nm^2}{C^2}(74e - 4e)}{(3.158E\text{-}12m)^2} = 1.011E16 \frac{N}{C}$$ outward

$70 \times 1.6E\text{-}19C$

$$\vec{F}_{el} = q\vec{E} = (-1.6E\text{-}19\,C)(1.011E16 \tfrac{N}{C}\,\hat{r}) = -.001617\,N\ (\text{inward}) = -m\frac{v^2}{r}$$

$$\sqrt{v^2} = \sqrt{\frac{.001617 \frac{kg\,m}{s^2} \cdot 3.158E\text{-}12m}{.911E\text{-}30kg}} = v = 74.87E6 \frac{m}{s}$$

2. 

$$\vec{E} = \frac{kQ}{r^2}\hat{r} = \frac{9E9 \frac{Nm^2}{C^2}(-2E6)(1.6E\text{-}19C)}{(.030m)^2} = -3.2 \frac{N}{C} (\downarrow)$$

$$\vec{F}_{el} = q\vec{E} = (12 \times 2E6 \cdot 1.6E\text{-}19C)(-3.2 \tfrac{N}{C} \downarrow) = -1.23E\text{-}11\ N\ (\downarrow)$$

3. $\vec{F}_{el} = -\vec{F}_{grav} = -m\vec{g} = -(.434E\text{-}3kg)(-9.8\frac{N}{kg}\downarrow) = 0.00425N\ (\uparrow)$

$$\vec{F}_{el} = q\vec{E} = \frac{Q_{dome} A_{tin}}{A_{dome}} \cdot \frac{k_c Q_{dome}}{R^2_{dome}} \qquad A_{dome} = 4\pi R^2$$

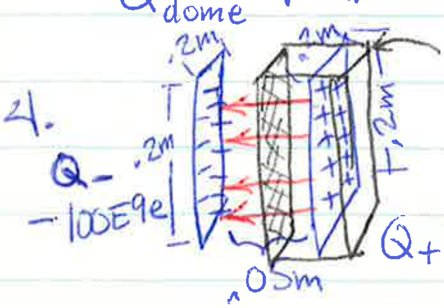
$R_{dome} \leftarrow 0.125m$

$$\frac{A_{tin}}{A_{dome}} = \frac{.00273\,m^2}{4\pi(.125m)^2} = 0.0139$$

$$Q^2_{dome} = \vec{F}_{el} \frac{(.125m)^2}{9E9 \frac{Nm^2}{C^2}(.0139)} = 5.307E\text{-}13\,C^2$$

negative root for this VdG

$$Q_{dome} = \sqrt{5.307E\text{-}13C^2} = -0.728E\text{-}6\,C = -.728\,\mu C = -728\,nC$$

4. 

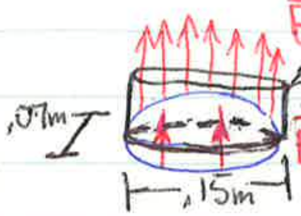
Gaussian box

$$\vec{E} \cdot \vec{A}_{\substack{box\\ out\ left}} = 4\pi k_c Q_+ \Rightarrow \vec{E} = \frac{4\pi 9E9 \frac{Nm^2}{C^2} 100E9 \times 1.6E\text{-}19C}{.2m \times .2m}$$

$$\vec{E}_{out} = 45239 \frac{N}{C} (\leftarrow)$$

4.(b) $\vec{F}_{el} = q\vec{E} = (100E9 \cdot 1.6E{-}19C)(45239 \frac{N}{C}) = .000724\,N$

5.



$\vec{E}_{outside} = 120\frac{N}{C}\,(\uparrow)$

Gaussian "pillbox" $A_{top} = \frac{\pi}{4}(.15m \times .07m)$

a) $\vec{E}_{inside} = \frac{\vec{E}_{outside}}{K} = \frac{120\frac{N}{C}}{15} = 8\frac{N}{C}\,(\uparrow)$

b) $\vec{E}_{outside}\cdot\vec{A}_{top} - \vec{E}_{inside}\cdot A_{bottom} = 4\pi k\, Q_{inside}$ (on back)

$(120\frac{N}{C} - 8\frac{N}{C})(\frac{\cancel{\pi}}{4}\,.15m \times .07m) = 4\cancel{\pi}\; 9E9\,\frac{Nm^2}{C^2}\, Q_{back}$

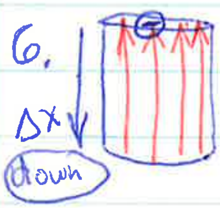
$Q_{back} = 112\frac{\cancel{N}}{\cancel{C}}\;\frac{.15\cancel{m}\times .07\cancel{m}\;\; C^{\cancel{2}}}{4\cdot 4\cdot 9E9\,\cancel{Nm^2}} = 8.17E{-}12\;C$

(positive, since more $\vec{E}$-field points away than points toward)

(there is the same amount of negative Q ~~at~~ at rat belly)

c) net Force upward to back $112\frac{N}{C}\times 8.2\,pC \Rightarrow 900\,pN$ ... $\vec{F}_{down}$@ rat belly

6.



$\vec{E}_{tube} = +6E5\frac{N}{C}\,(\uparrow)$

$\vec{F}_{el} = q\vec{E}_{tube} = (-1.6E{-}19C)(6E5\frac{N}{C}\uparrow) = -9.6E{-}14\,N\,(\downarrow)$

a) $\sum\vec{F} = \vec{F}_{el} = m\vec{a} \Rightarrow \vec{a} = \frac{\vec{F}_{el}}{m} = \frac{-9.6E{-}14N}{.911E{-}30kg} = -1.054E17\frac{N}{kg}\,(\downarrow)$

$v_i^2 + 2a\cdot\Delta x = v_f^2 = 0 + 2\cdot(-1.054E17\frac{m}{s^2})(-.15m) = 3.16E16\frac{m^2}{s^2}$

$v_f = \sqrt{3.16E16\frac{m^2}{s^2}} = -\,177.8E6\frac{m}{s}\,(\downarrow)$ ... over half the speed of light!