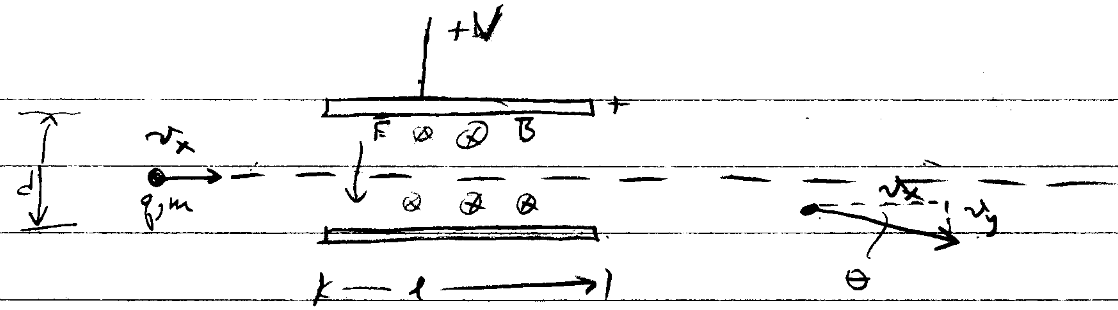
4-3 3rd ed.

~~33~~



a) Equ 3.7 says

$$\frac{q}{m} = \frac{V\theta}{B^2 l d}$$

We're given $l = 10.0\,cm$, $d = 2.00\,cm$, $V = 2000\,V$, $\theta = 0.2\,rad$, and $B = 4.57\times10^{-2}\,T$. Plug 'em in

$$\frac{q}{m} = \frac{2000V\ 0.2\,\text{radian}}{(4.57\times10^{-2}T)^2\ 10.0\,cm\ 2.00\,cm \times 10^{-4}}$$

$$\frac{q}{m} = 9.58\times10^{7}\ \frac{Coul}{kg}$$ ✓

b) Well, we have to look for a particle whose $\frac{q}{m}$ is $9.58\times10^{7}\ \frac{Coul}{kg}$.

The unknown particle is positively charged, so try the proton first

$$\frac{q}{m} = \frac{1.602\times10^{-19}\,Coul}{1.6726\times10^{-27}\,kg} = 9.58\times10^{7}\ \frac{Coul}{kg}.$$ ok

c) There's no deflection with the B-field turned on. So evidently $q v_x B = qE$.

Thus $v_x = \frac{E}{B} = \frac{V}{Bd} = 2.19\times10^{6}\ m/sec \approx \frac{c}{140}$

d) no, $v_x \leq 0.01c$.

4.7 graded

~~3.7~~ Follow example 3.3

~~time of fall~~ ~~fall~~ Speed $v = \frac{10.21\,mm}{11.894\,s} = 0.0858\,\frac{cm}{sec} = .000858\,\frac{m}{sec}$

The rise speed

$v_1' = \frac{10.21\,mm}{80.708\,sec} = 0.0126\,\frac{cm}{sec}$.

$v_2' = \frac{10.21\,mm}{22.361\,sec} = 0.0456\,\frac{cm}{sec}$, etc

$v_3' = 0.0456\,\frac{cm}{sec}$ $v_7' = 0.0294\,cm/sec$

$v_4' = 0.0456\,cm/sec$ $v_8' = 0.0294\,cm/sec$

$v_5' = 0.0073\,cm/sec$ $v_9' = 0.0349\,cm/sec$

$v_6' = 0.0128\,cm/sec$ $v_{10}' = 0.0349\,cm/sec$.

charge ratios

$\frac{q_1}{q_2} = \frac{v + v_1}{v + v_2} = \frac{0.0984}{0.1314} = 0.749 \approx \frac{8}{11}$ ×3

$\frac{q_1}{q_5} = \frac{v + v_1}{v + v_5} = \frac{.0984}{.0931} \approx 1$ ×1

$\frac{q_1}{q_7} = \frac{v + v_1}{v + v_7} = \frac{.0984}{.1152} = 0.854 \approx \frac{5}{6}$ ×2

$\frac{q_1}{q_6} = \frac{v + v_1}{v + v_6} = \frac{.0984}{.0986} = .998 \approx 1$

$\frac{q_1}{q_9} = \frac{v + v_1}{v + v_9} = \frac{.0984}{0.1207} = 0.815 \approx \frac{4}{5}$ × 2

The average is $\left[\frac{8}{11}\times 3 + 1\times 2 + \frac{5}{6}\times 2 + \frac{4}{5}\times 2\right]\frac{1}{9}$

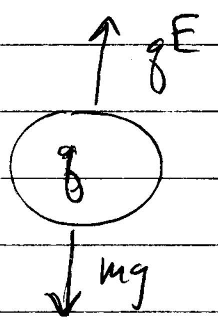
4.7

Now, we're given the radius of the drop $a = 2.76 \times 10^{-4}$ cm and its density is $\rho = 0.9561 \frac{g}{cm^3}$. From these we get

the mass of the drop $m = \rho \frac{4}{3} \pi a^3 = 8.42 \times 10^{-11}$ g $= 8.42 \times 10^{-14}$ kg

Next, the magnitude of the electric field 'tween the plates is

$$E = \frac{V}{d} = \frac{5085 \text{ V}}{16. \times 10^{-3} \text{ m}} = 3.18 \times 10^{5} \frac{\text{V}}{\text{m}}$$



The charge on a drop is gotten by equating its weight with the electric force in equilibrium:

$$q_i = \frac{mg}{E}\left(\frac{v + v_i'}{v}\right) = \frac{8.42 \times 10^{-14} \text{ kg} \cdot 9.8 \frac{\text{m}}{\text{sec}^2}}{3.18 \times 10^{5} \frac{\text{V}}{\text{m}}} \left(\frac{8.58 \times 10^{-4} \frac{\text{m}}{\text{sec}} + v_i'}{8.58 \times 10^{-4} \frac{\text{m}}{\text{sec}}}\right)$$

$$q_1 = 3.02 \times 10^{-15} \left(8.58 \times 10^{-4} \frac{\text{m}}{\text{sec}} + 1.26 \times 10^{-4} \frac{\text{m}}{\text{sec}}\right) \frac{\text{J}}{\text{V} \frac{\text{m}}{\text{sec}}}$$

$q_1 = 2.98 \times 10^{-18}$ Coul

$q_2 = 3.97 \times 10^{-18}$ Coul

$q_3 = 3.97 \times 10^{-18}$ Coul

$q_4 = 3.97 \times 10^{-18}$ Coul

$q_5 = 2.82 \times 10^{-18}$ Coul

$q_6 = 2.98 \times 10^{-18}$ Coul

$q_7 = 3.48 \times 10^{-18}$ Coul

$q_8 = 3.48 \times 10^{-18}$ Coul

$q_9 = 3.65 \times 10^{-18}$ Coul

$q_{10} = 3.65 \times 10^{-18}$ Coul

		or
try	$q_1 = 15e = q_6$	18
	$q_2 = 20e = q_3 = q_4$	24
	$q_5 = 14e$	17
	$q_7 = 17e = q_8$	21
	$q_9 = 18e = q_{10}$	22
		$e \simeq 1.61 \times 10^{-19}\,C$

I have 5 different estimates for e

$$e = \frac{2.98 \times 10^{-18}\ \text{Coul}}{15} = 1.99 \times 10^{-19}\ \text{Coul}$$

$$e = \frac{3.97 \times 10^{-18}\ \text{Coul}}{20} = 1.99 \times 10^{-19}\ \text{Coul}$$

$$e = \frac{2.82 \times 10^{-18}\ \text{Coul}}{14} = 2.01 \times 10^{-19}\ \text{Coul}$$

$$e = \frac{3.48 \times 10^{-18}\ \text{Coul}}{17} = 2.05 \times 10^{-19}\ \text{Coul}$$

$$e = \frac{3.65 \times 10^{-18}\ \text{Coul}}{18} = 2.03 \times 10^{-19}\ \text{Coul}$$

The average is $e = 2.01 \times 10^{-19}$ Coul.

Maybe I should have tried $q_1 = 20e$, etc

$$e = \frac{2.98 \times 10^{-18}\ \text{Coul}}{20} = 1.49 \times 10^{-19}\ \text{Coul}$$

4-8 in 3rd ed.

3.8 Rutherford Scattering

Eqn 3.16

$$\Delta n \propto (KE)^{-2}\left(\sin\frac{\phi}{2}\right)^{-4}$$

a) Given that $\Delta n = \frac{100}{min}$ at $\phi = 20°$, at 40°

$$\Delta n_{40} = \frac{\Delta n_{20}\left(\sin\frac{20°}{2}\right)^4}{\left(\sin\frac{40°}{2}\right)^4} = \frac{100}{min}\frac{\left(\sin\frac{20}{2}\right)^4}{\left(\sin\frac{40}{2}\right)^4} = \frac{6.64}{min}$$

similarly

$$\Delta n_{60} = \frac{1.45}{min}$$

$$\Delta n_{80} = 0.533/min$$

$$\Delta n_{100} = 0.264/min$$

b) If the KE is doubled then Δn is quartered.

$$\Delta n_{20} = 25/min$$

c) All else being equal $\Delta n \propto Z^2 N$, where Z is the atomic number of the target atoms and N is the number of target atoms per unit area.

So $$\frac{\Delta n_{Cu}}{\Delta n_{Au}} = \frac{Z_{Cu}^2 N_{Cu}}{Z_{Au}^2 N_{Au}}$$ [t = thickness of the foil.]

$$N_{Cu} = 8.9\frac{g}{cm^3}\ \frac{6.02\times10^{23}}{63.54 g}\cdot t = 8.43\times10^{22}\,t$$

$$N_{Au} = 19.3\frac{g}{cm^3}\times\frac{6.02\times10^{23}}{197 g}\cdot t = 5.90\times10^{22}\cdot t$$

$$\Delta n_{Cu} = \Delta n_{Au}(29)^2(8.43\times10^{22})/(79)^2/5.90\times10^{22} = 19.3/min$$