[redacted] /17

Name: Uni Lee

Lab Quiz – Electricity and Magnetism

1. In another universe (which is very cold), an alien student is performing a simulation that is identical to the one you did for Millikan's oil drop experiment simulation. The student is attempting to find the fundamental charge in their universe (the charge of a coolatron).
   Note: oddly enough, they use the identical units that we do, except that their fundamental charge has a different mass and a different charge.

The student collects the following data:

Evidence		
Mass of Oil Drop = 8.0×10^{-14} kg m	Plate Separation = 16 mm d	
Trial	Voltage (kV)	Electric Field (kV/m)
1	74.742	4671.4
2	37.371 ΔV	2335.7 ε
3	24.914	1557.1
4	21.355	1334.7
5	16.610	1038.1

[5] What is the magnitude of the charge on each of these oil drops (Round your answer to 3 s.d.)? You may show your work for the charge on one of the oil drops, beside the chart (for part marks, if your answers are incorrect).

Trial	Charge (C)
1	$\doteq 1.33 \times 10^{-10}$
2	$\doteq 6.65 \times 10^{-11}$
3	$\doteq 4.43 \times 10^{-11}$
4	$\doteq 3.80 \times 10^{-11}$
5	$\doteq 2.96 \times 10^{-11}$

0

$\varepsilon = \frac{k|q|}{R^2}$

can't use this (electrical field around a point charge)

$$467.14\,\frac{kV}{m} = \frac{8.99 \times 10^{9}\,\frac{Nm^2}{C^2}\,(q)}{(0.016\,m)^2}$$

$q = 1.330224694\ldots \times 10^{-10}$ C

$\doteq 1.33 \times 10^{-10}$ C

use Millikan's $q = \frac{mgr}{\Delta V}$

2. Use the above set of charges for the oil drops to determine the smallest possible charge (the charge of a coolatron). Briefly, show your thought process (note: use the rounded answers to determine the charge of a coolatron).

[2]

2.96×10^{-11} C $\quad 3.80 \times 10^{-11}$ C $\quad 4.43 \times 10^{-11} \quad 6.65 \times 10^{-11} \quad 1.33 \times 10^{-10}$

6.3×10^{-12}
smallest difference between charges

Test if its correct
$q = ne$
$1.33 \times 10^{-10}\,C = n(6.3 \times 10^{-12}\,C)$
$n = 21.11\ldots$
$\doteq 21$
yes. theyre whole numbers

2

∴ charge of coolatron is 6.3×10^{-12} C

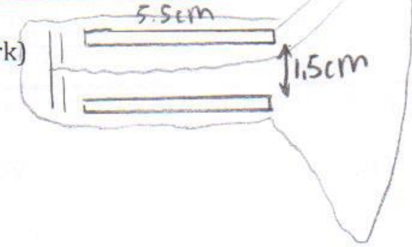
$q = ne$
$4.43 \times 10^{-11} = n(6.3 \times 10^{-12}\,C)$
$n = 7.03\ldots$
$= 7$

Name:

3. The student then goes on to perform a simulation that is identical to the one you did for Thomson's cathode ray tube experiment. Their goal is to determine the charge to mass ratio for the coolatron.

The student collects the following data:

Evidence		Plate Separation 1.5 cm		Plate Length 5.5 cm	
Trial	I (mA)	V (V)	|B| (mT)	|E| (kV/m)	θ (degrees)
1	-23.3	77.1	0.17	3.16	0
2	0	77.1	0	3.16	4.3



[4] a) What is the horizontal speed of the coolatron? (show your work)

F_C / F_M

$\sum \vec{F}_y = m a_y = 0$

$F_E - F_M = 0$

$F_E = F_M$

Given -½

$\mathcal{E} q = |q| v B$

$3160 \frac{V}{m} = v\,(0.17 \times 10^{-3}\ T)$

$v = 18588235.29\ m/s$

$\doteq 1.86 \times 10^7\ m/s$

3

-½ 1 s.d.

∴ speed of coolatron is $1.86 \times 10^7\ m/s$

[4] b) What is the charge to mass ratio of the coolatron? (Show your work)

$6.3 \times 10^{-12}\ C : 8.64 \times 10^{-16}\ kg$

$7291 : 1$

0

0 4. Based on your charge for a coolatron, what is the mass of a coolatron?

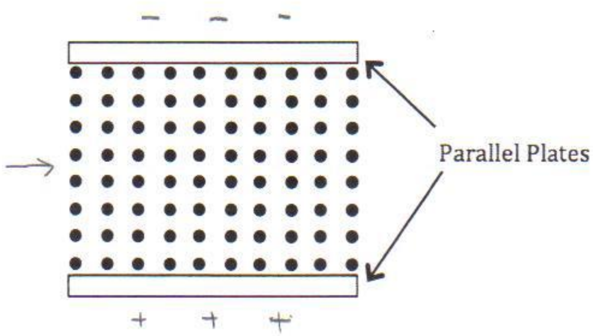
$6.3 \times 10^{-12}\ C$

$\doteq 8.64 \times 10^{-16}\ kg$

Name:

5. Based on the diagram shown below, using up/down descriptors, what electric field direction would be needed to produce opposing forces on a cathode ray particle (a coolatron)? In other words, what direction of electric field will allow the coolatron to pass through the magnetic field and electrical field undeflected. **Assume the particle is moving from left to right and that coolatrons are positively charged.**
The magnetic field direction is shown on the diagram.

[1]



The direction of the electrical field is:
(circle one)

UP or DOWN