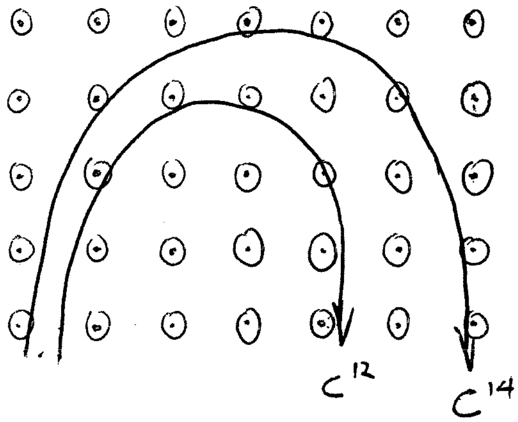
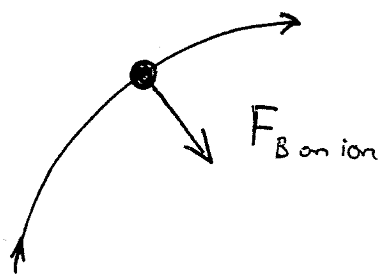
Exam 2 Free Response

11) (a)



(b)



(c) Use N2 in radial direction:

$$\frac{v^2}{r} = F_{net}/m \Rightarrow \frac{v^2}{r} = \frac{qvB}{m}$$

$$\Rightarrow r = \frac{mv}{qB}$$

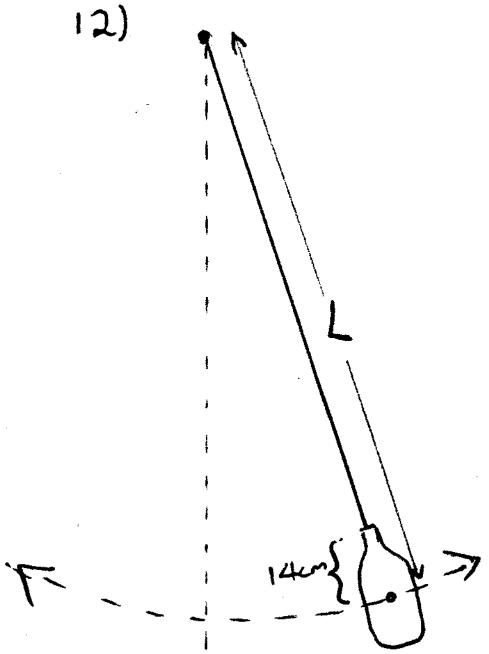
$$r_{C14} = \frac{m_{C14}\, v}{q\, B} = \frac{(2.32\times10^{-26})(1\times10^{6})}{(1.6\times10^{-19})(0.1)}$$

$$= 1.45 \text{ m}$$

$$r_{C12} = \frac{m_{C12}\, v}{qB} = \frac{(2\times10^{-26})(1\times10^{6})}{(1.6\times10^{-19})(0.1)}$$

$$= 1.25 \text{ m}$$

12)



Because the soda bottle is 28cm long it would be more accurate to measure the length of the pendulum from the center of mass of the bottle and subtract off the extra length of the bottle to find the length of the rope.

Assumptions:

① Assume the center of mass of the bottle is in the middle. Therefore I must subtract 14 cm from my answer for L to get the length of the rope.

② Assume that the soda bottle is small enough compared to the length of the rope so that I can treat it as a point object (The CM is the point.)

③ Assume the rope is much lighter than 1kg, so I can ignore its mass, as compared to the soda bottle.

④ Some rope may have been used to tie up the bottle ~ I'll ignore it.

⑤ Assume small amplitude oscillations.

$5T_{avg} = 12.9067s$; $T_{avg} = 2.581s$. Largest T is $2.592s$; smallest T is $2.570s$. Thus $T_{avg} = (2.581 \pm 0.011)s$

% uncertainty in $T = \frac{0.011s}{2.581s} \approx 0.4\%$

$$T = 2\pi\sqrt{\frac{L}{g}} \Rightarrow L = \frac{T^2 g}{4\pi^2} = 1.688m.$$

$L_{rope} = 1.688m - 0.14m = 1.548m$. Uncertainty: 0.4% of $1.548m \approx 0.006m$

$$L_{rope} = (1.548 \pm 0.006)m$$

13) - Measure the mass of the rope with a scale.
- Fix one end of the rope to a wall and stretch the rope out horizontally with a spring-scale attached to the other end. The spring scale allows me to exert a constant, known force on the rope.
- Measure the length of the stretched rope.
- I'll start a pulse travelling down the rope with a flick of my finger.
- With a stopwatch I can time the time for the pulse to leave my hand, be reflected & return to my hand, travelling a distance 2L. (Where L is the length of the stretched rope)
- For greater precision, I can time the pulse for 5 circuits (there & back). Repeat measurement several times

Estimate 1: Using the known L & time, I can estimate the speed using $v = d/t$. Uncertainty should be estimated from the variation of the time measurements.

Estimate 2: I can estimate v from $v = \sqrt{\frac{F_{tension}}{m/L}}$. Uncertainty should be estimated from the worst instrumental uncertainty - probably the spring-scale.

I would compare my two estimates for v & see if they agree to within experimental uncertainties. If the two numbers did not agree, I might devise a third check by using standing waves.