VICTORIA
UNIVERSITY OF WELLINGTON
TE WHARE WĀNANGA
O TE ŪPOKO O TE IKA A MĀUI

ENGR142 2018, 2nd Trimester

Lecturers: B. Ruck, F. Natali, and C. Hollitt

Assignment 3

Due date: 11:59 PM, Thursday 9th August, 2018

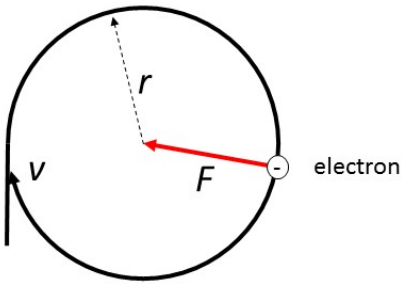
Problem 1: Cyclotron resonance *(5 Marks)*

An electron moving at velocity $v = 10^6$ ms^{-1} enters a magnetic field of strength 2 Tesla which is directed perpendicular to the velocity. The magnetic field exerts a force on the electron which is perpendicular to the velocity, and also perpendicular to the field. This causes the electron to move in a circle, as shown below, where the magnetic field is directed into the page.

(a) The strength of the magnetic force is given by $F = qvB$, where q is the electric charge, v the velocity, and B the magnetic field strength. Show that the orbit has radius given by

$$r = \frac{mv}{qB}, \tag{1}$$

and calculate the radius (use $q = -1.6 \times 10^{-19}$ C, $m = 9.1 \times 10^{-31}$ kg and $B = -2$ T since the field is directed into the page).



(b) The electron moves while the magnetic force is acting. Does the force do any work on the electron? Explain your answer, using only one short sentence.

Problem 2: Terminal velocity: numerical solution *(15 Marks)*

Write some code (e.g., using Python) to calculate the position and velocity as a function of time for a hailstone falling under the force of gravity while experiencing a drag force $F_D = -\eta v^2$. Assume the initial velocity is zero, take the mass to be 5×10^{-4} kg and use $\eta = 2 \times 10^{-5}$ kg/m. Refer to the lecture notes for an example of how to construct your code (especially lectures 7 and 8).
Append your code to your submitted assignment, and provide plots of height versus time and velocity versus time. From your results answer the following questions.

(a) How long does it take for the hailstone to come within 10% of its terminal velocity? Assume that the hailstone does not hit the ground first. **Note**: The value of the terminal velocity was calculated in assignment 2.

(b) How far has the hailstone fallen when it comes within 10% of its terminal velocity?