PHY2004: Assignment 2

Lecturer: Dr Charlotte Palmer

Remember:

- **The total number of marks available in this assignment is 100.**
- **Your total assignment scores contribute 20% of the total module mark.**
- **Make sure your name and student number are included in your submitted script and remember to use your student number to complete the appropriate portions of the assignment.**

Deadline: Named solutions should be uploaded to canvas by 22:00 on 11th March 2022.

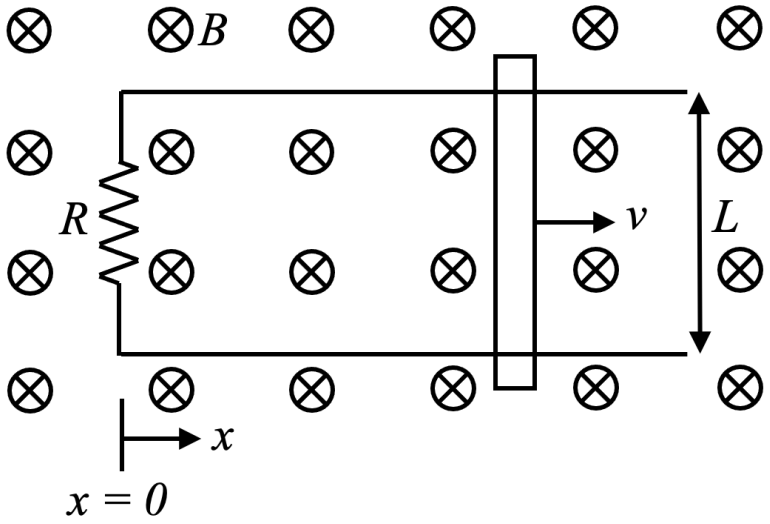
1) Write out both the macroscopic formulation of the Maxwell-Faraday law and the Maxwell-Ampere law [4].

Student number final digit is 0-4 inclusive:	Student number final digit is 5-9 inclusive:
provide the equations in differential form.	provide the equations in integral form.

Explaining each term in your own words [16] and in which situations this form of the equation is most useful [5].

[25/100]

2) The circuit below contains a resistor, R, and is closed with a movable bar of length, L. It sits within a constant magnetic field, B, directed into the page. The movable bar is pulled at constant velocity, v, to the right (along the x-axis).



	Student number penultimate digit is 0-4 inclusive:	**Student number penultimate digit is 5-9 inclusive:**
R [Ohms]	5	10
B [T]	0.1	0.5
L [m]	0.2	0.1
v [m/s]	1	2

a) Redraw/Annotate the diagram to indicate the direction of the current flow as the movable bar is pulled to the right at constant speed, v [3]. Explain the reasoning behind your choice [7].

b) Express the current through the resistor as a function of velocity and calculate its magnitude, as well as the power dissipated by the resistor [20]. Use the appropriate values from the table above for the calculation.

c) *Now neglecting the background magnetic field responsible for driving the current but assuming the same current is supplied,* considering the resistor as a cylinder with radius, a, and length, *l*. Given the current you calculated in b), sketch the electric and magnetic field at the resistor highlighting key features and explaining your choice and any assumptions used. [8]

d) Find an expression for the electric field, E, in terms of current, resistance and geometric properties of the resistor [10] and find an expression for the magnetic field, B, with radius, r>=a [5]. Include comments on any assumptions that you have made. **Note:** It is beneficial to consider cylindrical co-ordinates given the geometry of the problem.

e) Explain the meaning of the Poynting vector in your own words [2] and determine the Poynting vector on the surface of the resistor providing direction and sign [5]

f) Express the energy flux through the surface of the surface of the resistor [10], comment on the steps taken and the expression that you have determined [5].

[75/100]