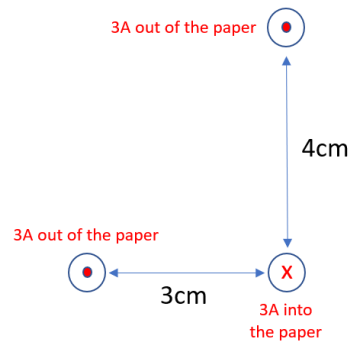


**Physics 1320 - Calculus-based Physics II**  
**Summer 2022**  
**Final Exam**

**Question 1** (15 pts)

Consider three infinitely long current carrying wires as shown below:

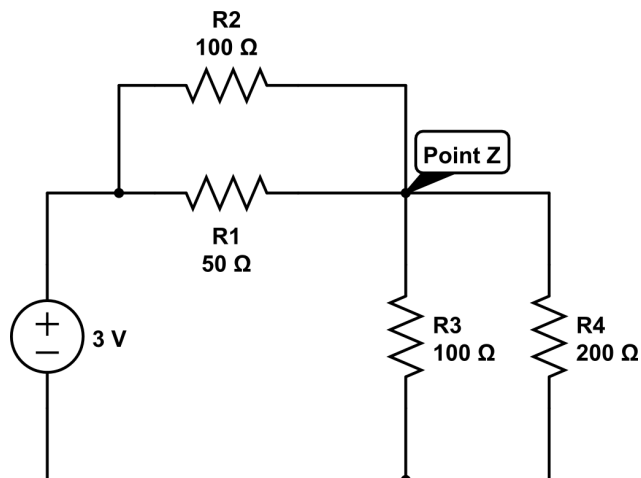
- Wire 1 is at the origin and carries  $3A$  out of the paper.
- Wire 2 is at coordinates  $(3\text{cm}, 0\text{cm})$  and carries  $3A$  into the paper.
- Wire 3 is at coordinates  $(3\text{cm}, 4\text{cm})$  and carries  $3A$  out of the paper.



What is the Force per unit length (magnitude and direction) exerted on Wire 3?

**Question 2** (10 pts)

Consider the circuit drawn below



- A What is the equivalent resistance of this circuit?
- B What is the voltage at Point Z?
- C What is the current through resistor R4?

**Question 3** (15 pts)

The LightSail spacecraft has a totally reflective mirror sail that has an area of  $32m^2$  and the total spacecraft weight is  $5.0kg$ . A laser beam is directed at the sail and has an intensity of  $13700 \frac{W}{m^2}$  when it reaches the LightSail.

- A What is the maximum acceleration the LightSail spacecraft can achieve?
- B Assuming the intensity remains constant during the journey, how fast with the LightSail be moving after a year?

**Question 4** (10 pts)

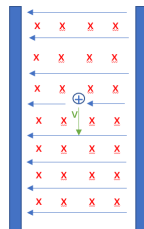
Recall the relationship that for two parallel plates separated by distance  $d$  that  $E = \frac{V}{d}$ . Consider a proton placed directly between the two plates with voltage of  $10.425kV$ .



At what speed and in what direction will the proton exit the plates.

**Question 5** (15 pts)

Consider the same proton from Problem 4, not traveling with a velocity  $\vec{v} = -1 * 10^6 (\frac{m}{s}) \hat{k}$ . It is passing through a chamber with an Electric Field  $\vec{E} = -100(\frac{J}{C}) \hat{j}$  and Magnetic Field  $\vec{B} = -0.1(mT) \hat{i}$ .



- A What is the force from the Electric Field ( $\vec{F}_E$ ) experienced by the proton?
- B What is the force from the Magnetic Field ( $\vec{F}_B$ ) experienced by the proton?
- C What is the net (or total) force ( $\vec{F}$ ) experienced by the proton?

**Question 6** (15 pts)

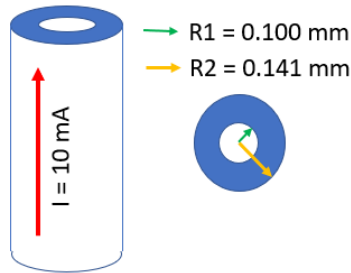
If the proton from Problem 6 now enters a uniform magnetic field  $\vec{B} = 10.5(mT)$  in the directions shown in the diagram below. If the proton enters the origin: point (0,0):



- A Where does the proton exit the magnetic field?
- B How long does the proton spend in the magnetic field?
- C If we combine the parts from Questions 4,5, and 6, what device do we have?

**Question 7** (20 pts)

Consider the following current-carrying conductor with  $R_1 = 0.100mm$  and  $R_2 = 0.141mm$ . Assume the current of  $10mA$  has a uniform current density in the conductor.



Utilizing Ampere's Law, write the equations for the magnitude of the magnetic field (B) for the below conditions.

- $r < R_1$ ?
- $R_1 < r < R_2$ ?
- $r > R_2$ ?

Finally, graph the resulting magnitude of magnetic field as a function of  $r$ ?

**Question 8 - Extra Credit** (5pts) Which of Maxwell's Equations can be attributed to Benjamin Franklin?