Center for Academic Resources in Engineering (CARE)
Peer Exam Review Session

Phys 212 — University Physics: Electricity and Magnetism

Midterm 2 Worksheet

The problems in this review are designed to help prepare you for your upcoming exam. Questions pertain to material covered in the course and are intended to reflect the topics likely to appear in the exam. Keep in mind that this worksheet was created by CARE tutors, and while it is thorough, it is not comprehensive. In addition to exam review sessions, CARE also hosts regularly scheduled tutoring hours.

Tutors are available to answer questions, review problems, and help you feel prepared for your exam during these times:

Session 1: Tuesday, October 27th, 6 - 7:30 pm Kristie and Henry

Session 2: Wednesday, October 28th, 6 - 7:30 pm Aaron and Avni

Can't make it to a session? Here's our schedule by course:

https://care.grainger.illinois.edu/tutoring/schedule-by-subject

Solutions will be available on our website after the last review session that we host.

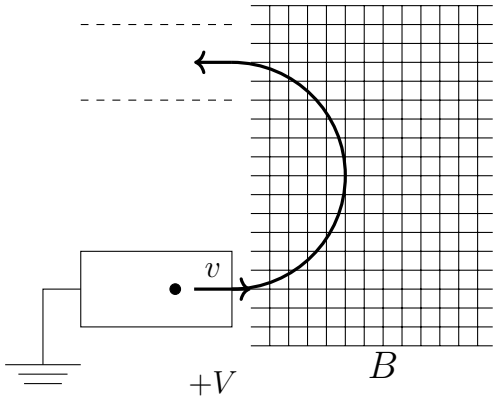
Step-by-step login for exam review session:

1. Log into Queue @ Illinois: https://queue.illinois.edu/q/queue/848
2. Click "New Question"
3. Add your NetID and Name
4. Press "Add to Queue"

Please be sure to follow the above steps to add yourself to the Queue.

Good luck with your exam!

1. An electron of mass m and charge q is put in a track and accelerated to the right (in the plane of the paper) from rest through a potential difference V. The electron then enters a region containing a uniform magnetic field, and makes a 180° turn in the field to enter a track that is parallel to its initial trajectory. Suppose the system is 2D lying on the ground.



$V = 300$ V
$B = 0.2$ T
$q = -1.6 \times 10^{-19}$ C
$m = 9.11 \times 10^{-31}$ kg

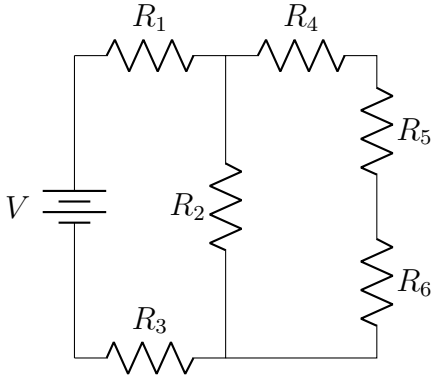
(i) In order to enter the destination track what is the direction of the magnetic field?

(ii) What is the speed of the electron?

(iii) What is the radius of the path?

(iv) How much time is spent in the magnetic field?

2. Six resistors are connected to a 15 V battery as shown in the figure $R_1 = 100\ \Omega$, $R_2 = 70\ \Omega$, $R_3 = 50\ \Omega$, $R_4 = 10\ \Omega$, $R_5 = 30\ \Omega$ and $R_6 = 20\ \Omega$.



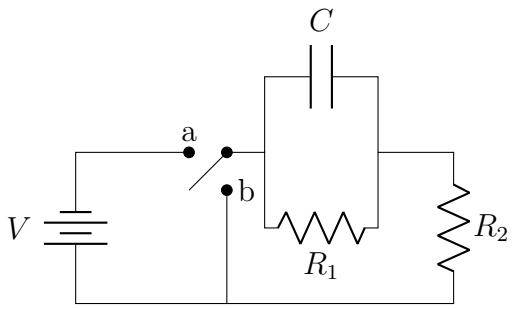
(i) Are R_1 and R_2 in series, parallel, both or neither?

(ii) What is the equivalent resistance of the circuit from the voltage source?

(iii) What is the voltage drop across R_2?

(iv) Say R_2 was replaced with a bare wire, what would be the new voltage drop across R_3

3. Two resistors of equal resistance ($R = 20\ \Omega$) are connected to a capacitor ($C = 40\ \mu F$) and a battery ($V = 5\ V$) as in the figure. In the beginning the switch is open from both positions, a and b, and the capacitor is uncharged.

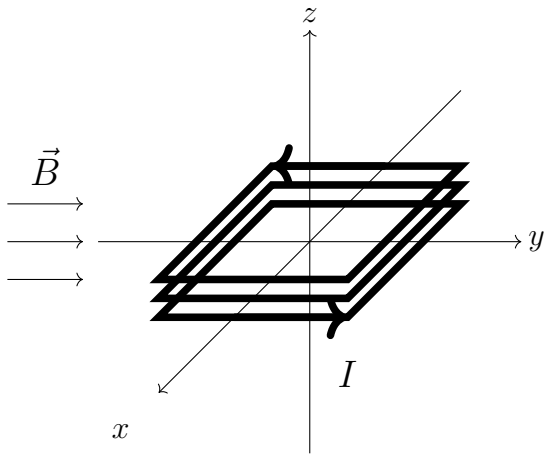


(i) What is the current through the capacitor immediately after the switch is moved to position a?

(ii) Calculate the charge on the capacitor after the switch has been in position a for a long time.

(iii) After the capacitor was fully charged, the switch is moved to position b, discharging the capacitor. What is the time constant of discharging the capacitor?

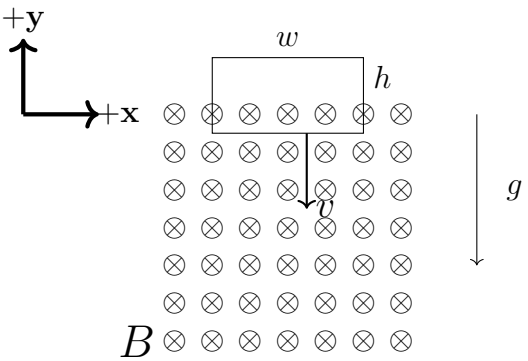
4. Three squares of current-carrying wire are centered at the origin with each side of length $2a$, as shown, with $a = 0.17$ m. There is a current I going through each in the counter-clockwise direction as seen looking down the z-axis. A uniform magnetic field with $B = 0.12$ T points along the y-axis. The magnitude of the total magnetic moment (for the three loops together) is $\mu = 4.5\ \mathrm{Tm}^2$.



(i) What is the magnitude of the current I?

(ii) What is the direction of the torque on the loop?

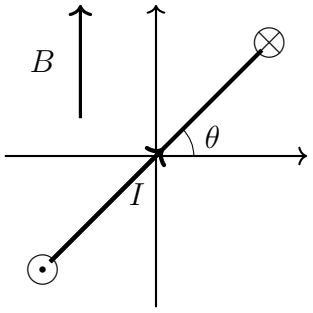
5. A wire loop with mass $m = 0.4$ kg, width $w = 1.5$ m and height $h = 0.8$ m is released from rest just above a region of uniform magnetic field $B = 2.5$ T directed into the page. There is no magnetic field outside this region. The gravitational force causes the loop to fall and its motion is constrained to the xy-plane (e.g. it falls straight down without rotating). At the moment shown it is observed to be moving downward with speed $|v| = 1.2$ m/s, and the magnitude of the current induced in the loop is measured to be $I = 0.74$ Amps.



(i) What is the resistance of the loop?

(ii) At the position shown in the figure the induced current in the loop is flowing clockwise or counterclockwise?

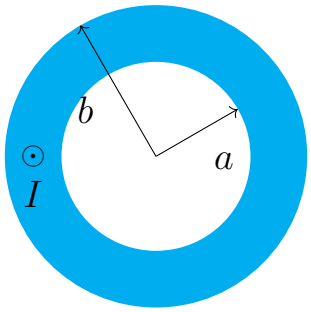
6. A generator consists consists of a square loop of wire with length $L = 1.5$ m spinning with constant angular velocity ω. A uniform magnetic field $B = 0.8$ T is directed in the positive y-direction as shown in the figure.



(i) As the loop spins, at which orientation is the peak voltage generated?

(ii) If the peak voltage generated is 250 Volts, what is the angular velocity of the loop?

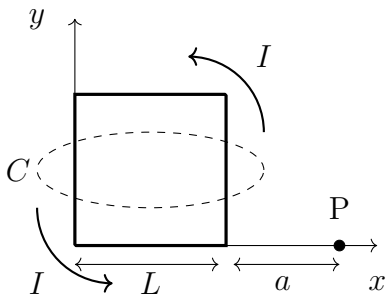
7. A current $I = 5$ mA is uniformly distributed over the above wire and pointing out of the page. The outer radius is $b = 4$ cm and the inner radius is $a = 2$ cm.



(i) What is the current density at a point inside the wire (where positive z points out of the page)?

(ii) What is the magnitude of the magnetic field at radius $r = 3$ cm from the central axis?

8. The following questions refer to the diagram below.



(i) Which of the following expressions computes the magnetic field at point P due only to the right vertical segment of the wire?

a) $-\hat{z}\frac{\mu_0 I}{4\pi}\int_0^L dy \frac{a}{(a^2+y^2)^{3/2}}$

b) $\hat{x}\frac{\mu_0 I}{4\pi}\int_0^L dy \frac{a}{(a^2+y^2)^{3/2}}$

c) $-\hat{z}\frac{\mu_0 I}{4\pi}\int_0^L dy \frac{a}{(a^2+y^2)}$

d) $\hat{x}\frac{\mu_0 I}{4\pi}\int_0^L dy \frac{a}{(a^2+y^2)}$

e) $\hat{z}\frac{\mu_0 I}{4\pi}\int_0^L dy \frac{a}{(a^2+y^2)}$

(ii) What is the line integral of the B field around the loop C that goes around the square shown in the above figure? $\oint B \cdot dl =$

a) 0

b) $2\mu_0 I$

c) $-2\mu_0 I$