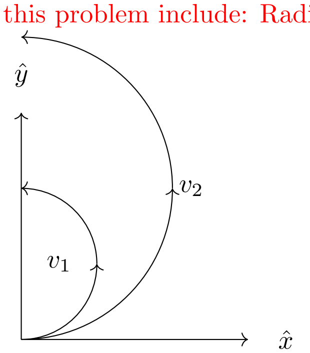
Make sure to fill out the grading sheet completely including your **name, exam flavor and UIN**. You are allowed to write and work on this exam copy, but your answers must be bubbled in on the grading sheet to receive credit. Your bubbled responses are the only responses that will be considered for the grade.

Physics 207 Exam 3 – **Flavor 1**

Problem 1 (4 points) Two electrons enter a region of uniform magnetic field shown below. This figure will be used for problems 1 and 2. Which of the following represents the relationship between the speeds of the electrons?
The major concepts used to solve this problem include: Radius of a charged particle in a magnetic field.



(A) $v_1 > v_2$
(B) $v_1 = v_2$
(C) $v_1 < v_2$ [4 points]

Problem 2 (4 points) What is the direction of the magnetic field in the previous problem?
The major concepts used to solve this problem include: $\vec{F} = q\vec{v} \times \vec{B}$.

(A) $+\hat{x}$
(B) $+\hat{y}$
(C) $+\hat{z}$ [4 points]
(D) $-\hat{x}$
(E) $-\hat{y}$
(F) $-\hat{z}$ [2 points]

Problem 3 (7 points) A proton enters a region of space with a uniform magnetic field $\vec{B} = B\hat{\imath}$. At the instant it enters the field, it experiences a magnetic force $\vec{F} = -F\hat{k}$. What could you conclude about an initial velocity of the proton? Note that B and F are both positive constants in this problem.
The major concepts used to solve this problem include: $\vec{F} = q\vec{v} \times \vec{B}$

(A) $v_x = \frac{F}{qB}$, $v_y = 0$, Nothing can be concluded about v_z

(B) $v_x = 0$, $v_y = \frac{F}{qB}$, Nothing can be concluded about v_z [2 points]

(C) $v_x = \frac{F}{qB}$, Nothing can be concluded about v_y, $v_z = 0$ [2 points]

(D) $v_x = 0$, Nothing can be concluded about v_y, $v_z = \frac{F}{qB}$

(E) Nothing can be concluded about v_x, $v_y = \frac{F}{qB}$, $v_z = 0$ [7 points]

(F) Nothing can be concluded about v_x, $v_y = 0$, $v_z = \frac{F}{qB}$ [2 points]

Problem 4 (7 points) If $I_2 = 2I_1$ in the figure below, what is the magnitude and direction of the magnetic field at the center of the circle? Consider only the circular parts of the wires.

The major concepts used to solve this problem include: Magnetic field created by N (1/2) loops of wire, Right Hand Rule for creation of magnetic field, Vector Addition.

(A) $B = \frac{\mu I_1}{4R}$ into the page [5 points]

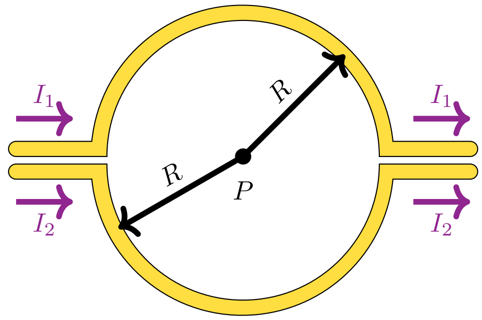
(B) $B = \frac{\mu I_1}{2R}$ into the page

(C) $B = \frac{\mu I_1}{R}$ into the page

(D) $B = \frac{\mu I_1}{4R}$ out of the page [7 points]

(E) $B = \frac{\mu I_1}{2R}$ out of the page [4 points]

(F) $B = \frac{\mu I_1}{R}$ out of the page [2 points]



Problem 5 (8 points) Two long parallel wires separated by a distance d are carrying the currents $4I$ and I in the same direction as it shows in the figure. At value of x is the total magnetic field exactly zero?

The major concepts used to solve this problem include: Magnetic field created by a long current carrying wire, Vector Addition.

(A) $x = -\frac{4d}{3}$ [3 points]

(B) $x = -\frac{4d}{5}$ [5 points]

(C) $x = -\frac{3d}{4}$

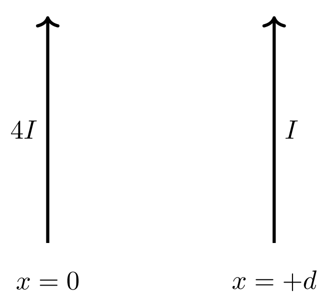
(D) $x = -\frac{3d}{5}$

(E) $x = +\frac{3d}{5}$

(F) $x = +\frac{3d}{4}$

(G) $x = +\frac{4d}{5}$ [8 points]

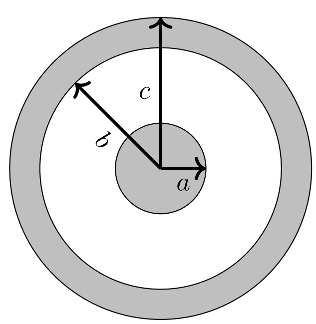
(H) $x = +\frac{4d}{3}$ [4 points]



Problem 6 (4 points) A long solid cylindrical conductor with a radius a carries a current I into the page from the perspective shown below. It is surrounded by a concentric tube with inner radius b and outer radius c carrying the current I in the opposite direction. The magnetic field in the outer tube ($b < r < c$) is directed:

The major concepts used to solve this problem include: Ampere's Law

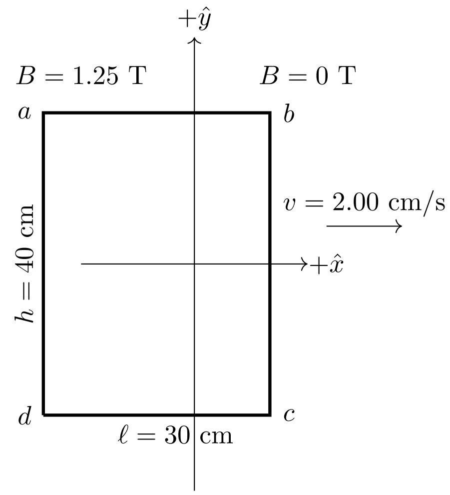
(A) Radially outward from the central axis
(B) Radially inward toward the central axis
(C) Clockwise from this perspective [4 points]
(D) Counterclockwise from this perspective [2 points]
(E) The magnetic field is zero in that region



Problem 7 (7 points) This figure and prompt is used for problems 7-9. A uniform magnetic field $B = 1.25$ T directed into the page is set in the region $x < 0$ while $B = 0$ in the region $x > 0$. A rectangular loop with a resistance $R = 1.00\ \Omega$ and with the vertical and horizontal dimensions of 40 cm and 30 cm is crossing the border between these two regions at the velocity 2.00 cm/s as shown in the figure.

What is the magnitude of the induced current in the loop.
The major concepts used to solve this problem include: Magnetic Flux, Faraday's Law and/or Motional Emf.

(A) 150 mA [2 points]
(B) 30 mA [2 points]
(C) 15 mA [1 points]
(D) 10 mA [7 points]
(E) 7.5 mA [5 points]
(F) 3 mA [3 points]



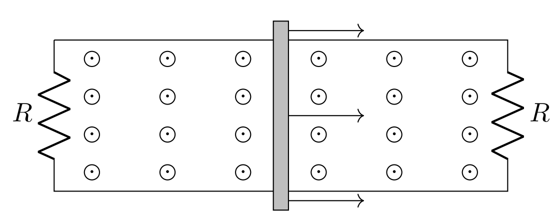
Problem 8 (3 points) What direction is the induced current in the loop?
The major concepts used to solve this problem include: Lenz's Law

(A) Clockwise [3 points]
(B) Counterclockwise

Problem 9 (3 points) Which side of the loop is the emf induced?
The major concepts used to solve this problem include: Motional Emf

(A) Side ab (top)
(B) Side bc (right)
(C) Side cd (bottom)
(D) Side da (left) [3 points]

Problem 10 (5 points) Find directions of the currents in the left & right resistor due to a slider moving with a velocity v to the right.
The major concepts used to solve this problem include: Lenz's Law and/or Motional Emf
(A) Both currents are up [5 points]
(B) Both currents are down
(C) Up through the left resistor and down through the right resistor [2 points]
(D) Down through the left resistor and up through the right resistor [2 points]
(E) Both currents are zero



Problem 11 (8 points) A proton enters a velocity selector with speed v_0 in the positive x-direction and propagates through the device without deflection. The electric field in the device is $\vec{E} = 1.8 \times 10^4 \hat{\jmath}$ and the magnetic field is $\vec{B} = 0.60\hat{k}$. When the proton leaves the selector it enters a mass spectrometer with a magnetic field $\vec{B} = 2.3\hat{k}$. What is the radius of the proton's path in the mass spectrometer? Assume all vectors have SI units.
The major concepts used to solve this problem include: Newton's First Law, $\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$, Vector Addition, Radius of a charged particle's path in a magnetic field.

(A) 8.8×10^{-5} m
(B) 7.2×10^{-5} m
(C) 6.5×10^{-4} m
(D) 5.2×10^{-4} m [5 points]
(E) 4.9×10^{-5} m
(F) 3.6×10^{-5} m [4 points]
(G) 2.7×10^{-4} m
(H) 1.4×10^{-4} m [8 points]

Problem 12 (3 points) Using the velocity selector from the previous problem, if the proton was traveling with speed $1.1v_0$, what direction would it be deflected?
The major concepts used to solve this problem include: Newton's First and Second Law, $\vec{F} = q(\vec{E}\vec{v} \times \vec{B})$, Vector Addition, Radius of a charged particle's path in a magnetic field.

(A) $+\hat{\imath}$
(B) $+\hat{\jmath}$ [1 points]
(C) $+\hat{k}$
(D) $-\hat{\imath}$
(E) $-\hat{\jmath}$ [3 points]
(F) $-\hat{k}$
(G) It would not be deflected

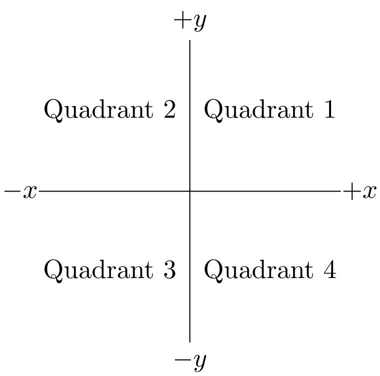
Problem 13 (7 points) A rectangular coil of wire with dimensions 2.0 cm by 3.0 cm and 75 turns carries a current of 4.0 A. The loop is placed in a uniform magnetic field of 0.30 T such that the plane of the loop makes an angle of 30 degrees with the magnetic field direction. What is the net torque acting on the loop?
The major concepts used to solve this problem include: Definition of torque on a current loop, direction of magnetic moment vector $\vec{\mu}$, Understanding definition of the plane of the loop and normal to the loop, Understanding which angle to use in a cross product.

(A) 1.6×10^{-2} Nm
(B) 2.7×10^{-2} Nm [5 points]
(C) 3.9×10^{-2} Nm
(D) 4.7×10^{-2} Nm [7 points]
(E) 6.2×10^{-2} Nm [4 points]
(F) 8.2×10^{-2} Nm

Problem 14 (9 points) An infinitely long straight wire lies along the y-axis and carries a current of 13 A in the $+\hat{\jmath}$-direction. At a particular moment in time, an electron is at the position $(x, y) = (5, -7)$ and is traveling with velocity $\vec{v} = 520\hat{\jmath}$. What is the magnitude of the force the wire exerts on the electron? Assume all values and vectors are in base SI units.
The major concepts used to solve this problem include: Magnetic field created by a long straight wire (and how r is defined), $\vec{F} = q\vec{v} \times \vec{B}$

(A) 2.5×10^{-23} N [5 points]
(B) 3.1×10^{-23} N [6 points]
(C) 4.3×10^{-23} N [9 points]
(D) 6.2×10^{-23} N
(E) 8.7×10^{-23} N
(F) 9.6×10^{-23} N

Problem 15 (4 points) In the previous problem, what is the direction of the force the ***electron*** exerts on the ***wire***?
The major concepts used to solve this problem include: Newton's third law, Right Hand Rule for the creation of magnetic field by a current, Right Hand Rule for magnetic force on a moving charge.



(A) $+x$ [2 points]
(B) Quadrant 1
(C) $+y$
(D) Quadrant 2
(E) $-x$ [4 points]
(F) Quadrant 3
(G) $-y$
(H) Quadrant 4

Problem 16 (9 points) There exists an object with a charge $q = 30.0$ mC that has a velocity vector $\vec{v} = 200\hat{\imath}$. There also exists and electric field $\vec{E} = -200\hat{\jmath} - 300\hat{k}$ and a magnetic field $\vec{B} = 3.00\hat{\jmath} - 4.00\hat{k}$. What is the magnitude of the net force acting on the object? (Assume the mass is very small so gravity can be ignored.)
The major concepts used to solve this problem include:

(A) 857 N
(B) 671 N [7 points]
(C) 73.1 N
(D) 40.8 N [5 points]
(E) 30.0 N [6 points]
(F) 20.1 N [9 points]
(G) 10.8 N [4 points]
(H) 2.43 N

Problem 17 (8 points) An object has a charge $q = 4.00$ C and a mass $m = 3.00$ mg. It is moving in a circular path with radius $r = 6.00$ m with a constant speed of $v = 250$ m/s. What is the magnetic field created by this object at the center of its circular path?
The major concepts used to solve this problem include: Magnetic field created by a moving charge. Note that this is not the same as the magnetic field needed to *contain* a moving charge to that radius.

(A) 4.89×10^{-4} T
(B) 3.13×10^{-5} T [2 points]
(C) 1.67×10^{-5} T [6 points]
(D) 7.18×10^{-6} T
(E) 2.78×10^{-6} T [8 points]