Physics 121 Common Exam 3, Spring 2023
April 24, 2023

Name (Print): ______________________________ UCID:________ Section: ______

Honors Code Pledge: For ethical and fairness reasons all students are pledged to comply with the provisions of the NJIT Academic Honor Code. You must answer the exam questions entirely by yourself. **Turn off all cell phones, pagers, or other communication devices**. Use only your own calculator.

Instructions:

- First, write your name and section number on **both** the Scantron card and this exam booklet.
- Use the formula sheet (last page of exam booklet) and no other materials.
- All questions are worth 1 point each. You need to answer a total of 16 questions correctly for a 100% score on the exam. No partial credit.
- **Briefly show work on this set of exam sheets for problems which require calculations.** Use the backs of pages if necessary.
- **Some answers may be approximate;** select the closest one.
- Answer each question on the Scantron card using #2 pencil. Also circle your answers on question papers.
- Do not hesitate to ask for clarification of any exam question, if needed, from your proctor or Professor.

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1. An electron has velocity $\vec{v} = v_x\hat{\imath} + v_z\hat{k}$ where v_x= 1000 m/s, and v_z = 1000 m/s. The magnetic field at its location is $\vec{B} = B_x\hat{\imath} + B_y\hat{\jmath}$ where B_x= 2.0 T and B_y = 2.0 T. The electron's charge is -1.6 × 10^{-19} C and its mass is 9.11 x 10^{-31} kg. Find the electron's resulting acceleration?

A) $a = 3.5 \times 10^{14}\left[\hat{\imath} - \hat{\jmath} - \hat{k}\right] m/s^2$
B) $a = 3.5 \times 10^{12}\left[-\hat{\imath} + \hat{\jmath} + \hat{k}\right] m/s^2$
C) $a = 1.76 \times 10^{14}\left[\hat{\jmath} - \hat{k}\right] m/s^2$
D) $a = 1.76 \times 10^{-12}[\hat{\imath} - \hat{\jmath}]\, m/s^2$
E) $a = 1.76 \times 10^{14}[\hat{\imath} + \hat{\jmath}]\, m/s^2$

2. A charged particle experiences force from a static (time-independent) magnetic field

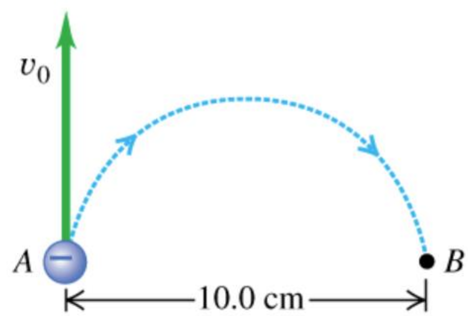
A) always
B) never
C) when the particle moves along the magnetic field lines
D) when it moves across the magnetic field lines
E) only when the charge is negative

3. A circular area with a radius of 6.40 cm lies in the xy-plane. What is the magnitude of the magnetic flux (in T·m ^{2}) through this circle due to a uniform magnetic field with a magnitude of 0.250 T in the + z -direction?

A) 1.2×10^{-3}
B) 2.2×10^{-3}
C) 3.2×10^{-3}
D) 4.2×10^{-3}
E) 5.2-x 10^{-3}

4. An electron at point A has a speed $v_0=1.40\times10^6$ m/s. Find the magnitude and the direction of the magnetic field that will cause the electron to follow the semicircular path with radius 5.0 cm from A to B, as shown in the figure (not to scale). (q_e= -1.6 x 10^{-19} C, m_e= 9.11 x 10^{-31} kg)

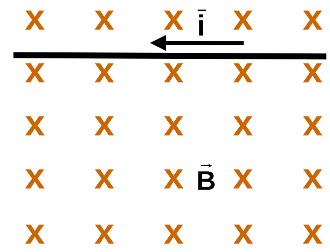
A) 3.6 x10^{-4}T, out of the page
B) 1.6 x10^{-4}T, into the page
C) 8.6 x10^{-2}T, into the page
D) 5.9 x10^{-2}T, out the page
E) Such a trajectory is impossible for any magnetic field



5. A pair of thin parallel wires are each carrying currents of 3.17 A in the opposite direction. The wires are separated by a perpendicular distance of 0.25 cm. The force per unit length between the wires is:

A) 0.0002 N/m, repulsion
B) 0.0004 N/m, attraction
C) 0.0008 N/m, repulsion
D) 0.0016 N/m, attractions
E) 0.0032 N/m, repulsion

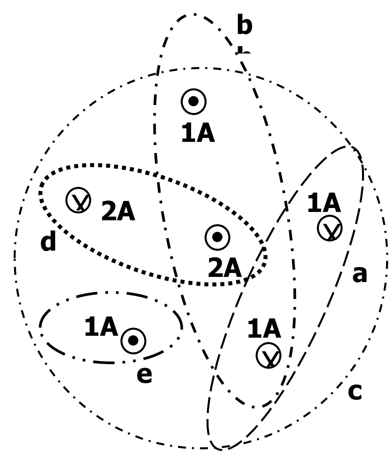
6. A wire whose length L = 15.0 cm is placed in a uniform magnetic field of magnitude B = 3.0 T which points into the page. The wire carries a current of 1.1 A to the left in the plane of the page. What are the magnitude and direction of the force exerted on the wire by the magnetic field?



A) 1.0 N out of the page
B) 0.5 N, up in the plane of the page
C) 2.25 N, up in the plane of the page
D) 0.5 N, down in the plane of the page
E) 2.25 N, down in the plane of the page

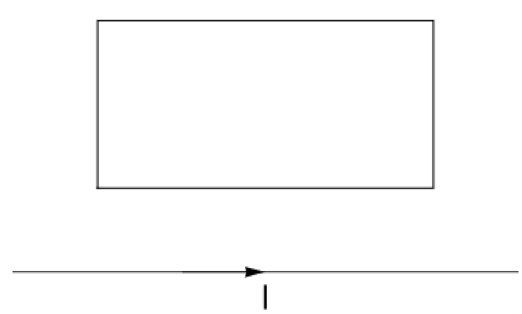
7. The sketch shows a cross-section view of 6 wires carrying current into or out of the page. Five possible Amperian paths labeled a, b, c, d, and e are shown. For which Amperian paths in the picture is $\oint \vec{B} \circ d\vec{s} = 0$ in Ampere's Law?

A) d
B) b
C) a and c
D) a, b, and c
E) c and d



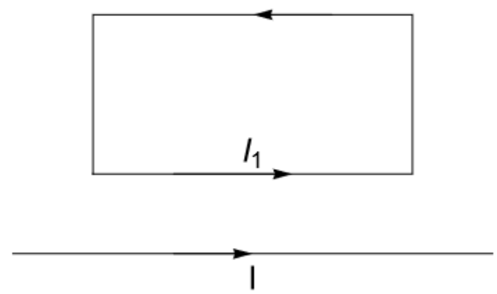
8. The current in the straight wire in the figure below increases with time at a constant rate. Find the direction of the induced current in the rectangular frame.

A) counter-clockwise
B) clockwise
C) oscillating
D) current is zero
E) insufficient information



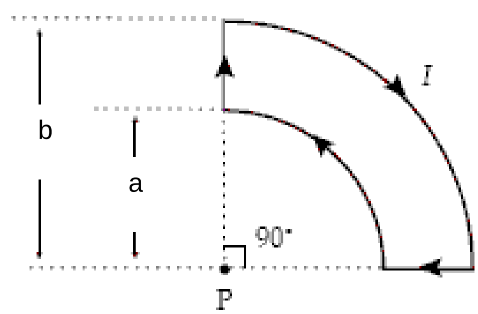
9. In the sketch below (not to scale) a long straight wire carries a current I to the right in the plane of the page. A rectangular wire loop is also in the plane of the page, above the straight wire. It carries a counterclockwise current of I_1 and its longer side is parallel to the wire. Which of the following statements correctly describes the net force and torque on the frame of wire:

A) The frame is attracted to the wire, no torque.
B) The frame is repelled by the wire, no torque.
C) The net force on the wire frame is zero, but the net torque attempts to rotate it around a horizontal axis.
D) The net force and torque on the wire frame are both zero.
E) The net torque on the wire frame attempts to rotate it counterclockwise.



10. If a = 30.0 cm, b = 40.0 cm, and current I = 36.0 A, what is the magnitude and direction of the magnetic field at point P, the center of curvature for the arc segments?

A) 1.62 μT, out of the page
B) 4.71 μT, out of the page
C) 26.2 μT, into the page
D) 52.4 μT, into the page
E) The field is zero

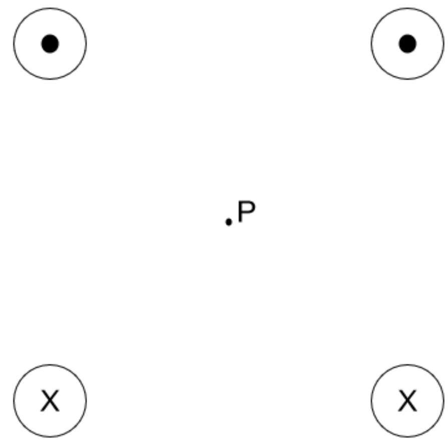


11. A wire ring of area A is placed in a magnetic field B that is normal to the plane of the ring. The field B varies in time according to the function $B(t) = B_0\sin(\omega t)$, where ω is the angular frequency. Find an expression for the magnitude of time-dependent Emf $\varepsilon_{ind}(t)$ induced in the ring?

A) $\varepsilon_{ind} = 0$
B) $\varepsilon_{ind} = AB_0\omega\,|\cos(\omega t)|$
C) $\varepsilon_{ind} = AB_0$
D) $\varepsilon_{ind} = \omega B_0\,|\cos(\omega t)|$
E) $\varepsilon_{ind} = A\omega B_0\,|\sin(\omega t)|$

12. The sketch shows four infinitely long parallel wires carrying equal currents of I = 2.0 A that are flowing into or out of the plane of the sketch. The wires pierce the plane of the sketch at the corners of a square, with the two upper currents going out of the plane and the two lower currents going into the plane of the sketch. Find the direction of the net magnetic field at point P – the center of the square.

A) Up
B) Down
C) Field is out of the plane of the page
D) Left
E) Right



13. For the previous problem, calculate the magnitude of the field at point P if the side of the square is 1.0 cm.

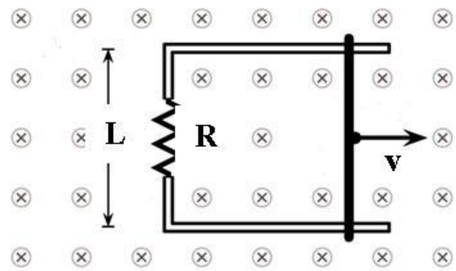
A) 0.02 mT
B) 0.04 mT
C) 0.08 mT
D) 0.16 mT
E) 0.32 mT

14. A magnetic field of 37.2 T has been achieved at one specialized Laboratory. Find the current needed to achieve such a field at the center of a circular coil of radius 47.0 cm that has 100 turns.

A) 7.8×10^5 A
B) 0.38×10^5 A
C) 2.8×10^5 A
D) 3.0×10^4 A
E) 4.7×10^4 A

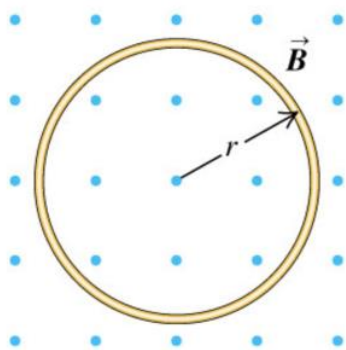
15. The bar in the sketch is moving to the right at constant speed of v = 50.0 m/s in a uniform magnetic field of 16.0 T directed into the page. The resistance R is 1.2 kΩ. The separation L between the rails is L = 3.0 m. The bar slides with no friction while making continuous electrical contact with the rails. Find the magnitude and direction of the current flowing in the resistor R.

A) 1 A, up
B) 2 A, down
C) 3 A, up
D) 4 A, down
E) 5 A, up



16. A circular loop of wire with radius r = 0.050 m and resistance 0.16 Ω is in a region of spatially uniform magnetic field B directed out of the page, as shown in the following figure (not to scale). The magnetic field has an initial value of 8.0 T and is decreasing at a rate of -0.70 T/s. Find the magnitude and direction of the induced current.

A) 0
B) 0.012 A, counter-clockwise
C) 0.023 A, clockwise
D) 0.034 A, counter-clockwise
E) 0.045 A, clockwise



Answer Key

1. A
2. D
3. C
4. B
5. C
6. D
7. E
8. B
9. A
10. B
11. B
12. E
13. D
14. C
15. B
16. D