PHYS 1250 Example Exam 1 Questions

- Please print your name clearly on each page of this exam.
- Put your answers to multiple choice questions on the bubble sheets supplied with this exam.
- Submit your answers to sections B and C on the attached pages with this cover sheet.
- If you are unclear on any question, ask a proctor.
- You must show work and/or logic to get full credit on parts B and C.
- You are permitted a single 8 ½ x11" sheet for notes (1 side) plus the math and formula sheets provided. Use of any other materials will result in a zero for this examination. You may use a calculator up to the TI Inspire for math functions.
- Collaboration on this exam will result in a non-droppable zero grade and letter to the Dean of Students for all students involved. Use of a communication device (e.g.- cell phone) during the exam will be interpreted as evidence of collaboration.
- Assume three significant figures unless otherwise stated.

Detailed Instructions:

PART A – Multiple Choice – 3 pts each – Put your answers to multiple choice questions on the bubble sheets supplied with this exam. No partial credit.

PART B – 7 points each – 4 pts for CLEARLY SHOWING logic and relevant formula(s), 2 pts for clearly showing correct supplied numbers in final formula, and 1 pt for numerical answer consistent with units.

PART C – 12 points each – Points as marked. You must clearly show/explain steps and logic to get full credit. Do not make us guess what you were thinking.

Approximate values of some useful constants:

$\mu_0 = 4\pi \times 10^{-7} \frac{\text{T-m}}{A} \cong 1.26 \times 10^{-6}$

$\varepsilon_0 \cong 8.85 \times 10^{-12} C^2/(\text{N}\bullet\text{m}^2)$

$k = \frac{1}{4\pi\varepsilon_0} \cong 9.0 \times 10^9 \frac{\text{Nm}^2}{C^2}$

$c \cong 3.00x10^8 \quad \text{m/s}$

$g \cong 9.81\ \text{m/s}$

$m_{electron} \cong 9.11 \times 10^{-31}\ \text{kg}$

$m_{proton} \cong 1.67 \times 10^{-27}\ \text{kg}$

$q_{electron} \cong -1.60 \times 10^{-19}\ \text{C}$

$h = 6.60x10^{-34}\ \text{J-s}$

Resistivity of nichrome: $1.0\text{x}10^{-6}\ \Omega - m.$

Resistivity of copper: $1.7\text{x}10^{-8}\ \Omega - m.$

1 nano-thing=10^{-9} thing

1 micro-thing=10^{-6} thing

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Part A Multiple Choice – 3 pts each – Put your answers to multiple choice questions on the bubble sheets supplied with this exam.

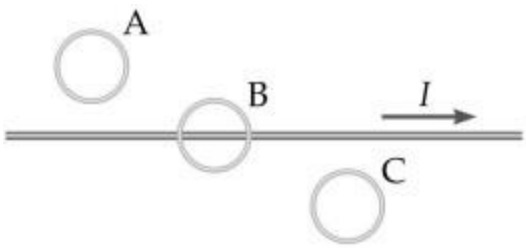
1) A horizontal wire carries a current straight toward you. From your point of view, the magnetic field at a point directly below the wire points

A) directly away from you.
B) to the left.
C) to the right.
D) directly toward you.
E) vertically upward.

2) At what distance from the central axis of a long straight thin wire carrying a current of 5.0 A is the magnitude of the magnetic field due to the wire equal to the strength of the Earth's magnetic field of about 5.0×10^{-5} T?

A) 1.0 cm
B) 2.0 cm
C) 3.0 cm
D) 4.0 cm
E) 5.0 cm

3) The long straight wire in the figure carries a current *I* that is decreasing with time at a constant rate. The circular loops A, B, and C all lie in a plane containing the wire. The induced emf in each of the loops A, B, and C is such that



A) no emf is induced in any of the loops.
B) a counterclockwise emf is induced in all the loops.
C) loop A has a clockwise emf, loop B has no induced emf, and loop C has a counterclockwise emf.
D) loop A has a counter-clockwise emf, loop B has no induced emf, and loop C has a clockwise emf.
E) loop A has a counter-clockwise emf, loops B and C have clockwise emfs.

4) Which of the following statements about inductors are correct?

A) When it is connected in a circuit, an inductor always resists having current flow through it.
B) Inductors store energy by building up charge.
C) When an inductor and a resistor are connected in series with a DC battery, the current in the circuit is reduced to zero in one time constant.
D) An inductor always resists any change in the current through it.
E) When an inductor and a resistor are connected in series with a DC battery, the current in the circuit is zero after a very long time.

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5) A 96-mH solenoid inductor is wound on a form 0.80 m in length and 0.10 m in diameter. A coil is tightly wound around the solenoid at its center. The coil's resistance is 9.9 ohms. The mutual inductance of the coil and solenoid is 31 μH. At a given instant, the current in the solenoid is 540 mA and is decreasing at the rate of 2.5 A/s. At the given instant, what is the magnitude of the induced current in the coil?

A) 7.8 μA
B) 6.3 μA
C) 9.4 μA
D) 11 μA
E) 13 μA

6) How much energy is stored in a room 3.0 m by 4.0 m by 2.4 m due to the earth's magnetic field with a strength of 5.0×10^{-5} T?

A) 570 mJ.
B) 29 mJ.
C) 10 mJ.
D) 100 mJ.
E) 57 mJ.

7) A 25.0-mH inductor, a 2.00-μF capacitor, and a certain resistor are connected in series across an ac voltage source at 1000 Hz. If the impedance of this circuit is 200 Ω, what is the resistance of the resistor?

A) 100 Ω
B) 184 Ω
C) 200 Ω
D) 552 Ω
E) 579 Ω

8) A series circuit consists of a 50-Hz ac source, a 50-Ω resistor, a 0.50-H inductor, and a 60-μF capacitor. The rms current in the circuit is measured to be 3.1 A. What is the voltage amplitude of the source?

A) 510 V
B) 270 V
C) 220 V
D) 180 V
E) 160 V

9) A resistor is connected to an ideal ac power supply. The current in the resistor

A) leads the voltage across the resistor by 90°.
B) lags the voltage across the resistor by 90°.
C) is in phase with the voltage across the resistor.
D) leads the voltage across the resistor by 45°.
E) lags the voltage across the resistor by 45°.

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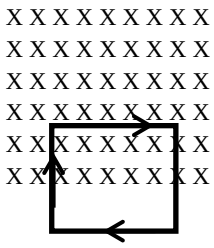
10) A resistor is connected to an ideal ac power supply. How does the average power dissipated in the resistor change as the frequency in the ac power supply decreases?

A) It decreases.
B) It increases.
C) It does not change.
D) It increases or decreases depending on the sign of the phase angle.

PART B – YOU MUST CLEARLY SHOW WORK AND EXPLAIN LOGICAL STEPS TO EARN FULL CREDIT.

B1) A charge of 2.00×10^{-6} C moves with velocity $3000\hat{\imath} + 4000\hat{\jmath}$ m/s through a magnetic field given by 1.50 T $\hat{\imath}$. Find the magnitude and direction of the force on the charge.

B2) A current flows in a clockwise direction in the square loop of perimeter length 0.80 m. The top half of the loop is in a uniform magnetic field of 0.25 T pointing into the paper. Calculate the current necessary to create a net magnetic force of 0.30 N on the loop.



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B3) A 10^{-6} F capacitor and 10^{-4} H inductor are wired in series with a 10 ohm resistor and driven with an AC voltage source. Find the driving frequency that leads to the largest voltage across the resistor?

B4) A circular wire loop of radius 0.360 cm lies in the xz-plane. There is a uniform magnetic field in the y-direction that decreases at 0.0150 T/s. Find the magnitude of the induced electric field in the wire.

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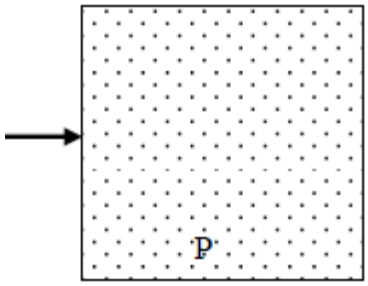
PART C – YOU MUST CLEARLY SHOW WORK AND EXPLAIN LOGICAL STEPS TO EARN FULL CREDIT

C1) A nanoparticle of charge $q = -1.60 \times 10^{-18}\text{C}$ and mass $2.55 \times 10^{-21}\text{kg}$ is shot from the left at velocity $v = 12.0\ \text{m/s}$ into the center if the side of a square region of uniform magnetic field of 1.50 T pointing out of the paper. The region is 10 cm long on each side.



a) What is the direction of the force on the particle as it enters the field region?

b) What is the magnitude of the force on the particle as it enters the field region?

c) Describe the trajectory of the particle as it travels within the field region. (e.g. – "It travels along a parabola pointing out of the paper."). Be quantitative if possible. (e.g. – "The radius of the trajectory is 20 m."). Which face (top, bottom, in, out, right, left, none) does the particle exit through?

d) (4 pts) In order to achieve its initial velocity of $v = 12$ m/s, the particle is accelerated from zero velocity using a potential difference of ΔV. What must ΔV be in volts?

e) (4 pts) As the particle enters the region, what is the magnitude and direction of the magnetic field created by the particle at point P at the center of the bottom side of the square?

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C2) An RC circuit is driven with a harmonic emf of $v(t) = 10V\cos(2\pi ft)$. The value of the resistance is 1000 ohms.

a) Write an equation for the reactance of the capacitor as a function of the frequency *f*.

b) At a driving frequency of $f = 10{,}000$ Hz, the amplitude of the voltage across the resistor is the same as that across the capacitor. What is the value of the reactance of the capacitor at this frequency?

c) What is the value of the capacitance?

d) What is the amplitude of the voltage across the capacitor at $f = 10{,}000$ Hz?

e) Given your voltage amplitude from part d), compute the time-average power $\langle P\rangle = \langle iv\rangle$ dissipated in the capacitor.

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C3) A charged capacitor, an inductor, and an open switch are in series. Their values are L = 0.50 mH, C = 2.0 μF, and the charge on the capacitor is q = 40 μC.

a) Find the period T of oscillation of this circuit when the switch is closed.

b) Find the current that will flow in the LC circuit immediately after the switch is closed (at t = 0).

c) Find the current that will flow in the LC circuit one-quarter period after the switch is closed (at t = T/4).

d) Indicate the direction of the induced emf in the inductor of the LC circuit one period after the switch is closed (at t = T) by sketching the circuit and drawing an arrow next to the inductor.