

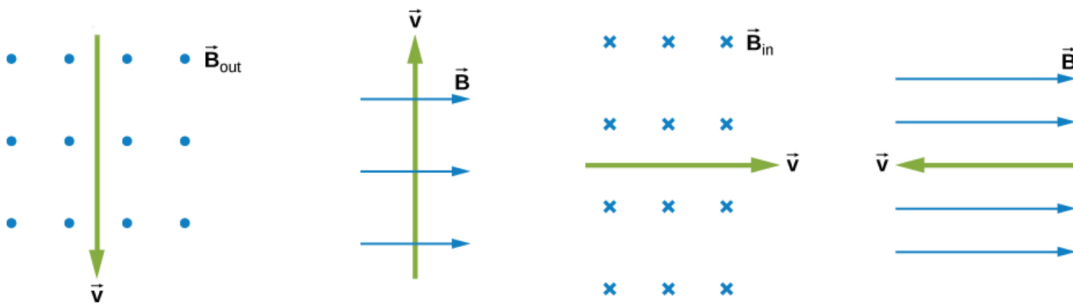
Name:

Physics 1320 – Spring 2024 – CORRECTED Practice Final Exam

Instructions:

- There are NINETEEN QUESTIONS on this exam.
- There is a table of helpful properties on the last page, some of which may be needed to answer the questions.
- You may use your formula sheet and a scientific calculator.
- No cell phones or other computing devices are permitted.
- If you get stuck on a problem, make an assumption and answer the rest of the problem for part credit.

Constant	Value (SI units)
fundamental charge	$e = 1.602 \times 10^{-19} C$
Coulomb constant	$k = 9.00 \times 10^9 Nm^2/C^2$
”Epsilon-naught”	$\epsilon_0 = 8.85 \times 10^{-12} F/m$



Problem 1: An electron moving in different uniform magnetic fields

Part 1: (Circle the best answer):

(Multiple Choice problems require *only* an answer. You *may* provide an explanation for multiple choice problems if you want an opportunity for partial credit.)

1. Each of the sketches above shows an *electron* moving in a uniform magnetic field. On each sketch, draw the direction of the force on the electron. (Use \odot or \otimes for forces out of, or into, paper.)

1. to right

1. out of page

1. down

1. 0

2. A rectangular current loop is 50 cm high by 70 cm wide. It has a 3 Amp current flowing counter-clockwise around it. The magnetic moment \vec{m} is?
- A. $1.05A \cdot m^2$ to the left
 - B. $3.00A \cdot m^2$ to the right
 - C. $0.35A \cdot m^2$ up
 - D. $3.00A \cdot m^2$ into the page
 - E. $1.05A \cdot m^2$ out of the page**
3. Electric field is usually expressed in N/C (Newtons/Coulomb). Which of these other choices is a valid SI unit to describe electric field?
- A. F (Farads) **B. V/m** C. J/C D. $N \cdot m$
4. Two 5 m long parallel wires are 1 cm apart and each carry a 400 ampere current in the same direction. The direction of the force between the wires is:
- A. zero (wires are uncharged)
 - B. attractive**
 - C. repulsive
 - D. out of the page
 - E. in the direction of current flow
5. Two 5 m long parallel wires are 1 cm apart and each carry a 400 ampere current. The magnitude of the force between the wires is:
- A. zero (wires are uncharged)
 - B. $8.02 \times 10^{-3} N$
 - C. 1.00 N
 - D. 3.21 N**
 - E. 16.05 N
 - F. 80.25 N
6. It can take up to 500 Amperes to start your car. If you are getting this current from a 12 V battery, how much power does it take to start your car?
- A. 2.75 MW **B. 6 kW** C. 41.7 W D. 0.024 W

Part 2: Long answer problems require you to show work on a separate page. Show any formulae used. Show numbers plugged into formulae before getting a numerical answer. (Answers without any work shown will get no credit). Answers should have three significant figures and include SI units.

7. Write down all the metric prefixes beginning with pico and proceeding by factors of 1000 up through Tera. Also write down the one letter abbreviation for them (Note: Capitalization can matter for the one-letter abbrev.). For example, 10^{-12} , pico, "p". **pico(p) nano(n)**

micro(μ) milli(m) - kilo(k) Mega(M) Giga(G) Tera(T)

8. The potential as a function of position in a region is given by $V(x) = x^3/3 - x^2/2 - 6x$, with x in meters and V in volts.

(a) Find the potential at x=1.

-37/6 V

(b) Find the electric field at x=1.

6 V/m

(c) Find the electric field at x=-2.

4 N/C

9: [NOTE: Changed Pentagon to Hexagon because the geometry is less annoying! – you are welcome] Because much of the class failed to help Buffy electrocute the vampire on exam 2, they are still alive. They have made a "hexagram" from six protons arranged in a hexagon surrounded by candles made from wax rendered from their victims. Vampires are very emotional beings and they can be defeated by physics problems solved calmly and methodically in their presence. The side of the hexagram is one nanometer.

(a) What is the potential (relative to infinity) at the center of the cursed hexagram?

8.64 V

(b) What is the electric field at the center of the hexagram?

0

(c) The proton at the apex of the hexagram is removed. Now what is the electric field magnitude at the center of the hexagram? (You can do this the hard way or the easy way. Do it the easy way!)

$1.44 \times 10^9 V/m$

10. Sketch the current loop from question 2. Which of the fields shown in problem 1 will give the maximum torque on this current loop.

2nd and 4th fields

Calculate the torque if the field magnitude is 0.5 T.

0.525 N-m

11. An "infinite" square plate 2 m on a side has a total charge of $0.4 \mu\text{C}$. A pith ball with a mass of 2 g and a charge of 2.83 mC is launched toward the plate from a distance of 20 cm at a speed of 40 m/s.

(a) Will the pith ball reach the plate?

No

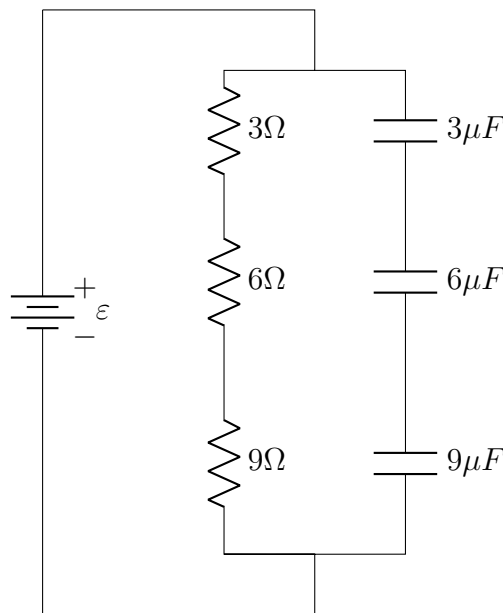
(b) If not, how close will it get before it turns around?

10 cm

12. You have never seen a problem with both resistors and capacitors, but you've got this! Resketch this circuit showing only the battery and a single equivalent resistance and equivalent capacitance. Calculate the values of the equivalent resistance and capacitance.

$R_{eq} = 18\Omega$

$C_{eq} = 18/11\mu\text{F}$



Problem 12: Circuit with battery three resistors and three capacitors.

13. You need to make a one Ohm resistor out of 30 feet of copper wire. What diameter of wire should you choose?

0.44 mm

14. When I worked in Silicon Valley I listened to radio station KOME, at 98.5-FM. (Yes, some of their slogans were obscene). 98.5 stands for a frequency of 98.5 MHz. What is your favorite radio station? (Use mine if you don't listen to the radio!). What is the frequency and wavelength of your favorite station?

$f = 98.5 \times 10^6 \text{ Hz}$

$\lambda = 3.05 \text{ m}$

15. You make a solenoid that is 20 cm long and 1 cm in diameter. It has 3000 windings. You run 5 Amps through the solenoid.

- (a) Sketch the solenoid and indicate the direction of the magnetic field inside and outside the solenoid. (You may want to indicate the direction of current flow to remove any ambiguity in your answer).

Along axis

Direction depends on what you picked for current (hitchhiker's rule)

- (b) What is the magnetic field magnitude inside the solenoid?

94.5 mT

- (c) You fill the solenoid with iron. What is the field magnitude now?

945 T

16. An electron moves in a circle of radius 2 m in Earth's magnetic field ($B_E = 50\mu T$).

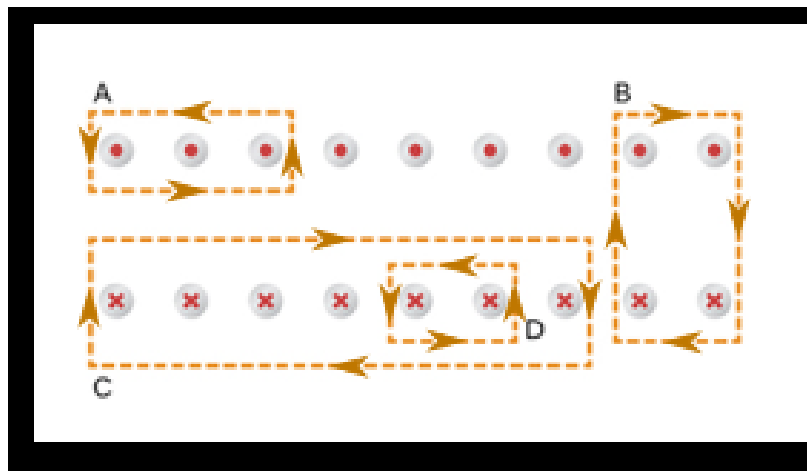
- (a) What is the speed of the electron?

1.75×10^7 m/s

- (b) What is the frequency of its orbit?

1.40 MHz

17. Refer to the figure on the next page where each circle with an x or a dot is a wire coming into or out of the page. Each wire carries a current of 200 Amperes. For each case (a, b, c, d) what is $\oint \vec{B} \cdot d\vec{l}$?



Problem 17: Different loops enclosing currents.

- $600\mu_0$
0
 $1400\mu_0$
 $-400\mu_0$

18. Refer to the figure on page 6. The uniform magnetic field in the figure decreases from 5 mT to zero in two millisecc. The loop is square with $s = 30 \text{ cm}$. The resistance of the lightbulb is 3 Ohms.

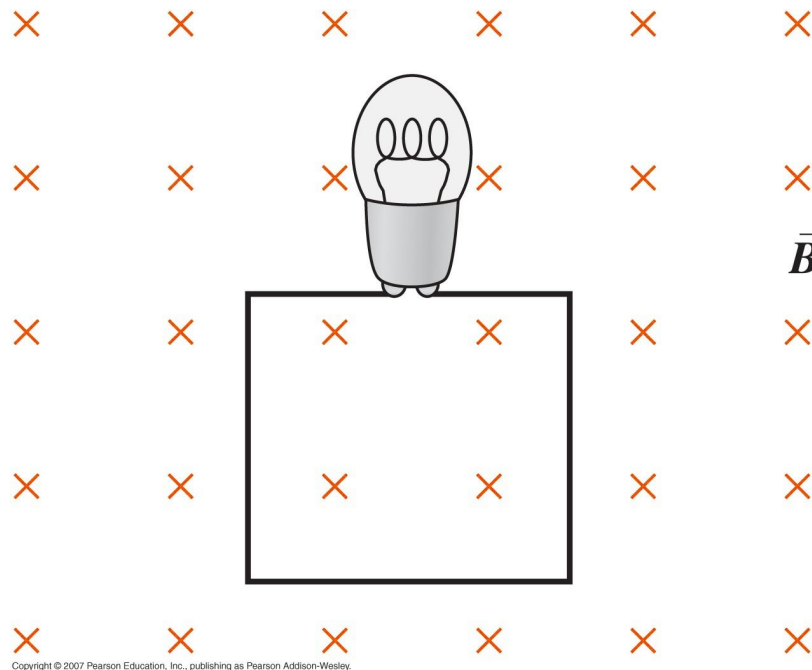
(a) What is the magnitude of the current through the lightbulb?

75 A

(b) Does the current go clockwise or counterclockwise and explain step by step how you got that answer.

CW

Flux decreases into page, which is same as increasing out of page. CCW current would cause this. Lenz's law says nature does the opposite.



Problem 18: A changing magnetic field in a loop of wire.

19. Refer to the figure on page 6. A wire moves to the right at constant speed v in a uniform magnetic field of strength B directed into the page. The wire slides on two rails that are a distance l apart. The circuit is completed by a resistor of value R .

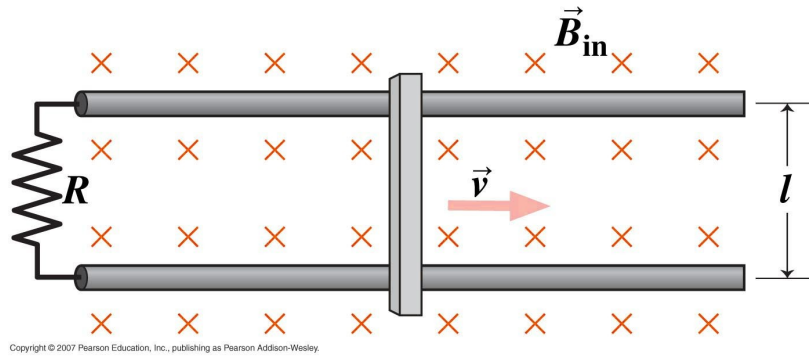
(a) What is the magnitude of the current through the resistor? (This is a symbols question, not a numbers question)

Blv/R

(b) Does the current go clockwise or counterclockwise and explain step by step how you got that answer.

CCW

Flux increases into page as loop grows. CW current would cause this. Lenz's law says nature does the opposite.



Problem 19: A wire moving to the right along two rails in a uniform magnetic field.

Material Properties

Material	Resistivity (ρ) (Ωm)	Dielectric Const (κ)	Magnetic Permeability μ_r
Teflon	1.7×10^{22}	3.0	1.0
Copper	1.7×10^{-8}	–	1.0
Human Blood	0.7	81	0.9999
Iron	9.7×10^{-8}	–	10,000