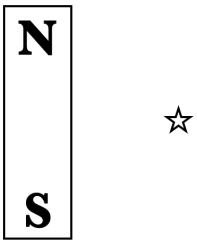
PHYS 2140 Name:_____

Wednesday, November 19 **Exam 3b** 19 questions, 100 points

1. The figure shows a bar magnet with its N pole at the top, and a location marked by a star.

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[4] (a) _____ The magnetic dipole moment $\vec{\mu}$ of this bar magnet points
**A)** ↑ **B)** → **C)** ↓ **D)** ←

[4] (b) _____ In what direction does the magnetic field point at the star?
**A)** ↑ **B)** → **C)** ↓ **D)** ←

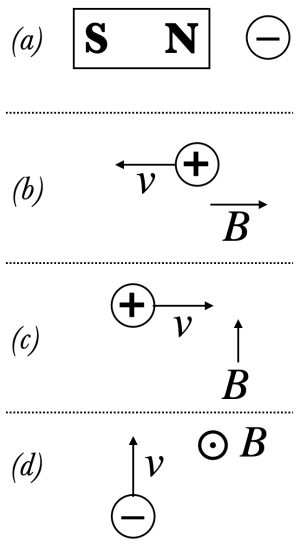
2. For each of the following, what is the direction of the force on the charge?
**A)** ↑ **B)** → **C)** ↓ **D)** ←
**E)** ⊗ (into page) **F)** ⊙ (out of page) **G)** zero

[2] (a) _____ negative, placed to the left of the N pole of a bar magnet.

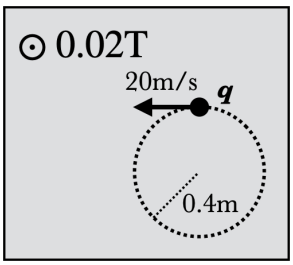
[2] (b) _____ positive, moves to the left in a $\vec{B}$ field that points to the right.

[2] (c) _____ positive, moves to the right in a $\vec{B}$ field that points upward.

[2] (d) _____ negative, moves upward in a $\vec{B}$ field that points outward.



3. A charge $q$ with mass 0.07 kg is moving in a circle due to a magnetic field 0.02 T that points out of the page. The radius of the circle is 0.4 m and the charge is moving at 20 m/s.




2 (a) _____ The sign of the charge is

**A)** positive **B)** negative

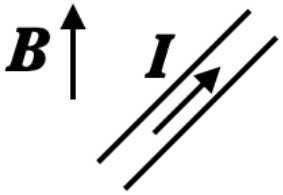
2 (b) _____ The magnitude of the charge is

**A)** 28 C **B)** 61 C **C)** 175 C **D)** 227 C

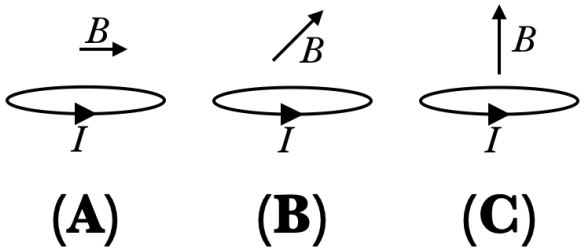
4 4. _____ A wire carries current $I$ up and to the right through a magnetic field that points upward. What is the direction of the force felt by the wire?

**A)** ↖ **B)** ↗ **C)** ↙ **D)** ↘

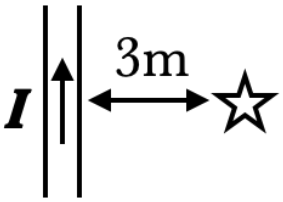
**E)** ⊙ (out of page) **F)** ⊗ (into page)




4 5. _____ These three loops carry the same current $I$, and they have are placed in three uniform magnetic fields with the same magnitude but which differ in direction. Which loop feels the **largest** torque due to the magnetic field?



6. A very long wire carries a current $I = 0.35\,\text{A}$ upward, which creates a magnetic field at the star, 3 meters to the right of the wire.



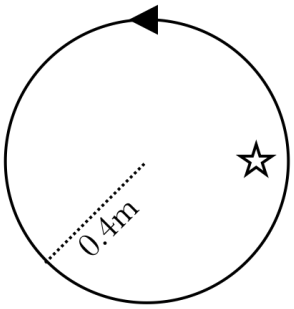

4 (a) _____ What direction does this magnetic field (at the star) point?

**A)** $\uparrow$ **B)** $\rightarrow$ **C)** $\downarrow$ **D)** $\leftarrow$
**E)** $\otimes$ (into page) **F)** $\odot$ (out of page)

4 (b) _____ The magnitude of the magnetic field is

**A)** $1.5 \times 10^{-8}\,\text{T}$ **B)** $2.3 \times 10^{-8}\,\text{T}$
**C)** $3.5 \times 10^{-8}\,\text{T}$ **D)** $4.7 \times 10^{-8}\,\text{T}$

7. The figure shows a counterclockwise current $I = 0.5\,\text{A}$ flowing through a circular loop with radius $r = 0.4\,\text{m}$.



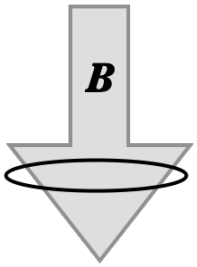

4 (a) _____ The magnetic field at the star points

**A)** $\uparrow$ **B)** $\rightarrow$ **C)** $\downarrow$ **D)** $\leftarrow$
**E)** $\otimes$ (into page) **F)** $\odot$ (out of page)

4 (b) _____ The magnetic dipole moment $\vec{\mu}$ of this loop is

**A)** $0.25\,\text{Am}^2\,\otimes$ **B)** $0.25\,\text{Am}^2\,\odot$
**C)** $0.63\,\text{Am}^2\,\otimes$ **D)** $0.63\,\text{Am}^2\,\odot$
**E)** $1.26\,\text{Am}^2\,\otimes$ **F)** $1.26\,\text{Am}^2\,\odot$

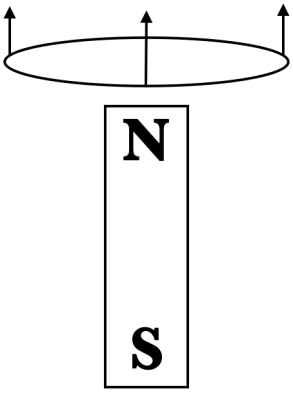
8. The figure shows a loop of wire in a downward-pointing magnetic field $\vec{B}$ which is increasing in magnitude. (The loop is not moving.)




2 (a) _____ The *original* or *external* flux through this loop points
**A)** up ↑ **B)** down ↓

2 (b) _____ The *induced* flux created by this loop points
**A)** up ↑ **B)** down ↓

9. A loop of wire is being lifted from the N pole of a bar magnet as shown.

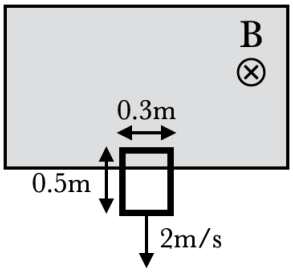



1 (a) _____ What is the direction of the original flux through this loop?
**A)** up ↑ **B)** down ↓

1 (b) _____ The original flux is
**A)** increasing **B)** decreasing **C)** constant

2 (c) _____ The induced flux through the loop points
**A)** up ↑ **B)** down ↓

10. The figure shows a rectangular loop of current which is falling out of a region with uniform magnetic field $B = 0.7\,\text{T}$. The loop is moving with a constant speed of $2\,\text{m/s}$.




2 (a) _____ The external flux through this loop is

**A)** increasing **B)** decreasing **C)** constant

2 (b) _____ The current induced in this loop runs

**A)** clockwise ↻ **B)** counterclockwise ↺

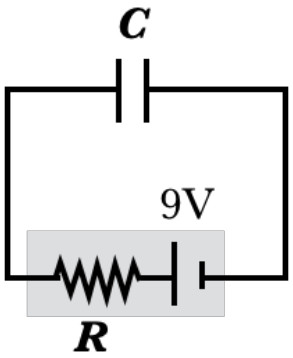
2 XC (c) _____ What is the induced emf $\mathcal{E}$ in this loop? *Show work for partial credit! You might want to let $x$ be the distance from the top of the loop to the bottom edge of the field.*

**A)** $0.105\,\text{V}$ **B)** $0.210\,\text{V}$ **C)** $0.420\,\text{V}$ **D)** $0.700\,\text{V}$

2 11. _____ Two pucks of the same mass and same frictional coefficients are pushed across a flat surface made of copper (which is a weak diamagnet). One puck is a strong magnet, and the other puck is not. Which puck will come to a stop first? (Explain.)

**A)** the non-magnet **B)** the magnet **C)** both the same

12. A $C = 200\,\mu\text{F}$ capacitor is connected to a battery with an emf of $\mathcal{E} = 9\,\text{V}$ and an internal resistance of $R = 0.3\,\Omega$, and the capacitor charges.




4 (a) _____ What is the time constant of this charging process?

**A)** $3.0 \times 10^{-8}\,\text{s}$ **B)** $6.0 \times 10^{-5}\,\text{s}$ **C)** $30\,\text{s}$
**D)** $130\,\text{s}$ **E)** $1.7 \times 10^{4}\,\text{s}$

4 (b) _____ What is the final charge on the positive plate of the capacitor?

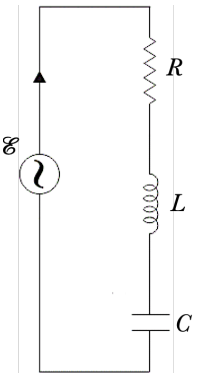
**A)** $0\,\text{C}$ **B)** $6.0 \times 10^{-5}\,\text{C}$ **C)** $1.8 \times 10^{-3}\,\text{C}$
**D)** $18\,\text{C}$ **E)** $30\,\text{C}$ **F)** $1.8 \times 10^{4}\,\text{C}$

4 (c) _____ What is the eventual current through the battery?

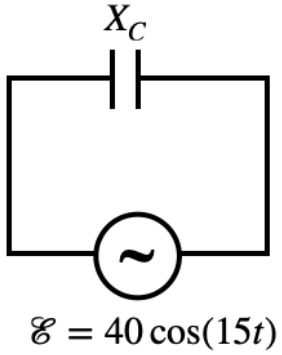
**A)** $0\,\text{A}$ **B)** $6.0 \times 10^{-5}\,\text{A}$ **C)** $1.8 \times 10^{-3}\,\text{A}$
**D)** $18\,\text{A}$ **E)** $30\,\text{A}$ **F)** $1.8 \times 10^{4}\,\text{A}$

4 13. _____ An RLC circuit has resistance $800\,\Omega$, capacitance $300\,\mu\text{F}$, and and inductance $0.2\,\text{H}$. What angular frequency $\omega$ must the power supply provide to get the maximum peak current through this circuit? (For partial credit, what is it called when this happens?)

**A)** $1.67\,\text{rad/s}$ **B)** $4.17\,\text{rad/s}$ **C)** $129\,\text{rad/s}$ **D)** $16{,}700\,\text{rad/s}$



14. An AC current with peak voltage 40 V and angular frequency $\omega = 15\,\text{rad/s}$ is connected to a capacitor. The capacitor has a reactance of $2.5\,\Omega$.



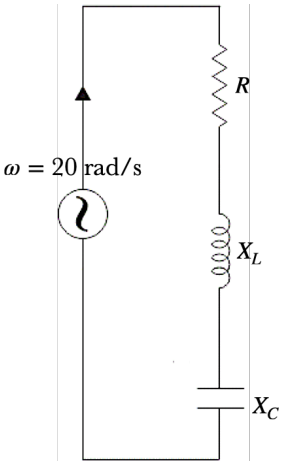

4 (a) _____ What is the capacitance of the capacitor?

**A)** 0.16 F **B)** 0.027 F **C)** 6 F **D)** 37.5 F **E)** 40 F

4 (b) _____ What is the peak current $I_0$ that flows through this current?

**A)** 0.01 A **B)** 0.0625 A **C)** 1 A **D)** 16 A **E)** 28 A

15. An RLC circuit connected to a power supply with an angular frequency $\omega = 20\,\text{Hz}$ has a resistance $80\,\Omega$, a capacitance reactance of $X_C = 140\,\Omega$, and an inductive reactance of $X_L = 10\,\Omega$.




4 (a) _____ What is the inductance $L$ of the circuit?

**A)** $3.65 \times 10^{-4}\,\text{H}$ **B)** $5 \times 10^{-3}\,\text{H}$
**C)** 0.5 H **D)** 2 H **E)** 20,000 H

4 (b) _____ What is the impedance of this circuit?

**A)** $153\,\Omega$ **B)** $162\,\Omega$ **C)** $170\,\Omega$ **D)** $210\,\Omega$ **E)** $230\,\Omega$

[4] 16. _____ Europe's alternating current has an rms voltage of 240 V. The peak voltage $\mathcal{E}_0$ of this alternating current is

**A)** 120 V **B)** 170 V **C)** 240 V **D)** 339 V

[2] 17. _____ The symbol $Z$ represents

**A)** resistance **B)** reactance **C)** impedance

[2] 18. _____ In the formula $X_C = \dfrac{1}{\omega C}$, the $C$ stands for

**A)** capacitance **B)** charge **C)** current

[2] 19. _____ What is the equation $d\vec{B} = \dfrac{\mu_0}{4\pi} I \dfrac{d\vec{s} \times \vec{d}}{d^3}$ called?

**A)** Ampere's Law **B)** Biot-Savart Law **C)** Gauss' Law **D)** Maxwell's Law