# PHYS 2140 Exam 3a Solutions

Wednesday, November 19

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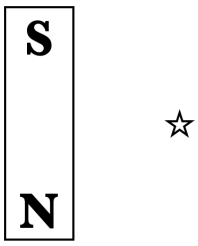
1. The figure shows a bar magnet with its N pole at the bottom, and a location marked by a star.




4 (a) **C** The magnetic dipole moment $\vec{\mu}$ of this bar magnet points

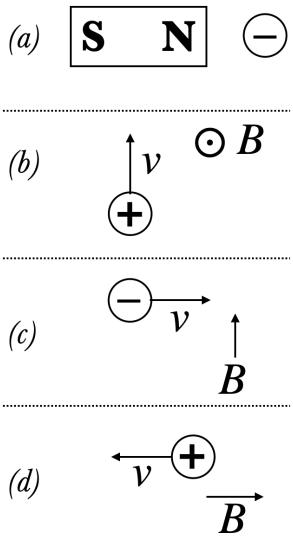
**A)** ↑ **B)** → **C)** ↓ **D)** ←

4 (b) **A** 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



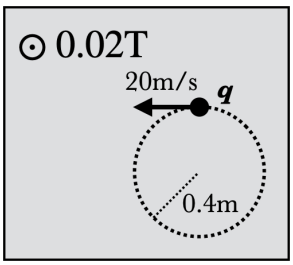

2 (a) **G** negative, placed to the left of the N pole of a bar magnet.

2 (b) **B** positive, moves upward in a $\vec{B}$ field that points outward.

2 (c) **E** negative, moves to the right in a $\vec{B}$ field that points upward.

2 (d) **G** positive, moves to the left in a $\vec{B}$ field that points to the right.

3. A charge $q$ with mass 0.03 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) B The sign of the charge is

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

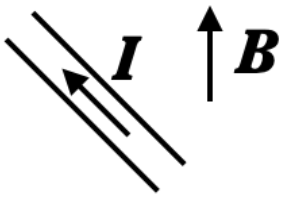
2 (b) D The magnitude of the charge is

**A)** 12 C **B)** 27 C **C)** 61 C **D)** 75 C

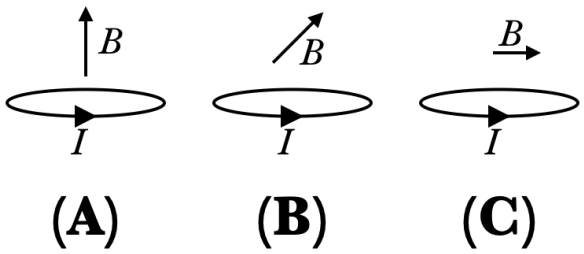
4 4. F A wire carries current $I$ up and to the left through a magnetic field that points upward. What is the direction of the force felt by the wire?

**A)** ↖ **B)** ↗ **C)** ↙ **D)** ↘

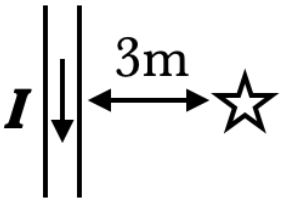
**E)** ⊙ (out of page) **F)** ⊗ (into page)




4 5. C 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 $I = 0.35\,\text{A}$ downward, which creates a magnetic field at the star, 3 meters to the right of the wire.



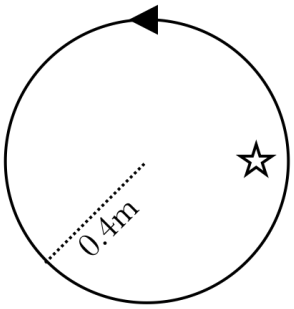

4 (a) **F** What direction does this magnetic field (at the star) point?

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

4 (b) **A** The magnitude of the magnetic field is

**A)** $2.3 \times 10^{-8}\,\text{T}$ **B)** $3.5 \times 10^{-8}\,\text{T}$
**C)** $4.7 \times 10^{-8}\,\text{T}$ **D)** $1.5 \times 10^{-7}\,\text{T}$

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



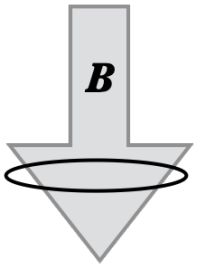

4 (a) **F** The magnetic field at the star points

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

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

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

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.)



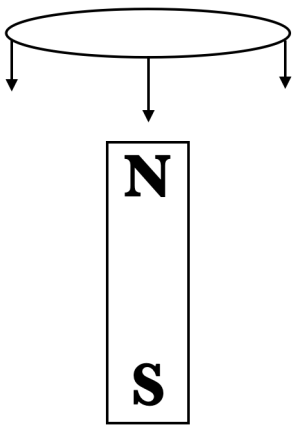

[2] (a) B The *original* or *external* flux through this loop points

**A)** up ↑ **B)** down ↓

[2] (b) A The *induced* flux created by this loop points

**A)** up ↑ **B)** down ↓

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




[1] (a) A What is the direction of the original flux through this loop?

**A)** up ↑ **B)** down ↓

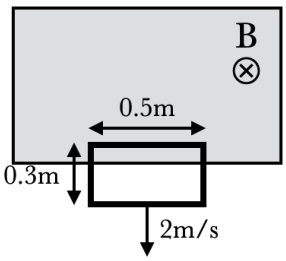
[1] (b) A The original flux is

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

[2] (c) B 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) **B** The external flux through this loop is

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

2 (b) **A** The current induced in this loop runs

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

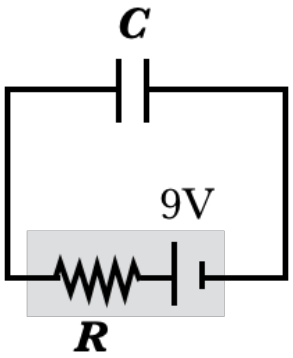
2 XC (c) **D** What is the induced emf $\mathcal{E}$ in this loop? *Show work for partial credit! You might want to let $x$ be the distance from the top of the loop to the bottom edge of the field.*

**A)** 0.105 V **B)** 0.210 V **C)** 0.420 V **D)** 0.700 V

2 11. **A** 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 magnet **B)** the non-magnet **C)** both the same

12. A $C = 500\,\mu\text{F}$ capacitor is connected to a battery with an emf of $\mathcal{E} = 9\,\text{V}$ and an internal resistance of $R = 0.2\,\Omega$, and the capacitor charges.




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

**A)** $1.0 \times 10^{-4}\,\text{s}$ **B)** $4.5 \times 10^{-3}\,\text{s}$ **C)** $45\,\text{s}$
**D)** $100\,\text{s}$ **E)** $1 \times 10^{4}\,\text{s}$

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

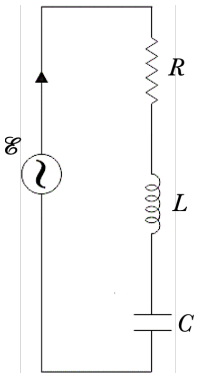
**A)** $0\,\text{C}$ **B)** $5.6 \times 10^{-5}\,\text{C}$ **C)** $1 \times 10^{-4}\,\text{C}$
**D)** $4.5 \times 10^{-3}\,\text{C}$ **E)** $45\,\text{C}$ **F)** $1.8 \times 10^{4}\,\text{C}$

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

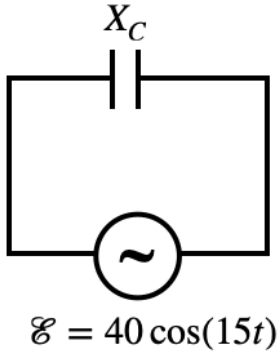
**A)** $0\,\text{A}$ **B)** $5.6 \times 10^{-5}\,\text{A}$ **C)** $1 \times 10^{-4}\,\text{A}$
**D)** $4.5 \times 10^{-3}\,\text{A}$ **E)** $45\,\text{A}$ **F)** $1.8 \times 10^{4}\,\text{A}$

4 13. **B** An RLC circuit has resistance $800\,\Omega$, capacitance $700\,\mu\text{F}$, 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)** $1.79\,\text{rad/s}$ **B)** $84.5\,\text{rad/s}$ **C)** $2390\,\text{rad/s}$ **D)** $7140\,\text{rad/s}$



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 $50\,\Omega$.



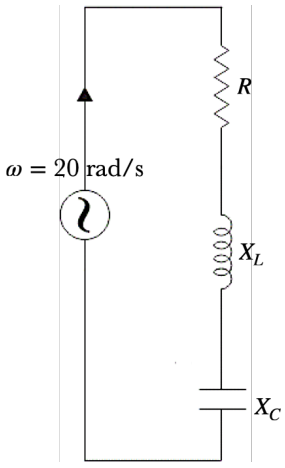

4 (a) **A** What is the capacitance of the capacitor?

**A)** $1.3 \times 10^{-3}\,\text{F}$ **B)** $0.3\,\text{F}$ **C)** $3.3\,\text{F}$ **D)** $64\,\text{F}$ **E)** $750\,\text{F}$

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

**A)** $0.0005\,\text{A}$ **B)** $0.8\,\text{A}$ **C)** $1.25\,\text{A}$ **D)** $28\,\text{A}$ **E)** $2000\,\text{A}$

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 $X_C = 40\,\Omega$, and an inductive reactance of $X_L = 100\,\Omega$.




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

**A)** $5 \times 10^{-4}\,\text{H}$ **B)** $1.25 \times 10^{-3}\,\text{H}$ **C)** $0.2\,\text{H}$ **D)** $5\,\text{H}$ **E)** $2000\,\text{H}$

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

**A)** $20\,\Omega$ **B)** $100\,\Omega$ **C)** $134\,\Omega$ **D)** $161\,\Omega$ **E)** $220\,\Omega$

4 16. **D** 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. **A** The symbol $Z$ represents

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

2 18. **A** In the formula $X_C = \frac{1}{\omega C}$, the $C$ stands for

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

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

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