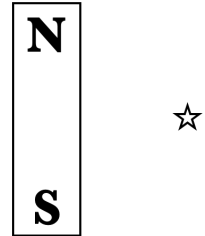


PHYS 2140 Exam 3b Solutions
Wednesday, November 19

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



- (a) A The magnetic dipole moment $\vec{\mu}$ of this bar magnet points
A) $\uparrow$ B) $\rightarrow$ C) $\downarrow$ D) $\leftarrow$

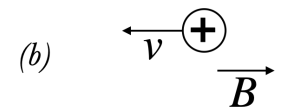
- (b) C In what direction does the magnetic field point at the star?
A) $\uparrow$ B) $\rightarrow$ C) $\downarrow$ D) $\leftarrow$

2. For each of the following, what is the direction of the force on the charge?

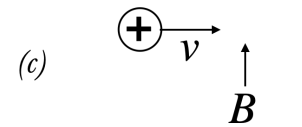
A) $\uparrow$ B) $\rightarrow$ C) $\downarrow$ D) $\leftarrow$
E) $\otimes$ (into page) F) $\odot$ (out of page) G) zero



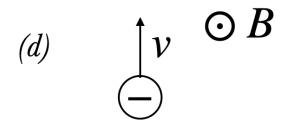
- (a) G negative, placed to the left of the N pole of a bar magnet.



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

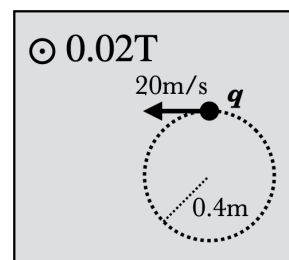


- (c) F positive, moves to the right in a $\vec{B}$ field that points upward.



- (d) D negative, moves upward in a $\vec{B}$ field that points outward.

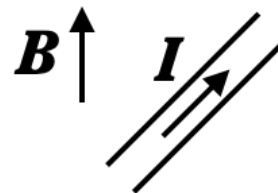
3. A charge q with mass 0.07 kg is moving in a circle due to a magnetic field 0.02 T that points out of the page. The radius of the circle is 0.4 m and the charge is moving at 20 m/s .



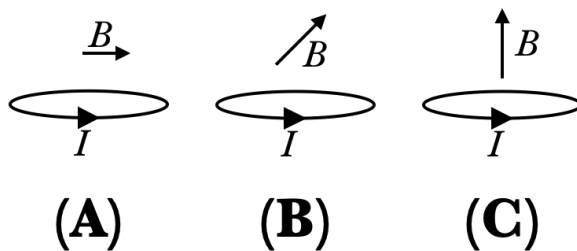
- (a) B The sign of the charge is
A) positive **B)** negative
- (b) C The magnitude of the charge is
A) 28 C **B)** 61 C **C)** 175 C **D)** 227 C

4. E 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?

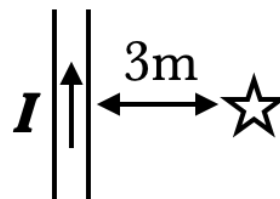
- A)** ↖ **B)** ↗ **C)** ↙ **D)** ↘
E) $\odot$ (out of page) **F)** $\otimes$ (into page)



5. A 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?



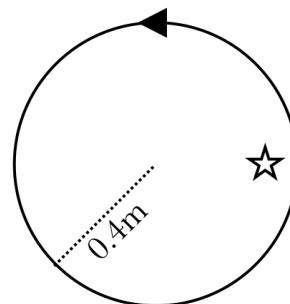
6. A very long wire carries a current $I = 0.35 \text{ A}$ upward, which creates a magnetic field at the star, 3 meters to the right of the wire.



- (a) **E** 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)

- (b) **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)** $4.7 \times 10^{-8} \text{ T}$

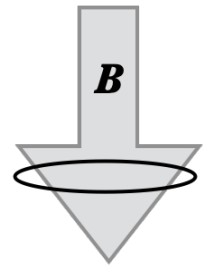
7. The figure shows a counterclockwise current $I = 0.5 \text{ A}$ flowing through a circular loop with radius $r = 0.4 \text{ m}$.



- (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)

- (b) **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)** $1.26 \text{ Am}^2 \odot$

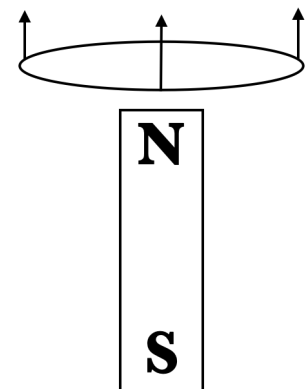
8. The figure shows a loop of wire in a downward-pointing magnetic field $\vec{B}$ which is increasing in magnitude. (The loop is not moving.)



(a) B The *original* or *external* flux through this loop points
A) up $\uparrow$ **B)** down $\downarrow$

(b) A The *induced* flux created by this loop points
A) up $\uparrow$ **B)** down $\downarrow$

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

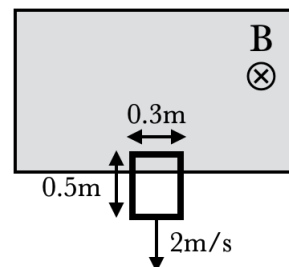


(a) A What is the direction of the original flux through this loop?
A) up $\uparrow$ **B)** down $\downarrow$

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

(c) A The induced flux through the loop points
A) up $\uparrow$ **B)** down $\downarrow$

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 m/s .



- (a) B The external flux through this loop is
A) increasing **B)** decreasing **C)** constant
- (b) A The current induced in this loop runs
A) clockwise $\odot$ **B)** counterclockwise $\ominus$
- (c) 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 V **B)** 0.210 V **C)** 0.420 V **D)** 0.700 V

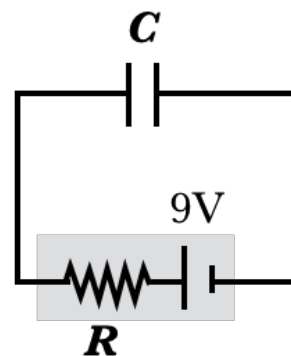
11. B Two pucks of the same mass and same frictional coefficients are pushed across a flat surface made of copper (which is a weak diamagnet). One puck is a strong magnet, and the other puck is not. Which puck will come to a stop first? (Explain.)
A) the non-magnet **B)** the magnet **C)** both the same

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) B 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 s
D) 130 s E) $1.7 \times 10^4\text{ s}$



4

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

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

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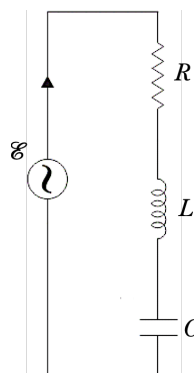
(c) A What is the eventual current through the battery?

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

4

13. C An RLC circuit has resistance $800\ \Omega$, capacitance $300\ \mu\text{F}$, and inductance 0.2 H . What angular frequency ω 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 rad/s B) 4.17 rad/s C) 129 rad/s D) $16,700\text{ rad/s}$

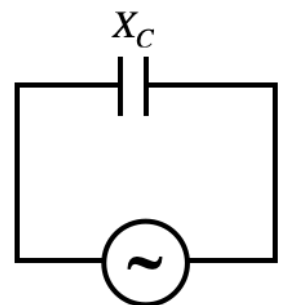


14. An AC current with peak voltage 40 V and angular frequency $\omega = 15\text{ rad/s}$ is connected to a capacitor. The capacitor has a reactance of $2.5\ \Omega$.

4

(a) B 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



$$\mathcal{E} = 40 \cos(15t)$$

4

(b) D What is the peak current I_0 that flows through this current?

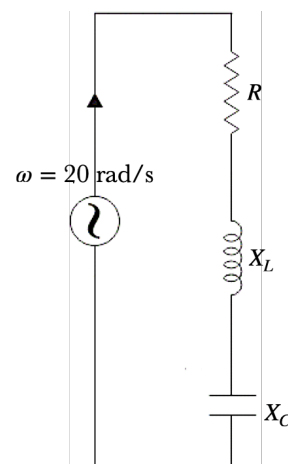
A) 0.01 A B) 0.0625 A C) 1 A D) 16 A E) 28 A

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) C 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) $20,000\text{ H}$



4

(b) A What is the impedance of this circuit?

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

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. **C** The symbol Z represents
A) resistance B) reactance C) impedance

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