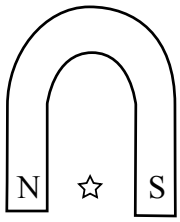
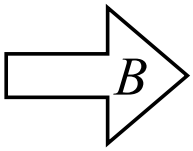
Some Sample Questions for Exam 3 version 2

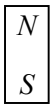
Not complete alas

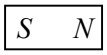
[3] **1.** **C** What direction does the magnetic field at the star point? (Hint: WWCD.)
A) ← **B)** ↑ **C)** → **D)** ↓ **E)** ⊙ (out) **F)** ⊗ (in)



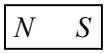
[3] **2.** **B** If a bar magnet is placed in a magnetic field which points to the right, and the bar magnet can turn freely, which direction will it face?



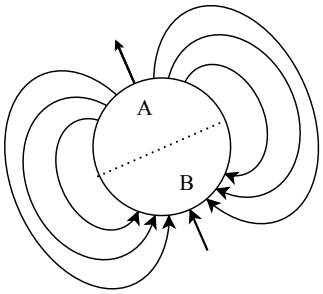
A) 

B) 

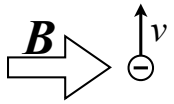
C) 

D) 

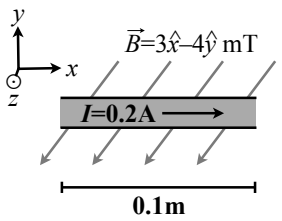
[2] **3.** **B** The figure shows the magnetic field of the Earth. Which point (A or B) could mark the location of Toledo? (Hint: we're in the northern hemisphere. :-))



[3] **4.** **E** What is the direction of the force on this negative charge that is moving upward?
A) ← **B)** → **C)** ↑ **D)** ↓ **E)** ⊙ (out of page) **F)** ⊗ (into page)



[3] **5.** A 0.1 m long wire carries $I = 0.2\,\text{A}$ in the $+\hat{x}$ direction in a magnetic field $\vec{B} = 3\times10^{-3}\hat{x} - 4\times10^{-3}\hat{y}$ T. Find the force on the wire. For partial credit, indicate the *direction* of the force.



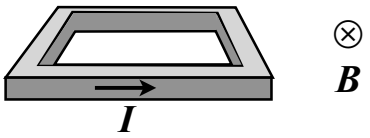
$$\vec{F} = I\vec{L}\times\vec{B}$$

$$= (0.2\,\text{A})(0.1\,\text{m}\hat{x})\times(3\hat{x}-4\hat{y})\times10^{-3}\,\text{T}$$

$$= 0.02\times10^{-3}\,[3\hat{x}\times\hat{x} - 4\hat{x}\times\hat{y}]$$

$$= 2\times10^{-5}\,[0 - 4\hat{z}] = \boxed{-8\times10^{-5}\hat{z}\,\text{N}}$$

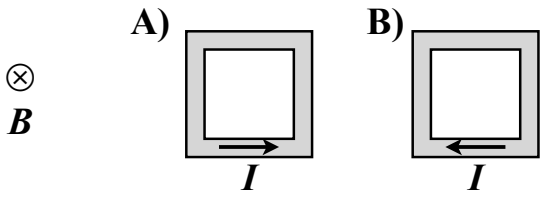
6. This square loop of wire is placed in a magnetic field which points into the page. Current flows through the wire as shown.



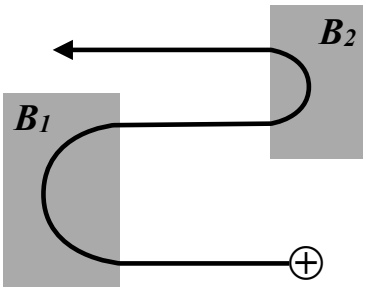
2 (a) **A** The magnetic dipole moment of the loop at the moment pictured is

A) ↑ **B)** ↓ **C)** ⊗ (in) **D)** ⊙ (out)

2 (b) **B** The loop will turn until it is oriented in which of the following directions?



7. A positive charge initially moves to the left. Two magnetic fields, B_1 and B_2, cause it to take a serpentine path as shown. The charge's speed remains constant.



2 (a) **B** What direction does B_1 point?

A) into the page ⊗ **B)** out of the page ⊙

2 (b) **A** What direction does B_2 point?

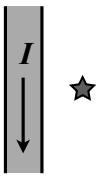
A) into the page ⊗ **B)** out of the page ⊙

3 (c) **B** Which field is stronger in magnitude?

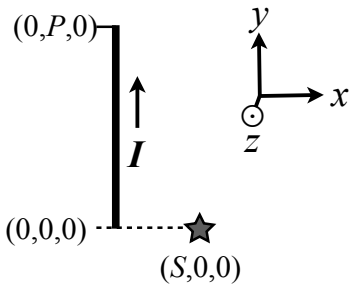
A) B_1 **B)** B_2 **C)** Both have the same strength

3 **8.** **F** A wire carries a current downward. The magnetic field it creates at the star points

A) ↑ **B)** ↓ **C)** ← **D)** → **E)** ⊗ (in) **F)** ⊙ (out)



9. Suppose a small segment of wire carries current from point $(0, 0, 0)$ to $(0, P, 0)$. Suppose I want to use Biot-Savart law to find the magnetic field at the star, at point $(S, 0, 0)$.



2 (a) D What direction does the magnetic field at the star point?

A) ↘ **B)** ↖ **C)** ⊙ (out) **D)** ⊗ (in)

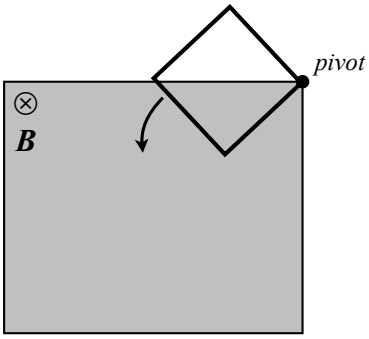
3 **10.** B A square loop of wire can pivot as shown. At this moment, the wire is swinging into a region of uniform magnetic field. Which is true?

A) A **clockwise** ↷ current is induced in the wire

B) A **counterclockwise** ↶ current is induced in the wire

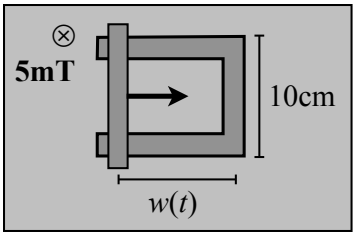
C) No current is induced in the wire

For partial credit, explain your reasoning. (For example, you could give your answer to the Four Questions.)



The external flux is ⊗ and increasing, so the induced flux is ⊙.

11. A metal bar slides along a U–shaped piece of metal, forming a closed loop that current can run through. The entire device is in a magnetic field $B = 5 \times 10^{-3}\,\mathrm{T}$ which points into the field. The height of the loop is 0.1 m and the width of the loop is decreasing with time:
$w(t) = 0.2\,\mathrm{m} - (0.005\,\mathrm{m/s})t$.



3 (a) **A** What direction does the induced current run in the circuit?
A) Clockwise ↷ **B)** Counterclockwise ↶

3 (b) Find the induced emf $|\mathcal{E}|$ in the wire.

The flux through the loop is $\Phi = \vec{B} \cdot \vec{A} = BA = Bhw$ and the induced emf is

$$\mathcal{E} = \frac{d\Phi}{dt} = \frac{dBhw}{dt} = Bh\frac{dw}{dt}$$

(B and h are constants with respect to time. The derivative of $\frac{dw}{dt} = -0.005\,\mathrm{m/s}$, and so

$$|\mathcal{E}| = (5 \times 10^{-3}\,\mathrm{T})(0.1\,\mathrm{m})(0.005\,\mathrm{m/s}) = \boxed{2.5 \times 10^{-6}\,\mathrm{V}}$$

12. An RLC circuit has a resistance of $100\,\Omega$, a capacitance of $C = 200\,\mu\text{F}$, and an inductance of $0.4\,\text{H}$. The power supply's emf is given by $\mathcal{E}(t) = 20\cos(350t)$.

3 (a) What is the reactance of the capacitor?

Since $\mathcal{E}(t) = \mathcal{E}_0\cos(\omega t + \phi_0)$, we have $\omega = 350\,\text{rad/s}$, and so

$$X_C = \frac{1}{\omega C} = \frac{1}{(350)(200\,\mu\text{F})} = 14.3\,\Omega$$

3 (b) What is the reactance of the inductor?

$$X_L = \omega L = (350)(0.4) = 140\,\Omega$$

3 (c) What is the impedance of the circuit?

$$Z = \sqrt{R^2 + (X_C - X_L)^2} = \sqrt{(100)^2 + (140 - 14.3)^2} = 161\,\Omega$$

3 (d) What is the resonant frequency of this circuit?

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(0.4)(200\times 10^{-6})}} = 112\,\text{rad/s}$$

3 (e) What is the peak current in the circuit?

$$I_0 = \frac{V_0}{Z} = \frac{20}{161} = 0.124\,\text{A}$$