Name: _____ DISC: _____ Score: _____ / 20

Instructions:

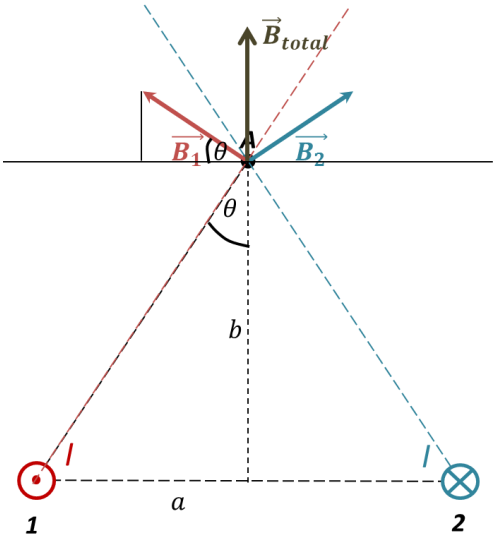
- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

Q1	Q2	Q3	Q4
10	5	5	5

B from a wire	$B = \frac{\mu_0 I}{2\,\pi r}$
FORCE	$F = IBL$
MAGNETIC FLUX	$\Phi = BA\cos\varphi$
	For Problem 1
a	$0.2\ m$
b	$0.4\ m$
I	$0.1\ A$
μ_0	$4\pi \times 10^{-7} T\ m/A$

Useful Information for All Problems

1. Consider the two parallel wires shown in the diagram below. Each wire carries the same current I



Direction 1 (2 pts):

a. At point ***A*** draw and label the direction of the magnetic field *from wire 1* on the diagram.

See Diagram

Direction 2(2 pts):

b. At point ***A*** draw and label the direction of the magnetic field *from wire 2* on the diagram.

See Diagram

c. At point ***A*** draw and label the direction of the *total magnetic field* on the diagram.

See Diagram

Direction 2(2 pts):

d. Calculate the *total magnetic field* at point ***A***. *Show all of your work.*

Remember: Magnetic field is a vector quantity, so we need to use our trigonometry to correctly calculate the final magnetic field: *(points as listed: Full credit for any other correct solution)*

Magnetic field (4 pts):

1 Point Step 1: Calculate

$$r = \sqrt{(0.2 \times 0.2)\,m^2 + (0.4 \times 0.4)\,m^2} = \sqrt{(0.04)\,m^2 + (0.16)\,m^2} = \sqrt{(0.2)\,m^2} = 0.4472\ m$$

0.5 Point Step 2: The magnitude of the magnetic field at point A from wire 1: $B_1 = \frac{\mu_0 I_1}{2\pi r} = \frac{(4\pi\times10^{-7}\times0.1)}{2\times\pi\times0.4472} = \frac{0.2\times10^{-7}}{0.4472} = 0.4472 \times 10^{-7} T = 4.47 \times 10^{-8}\ T$

0.5 Point Step 3: Repeat for the field at point A from wire 2: $B_2 = \frac{\mu_0 I_1}{2\pi r} = \frac{(4\pi\times10^{-7}\times0.1)}{2\times\pi\times0.4472} = \frac{0.2\times10^{-7}}{0.4472} = 0.4472 \times 10^{-7} T = 4.47 \times 10^{-8}\ T$

1 Point **Step 4: From the diagram we can see that we want the y-component of *each field:***

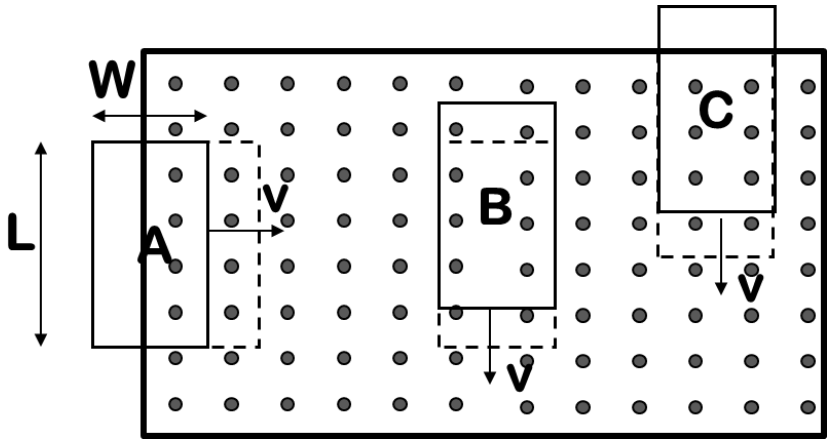
$B_{1y} = B_1 \sin\theta = \frac{B_1 a}{r} = B_1 \times \frac{0.2}{0.4472} = B_1 \times 0.4473 = (4.47 \times 10^{-8}\ T)(0.4473) = 2.00 \times 10^{-8}\ T$. **Notice:** $B_{y1} = B_{y2}$

1 Point **Step 5: Add the y-components:** $B_{total} = B_{y1} + B_{y2} = 2\,B_{y1} = 4 \times 10^{-8}\ T$

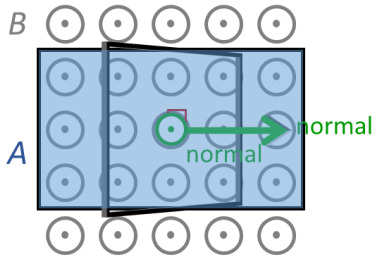
2. Each current loop moves through a magnetic field as shown. Which loop experiences the greatest induced EMF and why?

Choice & Explanation (5 pts):

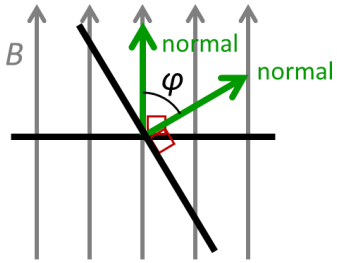
Because box A will acquire the most field lines as it moves into the field region, it will experience the greatest induced EMF.



3. A loop starts at $t = 0\ s$ with its normal parallel to a constant magnetic field and rotates with constant angular velocity as shown in the diagram:



Top view



Side view

	For Problem 2
Angular Velocity	$\boldsymbol{\omega = 5\ rad/s}$
Area	$\boldsymbol{A = 0.02\ m^2}$
Field	$\boldsymbol{B = 0.05\ T}$
Radians to Degrees	$\boldsymbol{180° = \pi}$

Initial Flux (1 pts):

a. What is the flux through the loop just before the loop starts to rotate?

$$\boldsymbol{\Phi = BA\cos\varphi = BA = 0.05 \times 0.02 = 0.001\ Wb}$$

Final Flux (1 pts):

b. What is the flux through the loop at $t = 0.5\ s$?

$$\boldsymbol{\Phi = BA\cos\varphi = 0.05 \times 0.02 \times cos(2.5) = 0.001 \times (-0.8011) = 0.0008\ Wb}$$

Angle (1 pts):

c. At what angle is the normal pointed at $t = 0.5\ s$?

$$\boldsymbol{\varphi = 2.5\ rad = 2.5 \times \frac{180°}{pi} = 143.24°}$$

Current direction: (2 pts):

d. As viewed from the top, in what direction does the current flow at $t = 0.5\ s$? Choose one of the options below and explain your answer.

i. **Clockwise** **The flux is increasing, adding field lines pointing up—to counter act this we need to add field lines going down—a clockwise current.**

ii. **Counter-clockwise**

iii. **No Current Flows**

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