

Midterm Exam 03 (2022 Spring)

PHYS 203B-001: College Physics

Date: 2022 Apr 8

(Name)

(Signature)

Instructions

1. Seating direction: Please be seated on seats with seat numbers divisible by 4.
2. Total time = 50 minutes.
3. There are 8 questions in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. **(5 points.)** Draw the magnetic field lines around a straight wire of infinite extent carrying a uniform current. Recall that field lines describe the magnitude and direction of the field everywhere in space.

2. (5 points.) What is the significance of the negative sign in the Faraday law of induction,

$$V_{\text{eff}} = -\frac{\Delta\Phi_B}{\Delta t}, \quad (1)$$

where Φ_B is the magnetic flux, t is time, and V_{eff} is the induced voltage.

3. (5 points.) Both, radio wave and x-ray, are electromagnetic waves. Which of the two has a longer wavelength?

4. (5 points.) What is the dimension of the ratio

$$\frac{E}{B}, \quad (2)$$

where E is electric field and B is magnetic field.

Hint: Express the units of the quantities in terms of kilogram, meter, second, and Coulomb.

5. (10 points.) A steady current $I = 1.0\text{ A}$ flows through each of the three wires of infinite extent lying in the plane of paper in Fig. 1. Observe that the current in the middle wire is flowing in (relative) opposite direction. Determine the magnitude and direction of the total magnetic field at point P . Given $a = 10.0\text{ cm}$.

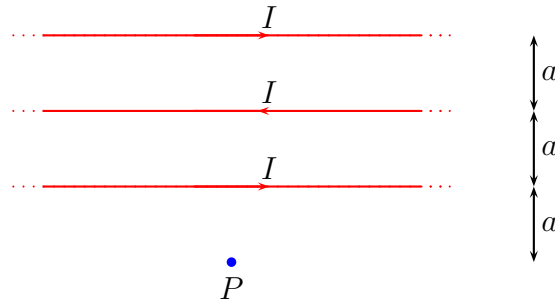


Figure 1: Problem 5

6. (10 points.) A rectangular loop of wire carrying current $I_2 = 5.0$ A is placed near an infinitely long wire carrying current $I_1 = 1.0$ A, such that two of the sides of the rectangle are parallel to the current I_1 . Let the distances be $a = 2.0$ cm, $b = 3.0$ cm, and $l = 5.0$ cm. See Figure 2. Determine the force on side '1' of the loop.

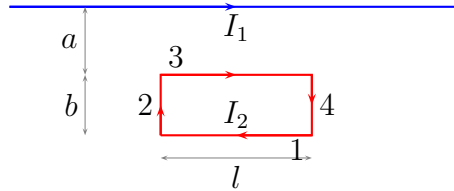


Figure 2: Problem 6

7. (10 points.) Figure 3 shows a conducting rod being pulled along horizontal, frictionless, conducting rails at a constant speed v . A uniform magnetic field \mathbf{B} fills the region in which the rod moves. Assume $L = 5.0\text{ cm}$, $v = 7.0\text{ m/s}$, $B = 1.0\text{ mT}$, and $R = 25\ \Omega$. Determine the magnitude and direction of the induced current in the loop.

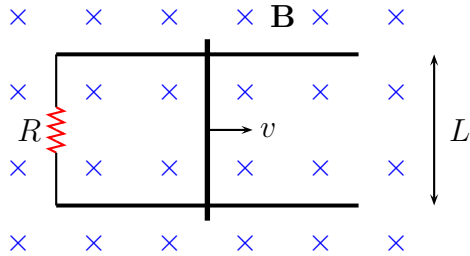


Figure 3: Problem 7

8. (**10 points.**) The wavelength of an electromagnetic wave is 540 nm. What is the timeperiod of the oscillations in magnetic field in this wave?