University of California at Berkeley

Department of Physics

Physics 8B, Spring 2009, Section 1

Second Midterm Exam

April 13, 2011

You will be given 120 minutes to work this exam. No books or calculators are allowed, but you may use two sides of handwritten notes on paper no larger than 8.5" by 11". Do not use a blue book or scratch paper other than that provided. Your description of the physics involved in a problem is worth significantly more than any numerical answer. Show all work and take particular care to explain what you are doing. Please use the symbols described in the problems, tell us why you are writing any new equations, and label any drawings that you make. Write the answers in the space following the question, *after you have decided on your answer*. If there are parts of your solution on other sheets, make a note in the answer space telling us where to look for the additional information, and label that information with the number of the problem. Write clearly; if we can't read it we can't give credit.

NAME:_____

SID NUMBER:_____

DISCUSSION SECTION
NUMBER:_____

DISCUSSION SECTION
DAY / TIME:_____

1 (25 pts.)	
2 (30 pts.)	
3 (25 pts.)	
4 (30 pts.)	
5 (30 pts.)	
6 (20 pts.)	
7 (20 pts.)	
8 (20 pts.)	
Total (200 pts.)	

Constants : $c = 3 \times 10^8$ m/sec,
1 nanometer $= 10^{-9}$ m, 1 micrometer $= 10^{-6}$ m, 1 millimeter $= 10^{-3}$ m

1) Maxwell's Equations are supposed to be able to explain all electromagnetic field phenomena.

(A) Which of Maxwell's Equations is/are most applicable to explain the behavior of a **capacitor**? Write the applicable Equation(s) and describe the connection.

(B) Which of Maxwell's Equations is/are most applicable to explain the behavior of an **inductor**? Write the applicable Equation(s) and describe the connection.

(C) Which of Maxwell's Equations is/are most applicable to explain the behavior of **electromagnetic waves**? Write the applicable Equation(s) and describe the connection.

(D) Which of Maxwell's Equations is/are most applicable to explain the behavior of the **transformer**? Write the applicable Equation(s) and describe the connection.

(E) If magnetic monopoles were observed, which of Maxwell's Equations would be most changed? Explain.

2) The Figure shows a loop that is being turned in the fixed magnetic field of an electric generator. The magnetic field strength is 0.1 T, with the N pole to the left. The loop is 1m. long and 0.5m on the shorter side. A turbine rotates the loop counter-clock-wise (ccw) at a rate of 60 revolutions per second.

(A) What is the <u>name</u> of the Law of electromagnetism that expresses the observation that a turbine (or other means) is required to force the loop to rotate?

Rotating slip rings

Stationary brushes

Rotating conducting loop

N

S

Electric load

B) What is the direction of the force that the magnetic field exerts on the loop? Do this in 2 steps:

1) What is the direction of the induced current in the loop at the moment shown? Show this by drawing an arrow in the upper side of the loop, label it *i*, in the direction of the current, and explain.
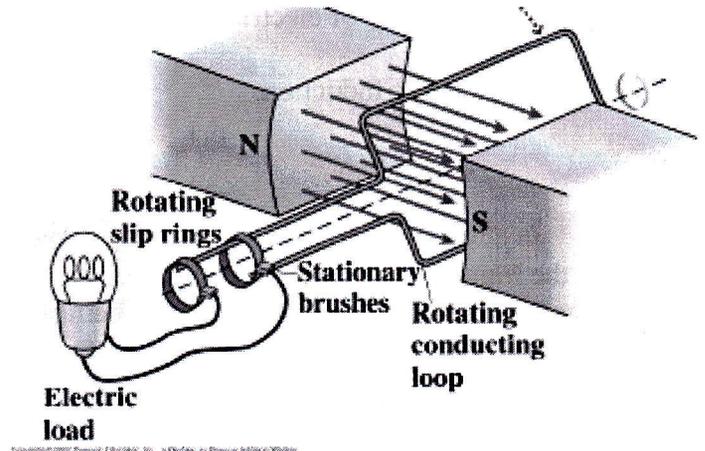
2) In what sense of rotation (ccw, clock-wise (cw), parallel) does the force of the magnetic field act on the upper side of the loop? (Explain) Draw an arrow, label it F, at the upper side of the loop to show the direction of the force.
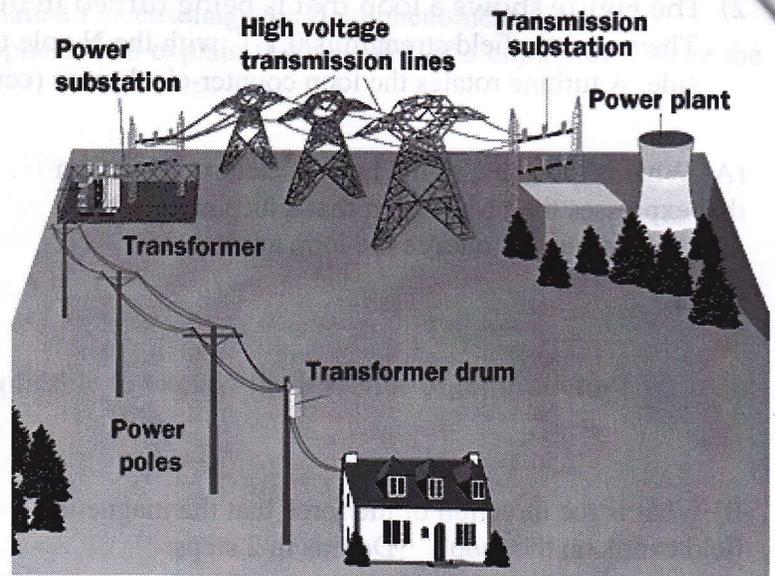
C) In what sense of rotation (ccw, cw, anti-parallel) does the force of the turbine act on the loop?

D) Calculate the maximum emf produced by this generator. Explain.

3) Faraday's Law of Induction is used
in the creation and delivery of electrical energy.

(A) State the Law of Induction.

(B) In the Figure at the right, identify four
places where the Law of Induction is being
applied. Describe the electrical purpose and
what is happening there.

Power substation

High voltage transmission lines

Transmission substation

Power plant

Transformer

Transformer drum

Power poles

Electric load

(1)

(2)

(3)

(4)

4) (A) Describe qualitatively how electric charges generate electromagnetic waves.

(B) Apply the mechanism in A) and the Kinetic Theory of Heat, to explain *qualitatively* the emission of electromagnetic radiation by material bodies at temperatures above absolute zero. In other words, how does heat create light?

(C) Describe <u>one</u> of the following phenomena. Give a qualitative physical explanation of it, based on part (A): Huygens's principle,   Brewster's angle of polarization,   the index of refraction.

5) An object is located 27.0 cm from a certain lens. The lens forms a real image that is twice as high as the object.

(A) What is the **focal length** of this lens?

(B) The lens used in Part A is taken away and is replaced with another lens. Everything else remains the same. The new lens is a diverging lens whose focal points are at the same distance from the lens as the focal points of the first lens. The object is still located 27.0 cm from the lens. If the object is 5.00 cm high, what is the **height of the image** formed by the new lens?

6) The starships of the Solar Federation are marked with the symbol of the Federation, a circle, whereas starships of the Denebian Empire are marked with the Empire's symbol, an ellipse whose major axis is k times its minor axis ($a = kb$ in the figure).
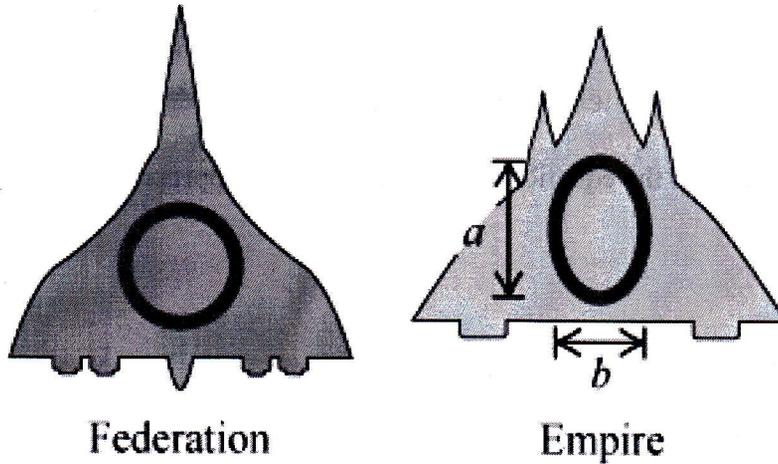
Federation   Empire

How fast, relative to observers lined up in the direction of a, does an Empire ship have to travel for its markings to be confused with those of a Federation ship? Use c for the speed of light in a vacuum.
Express your answer in terms of k and c.

7) A standard 14-inch (0.36-meter, on the diagonal) computer monitor is 1024 pixels wide and 768 pixels tall. Each pixel is a square approximately 281 micrometers on each side, and they are side-by-side. Up close, you can see the individual pixels, but from a distance they appear to blend together and form the image on the screen.

(A) If the maximum distance between the screen and your eyes at which you can just barely resolve two adjacent pixels is 1.3 meters, what is the effective diameter d of your pupil? Assume that the resolvability is diffraction-limited. Furthermore, use $\lambda = 550$ nanometers as a characteristic optical wavelength.
(1 nanometer $= 10^{-9}$ m, 1 micrometer $= 10^{-6}$ m, 1 millimeter $= 10^{-3}$ m)

Express your answer by setting up the equation and substituting the appropriate values. You need not complete the arithmetic.

(B) Assuming that the screen is sufficiently bright, at what distance can you no longer resolve two pixels on diagonally opposite corners of the screen, so that the entire screen looks like a single spot? Note that the size (0.360 meters) quoted for a monitor is the length of the diagonal.
Express your answer by setting up the equation and substituting the appropriate values. You need not complete the arithmetic.

8) List two similarities and two differences between capacitors and inductors in their electromagnetic properties.

Similar:

Similar:

Different:

Different: