Practice problems for the 3rd midterm (Fall 2010)

1. A video camera is set in an unknown liquid. When you change the angle to look up the liquid-air boundary, at certain point, it looks like mirror on the boundary. If the angle of the camera is 46.0^{o} from the vertical, what is the index of refraction of the liquid? [Conceptual note: What is the name of this phenomenon? Is there any application of this?]

2. A frequency tuned for a certain signal is found out to be 3400 Hz with an inductor and a capacitor circuit. If the inductor is adjusted as 2.40×10^{-4} H to have the frequency, what is the capacitance? [Conceptual note: What is this frequency called? What is the condition to obtain it?]

3. You create an *emf* (3.8 V) with a straight metal rod whose length is 1.5 m. If the magnetic field applied is 1.7 T, what is the speed of the rod passing through the field? [Conceptual note: Can you draw the picture? What if a rectangular coil is rotating?]

4. There is a coil to make an *emf* for the circuit connected to an AC source. The induced *emf* is found as 22×10^{-3} V. If the self inductance is 3.2×10^{-3} H, what is the change of current in 1.2 seconds? [Conceptual note: What is the self-inductance? Can you draw a picture of this problem setting?]

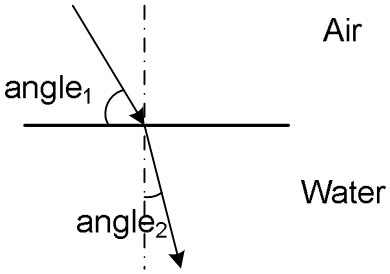
5. There is one coil circuit. If the total current and the inductance are 2.2 A and 0.0076 H, respectively, what is the energy stored in the coil? [Conceptual note: If you increase current twice as you have originally, how will the energy be changed?]

6. What is the frequency of the electromagnetic wave in a microwave oven, knowing that the wavelength is 12.5 cm? [Conceptual note: What if the EM wave goes into water? Which physical quantity will be changed?]

7. You find the "magnitude" of the focal length of a concave lens as 1.2 m. If you measure the "magnitude" of the object distance as 1.3 m, what is the magnification? [Conceptual note: What if it is a convex lens?]

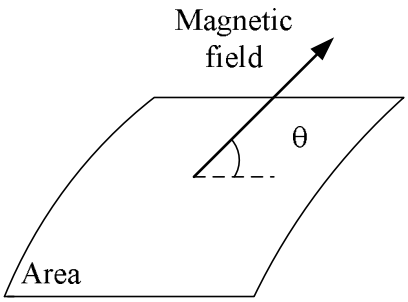
8. A square coil is rotating in a magnetic field to obtain a maximum voltage, 46 V. If the magnetic field, the angular speed, and the number of turns of coil are 2.6 T, 30 rad/s, and 19 turns, respectively, what is the length of the side of the coil? [Conceptual note: How do you associate this with AC voltages?]

9. A light goes into water as shown. The angle$_1$ is 70.0^o. What is the angle$_2$, knowing the index of refraction of water as 1.33? [Conceptual note: What is the name of the law? Which angles do you have to use?]



10. There is a series RLC circuit connected to an AC power supply whose frequency is 60 Hz. You find the impedance as 3900 Ω. The resistance and capacitive reactance are 3800 Ω and 880 Ω, respectively. What is the inductance? [Conceptual note: What is the meaning of the reactance and impedance?]

11. A magnetic field going through an area, 0.67 m^2, is found out to be 1.7 T. If the angle θ shown in the figure is 35^o, what is the magnetic flux? [Conceptual note: What is the difference from the magnetic field? Find every formula which includes the magnetic flux.]



12. There is an electric device. The number of turns of the coil connected to a power supply is 4300 turns. The other coil has 230 turns. If you use an outlet from the wall (US standard), what voltage will the device obtain after converted? [Conceptual note: Can you draw the picture?]

13. An electromagnetic wave has wavelength, 6.98×10^{-6} m. What is the energy equivalent with its photon? [Conceptual note: What is the relationship between energy and frequency; and between energy and wavelength?]

14. A peak intensity of an EM wave is 3.40×10^{7} W/m^2. If the peak magnetic field is 2.87×10^{-6} T, what is the peak electric field? [Conceptual note: Is a magnetic field can be the electric field? Explain?]

15. There is a convex mirror. If the radius of curvature is 2.8 m, what is the focal length? [Conceptual note: What if it is a concave mirror?]

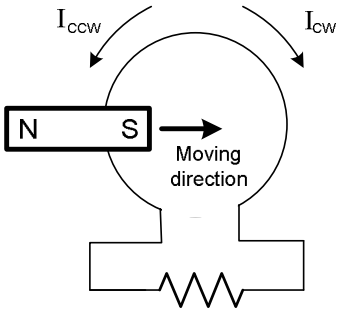
16. A light ray (some EM wave) comes into a material. If the permittivity in the material is 4.98 $\times 10^{-12}$ C^2/Nm^2, calculate the permeability, knowing the index of refraction as 1.52. [Conceptual note: Why is this permittivity different from ε_0?]

17. If a peak electric field is 3.80×10^{4} N/C, what is the root mean square of the magnetic field? [Conceptual note: How do you generalize peak and rms values, considering other cases like AC voltage sources?]

18. There is a solenoid. The total number of turns is 360 turns, and the length is 1.3 m. The inductance is known as 2.8×10^{-2} H. Find the cross-sectional area of the solenoid. [Conceptual note: Draw the picture.]

19. There is a rectangular coil to generate voltage, 4.0 V, in a magnetic field, 3.4 T. If the length of the coil, which is perpendicular to the magnetic field, is 0.71 m, what is the tangential speed? [Conceptual note: Write two formulas related to this system. Which one can you use for this condition?]

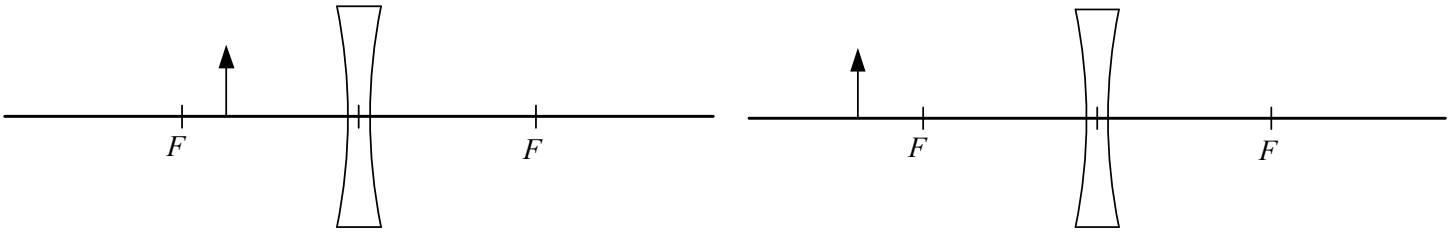
20. The magnitude of an *emf* created by a moving magnet in a coil is 3.50 V. The change of the magnetic flux is 0.200 Wb in 0.343 s. What is the number of turns of the coil? Find also the direction of the current. [Conceptual note: Can you find the directions for any cases of magnet orientations and its moving directions? What if you have to calculate the magnitude of the current flow?]



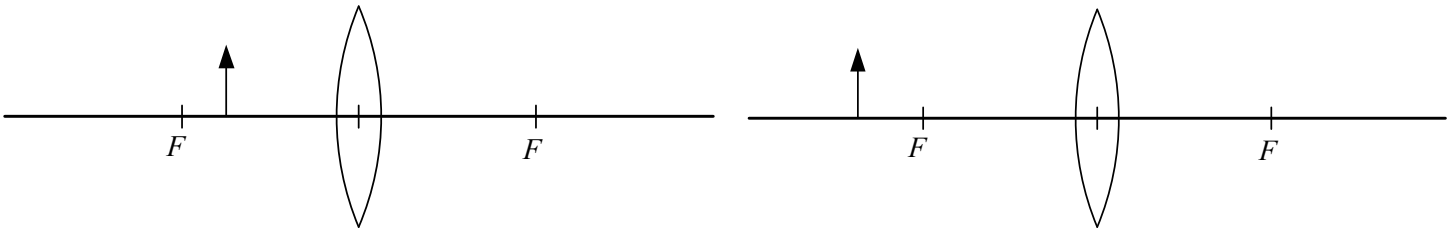
21. The magnification is found as 2.8 with a thin lens. If the image distance is -0.45 m (negative distance → virtual), what is the object distance? [Conceptual note: What is the meaning of the magnification? What kind of lens is this?]

22. A swimmer is treading water (with her head above the water) at the surface of a 3.00-m-deep pool. She sees a coin on the bottom directly below. How deep does the coin appear to be? (Index of refraction of water = 1.33) [Conceptual note: Does the coin appear to be shallower or deeper?]

23. Find the images of a concave lens by drawing the diagram. The *F* denotes the focal point. After drawing, state the properties of image, such as {upright or inverted}, {real or virtual}, and {magnified or reduced}. [Conceptual note: Do you remember the sign conventions? Which sign conventions are important to remember?]



24. Find the images of a convex lens by drawing the diagram. The *F* denotes the focal point. After drawing, state the properties of image, such as {upright or inverted}, {real or virtual}, and {magnified or reduced}. [Conceptual note: Do you remember the sign conventions? Which sign conventions are important to remember?]



Answers

1. 1.39
2. 9.13×10^{-6} F
3. 1.5 m/s
4. 8.25 A
5. 0.018 J
6. 2.40×10^{9} Hz
7. 0.48
8. 0.176 m
9. 14.9^{o}
10. 4.7 H
11. 0.65 Wb
12. 6.4 V
13. 2.85×10^{-20} J
14. 2.98×10^{7} N/C
15. -1.4 m
16. 5.15×10^{-6} N/A^2
17. 8.96×10^{-5} T
18. 0.22 m^2
19. 0.83 m/s
20. 6 turns; I_{CW} (direction of current)
21. 0.16 m
22. 2.26 m
23. Left figure: [upright, virtual, reduced], Right figure: [upright, virtual, reduced]
24. Left figure: [upright, virtual, magnified], Right figure: [inverted, real, reduced]

For 23 and 24, make sure if your diagrams are correct with your instructor.

Check out the following before the exam:

- **Can you solve all the questions from the beginning without any help and hints?**
- **Do you understand the concept behind each question? Can you relate them to the lecture topics? Can you imagine the physical situations?**