Assignment VIII, PHYS 112 (General Physics II)
Fall 2020
Due via pdf upload to OAKS prior to Friday, October 23rd at 10:00 AM

General instructions:
For this, and all other homework assignments, please turn in your solutions with all supporting work; answers without supporting work will not earn credit. You do not need to upload the sheet with the questions on it, but please clearly number your problems and circle or box your final answers. I encourage you to collaborate with classmates to discuss how to approach a particular question, but the mathematical steps to generate your final answer on your submitted work should be your own. If I see the same simple mistake on multiple homework assignments, I will take off more points for that error than I normally would. Please include *words* in your answers. When you get answer keys back from me, you'll see that there are explanations, ideas, commentary, and thought processes included – not just a set of equations one after another. Finally, please ensure that all numerical answers have units.

Since several people in class asked for this, here are some suggested (but ungraded) extra problems from the textbook for practice: (All problems out of Halliday, Resnick, and Walker, 10th Extended Edition, "Fundamentals of Physics"). (I chose all odd-numbered problems since the answers to those problems are in the back of the book and that's a good way to check if your practice is accurate.) No need to turn these in, but if you are looking for extra things you can work on if you want to practice problem solving some more, here's what I would advise.

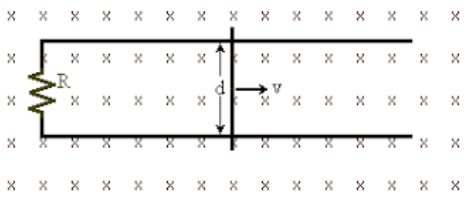
Chapter 30, problems 19, 21, 23, 29, 31, 33
Chapter 33, questions 3, 5, 7
Chapter 33, problems 3, 7, 9, 13, 15, 19, 21, 29, 33, 37, 47, 55

1. Below is a figure that shows the same basic structure of the motional emf problems that we did in class. Let a circuit have total resistance R and let there be magnetic field $\vec{B}$ aligned perpendicular to the plane of the circuit as shown. Let the distance between the top and bottom wires be d as shown and let the sliding contact move to the right due to an applied force with constant speed v. Let the bar be at a position a distance $2d$ to the right of the resistor at the time we will call $t = 0$.

   a) If $\vec{B}$ is a constant 175 Gauss into the paper, $R = 100\ \Omega$, $d = 0.3$ m, and $v = 3.5$ m/s what is the resulting current in the wire? Make sure to indicate if the current runs clockwise or counter-clockwise AND specify the current's magnitude.

   b) Let us say that instead of a constant $\vec{B}$ as indicated in part (a) above, the strength of the magnetic field is governed by the following function: $|B(t)| = (0.2T)\left(\frac{t^2}{100\ \mathrm{s}^2}\right)$ (with the same other parameters of $R = 100\Omega$, $d = 0.3$ m, the position of the vertical bar at time $t = 0$ being $2d = 0.6$ m to the right of the resistor, and the bar being moved at a steady speed of $v = 3.5$ m/s to the right). In this case, indicate what is the current I as a function of time t. For the sake of *this part* of this problem, we will state that a positive current indicates a clock-wise current and a negative current indicates a counter-clockwise current.

   c) Use your answer to part (b) to determine how much charge moves through the resistor between $t = 0$ and $t = 20$ s.



2. What is the frequency of green light (in air), assuming that green light has a wavelength of 550 nm?

3. As you drive by an AM radio station, you notice a sign saying that its antenna is 112 m high. If this height represents one quarter-wavelength of its signal, what is the frequency of the station?

4. In Charleston, Public Radio broadcasts at a frequency of 89.3 MHz. What is the wavelength of this broadcast?

5. Light travels a distance of 0.960 m in 4.00 ns in a given substance. What is the index of refraction of this substance?

6. Light is refracted as it travels from a point A in medium 1 to a point B in medium 2. If the index of refraction is 1.33 in medium 1 and 1.51 in medium 2, how long does it take light to go from A to B, assuming it travels 331 cm in medium 1 and 151 cm in medium 2?

7. Unpolarized light passes through two polarizers whose transmission axes are at an angle of 30.0° with respect to each other. What fraction of the incident intensity is transmitted through the polarizers?

8. Four polarizers are set up so that the transmission axis of each successive polarizer is rotated clockwise by an angle θ relative to the previous polarizer. Find the angle θ for which unpolarized light is transmitted through these four polarizers with its intensity reduced by a factor of 25 from the intensity of the initial unpolarized light.

9. The frequency of light doesn't change when light moves into media with different indicies of refraction. Given that information, what would the wavelength of 675 nm red light be inside a diamond? (You might have to look something up about diamonds to answer this).

10. A lightbulb with a power rating of P (aka $P = 60$ W or something similar) emits some fraction α of its power as electromagnetic radiation. (The remaining $P(1-\alpha)$ is lost to heat). What is the resulting radiation pressure on a surface of area A a distance d away from the bulb, assuming that the area is flat and oriented with $\mathrm{d}A$ of the surface aligned with the vector pointing straight out from the bulb – and assuming that the light surface is perfectly reflecting (e.g. none of the light is absorbed). Leave your answer in terms of variables in the problem statement and/or fundamental physical constants only.