AP Physics 2: Spring Semester Wizard Challenges by Unit

These problems are more advanced than those in the regular homework: successfully completing them will earn you one point per problem, applied to the Assessments category of your grade. Limit of ten points: partial credit is given for legitimate attempts.

Please print this PDF and complete these on another sheet of paper.

Unit 3.C: Basic Circuits

- 1. (Section 3.C.2) A wire made of brass and a wire made of silver have the same length, but the diameter of the brass wire is 4 times that of the silver wire. The resistivity of brass is 5 times greater than the resistivity of silver. If R_B denotes the resistance of the brass wire and R_S denotes the resistance of the silver wire, what is the ratio of resistance between brass and silver (in the form $R_B : R_S$).
- 2. A series RC Circuit consisting of a 5.0 M Ω resistor and a 0.40 μ F capacitor is connected to a 12.0 V battery. The capacitor is initially uncharged.
 - A. What is the change in voltage across it between $t = 2\tau$ and $t = 4\tau$?
 - B. By how much does the capacitor's stored energy change in the same time interval?

Unit 4: Magnetism

- 1. (Section 4.4) In a physics lab, a student discovers that the magnitude of the magnetic field at a certain distance from a long wire is 4.0 μ T. If the wire carries a current of 5.0 A, what is the distance of the magnetic field from the wire?
- 2. (Section 4.4) Two long, straight wires are hanging parallel to each other and are 1 cm apart. The current in Wire 1 is 5 A, and the current in Wire 2 is 10 A, in the same direction. What is the magnetic force between the wires? Is it attractive or repulsive?
- 3. (Section 4.5) A loop (r = 20.0 cm) is in a uniform magnetic field of 0.15 T. What angle(s) between the normal to the plane of the loop and the field would result in a flux with a magnitude of 0.014 T \cdot m²?
- 4. (Section 4.5) In the figure, a small, circular loop of wire (radius *r*) is placed on an insulating stand inside a hollow solenoid of radius *R*. The solenoid has *n* turns per unit length and carries a counter-clockwise current *I*. If the current in the solenoid is decreased at a steady rate of *a* amps/s, determine the induced emf, ε (symbolically – no numbers needed), and the direction of the induced current in the loop (clockwise or counterclockwise).



5. Due to the magnetic force, a positively charged particle executes uniform circular motion within a uniform magnetic field, B. If the charge is q and the radius of its path is r, which of the following expressions gives the magnitude of the particle's linear momentum?

A. qBr B. qB/r C. q/(Br) D. B/(qr) E. r/(qB)

Unit 5.B: Geometric Optics

- 1. If you hold a 900. cm² square plane mirror 45 cm from your eyes and can just see the full length of an 8.5 m flagpole behind you, how far are you from the pole?
- 2. A child looks at a reflective Christmas tree ball ornament that has a diameter of 9.0 cm and sees an image of her face that is 1/8 the real size. How far is the child's face from to ball?

Unit 5.C: Physical Optics

- 1. To study wave interference, a student uses two speakers driven by the same sound wave of wavelength 0.50 m. If the distances from a point to the speakers differ by 0.75 m, will the waves interfere constructively or destructively at that point? What if the distances differ by 1.0 m?
- 2. A slit of width 0.15 mm is illuminated with monochromatic light of wavelength 632.8 nm. At what angle will the first maximum occur?
- 3. A teacher standing in a doorway 1.0 m wide blows a whistle with a frequency of 1000 Hz to summon children from the playground. Two boys are playing on swings 20.0 m away from the school building. One boy is at an angle of 0.0° and another one is at 19.6° from a line normal to the doorway. Taking the speed of sound in air to be 335 m/s, which boy may not hear the whistle? Prove your answer.
- 4. A film on a lens with an index of refraction of 1.5 is 1.0 E -7 m thick and is illuminated with white light. The index of refraction of the film is 1.4.
 - A. The number of waves that experience the 180° phase shift is (1) zero, (2) one, (3) two. Explain.



- B. For what wavelength of visible light will the lens be nonreflecting?
- 5. Some types of glass have a range of indices of refraction of about 1.4 to 1.7. What is the range of the polarizing (Brewster) angle for these glasses when light is incident on them from air?

Unit 6: Modern Physics

- 1. The work function of a material is 3.5 eV. If the material is illuminated with monochromatic light ($\lambda = 300 \text{ nm}$), what are the stopping potential and the cutoff frequency?
- 2. (Section 6.7) An electron is accelerated from rest through a potential difference of 2.50 MV. Find the electron's a) speed, b) kinetic energy, and c) momentum.
- 3. (Section 6.7) If a reactor produces an average power of 1000 MW for a year, how much 235U is used up assuming 200 MeV are released per fission?