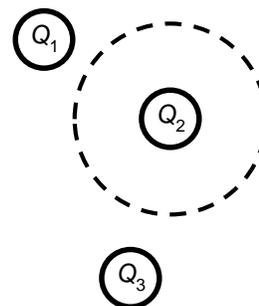


Mock exam IV

Print off your own copy of the mock exam and do your best to complete it before the mock exam session. We will not take any time during the mock exam session to complete the mock exam.

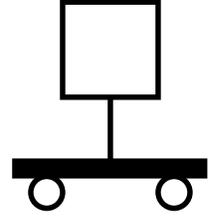
This mock exam will be most beneficial to you if you complete it under testing conditions. It should take you about 1 hour and 30 minutes to complete. Use the equation sheet provided by Dr. Wenger on Blackboard and the same calculator that you plan to use during the actual exam. If you get stuck, try to use the strategy in the document called “How to solve a physics problem” to help you. Do not use your book or notes from class until you have attempted the problems in the mock exam on your own at least once.

1. Three charges are arranged as shown in the figure to the right. Charges 1 and 2 have a positive charge, and charge 3 has a negative charge. What is the magnetic flux through the dashed surface around charge 2?



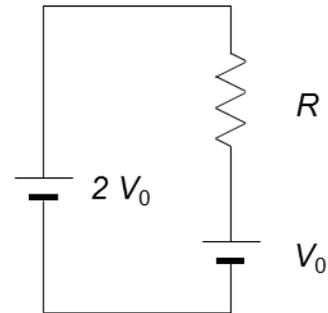
- A.  $\frac{Q_1 + Q_2 + Q_3}{\epsilon_0}$
- B.  $\frac{Q_1 + Q_2 - Q_3}{\epsilon_0}$
- C.  $\frac{Q_2}{\epsilon_0}$
- D.  $\frac{Q_1 + Q_3}{\epsilon_0}$
- E.  $\frac{Q_1 - Q_3}{\epsilon_0}$
2. A uniform electric field exists between two charged metal plates. An electron is released from rest between the plates and accelerates toward one plate, achieving a final speed  $v_0$ . Then, the space in between the plates is filled with chlorine gas, which has a dielectric constant  $\kappa$  of 16, and the battery attached to the plates is disconnected. A second electron is released from rest in the same location as the first. What is the final speed of the second electron compared to  $v_0$ ? Assume that the gas does not interact with the electron during its movement.
- A. The final speed is larger than  $v_0$  by a factor of 16
- B. The final speed is larger than  $v_0$  by a factor of 4
- C. The final speed is equal to  $v_0$
- D. The final speed is smaller than  $v_0$  by a factor of 4
- E. The final speed is smaller than  $v_0$  by a factor of 16

3. A square loop of conducting wire is mounted on top of a cart as shown to the right. The cart is given a push so that it travels to the right with a constant speed over a frictionless surface. Then, the cart enters a region containing a uniform magnetic field pointing into the page. What happens to the cart during the time period between starting to enter the magnetic field and fully entering the magnetic field?



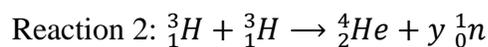
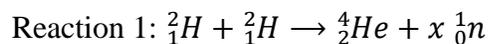
- A. Current is induced in the clockwise direction, and the cart's speed increases
- B. Current is induced in the counterclockwise direction, and the cart's speed increases
- C. Current is induced in the clockwise direction, and the cart's speed decreases
- D. Current is induced in the counterclockwise direction, and the cart's speed decreases
- E. Current is induced in the clockwise direction, and the cart's speed does not change
- F. Current is induced in the counterclockwise direction, and the cart's speed does not change

4. At what rate is heat generated by the resistor in the circuit depicted to the right?



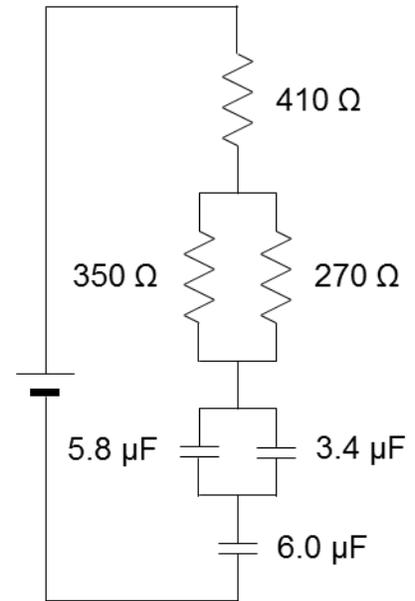
- A.  $\frac{3V_0}{R}$
- B.  $\frac{V_0}{R}$
- C.  $\frac{9V_0^2}{R}$
- D.  $\frac{3V_0^2}{R}$
- E.  $\frac{V_0^2}{R}$

5. You are designing an interface that needs to refract light at a boundary with water (refractive index 1.333) at incident angles up to  $75^\circ$ . What is the largest refractive index that can be used for the material at the interface?
- A. 0.725
  - B. 1.288
  - C. 1.380
  - D. Any material can achieve this effect
  - E. No material can achieve this effect
6. A photon undergoes a collision with an electron and transfer some of its momentum to the electron. How does this collision change the photon?
- A. The photon has less energy
  - B. The photon undergoes a wavelength shift toward blue light
  - C. The photon undergoes a wavelength shift toward red light
  - D. Both A and B
  - E. Both A and C
7. Which of the following fusion reactions will produce the most energy? The mass of deuterium ( ${}^2_1H$ ) is 2.0141 u, the mass of tritium ( ${}^3_1H$ ) is 3.0161 u, and the mass of the helium atom is 4.0026 u.  $x$  and  $y$  are integers.



- A. Reaction 1 produces the most energy
- B. Reaction 2 produces the most energy
- C. Both reactions produce the same amount of energy

8. Calculate the time constant of the RC circuit depicted to the right.



9. Prove that the following two expressions for the energy density of an electromagnetic wave are equivalent.

$$u = \epsilon_0 E^2$$

$$u = \frac{1}{\mu_0} B^2$$

10. Polonium-210 (atomic number 84) undergoes radioactive decay to form stable lead-206 (atomic number 82) in the presence of a magnetic field with strength 2.6 T. If the speed of the particle emitted from the radioactive decay is  $3 \times 10^5 \text{ m} \cdot \text{s}^{-1}$ , what is the radius of curvature of the path taken by the particle?

