Flavour 5

Physics 207 – Exam II

Fall 2024 (all UP sections) September 23, 2024

Do **not** open the exam until told to do so.

Before you begin, make sure you filled out the bubbles on the grading sheet indicating this exam flavour (this is **flavour 5**) *and* your UIN! Without this information, your exam will not be able to be processed and may result in a zero.

Mark what answers you put on the bubble sheet on this copy of the exam and keep it for your records so that you can refer back to this later in the semester and know what you did; it will be your only record of Exam II.

There are several flavours of this exam. Do not read anything into the sequence of the questions nor the answers; they are randomized. The "*Qid*" label is the ordering of questions the answer key (and your professor, should you want to ask about a particular problem) will have.

⇒ When filling out the grading sheet, **use the problem number of your flavour**, *not* the "*Qid*" ⇐

Rules of the exam:

1) You have **120** minutes to complete the exam.

2) You will answer using the **Grading Sheet** provided. **Make sure you have one before the exam starts**. Be sure to fill out the bubbles of the Grading sheet **completely** with a dark (e.g. #2) pencil or dark (black, blue) pen so as not to lose marks. If necessary (e.g. you cannot adequately erase a mistake), the proctor has extra Grading Sheets.

3) Formulae are similarly provided to you for the exam. **Make sure you have one before the exam starts**. You may *not* use your own or any other formula sheet.

4) Cell phone use during the exam is **strictly prohibited**. Please turn off all ringers as calls during an exam can be quite distracting. If we see you using a cell phone we will assume you are cheating.

5) Check to see that there are **13 numbered pages** (7 double-sided sheets) in your exam.

6) You are **not** required to show any work, and you will only submit the Grading Sheet at the end of the exam. You may use the blank spaces on the exam to work out problems. If you run out of room, your proctor should have extra scratch paper you may use.

7) Calculators that cannot wirelessly connect to the internet are allowed during the exam.

8) There is only one correct answer of the options given, but incorrect answers may yield some reduced amount of points as partial credit.

   - **Multiple answers are not allowed**. If two or more bubbles are filled for a given question, you will receive a zero for that question – even if one is correct.
   - There is **no penalty** for incorrect answers. So there is no harm in guessing if you can't solve the problem and/or run out of time.

9) Have your **TAMU ID ready when submitting your Grading Sheet** to the proctor. You should keep the exam, any blank sheets you used to work out problems, and/or the formula sheet following submitting your grading sheet. Alternatively, your proctor can recycle any material you don't want to keep.

1. [*Qid 7*] (6 points) In the circuits given below, all bulbs are identical. Which of the following correctly indicates the relative brightness of the bulbs? (D>B implies that D is brighter than B.)

   The concepts necessary to solve this problem correctly: Kirchoff's Loop Rule, Electrical Power (as it relates to brightness).

   (A) D=A=B=C

   (B) D=B=C>A

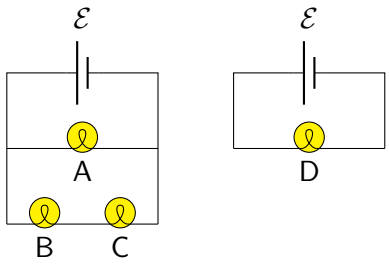
   (C) D=A<B=C

   (D) D>A>B>C

   (E) D<B<C<A

   (F) D=A>B=C

   (G) D<A<B<C



2. [*Qid 3*] (8 points) The figure shows a 2.0-cm diameter roller that turns at 90 rpm. A 4.0-cm wide plastic film is being wrapped onto the roller, and this plastic carries an excess electric charge having a uniform surface charge density of 5.0 nC/cm^2. What is the current of the moving film?

The concepts necessary to solve this problem correctly: Definition of current and charge density

(A) 11300 nA

(B) 8130 nA

(C) 47.1 nA

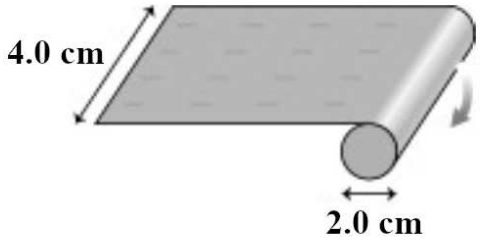
(D) 7100 nA

(E) 188 nA

(F) 4800 nA

(G) 377 nA

(H) 1370 nA



3. [*Qid 15*] (8 points) A bar has a radius of 1.00 cm and a length of 50.0 cm. It was constructed so that it is entirely copper at one end, zinc at the other and linearly changes composition along the way. The resistivity can be given by the function $\rho(x) = \rho_0 + ax$ where $\rho_0 = 1.68 \times 10^{-8}$ Ωm and $a = 8.44 \times 10^{-8}$ Ω. What is the resistance of this bar?

   The concepts necessary to solve this problem correctly: Resistance with varying resistivity

   (A) 1.90×10^{-8} Ω

   (B) 5.90×10^{-8} Ω

   (C) 9.39×10^{-5} Ω

   (D) 6.03×10^{-5} Ω

4. [*Qid 9*] (6 points) In the circuit diagram below, you know there is a 1.0 A current passing through the 1.0 Ω resistor moving to the left. The rectangular box represents an unknown battery with emf $\mathcal{E}$. What is the unknown emf and which side of it is the positive terminal?

   The concepts necessary to solve this problem correctly: Kirchoff's Loop and Junction Rules

   (A) 9.0 V with the positive terminal on the left

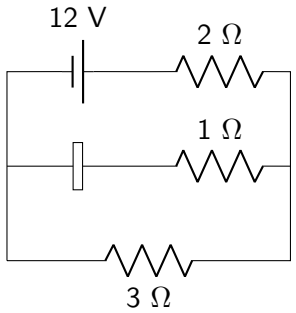
   (B) 7.0 V with the positive terminal on the left

   (C) 9.0 V with the positive terminal on the right

   (D) 5.0 V with the positive terminal on the right

   (E) 7.0 V with the positive terminal on the right

   (F) 5.0 V with the positive terminal on the left



5. [*Qid 2*] (4 points) You are given a copper bar of dimensions 3 cm $\times$ 5 cm $\times$ 8 cm and asked to attach leads to it in order to make a resistor. If you want to achieve the *smallest* possible resistance, you should attach the leads to the opposite faces that have which measurements?

   The concepts necessary to solve this problem correctly: Definition of resistance

   (A) 3 cm $\times$ 5 cm

   (B) 3 cm $\times$ 8 cm

   (C) 5 cm $\times$ 8 cm

   (D) Any pair of faces will produce the same resistance since the resistivity is the same.

6. [*Qid 14*] (6 points) A 5.0 μF capacitor is fully charged by a 12 V battery and then disconnected from the battery. The capacitor is then connected in parallel to an unknown capacitor that is initially uncharged. After reaching equilibrium, it is found that the potential difference across this unkonwn capacitor is 3.0 V. What is the capacitance of the unknown capacitor?

   The concepts necessary to solve this problem correctly: Capacitors with dielectrics, definition of capacitance, Definition of elements in parallel

   (A) 15 μF

   (B) 10 μF

   (C) 5 μF

   (D) 25 μF

   (E) 20 μF

7. [*Qid 6*] (6 points) The emf and the internal resistance of a battery are as shown in the figure. If a current of 8.30 A is drawn from the battery when a hair dryer is connected across the terminals ab of the battery, what is the power dissipated by the dryer?

   The concepts necessary to solve this problem correctly: Kirchoff's Loop Rule, Electrical Power

   (A) 444 W

   (B) 700 W

   (C) 622 W

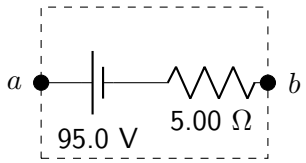
   (D) 538 W

   (E) 791 W

   (F) 1130 W

   (G) 42.0 W

   (H) 789 W



8. [*Qid 16*] (6 points) The current through the cross section of a conductor is given by the formula $I_0 e^{-\alpha t}$ where $I_0 = 8.00$ mA and $\alpha = 0.200$ s^{-1}. What is the magnitude of charge that passes through this cross section between $t = 3.00$ and $t = 9.00$ s?

   The concepts necessary to solve this problem correctly: Definition of current

   (A) 4.89 mC

   (B) 12.7 mC

   (C) 2.41 mC

   (D) 3.07 mC

   (E) 15.3 mC

   (F) 9.91 mC

9. [*Qid 17*] (6 points) In the previous problem, assume that the provided function is the current in a simple RC series circuit. If the battery was supplying an emf of 24.0 V, what was the effective capacitance of the circuit?

   The concepts necessary to solve this problem correctly: Time dependence of RC-circuits

   (A) 114 μF

   (B) 66.7 μF

   (C) 4.85 μF

   (D) 1670 μF

10. [*Qid 4*] (6 points) An aluminum cylinder is 10.0 cm long and has a cross-sectional area of 2.00×10^{-4} m^2. When a voltage difference 3 V is applied, what is power dissipated through it? (the resistivity of aluminum is 2.82×10^{-8} Ωm).

The concepts necessary to solve this problem correctly: Definition of resistance, Ohm's Law

(A) 7.8×10^5 W

(B) 5.5×10^5 W

(C) 6.4×10^5 W

(D) 2.1×10^5 W

(E) 1.1×10^5 W

11. [*Qid 12*] (4 points) Two identically shaped parallel plate capacitors are connected in parallel to a battery and stay connected to that battery. One is filled with a dielectric with constant κ, the other is filled with air. What is the change in charge collected on C_1 if the dielectric is removed from C_1 and inserted into C_2?

The concepts necessary to solve this problem correctly: Capacitors with dielectrics, definition of capacitance, Definition of elements in parallel

(A) The charge on C_1 decreases by a factor of κ

(B) The charge on C_1 increases by a factor of κ^2

(C) The charge on C_1 decreases by a factor of κ^2

(D) The charge on C_1 increases by a factor of κ

(E) The amount of charge on C_1 will not change

12. [*Qid 13*] (4 points) In the previous problem, what is the change in the *total charge* delivered by the battery to the circuit?

The concepts necessary to solve this problem correctly: Capacitors with dielectrics, definition of capacitance, Definition of elements in parallel

(A) The total charge will not change

(B) The total charge increases by a factor of κ^2

(C) The total charge decreases by a factor of κ^2

(D) The total charge decreases by a factor of κ

(E) The total charge increases by a factor of κ

13. [*Qid 1*] (6 points) The figure shows two connected wires that are made of the same material. The current entering the wire on the left is 2.0 A and in that wire the electron drift speed is v_d. What is the electron drift speed in the wire on the right side?

The concepts necessary to solve this problem correctly: Relationship between current and current density, Definition of elements being in series

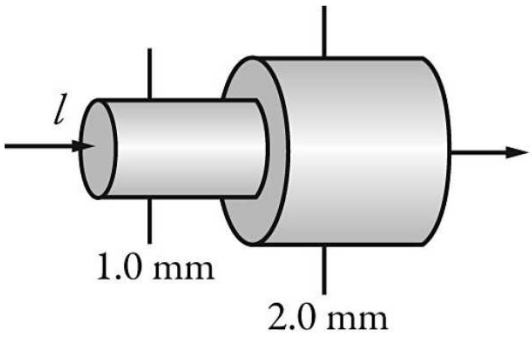
(A) $\frac{1}{4}v_d$

(B) $2v_d$

(C) $4v_d$

(D) v_d

(E) $\frac{1}{2}v_d$



14. [*Qid 11*] (6 points) In the circuit below all capacitors are uncharged and the switch has been open for a long time. At $t = 0$ the switch is closed. What is the potential difference $V_a - V_b$ between a and b after the switch has been closed for a long time.

The concepts necessary to solve this problem correctly: Effective Capacitance, Time dependence of RC-circuits, Potential difference between points in a circuit

(A) -12 V

(B) -8 V

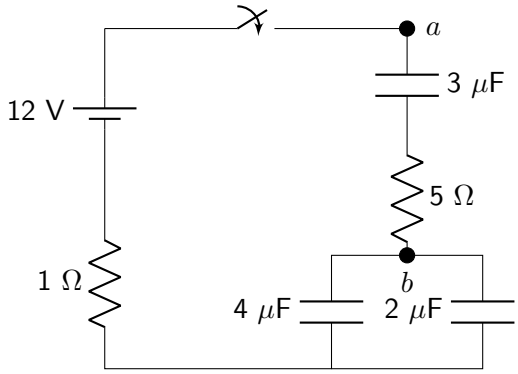
(C) 0 V

(D) +4 V

(E) -4 V

(F) +12 V

(G) +8 V



15. [*Qid 10*] (6 points) Assume the switch below is closed. After a long time, which of the following will affect the final voltage across the capacitor?

The concepts necessary to solve this problem correctly: Time dependence of RC-circuits, Kirchoff's Loop and Junction Rules

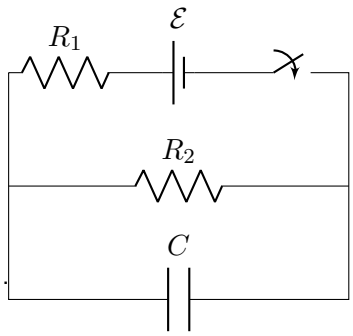
(A) The emf, $\mathcal{E}$, and only the resistance R_2.

(B) The emf, $\mathcal{E}$, and only the capacitance C.

(C) The emf, $\mathcal{E}$, and only the resistance R_1.

(D) The emf, $\mathcal{E}$, and both resistances R_1 and R_2.

(E) The emf, $\mathcal{E}$, the capacitance C and both the resistances R_1 and R_2.



16. [*Qid 8*] (6 points) In the diagram below, find current through the 6.0 Ω resistor?

The concepts necessary to solve this problem correctly: Effective Resistance, Kirchoff's Loop Rule, Ohm's Law

(A) 4.6 A

(B) 1.3 A

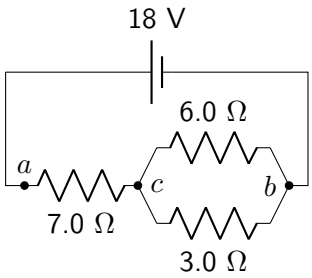
(C) 1.5 A

(D) 0.67 A

(E) 2.0 A

(F) 3.0 A

(G) 2.3 A



17. [*Qid 5*] (6 points) In the circuit below you are given the current through the two indicated resistors. What is the current through the 6 V battery?

The concepts necessary to solve this problem correctly: Kirchoff's Loop and Junction Rules

(A) 0.62 A

(B) 0.36 A

(C) 0.26 A

(D) 0.40 A

(E) 0.22 A

(F) 0.12 A