

Electromagnetism and Optics: Class Exam II

9 March 2026

Name: _____

Total: _____/80

Instructions

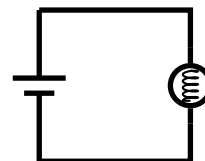
- There are 8 questions on 6 pages.
- Show your reasoning and calculations and always explain your answers.

Physical constants and useful formulae

$$\begin{aligned} e &= 1.60 \times 10^{-19} \text{ C} & q_{\text{electron}} &= -e & q_{\text{proton}} &= +e \\ m_{\text{electron}} &= 9.11 \times 10^{-31} \text{ kg} & m_{\text{proton}} &= 1.67 \times 10^{-27} \text{ kg} \\ k &= 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2 & \epsilon_0 &= 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2 \end{aligned}$$

Question 1

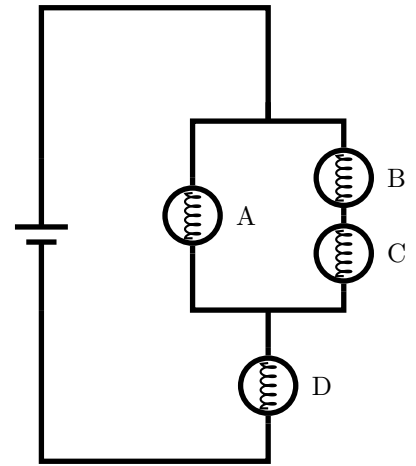
A bulb, which can be regarded as a resistor, is connected to a battery. When the bulb is connected to a 3.00 V battery it produces power of 4.00 W. The same bulb is connected to a 1.50 V battery. Determine the power produced by the bulb when it is connected to the 1.50 V battery.



Question 2

A circuit containing several identical bulbs is connected as illustrated.

- a) Which of the following (choose one) describes the ranking of the bulbs in order of descending brightness?
- i) $A = B = C > D$
 - ii) $A > B = C > D$
 - iii) $A = B > C > D$
 - iv) $D > A > B = C$
 - v) $D > B = C > A$
- b) Suppose that bulb A is replaced by a wire. What happens to the brightness (increase, decrease, stay the same) of each bulb compared to what it was before replacement? Explain your answer.

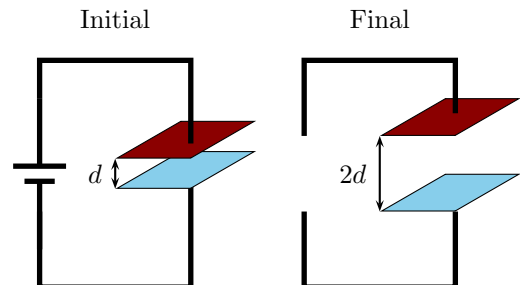


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Question 3

A parallel plate capacitor with movable plates is connected to a battery whose voltage is 9 V . After charging, the battery is completely disconnected. After this, the separation between the plates is doubled. What is the voltage across the capacitor ΔV after the separation has been increased?

- i) $\Delta V = 9\text{ V}$
- ii) $\Delta V = 18\text{ V}$
- iii) $\Delta V = 4.5\text{ V}$
- iv) $\Delta V = 2.25\text{ V}$

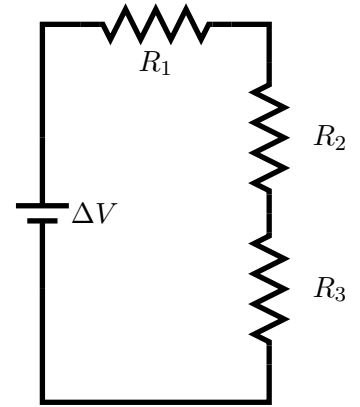


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Question 4

Three resistors are connected to a battery as illustrated in the following circuit.

- a) Determine an expression for the potential difference across R_2 . The answer must be expressed in terms of R_1, R_2, R_3 and ΔV .

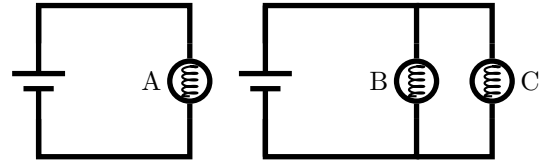


- b) Determine an expression for the power delivered by R_2 . The answer must be expressed in terms of R_1, R_2, R_3 and ΔV .

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Question 5

Identical bulbs are connected to identical ideal batteries as illustrated. The wires have zero resistance. Which of the following (choose one) is true?



- i) The current through bulb C is less than the current through bulb A.
- ii) The current through bulb C is more than the current through bulb A.
- iii) The current through bulb C is the same as the current through bulb A.

Explain your answer.

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Question 6

A capacitor is charged with potential difference across it 150 V. The capacitor discharges rapidly over a period of 3.00 ms and while doing so provides constant power of 6.00 W.

- a) Determine the energy stored in the capacitor just before it discharges.

- b) Determine the capacitance of the capacitor.

- c) Determine the charge stored in the capacitor just before it discharges.

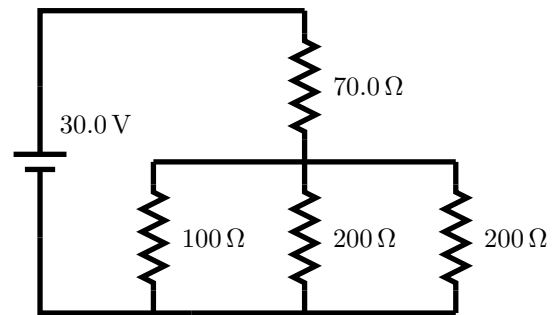
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Question 7

Determine:

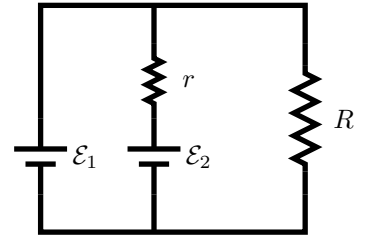
- the currents through,
- the voltages across and,
- the power dissipated

by *each* resistor in the illustrated circuit.



Question 8

Two batteries, one ideal and the other with an internal resistance, are connected to a resistor as illustrated. Suppose that the ideal battery provides EMF $\mathcal{E}_1 = 3.00 \text{ V}$. The battery with internal resistance provides EMF $\mathcal{E}_2 = 2.75 \text{ V}$ and internal resistance $r = 2.50 \Omega$. The resistor has resistance $R = 30.0 \Omega$.



- a) Determine the magnitude and direction of the current that flows through R .

- b) Determine the magnitude and direction of the current that flows through r .