Seminar 7: Lectures 13-14

Print and answer all questions found below.
Please bring your completed worksheet to the Seminar Class. [1]

Question 1

(a) Explain how a battery generates an electric current in a closed circuit.

(b) Calculate the current flowing through the circuit if the battery provides a potential of 9 V and the resistance is 18 ohms.

(c) Discuss the effect of increasing the battery voltage on the current.

[1] It is assumed that you have access to the standard physical constants.

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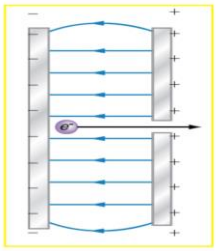
Question 2

A simple and common technique for accelerating electrons is shown in Figure below, where there is a uniform electric field between two plates. Electrons are released, usually from a hot filament, near the negative plate, and there is a small hole in the positive plate that allows the electrons to continue moving.

(a) Calculate the acceleration of the electron if the field strength is $2.50 \times 10^4 N/C$.

(b) Explain why the electron will not be pulled back to the positive plate once it moves through the hole.



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Question 3

A small office-building air conditioner operates on 408-V AC and consumes 50.0 kW.

(a) What is its effective resistance?

(b) What is the cost of running the air conditioner during a hot summer month when it is on 8.00 h per day for 30 days and electricity costs 0.5 RMB/kW·h?

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Question 4

An 1800-W toaster, a 1400-W electric frying pan, and a 75-W lamp are plugged into the same outlet in a 15-A, 120-V circuit. The three devices are in parallel when plugged into the same socket.

(a) What current is drawn by each device?
(b) Will this combination blow the 15-A fuse?

Question 5

(a) Define resistivity and its unit.
(b) Given a copper wire (resistivity at 20°C is $1.68 \times 10^{-8}\,\Omega \cdot m$), calculate the new resistance if the temperature is raised to 100°C. Assume a temperature coefficient of $0.00386\,°C^{-1}$.
(c) Discuss how the resistivity change affects the efficiency of electrical transmission over long distances.

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Question 6

How much charge does a 12 V battery have to supply to fully charge 2.5 μF capacitor and a 5 μF capacitor when they are:

(a) in parallel

(b) in series

(c) How much energy does the battery have to supply in each case?

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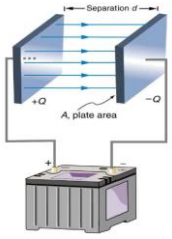
Question 7

A parallel-plate vacuum capacitor has 8.38 J of energy stored in it. The separation between the plates is 2.30 mm. If the separation is decreased to 1.15 mm, what is the energy stored

(a) if the capacitor is disconnected from the potential source so the charge on the plates remains constant, and

(b) if the capacitor remains connected to the potential source so the potential difference between the plates remains constant?



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Question 8

A parallel-plate air capacitor has a capacitance of 500.0 pF and a charge of magnitude 0.2 μC on each plate. The plates are 0.600 mm apart.

(a) What is the potential difference between the plates?

(b) What is the area of each plate?

(c) What is the electric-field magnitude between the plates?

(d) What is the surface charge density on each plate?

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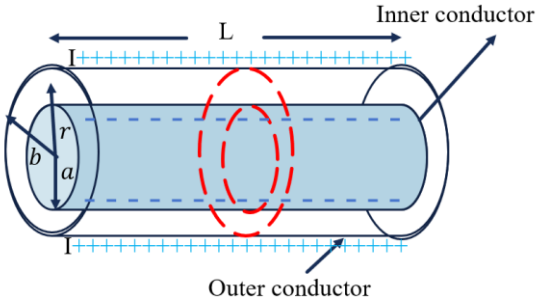
Extension Questions

Question 9

What is the capacitance per unit length ($^{F}/_{m}$) of a coaxial cable whose inner conductor has a 1.0 mm diameter, and the outer cylindrical sheath has a 5.0 mm diameter? Assume the space between is filled with air.



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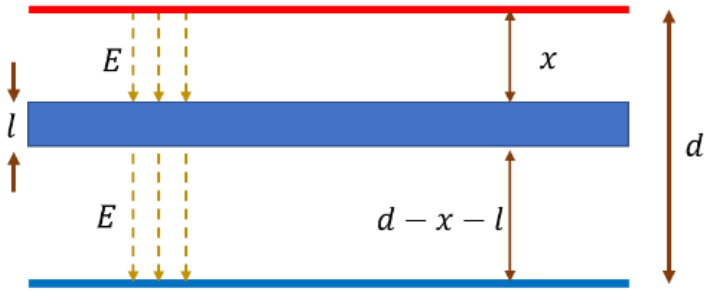
Question 10

A large metal sheet of thickness l is placed between, and parallel to, the plates of the parallel-plate capacitor as shown in the figure below. It does not touch the plates and extends beyond their edges.

(a) What is now the net capacitance in terms of A, d, and l?

(b) If $l = 0.40d$, by what factor does the capacitance change when the sheet is inserted?



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Question 11

Three conducting plates, each of area A, are connected as shown in the figure below.

(a) Are the two capacitors thus formed connected in series or in parallel?

(b) Determine capacitance, C, as a function of d_1, d_2, and A. Assume $d_1 + d_2$ is much less than the dimensions of the plates.

(c) The middle plate can be moved (changing the values of d_1 and d_2), to vary the capacitance of the system. What are the minimum and maximum values of the net capacitance?