

Physics 112 Midterm Exam (example)

Please answer all problems on the blank paper provided. Clearly print your name and student ID on every sheet you use. Please hand in your formula sheet along with your answers

You must show working for all questions.

Even on multiple choice questions you should show some support for your answer.

There are 3 questions and 1 extra-credit bonus question.

You have 70 minutes to complete as much of the test as you can

$$k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$$

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$$

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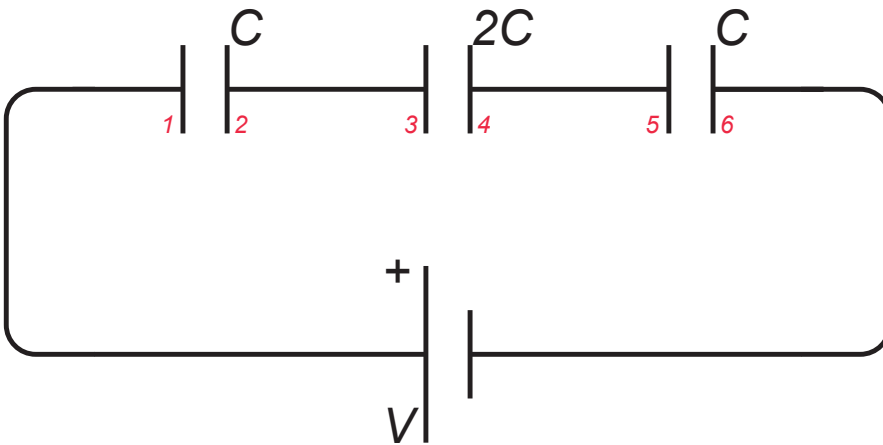
Question 1.

1.1 A parallel-plate capacitor having rectangular plates of area A and separation d is held at a fixed potential difference by a battery.

If the plates are moved further apart while they are held at the same potential difference,

- (a) the capacitance *A. Increases, B. Decreases, C. Stays the same*
(b) the amount of charge on each plate *A. Increases, B. Decreases, C. Stays the same*
(c) the energy stored in the capacitor *A. Increases, B. Decreases, C. Stays the same*

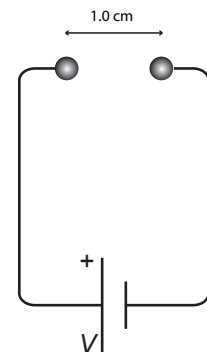
1.2 Shown below is a circuit of three capacitors attached in series with an ideal emf source.



- (a) If the charge on plate 1 is $+Q$, what is the charge on plate 2? Explain your answer.
(b) What is the charge on plate 3? Explain your answer.
(c) If $C = 8 \text{ nF}$, what is the equivalent capacitance of the three capacitors in series?
(d) If $C = 8 \text{ nF}$ and $V = 50 \text{ V}$, what is the voltage drop across the middle capacitor?

1.3 Two metal spheres separated by a distance of 1.0 cm are attached to a battery (as shown). This set-up acts as a capacitor. The battery did $1.0 \times 10^{-6} \text{ J}$ of work to set up the static electric field around the spheres.

- (a) Given that the battery ensures a constant voltage of 2.0 V , what is the capacitance of the two spheres?
(b) The battery is replaced by one supplying 10 V , what is the charge on the rightmost sphere?



[25 points]

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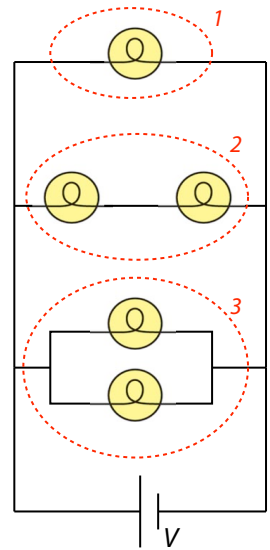
Question 2.

2.1 Two identical metal rods are attached together end to end. Each rod has length L , resistivity ρ and cross-sectional area A .

- (a) What is the resistivity of the combination? A. 2ρ B. ρ C. $\rho/2$ D. 4ρ
 (b) What is the resistance of the combination? A. $2\rho L/A$ B. $\rho L/A$ C. $\rho L/2A$ D. $4\rho L/A$

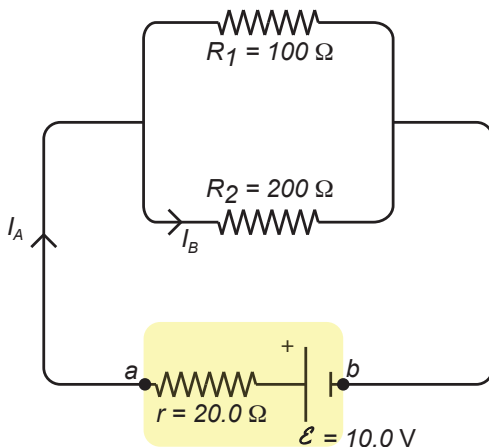
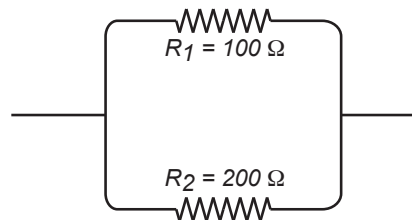
2.2 Consider the arrangement of identical bulbs shown. The uppermost bulb (1) has a power output of 200 W.

- (a) What is the total power output of the two bulbs in oval (2)?
 (b) What is the total power output of the two bulbs in oval (3)?



2.3

(a) What is the equivalent resistance of the following combination of resistors?



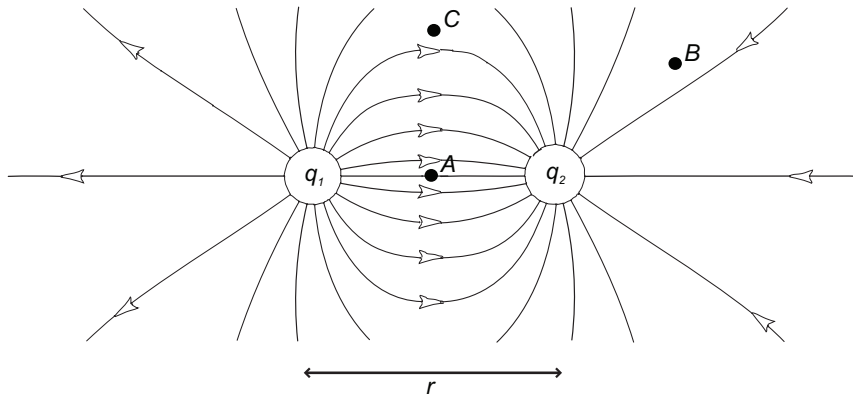
- (b) What are the currents I_A , I_B in the circuit shown?
 (c) What is the potential difference between the terminals of the battery (points a and b)?
 (d) How much power is lost from the circuit through heating of the battery's internal resistance?

[30 points]

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Question 3.

3.1 The image below shows the electric field lines originating from a system of two charges q_1 and q_2 .



(a) What are the signs of q_1 and q_2 ? Explain your answer.

(b) Where is the magnitude of \vec{E} largest, at A , B or C ? Explain your answer.

(c) If $|q_1| = |q_2| = 1.0 \text{ nC}$ and $r = 2.0 \text{ cm}$ what is the magnitude of the electric field at A (midway between q_1 and q_2)? (You will need the equation for the electric field strength from a point charge).

3.2 Three points (A , B , and C) are located on equipotential lines as shown.

(a) A proton is released from Point A . The direction of the electric force vector acting on the proton is
A. left B. right C. up D. down

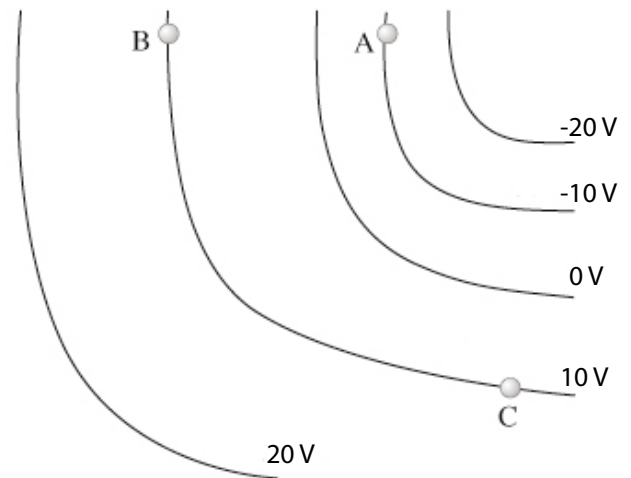
(b) An electron is released from Point B . The direction of the electric force vector acting on the electron is
A. left B. right C. up D. down

(c) An electron is released from Point A and a second electron is released from Point C . What can you say about the accelerations experienced by these electrons the instant they are released?

*A. acceleration at A is larger B. they are the same
C. acceleration at C is larger*

(d) How much does the potential energy of a charge of 10 C change when it moves from Point B to Point A ?

(e) A 10 C charge moves from B to A then on to C - how much work is done by the electric field? Explain your answer.

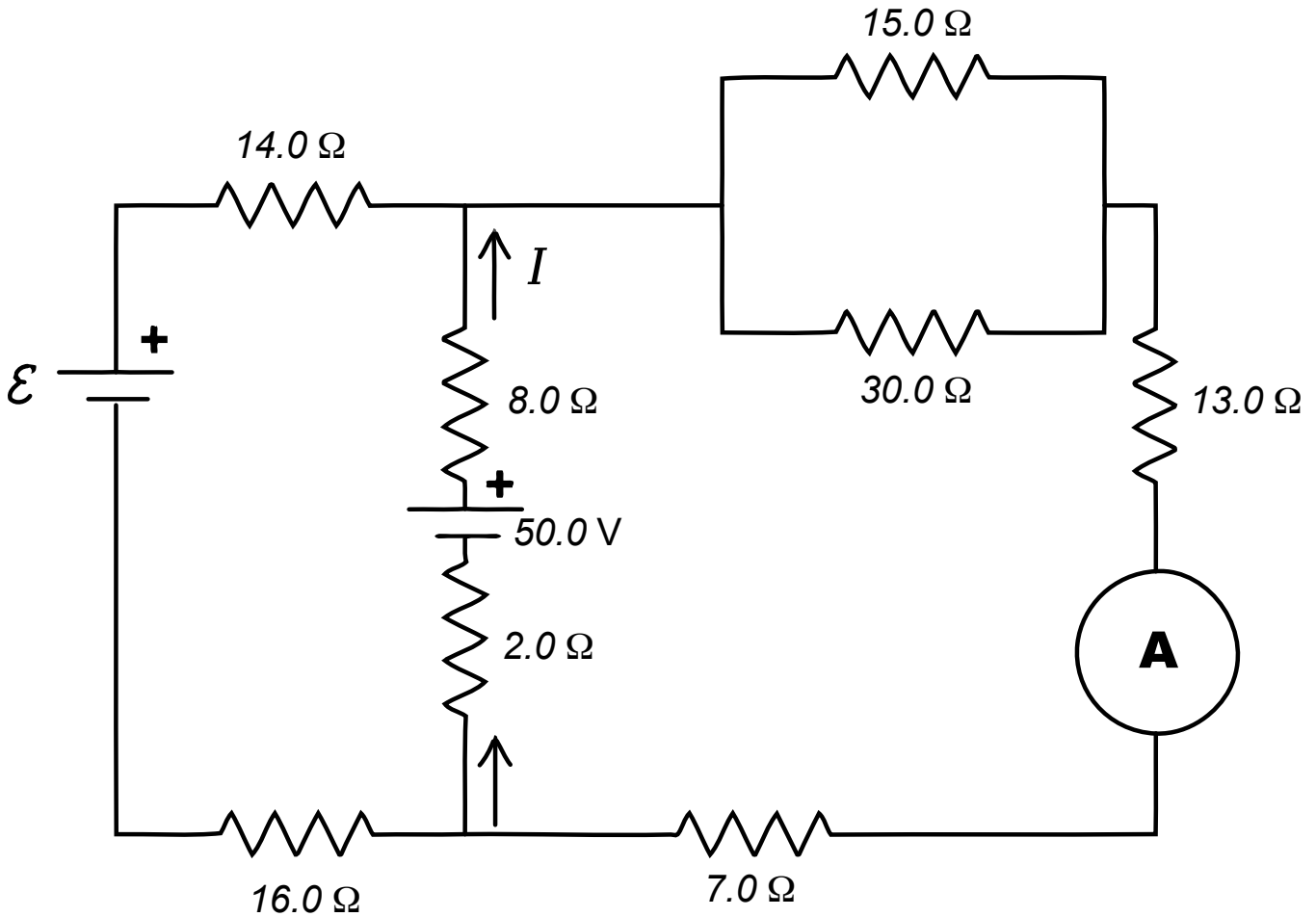


[25 points]

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Extra credit

Consider the following circuit:



The power output of the 8.0Ω resistor is 11.52 W ; what is the current, I ?

By application of Kirchhoff's rules, find the unknown emf \mathcal{E} and the current through the ammeter. You may wish to replace the $15 \Omega - 30 \Omega$ parallel system by an equivalent resistance. Show your working.

[15 extra credit points]
