

# MIDTERM

19 February 2002

## Directions

- You may use your notes, homework, text, etc.
  - **You may not collaborate on this exam; do not work with others.**
  - Unless you and I have arranged otherwise, you should return this to me by the end of the day on Thursday Feb. 21.
  - When you are done with the exam, place it under my office door or give it to me at the beginning of class on Friday.
1. Consider the arrangement of charges shown in Fig. 1. Let  $Q_1 = 3 \text{ nC}$  and  $Q_2 = 5 \text{ nC}$ . (25 points).
    - (a) What is the field at point A due to the charges  $Q_1$  and  $Q_2$ ? Remember that the electric field is a vector.
    - (b) If a charge of  $-2$  micro Coulombs is placed at point A, what is the force exerted on it by  $Q_1$  and  $Q_2$ ?

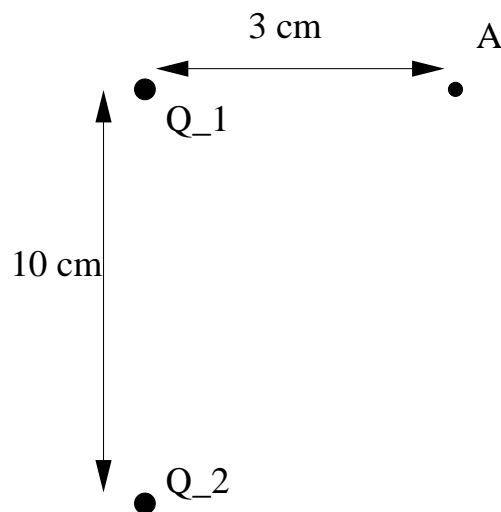


Figure 1: Two point charges.

2. At  $t = 0$  you send out a light flash to Neptune, approximately 4 hr away. When the light hits Neptune, aliens launch a spaceship headed straight for earth, at a velocity of .5. Draw a spacetime diagram for these events.
3. Spell the word “parallel.”
4. Approximately how far is it from campus to Ellsworth in SR units?

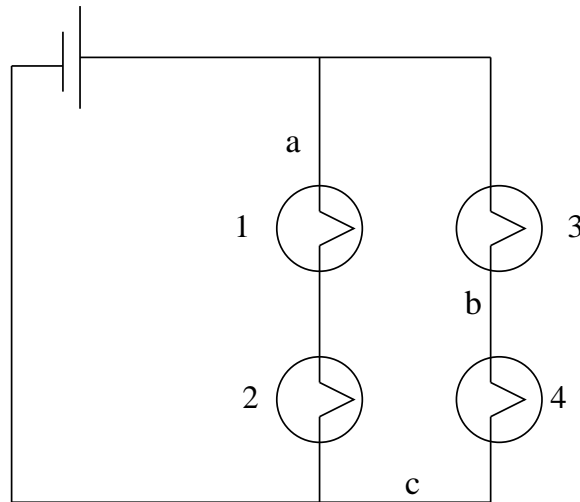


Figure 2: A circuit.

5. Someone hands you  $10^9$  electrons. This same person hands your friend  $10^9$  protons. If you and your friend stand one meter apart, what is the electrostatic force between you?
6. A circuit is made from a 1.5 volt battery and a long piece of wire.
  - (a) If I double the length of the wire, what happens to the field strength in the wire? Why?
  - (b) If I double the length of the wire, what happens to the current in the wire? Why?
  - (c) If I double the radius of the wire, what happens to the field strength in the wire? Why?
  - (d) If I double the radius of the wire, what happens to the current in the wire? Why?
7. These questions refer to the circuit shown in Fig. 2. Assume all four light bulbs have the same resistance.
  - (a) If bulb 2 is unscrewed, what would happen to the brightness of the other bulbs? Explain your reasoning.
  - (b) If a wire is connected between points a and c, what would happen to the brightness of the other bulbs? Explain your reasoning.

- (c) If a wire is connected between points a and b, what would happen to the brightness of the other bulbs? Explain your reasoning.
8. These questions also refer to the circuit shown in Fig. 2. Now assume that the emf delivered by the battery is 20 V, and that each bulb has a resistance of  $40\Omega$ .
- (a) What is the current that flows out of the battery?
  - (b) What is the voltage drop across bulb 3?
  - (c) What is the power output by bulb 3?
9. You have a 100 Watt lightbulb. This means that this bulb is designed to deliver 100 Watts of power when hooked up to a household outlet in the United States.
- (a) What is the resistance of the bulb?
  - (b) You decide that 100 Watts is too bright for your room. You happen to have a 500 Ohm resistor handy. If you hook the resistor up in series with the light bulb, what power does the bulb now output?