

Midterm Exam No. 02 (2016 Fall)

PHYS 205B: University Physics

Date: 2016 Oct 13

(Name)

(Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 3.
2. Total time = 75 minutes.
3. There are 8 questions in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (10 points.) The two charges in Figure 1 are separated by a distance $a = 5.00$ cm. Let $q = 5.00$ nC.

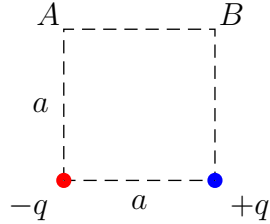


Figure 1: Problem 1

- Find the electric potential at point A , choosing the potential at infinity to be zero.
- Find the electric potential at point B , choosing the potential at infinity to be zero.
- Determine the potential difference between points B and A .
- Determine the change in electric potential energy when a third charge of $2.00 \mu\text{C}$ is moved from point A to B .

2. (10 points.) The potential in a region between $x = 0$ and $x = 5.00$ cm is given by

$$V = a + bx^2, \quad (1)$$

where $a = 0$ V and $b = -450$ V/cm². Determine the magnitude and direction of the electric field at $x = 2.00$ cm.

3. (10 points.) A spherical conductor has a radius of 14.0 cm and a charge of $8.0 \mu\text{C}$. Calculate the electric potential at the following distances from the center.

(a) $r = 8.00 \text{ cm}$

(b) $r = 16.00 \text{ cm}$

4. (10 points.) The average cost of energy delivered to residences by electrical transmission in Illinois is 0.12 USD per kWh. At this price, calculate the cost of leaving a 100.0 W porch light on for two weeks while you are on vacation.

5. **(10 points.)** One hundred identical resistors of resistance $200.0\ \Omega$ are connected in parallel to each other. Determine the equivalent resistance of the configuration.

6. (10 points.) Two capacitors ($C_1 = 1.00 \mu\text{F}$ and $C_2 = 2.00 \mu\text{F}$) are connected in series and to a 10.0 V battery.
- (a) Find the equivalent capacitance of the combination.
 - (b) Find the charge on each capacitor.
 - (c) Find the potential difference across each capacitor.

7. (10 points.) Consider the circuit in Figure 2 with $V_1 = 10.0\text{ V}$, $V_2 = 20.0\text{ V}$, $R_1 = 100.0\ \Omega$, $R_2 = 200.0\ \Omega$, $R_3 = 300.0\ \Omega$. Find the currents I_3 (with direction) through the resistor R_3 .

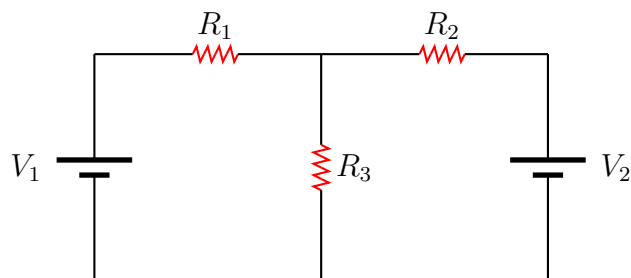


Figure 2: Problem 7

8. (10 points.) Consider the process of charging the capacitor C in Figure 8.

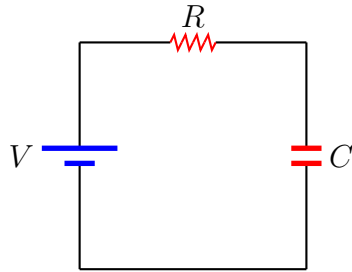


Figure 3: Problem 8

- (a) Using Kirchoff's law, write down the equation relating the current I in the circuit and the charge Q on the capacitor.
- (b) The solution to the equation, in Question (8a), for the initial condition $Q(0) = 0$ is

$$Q(t) = CV \left[1 - e^{-\frac{t}{RC}} \right]. \quad (2)$$

How much time does it take to charge the capacitor to 70% of the maximum value?
Given $C = 10.0 \mu\text{F}$, $R = 30.0 \text{ k}\Omega$, and $V = 10.0 \text{ V}$.