RH = /44 CH1 = /100

PHYS 251 TEST #2 9/28/18 Dr. Holmes NAME ___Key_____

DO ALL EIGHT PROBLEMS. THE WORTH OF EACH PROBLEM IS MARKED BESIDE THE PROBLEM. SHOW YOUR WORK FOR PARTIAL CREDIT.

For problems 1d, 4d, 4e, and 5c, use one of the following answers:

a) increase by a factor of 4
b) decrease by a factor of ½
c) increase by a factor of 2
d) decrease by a factor of ¼
e) increase by some other factor
f) decrease by some other factor
g) stay the same
h) can't determine whether it will change based on info given.

1) a) Through what potential difference should an electron be accelerated to reach a speed of 5 million m/s if it starts from rest?

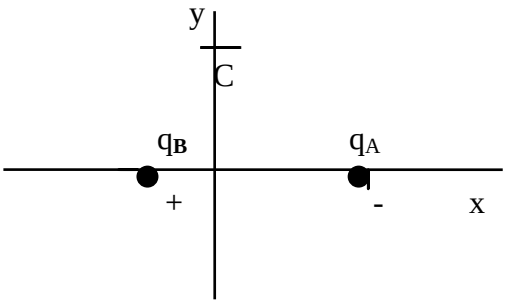
[6] _____71.1 V_____. b) Should the final voltage be higher or lower than the initial voltage?

[2] _____higher_____. c) If a proton were to be accelerated by the same voltage, would it be going [slower than, the same speed as, or faster than] the electron?

[2] _____slower_____. d) If you doubled the voltage through which the electron of part a accelerated, would the final speed of the proton: (see answer selection above)

[2] ___e_____
increase by other

For problem 2, consider the following situation: point C located at (0 m, +7 m); q_A = -6 μC located at (+6 m, 0 m); q_B = +2 μC located at (-2 m, 0 m).



2) a) Assuming that the voltage is zero at infinity, what is the voltage at the point C?

[9] ____-3,385 V_____. b) How much energy would it take to bring a third charge of +5 μC from very far away (assume infinitely far away) and place it at point C? [Note: a + answer indicates it takes energy to make the move, a negative answer indicates it gives up energy in the move.]

[4] _____-0.017 J_____.

3) DESIGN a 2 nF capacitor (that is, specify the 'geometry' and the materials to be used). Be sure to make a drawing showing all the values required by your design. [14]

4) Consider a coaxial cable that has an inner wire of radius 2 mm and an outside cylinder of radius 14 mm. The cable is 70 cm long. A voltage of 40 volts is placed across the inner wire and the outer cylinder Assume that vacuum is between the wire and the cylinder. a) What is the capacitance of the cable?

[4] **20 pF**. b) What is the magnitude of the charge on the inner wire when the 30 volts is placed across the wire and cylinder?

[4] **800 pC**.

c) If the inner wire has the positive (higher) voltage, does it have the positive or negative charge on it?

[2] **positive**. d) If the voltage is doubled to 80 volts, how will the capacitance change (see page 1 for choices) ?

[2] **g (same)**. e) If the radius of the outer cylinder is doubled to 28 mm, how will the capacitance change (see page 1 for choices) ?

[2] **f (decrease by other)**.

5) A material (Teflon) of dielectric constant 2.1 is inserted between the inner wire and the outer cylinder of the capacitor in problem #4. a) What will the capacitance be now?

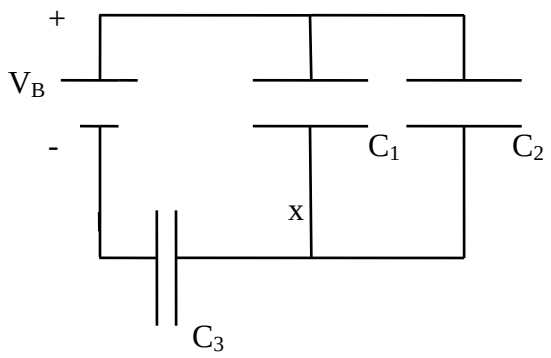
[4] **42 pF**

b) How much energy will be stored in this capacitor (with the dielectric) with the 40 volts applied to it?

[4] **33.6 nJ**. c) If you double the voltage on this capacitor, how will the energy stored change (see page 1 for choices) ?

[2] **a (4x)**.

6) You are given three capacitors: $C_1 = 3$ nF; $C_2 = 6$ nF; $C_3 = 9$ nF. They are connected to a 40 volt power supply as shown in the diagram.



a) What is the effective capacitance of the three capacitors?

[4] ___**4.5 nF**_____.

b) What is the effective charge stored on this set of capacitors?

[4] ___**180 nC**_____.

c) If the negative terminal of the battery is grounded (set at 0 volts) so that the positive terminal of the battery is at 40 volts, what is the voltage at the point marked with an x on the diagram?

[3] ___**20 V**_____.

7) You are given three resistors: 3 Ω, 6 Ω, and 9 Ω.

(a) Draw a diagram showing how to connect the resistors to a battery so that you get the **largest** effective resistance: [5]

(b) Is your connection above purely parallel, purely series, or a combination?

[2] ___**series**__.

(c) Draw a second diagram below showing how to connect the resistors to a battery so that you get the smallest effective resistance: [5]

(d) Draw a third diagram below showing how to connect the resistors to a battery so that you get some value between 6 Ω and 9 Ω for the effective resistance, and then specify what value you will get: [4]

value: _____, diagram:

8) A 6 μF capacitor in series with a 12 Ω resistor is charged with a power supply of 40 volts.
a) What is the maximum charge that this capacitor will store given this voltage?

[2] **240 μC**.

b) How long a time will it take for this capacitor to store half of the maximum charge?

[2] **49.9 μs**. c) How long a time (from the switch being closed initially) will it take for this capacitor to store three fourths of the maximum charge?

[2] **99.8 μs**.

d) The power supply is then disconnected, and when a switch is thrown the capacitor discharges through a 10 MΩ resistor (MΩ is a Mega-ohm = 1 million ohms). How long a time will it take to lose half of the charge that it had stored?

[2] **41.6 sec**. (e) After it loses half of its charge so that it has half its charge remaining, will it have: [more than ¾, ¾, between ½ & ¾, ½, between ¼ and ½, ¼, or less than ¼] of its stored energy remaining?

[2] ¼.