PY111 Practice Midterm 2 SOLUTIONS

NAME: LAST FOUR DIGITS OF SSN:

Answer in the space provided. You may use the backs of sheets if required. Box your answers on questions 2 and 3. There are 30 possible points in this midterm.

written response

1. Does it make sense to separate the world into conductors and insulators?

No. There is really a continuum of materials in terms of conductivity. And it is even more compicated if you consider semiconductors...

partial credit questions

2. An electron is accelerated from rest through a potential of 10,000 V and sent down a long evacuated tube which has a target of charge -6 μC at the end. Determine how close the electron gets to the target.

Conserve energy to solve this problem. The initial EPE is given by qV where $V = 10000$. The initial KE is zero. The sum of these must equal the final KE, which is zero, and the final EPE, which we approximate to be $EPE_f = qV = kqQ/R$ where Q is 6 μC and R is the distance of closest approach. Solving (q cancels out) gives $R = 5.4m$.

3. An electric field does 5.8 mJ of work in moving a charge with $q = +3\mu C$ from A to B.

(a) What is the value of $EPE_A - EPE_B$?

(b) Determine $V_A - V_B$.

(c) Is A or B at higher potential?

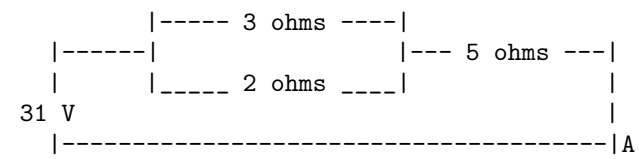
(a) $EPE_A - EPE_B = W_{AB} = 5.8mJ$.

(b) $V_A - V_B = (EPE_A - EPE_B)/q \approx 2kV$

(c) Since the field does work on the charge, the charge must be moving it to lower potential, $V_B < V_A$.

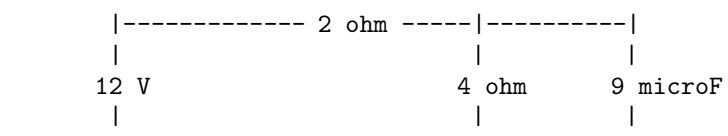
multiple choice questions

4. Determine the current through the 2 ohm resister.



(a) 2 A
(b) 3 A
(c) 1 A
(d) 4 A
$R_{eq} = 2 \cdot 3/(2+3) + 5 = 31/5$ ohms. Thus $I = 5A$. Thus the voltage drop across the 3 and 2 ohm portion of the cricuit is 6V and the current through the 2 ohm resistor is 3A.

5. Determine the charge on the capacitor after it has fully charged.



(a) 36 μC
(b) 72 μC
(c) 18 μC
(d) 180 μC
Once the capacitor is fully charged no current flows through it. Thus the total current is $I = 2A$. Since $q = CV$ and the voltage drop across the capacitor (and 4 ohm resistor) is 8V, we get $q = 72 \cdot 10^{-6} C$.

6. A cardiologist doubles the length of a copper wire feeding artificial heart, what happens to the wire's resistance?
(a) halves
(b) stays the same
(c) doubles
(d) quadruples
Use $R = \rho L/A$

7. An electric space heater has been brought into the ER in an attempt to keep patients from freezing. If it is made of wire with a resistance on 12 ohms and is plugged into a 115V AC outlet, how much heat is added to the room in two minutes?
(a) 8 kJ
(b) 66 kJ
(c) 2200 J
(d) 1100 J
(e) 0.13 MJ
Use $P = V^2/R$ to get $P = 1100W$. Multiply by 120 seconds to get the total heat energy $Q = 1.3 \cdot 10^5 J$.

8. If a capacitor stores $5 \cdot 10^{-4}$ J of energy when attached to 10 V battery, how much does it store when attached to a 20 V battery?

(a) 2 mJ
(b) 20 mJ
(c) 1 mJ
(d) 0.5 mJ
The voltage doubles and $E = 1/2CV^2$.

equations

$W_{AB} = EPE_A - EPE_B \qquad qV = EPE \qquad V = kq/r$

$E = -\frac{\Delta V}{\Delta s} \qquad q = CV \qquad \kappa = E_0/E \qquad C = \kappa\epsilon_0 A/d$

$E = \frac{1}{2}CV^2 \qquad E = \frac{1}{2}\kappa\epsilon_0 E^2 \qquad I = \frac{\Delta q}{\Delta t} \qquad V = IR \qquad R = \rho L/A \qquad P = IV$

$\bar{P} = I_{rms}V_{rms} \qquad V = V_0 \sin 2\pi f t \qquad R_{eq} = R_1 + R_2 + \ldots \qquad 1/R_{eq} = 1/R_1 + 1/R_2 + \ldots$

$C_{eq} = C_1 + C_2 + \ldots \qquad 1/C_{eq} = 1/C_1 + 1/C_2 + \ldots \qquad q = q_0(1 - \mathrm{e}^{-t/RC}) \qquad q = q_0\mathrm{e}^{-t/RC}$

$\epsilon_0 = 8.85 \cdot 10^{-12} C^2/N \cdot m^2 \qquad q_e = -1.6 \cdot 10^{-19} C \qquad m_e = 9.1 \cdot 10^{-31} kg \qquad k = 8.99 \cdot 10^9 N \cdot m^2/C^2$