

Physics 2135 Exam 2

March 22, 2016

Exam Total

/ 200

Printed Name: _____

Rec. Sec. Letter: _____

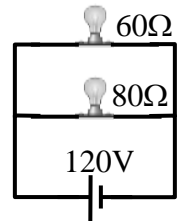
Five multiple choice questions, 8 points each. Choose the **best** or **most nearly correct** answer.

_____ 1. An air-filled parallel plate capacitor is connected across a potential difference V_0 and fully charged. The capacitor is then disconnected from the circuit. After that, the separation between the plates is doubled. Which of the following best describes the change that results?

- [A] The charge stored on the capacitor decreases.
- [B] The potential difference across the plates increases.
- [C] The capacitance of the capacitor increases.
- [D] The electric energy stored in the capacitor decreases.

_____ 2. A light bulb having $60\ \Omega$ resistance and a light bulb having $80\ \Omega$ resistance are connected in parallel across a 120 V power line. Which statement is true?

- [A] The $60\ \Omega$ bulb glows brighter and draws a larger current than the $80\ \Omega$ bulb.
- [B] The $60\ \Omega$ bulb glows brighter and draws the same current as the $80\ \Omega$ bulb.
- [C] The $80\ \Omega$ bulb glows brighter and draws a larger current than the $60\ \Omega$ bulb.
- [D] The $80\ \Omega$ bulb glows brighter and draws the same current as the $60\ \Omega$ bulb.

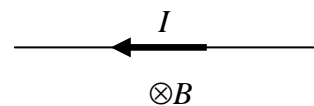


_____ 3. The magnetic potential energy of a magnetic dipole $\vec{\mu}$ in a uniform magnetic field is maximum when

- [A] $\vec{\mu}$ is parallel to \vec{B}
- [B] $\vec{\mu} \perp \vec{B}$
- [C] $\vec{\mu}$ is antiparallel to \vec{B} .

_____ 4. A straight wire segment carries a current I . The wire segment is in a region where there is a uniform magnetic field B as shown. What is the direction of the magnetic force on the wire segment?

- [A] \otimes
- [B] \uparrow
- [C] \downarrow
- [D] \odot



_____ 5. What is causing the dog to levitate?

- [A] Magnetism.
- [B] Physics.
- [C] The Mind of Dr. Pringle.
- [D] Magic.



_____ /40 for page 1

6. (20 points total) A light bulb is connected across a constant potential difference V_0 . When it is first turned on at 20°C the light bulb filament carries a current I_0 . After several minutes, the light bulb filament reaches a temperature of 820°C and carries a current of $0.20 I_0$.

(a) (10 points) Calculate the temperature coefficient of resistivity of the light bulb filament material. Start with OSE's and show all steps in your derivation of the final result.

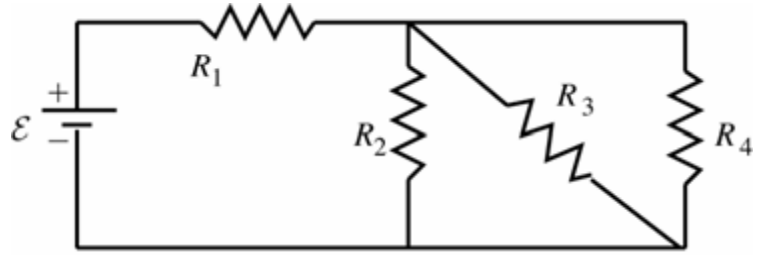
(b) (10 points) Calculate the percentage change in the energy per second dissipated by the light bulb as the temperature rises from 20°C to 820°C .

7. (20 points total) A $4.00\ \mu\text{F}$ parallel-plate capacitor is charged with a $9.0\ \text{V}$ battery. The air-filled distance between the plates is $2.0\ \text{cm}$.

(a) (10 points) Calculate the energy stored in the capacitor.

(b) (10 points) The capacitor **is disconnected from the battery**, and a material with dielectric constant $\kappa = 3.0$ is inserted between the plates. Find the electric field between the plates of the capacitor.

8. (40 points total) In the circuit shown, $R_1 = 300 \Omega$, $R_2 = 200 \Omega$, $R_3 = 300 \Omega$ and $R_4 = 600 \Omega$. In this configuration, the power supply (which has negligible internal resistance) provides 1 W of power to the rest of the circuit. **Put your answers, with units, in the boxes provided.**



(a) (10 points) Find the equivalent resistance of the resistors connected across the power supply.

$R_{eq} =$

(b) (10 points) Find the emf ε of the power supply.

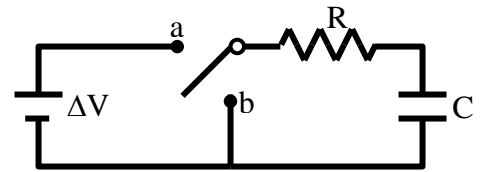
$\varepsilon =$

(c) (20 points) Find the voltage across the resistor R_1 , and the power dissipated by that resistor.

$V_1 =$	$P_1 =$
---------	---------

_____/40 for page 3

9. (40 points total) In the circuit shown, the uncharged capacitor has a capacitance of $C=10\mu\text{F}$ and the resistor has a resistance of $R=20\Omega$. The voltage source provides $\Delta V=12\text{ V}$.

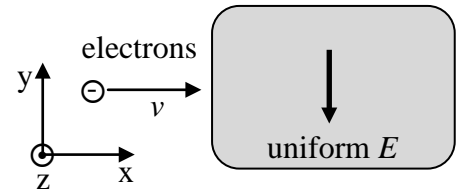


(a) (5 points) At $t=0$, the switch is thrown to position a. What is the current through the resistor immediately after the switch is thrown to position a?

(b) (20 points) How long does it take before the current through the resistor is one third of its maximum value? Begin with the OSE for the time dependent charge and derive an expression for the time dependent current.

(c) (15 points) After the capacitor is fully charged, the switch is thrown to position b. What is the charge on the capacitor at $t=0.3\text{ ms}$ after the switch is thrown to position b?

10. (40 points total) A beam of electrons of charge $-e$ and mass m with random speeds in the $+x$ direction enters a region containing a uniform electric field \vec{E} pointing in the $-y$ direction. We want to use a magnetic field \vec{B} to make a velocity selector.

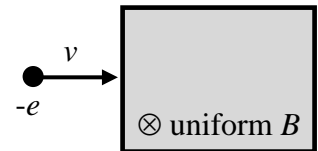


(a) (5 points) What direction should the magnetic field be to exert a force in the opposite direction of the force of the electric field?

Circle one: $+\hat{i}$ $-\hat{i}$ $+\hat{j}$ $-\hat{j}$ $+\hat{k}$ $-\hat{k}$

(b) (15 points) Starting with OSE's, derive an expression for the speed v of the particles that will be undeflected by the given electric and magnetic fields.

After the electrons with speed v leave the velocity selector, they enter a region of space where the only field present is a uniform magnetic field \vec{B} different in magnitude from that of part (a) and pointing in the $-z$ direction.



(c) (5 points) When they enter this new magnetic field region, the electrons begin to travel in a circle that is oriented (circle one below)

CLOCKWISE or COUNTERCLOCKWISE.

(d) (10 points) Starting with OSE's, derive an expression for the radius of the circle.

(e) (5 points) What is the period of the motion?