

Name _____

Exam # 3
Physics 248
April 25, 2007

Problems will be graded on reasoning and intermediate steps as well as on the final answer. Be sure to include units and direction of vectors when needed.

Each problem is worth 25 points

Constants:

$$c \approx 3 \times 10^8 \text{ m/s}, k \approx 9 \times 10^9 \text{ Nm}^2/\text{C}^2, m_e = 9.1 \times 10^{-31} \text{ kg} = 0.51 \text{ MeV}/c^2,$$

$$m_{\text{proton}} = 1.67 \times 10^{-27} \text{ kg},$$

$$h = 6.62 \times 10^{-34} \text{ m}^2 \text{ kg/s}, \hbar c = 197.3 \text{ eV} \cdot \text{nm}, e = 1.6 \times 10^{-19} \text{ C}$$

Problem	Score
1	
2	
3	
4	
Total	

1. Multiple choice questions and short problems. Explain your reasoning that leads to the final answer.

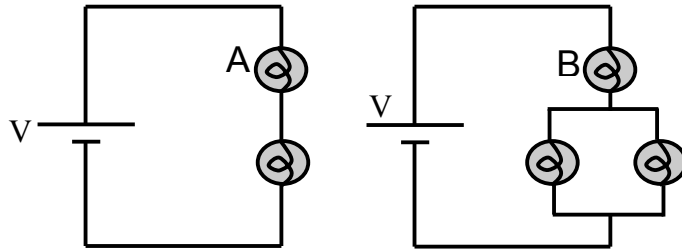
A) Circle the correct answer below:

How does the brightness of the labeled bulbs compare in these two circuits? All bulbs are identical. The batteries are ideal and identical.

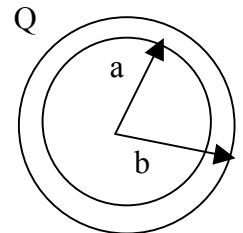
A brighter than B

A dimmer than B

A & B same brightness



B) How does the electric field of a charged conducting spherical shell of inner radius a and outer radius b depend on the distance from its center r ? Q is the charge of the shell.



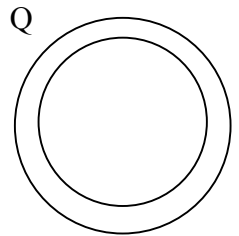
C) A parallel plate capacitor of area A and distance between the plates d is charged with charge Q and insulated. A dielectric of dielectric constant $\kappa=4$ is inserted between the plates so that it fills completely the space between the plates.

What is the change in the capacitor potential energy with respect to the case in which it is empty? Does the potential energy increase or decrease?

D) Answer True or False for the following statements and explain shortly why.

- The potential difference between the inner and outer surface of a charged conducting spherical shell is zero.

- The potential of the inner surface is zero.



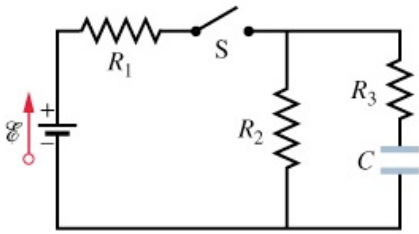
2. Assume a nuclear charge of Ze with $Z = 4$ and a single electron orbiting. Answer to these short questions about the Bohr's model:

a. Find the radius of the electron in a circular orbit around the nucleus as a function of the velocity considering the interaction between the nucleus and the electron.

b. Apply the Bohr quantization condition on the angular momentum to find the velocity of the electron in the n state as a function of k , Z , m_e , \hbar and n .

c. To find out how relativistic is the electron motion in the orbit, calculate the numerical ratio of v/c for the ground state $n = 1$ where c is the velocity of light (see front page for its value).

3. In the circuit in the figure, $\varepsilon = 1.2 \text{ kV}$, $C = 6.5 \text{ } \mu\text{F}$ e $R_1 = R_2 = R_3 = R = 1.0 \text{ M}\Omega$, C is completely discharged at $t = 0$ when the switch S is closed.



A) Draw the equivalent circuit and calculate the current through R_3 at $t = 0$;

B) Draw the equivalent circuit and calculate the current in R_1 and in R_3 after an infinite time when the capacitor can be considered fully charged.

Let's suppose that the capacitor is now fully charged. The switch is open and the capacitor begins to discharge.

C) Calculate the value of the time constant of the circuit for the discharge of the capacitor (switch open)

4. Calculate the cyclotron frequency of a proton moving in a plane perpendicular to a uniform magnetic field of 1.0 T. Does it depend on the velocity of the proton?