

## 8.02x Electricity and Magnetism

### Problem Set 5

~~Issued: Fri, Mar 4~~

~~Due: Fri, Mar 11, 4PM < note Date + Time!~~

~~Note that the EF write-up from both lab partners is also due on 3/11 4PM!~~

~~Reading suggestions (from Young & Freedman)~~

~~Mon: Electric Current, Resistivity, Circuits, chapters 25.1 to 25.5~~

~~Wed: DC Circuits, Kirchoffs Rules, chapters 26.1 to 26.3~~

~~Fri: Quiz 2 review~~

### ~~Homework Problems (30 points total)~~

~~**Problem 1 (10 points)** Consider a simple parallel plate capacitor of Area  $A$  for each plate and separation  $d$  between the plates. The plates are given equal and opposite charges  $Q$  and the capacitor is isolated from the rest of the world~~

- ~~(a) What is the potential difference between the plates in terms of the given variables?~~
- ~~(b) What is the stored energy in the capacitor?~~
- ~~(c) Assume the plates are moved from a separation  $d$  to  $2*d$ . How much does the stored energy in the capacitor change?~~
- ~~(d) Show that the change in potential energy in question (c) is identical to the work done on the plates when moving them from  $d$  to  $2*d$ .~~
- ~~(e) Assume a dielectric with dielectric constant  $k=10$  is inserted such that it fills the gap of the capacitor. How much does the stored energy change? How is energy conservation satisfied?~~

~~**Problem 2 (5 points)** For the HVPS experiment, you found that the voltage across the output capacitor was lowest when the load had the lowest resistance. Explain this observation.~~

~~**Problem 4 (5 points)** Young & Freedman, page 972, Question Q25.11~~

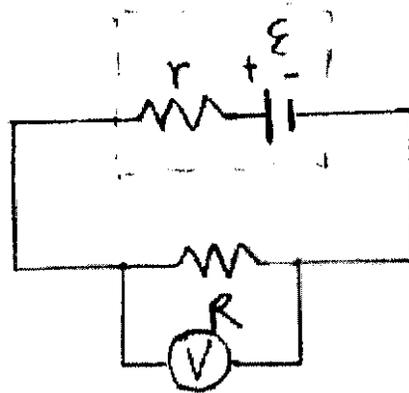
~~**Problem 5 (5 points)** Young & Freedman, page 975, 25.34~~

~~**Problem 6 (5 points)** Young & Freedman, page 975, 25.38~~

~~Note that check-off and experiment write-up for experiment 'Electrostatic Force (EF)' are due on Fri, 3/11. EF questions were provided in a separate document. There will be 2 bonus points for EF check-off on 3/7 and 1 bonus point on 3/8.~~

~~The energy conservation is still satisfied by noticing that the electric field did work on the dielectric:  $W = U - U'$ , which causes the reduce of stored energy in the capacitor.~~

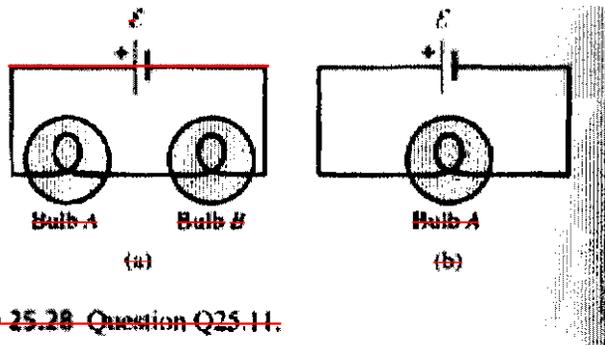
**Problem 2 (5 points)** For the HVPS experiment, you found that the voltage across the output capacitor was lowest when the load had the lowest resistance. Explain this observation.



HVPS has an internal resistance  $r$ . Denote the resistance of the load by  $R$ :

$$V = IR = \frac{\varepsilon R}{R+r} = \frac{\varepsilon}{1+(r/R)} \Rightarrow \text{the lower the resistance } R, \text{ the lower the voltage cross } R.$$

**Problem 4 (5 points)** ~~Young & Freedman, page 972, Question Q25.11~~



~~Figure 25.28 Question Q25.11.~~

~~Denote the resistance of the battery as  $r$ , and the resistance of Bulb A as  $R_A$ , the resistance of the battery as  $R_B$ . Since Bulb A and Bulb B are identical, we have  $R_A = R_B = R$ .~~

~~a) The current in the circuit is  $I_a = \frac{\varepsilon}{r+2R}$ , and the power dissipated in the Bulb A and Bulb B are the same  $I_a^2 R$ . Thus Bulb B should be as bright as Bulb A.~~