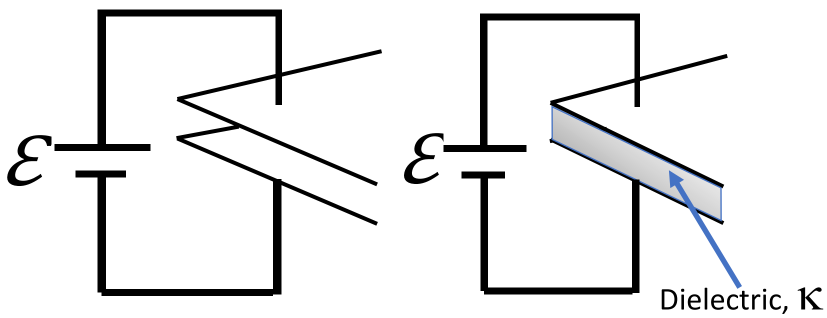
Physics 207 – Exam 2

Sections (207-212, 543-583) – October 14th, 2021

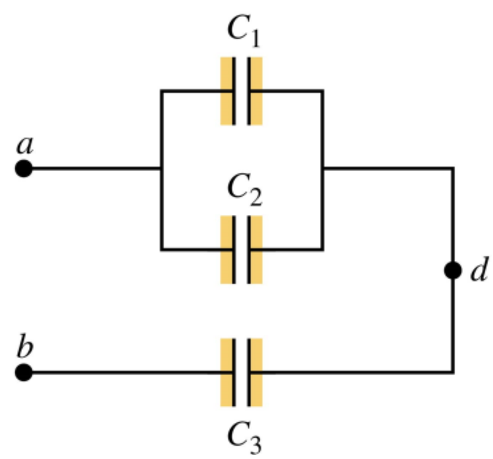
1) [*10 pts*] A parallel-plate capacitor C is connected to a battery of emf $\mathcal{E}$. You slide between its plates a slab of dielectric with dielectric constant κ, completely filling the space between its plates. If the initial charge is Q and the initial stored energy is U, what are the charge and energy after the dielectric has been slid into place and the system is in equilibrium?

   A. κQ, U/κ
   B. κQ, κU
   C. Q/κ, κU
   D. Q/κ, U/κ
   E. Q/κ, U/κ^2
   F. Q/κ, $\kappa^2 U$
   G. $\kappa^2 Q$, $\kappa^2 U$



2) [*6 pts*] The three capacitors shown below have the same capacitance $C_1 = C_2 = C_3 = 3$ μF. The equivalent capacitance is

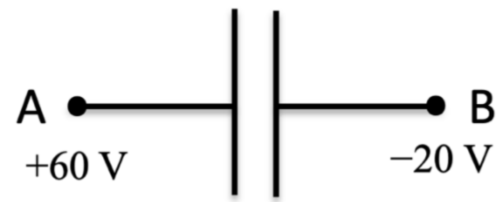
   A. 4.5 μF
   B. 2.0 μF
   C. 9.0 μF
   D. 1.0 μF
   E. 12.0 μF
   F. 6.5 μF



3) [*10 pts*] Consider the same capacitor network as in the previous problem. If we apply $V_a = 3$ V and $V_b = -15$ V, find the charge on the *first* and on the *third* capacitor:

   A. 40.5 μC, 81.0 μC
   B. 26.0 μC, 42.5 μC
   C. 18.0 μC, 36.0 μC
   D. 36.0 μC, 18.0 μC
   E. 53.0 μC, 21.0 μC
   F. 81.0 μC, 40.5 μC

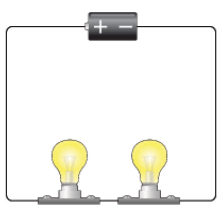
4) [*10 pts*] A 20 μF capacitor has plate A at +60 V and plate B at –20V. Find the charges on plates A and B.

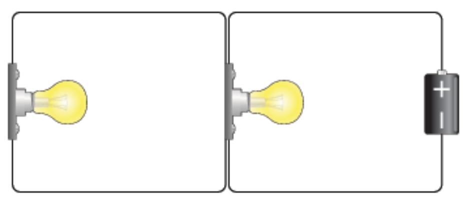


A. 1.2 mC, –0.4 mC
B. –1.2 mC, 0.4 mC
C. 1.6 mC, –1.6 mC
D. –1.6 mC, 1.6 mC
E. 0.8 mC, –0.8 mC,
F. –0.4 mC, –1.2 mC.

5) [*8 pts*] For identical light bulbs A and B, compare their <u>total power output</u> (A+B) when they are in parallel (p) and in series (s). That is, find P_p/P_s.

P_s

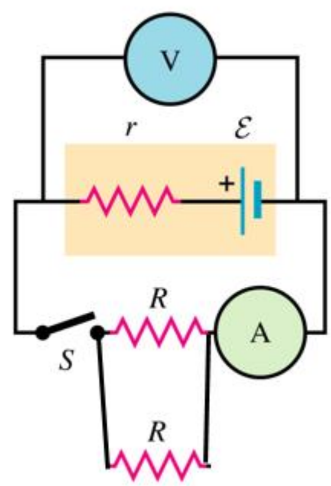




P_p

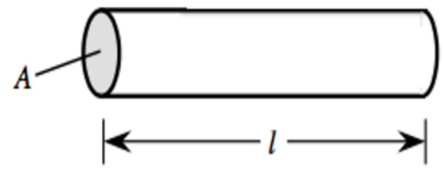
A. $P_p/P_s = 4$
B. $P_p/P_s = 2$
C. $P_p/P_s = 1$
D. $P_p/P_s = 0.75$
E. $P_p/P_s = 0.5$
F. $P_p/P_s = 0.25$

6) [*10 pts*] The circuit below contains a non-ideal battery with emf $\mathcal{E}$=12 V, and an internal resistance r =2 Ω. The battery is connected to the a circuit with a voltmeter, an ammeter, and two identical resistances of R = 4 Ω. The voltmeter and ammeter are ideal. In terms of the quantities given what are the readings of the voltmeter before the switch is closed (V_0) and of the ammeter after the switch is closed (I_1)?



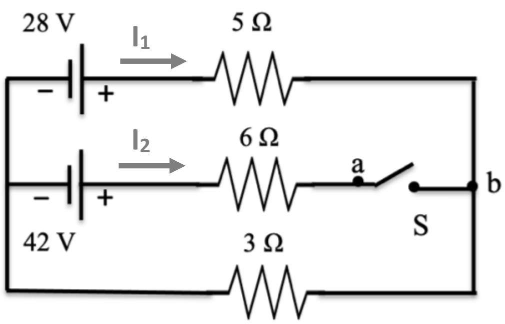
A. V_0=6 V, I_1=1.2 A
B. V_0=0 V, I_1=2 A
C. V_0=6 V, I_1=2 A
D. V_0=12 V, I_1=3 A
E. V_0=12 V, I_1=0 A
F. V_0=0 V, I_1=3 A

7) [*8 pts*] Consider a wire of area A=4 mm^2 and length l=3 m. If a voltage difference of 4.5 V is applied to its ends, then a current of 2 A flows through it. Find the resistivity ρ.



A. 3.0x10^{-3} Ω-m
B. 6.0x10^{-6} Ω/m
C. 9.0x10^{-9} Ω/m
D. 3.0x10^{-6} Ω/m
E. 3.0x10^{-6} Ω-m
F. 2.0x10^{-9} Ω-m

8) [*10 pts*] For the DC circuit shown below the switch S is open. The current through the 28V battery and the voltage difference V_{ab} between the contacts a and b of the open switch are

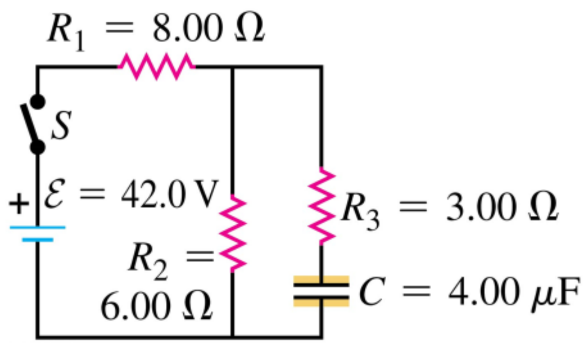


A. 4.0 A, –31.5 V
B. 1.2 A, 11.5 V
C. 1.2 A, –15 V
D. 3.5 A, 52.5 V
E. 3.5 A, 31.5 V
F. 4.0 A, 22 V

9) [*8 pts*] For the DC circuit above the switch S is now closed. Let rightward correspond to positive currents I_1 and I_2 through the 5 Ω and 6 Ω resistors. Taking a clockwise loop direction, the Kirchoff loop equation for the upper loop (containing both batteries) is:

A. $28V - (5\Omega)I_1 - (6\Omega)I_2 + 42V=0$
B. $-28V + (5\Omega)I_1 + (6\Omega)I_2 - 42V=0$
C. $28V +(5\Omega)I_1 - (9\Omega)I_2 + 42V=0$
D. $28V - (5\Omega)I_1 + (6\Omega)I_2 - 42V=0$
E. $-28V + (5\Omega)I_1 + (6\Omega)I_2 - (3\Omega)(I_1 +I_2)=0$
F. $28V + (5\Omega)I_1 -(3\Omega)(I_1 +I_2) + 42V=0$

10) [*10 pts*] The capacitor in the circuit shown below is initially uncharged. At $t = 0$ the switch is closed. The currents through the resistor R_1 initially (t=0) and after a very long time are:



A. 3.0 A, 4.2 A
B. 4.2 A, 2.0 A
C. 2.0 A, 3.0 A
D. 4.2 A, 3.0 A
E. 5.2 A, 1.0 A
F. 2.0 A, 5.2 A

11) [*10 pts*] In the previous problem after the switch had been closed for a long time the capacitor became fully charged at 72 μC. The switch is now opened at the new initial time. (i) What is the initial current I_0 through resistor R_3? (ii) The capacitor initially stores an electrical energy U_0. After the current has decreased to $I_0/3$ it stores an electrical energy U. What is U/U_0?

A. 6.0 A, 1/3
B. 4.2 A, 1/6
C. 2.0 A, 1/9
D. 2.0 A, 2/3
E. 6.0 A, 1/9
F. 4.2 A, 5/6

Scratch Paper