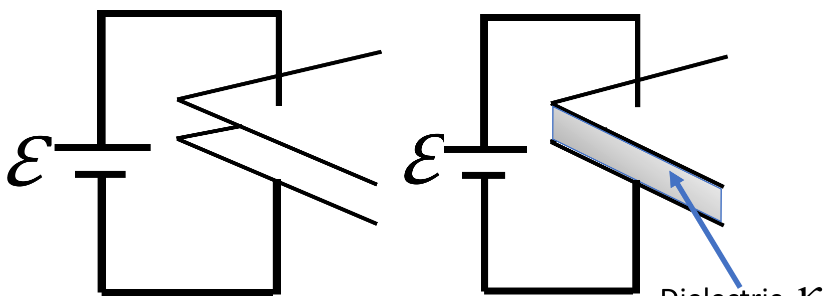
Physics 207 – Exam 2

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

Right answer indicated by ←. Number of points indicated in parenthesis, zero otherwise

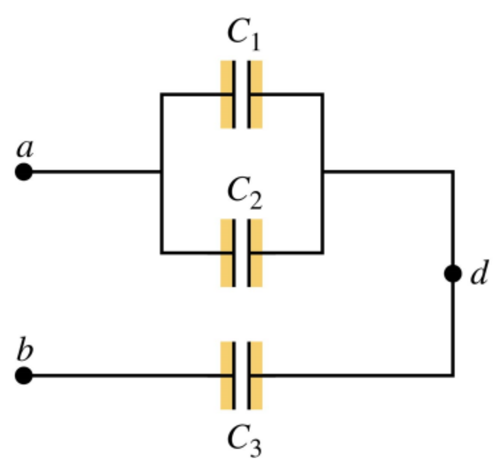
1) [*10 pts*] A parallel-plate capacitor C is connected to a battery of emf $\mathcal{E}$. You slide between its plates a slab of dielectric with dielectric constant κ, completely filling the space between its plates. If the initial charge is Q and the initial stored energy is U, what are the charge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

   A. κQ, U/κ (5)
   B. κQ, κU (10) ←
   C. Q/κ, κU (5)
   D. Q/κ, U/κ (0)
   E. Q/κ, U/κ^2 (0)
   F. Q/κ, $\kappa^2 U$ (0)
   G. $\kappa^2 Q$, $\kappa^2 U$ (0)



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 (3) (confuse parallel and series connection)
   B. 2.0 μF (6) ←
   C. 9.0 μF (0)
   D. 1.0 μF (0)
   E. 12.0 μF (0)
   F. 6.5 μF (0)

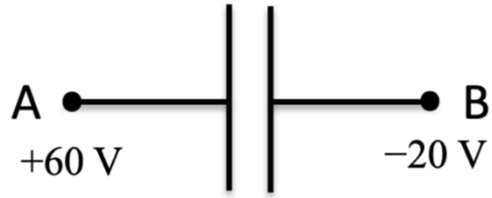


3) [*10 pts*] Consider the same capacitor network as in the previous problem. If we apply $V_a = 3$ V and $V_b = -15$ V, find the charge on the *first* and on the *third* capacitor:

   A. 40.5 μC, 81.0 μC (5) (if they confuse parallel and series connections)
   B. 26.0 μC, 42.5 μC (0)
   C. 18.0 μC, 36.0 μC (10) ←
   D. 36.0 μC, 18.0 μC (5) (if they confuse order of capacitors)
   E. 53.0 μC, 21.0 μC (0)
   F. 81.0 μC, 40.5 μC (2) (confuse both parallel and series and order of capacitors)

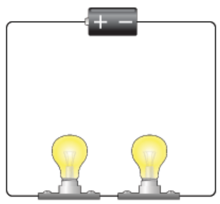
4) [*10 pts*] A 20 μF capacitor has plate A at +60 V and plate B at –20V. Find the charges on plates A and B.

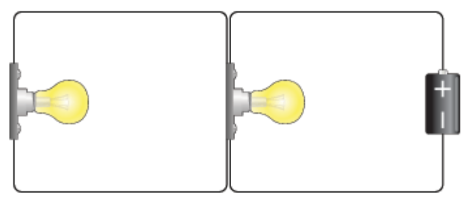
A. 1.2 mC, –0.4 mC (0)
B. –1.2 mC, 0.4 mC (0)
C. 1.6 mC, –1.6 mC (10) ←
D. –1.6 mC, 1.6 mC (5)
E. 0.8 mC, –0.8 mC, (2)
F. –0.4 mC, –1.2 mC. (0)



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

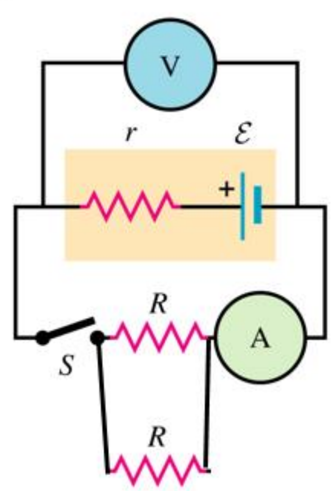




P_p

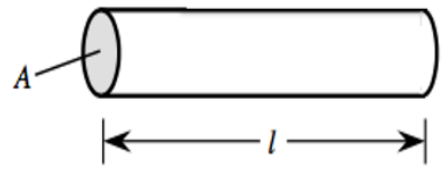
A. $P_p/P_s = 4$ (8) ←
B. $P_p/P_s = 2$ (2)
C. $P_p/P_s = 1$ (0)
D. $P_p/P_s = 0.75$ (0)
E. $P_p/P_s = 0.5$ (0)
F. $P_p/P_s = 0.25$ (0)

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)?



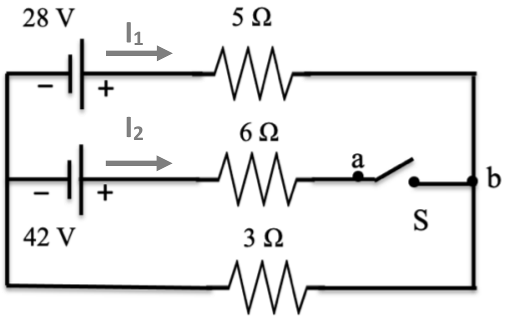
A. V_0=6 V, I_1=1.2 A (0)
B. V_0=0 V, I_1=2 A (0)
C. V_0=6 V, I_1=2 A (0)
D. V_0=12 V, I_1=3 A (10) ←
E. V_0=12 V, I_1=0 A (5)
F. V_0=0 V, I_1=3 A (5)

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. $3.0\text{x}10^{-3}$ Ω-m (0)
B. $6.0\text{x}10^{-6}$ Ω/m (0)
C. $9.0\text{x}10^{-9}$ Ω/m (0)
D. $3.0\text{x}10^{-6}$ Ω/m (2)
E. $3.0\text{x}10^{-6}$ Ω-m (8) 🡐
F. $2.0\text{x}10^{-9}$ Ω-m (0)

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

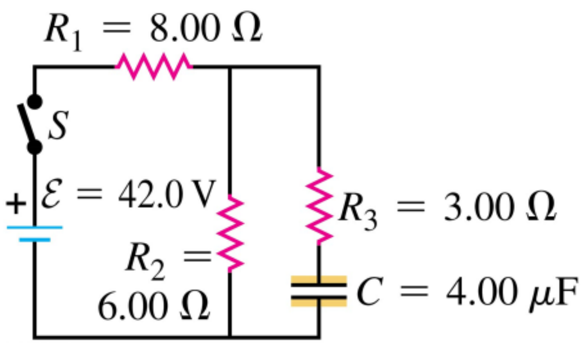


A. 4.0 A, –31.5 V (0)
B. 1.2 A, 11.5 V (0)
C. 1.2 A, –15 V (0)
D. 3.5 A, 52.5 V (8)
E. 3.5 A, 31.5 V (10) 🡐
F. 4.0 A, 22 V (0)

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. $28\text{V} - (5\Omega)I_1 - (6\Omega)I_2 + 42\text{V}=0$ (4)
B. $-28\text{V} + (5\Omega)I_1 + (6\Omega)I_2 - 42\text{V}=0$ (4)
C. $28\text{V} +(5\Omega)I_1 - (9\Omega)I_2 + 42\text{V}=0$ (0)
D. $28\text{V} - (5\Omega)I_1 + (6\Omega)I_2 - 42\text{V}=0$ (8) 🡐
E. $-28\text{V} + (5\Omega)I_1 + (6\Omega)I_2 - (3\Omega)(I_1 +I_2)=0$ (0)
F. $28\text{V} + (5\Omega)I_1 -(3\Omega)(I_1 +I_2) + 42\text{V}=0$ (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 (3)
B. 4.2 A, 2.0 A (3)
C. 2.0 A, 3.0 A (3)
D. 4.2 A, 3.0 A (10) ←
E. 5.2 A, 1.0 A (0)
F. 2.0 A, 5.2 A (0)

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 (2)
B. 4.2 A, 1/6 (0)
C. 2.0 A, 1/9 (10) ←
D. 2.0 A, 2/3 (5)
E. 6.0 A, 1/9 (5)
F. 4.2 A, 5/6 (0)

Scratch Paper