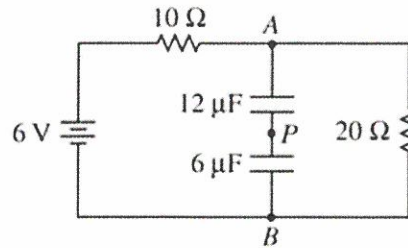# Electric Circuits Exam Review

Directions – Complete the following problems to help prepare you for the upcoming test.

2003 AP® PHYSICS B FREE-RESPONSE QUESTIONS

2. (15 points)

A circuit contains two resistors ($10\ \Omega$ and $20\ \Omega$) and two capacitors ($12\ \mu F$ and $6\ \mu F$) connected to a 6 V battery, as shown in the diagram above. The circuit has been connected for a long time.

(a) Calculate the total capacitance of the circuit.

(b) Calculate the current in the $10\ \Omega$ resistor.

(c) Calculate the potential difference between points A and B.

(d) Calculate the charge stored on one plate of the $6\ \mu F$ capacitor.

(e) The wire is cut at point P. Will the potential difference between points A and B increase, decrease, or remain the same?

_____ increase   _____ decrease   _____ remain the same

Justify your answer.

a) $\dfrac{1}{C_S} = \dfrac{1}{C_1} + \dfrac{1}{C_2}$

$= \dfrac{1}{12\mu F} + \dfrac{1}{6\mu F}$

$C_S = 4\mu F$

b) ① $R_T = R_1 + R_2$

$= 10\Omega + 20\Omega$

$= 30\Omega$

② $I_T = I_1 = I_2 = \dfrac{V_T}{R_T}$

$= \dfrac{6V}{30\Omega}$

$= .20 A$

c) $V_2 = I_2 R_2 = (.20A)(20\Omega)$

$= 4V$

V_{AB} // to $V_2 = 4V$

d) $Q_T = Q_1 = Q_2$

$Q = C_T V_T$

$= (4\times10^{-6}F)(4V)$

$= 16\times10^{-6}C$

$= 1.6\times10^{-5}C$

OR

ratio of $V_1 : V_2$
2 : 1
sum to 4

$Q_2 = C_2 V_2$

$= (6\times10^{-6}F)(2-?)$

$= 16\times10^{-6}C$

$= 1.6\times10^{-5}C$

e) no current is flowing A→B anyways. Cutting the wire will not affect the outer loop keeping potential difference in the 20Ω resistor the same

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3. (15 points)

Two lightbulbs, one rated 30 W at 120 V and another rated 40 W at 120 V, are arranged in two different circuits.

(a) The two bulbs are first connected in parallel to a 120 V source.

    i. Determine the resistance of the bulb rated 30 W and the current in it when it is connected in this circuit.

    ii. Determine the resistance of the bulb rated 40 W and the current in it when it is connected in this circuit.

(b) The bulbs are now connected in series with each other and a 120 V source.

    i. Determine the resistance of the bulb rated 30 W and the current in it when it is connected in this circuit.

    ii. Determine the resistance of the bulb rated 40 W and the current in it when it is connected in this circuit.

(c) In the spaces below, number the bulbs in each situation described, in order of their brightness. (1 = brightest, 4 = dimmest)

    __2__ 30 W bulb in the parallel circuit

    __1__ 40 W bulb in the parallel circuit

    __3__ 30 W bulb in the series circuit

    __4__ 40 W bulb in the series circuit

parallel better → more current
than series   is more brightness
P=IV
same V
↑P ↑I

P=I²R   same I
↑P ↑R

(d) Calculate the total power dissipated by the two bulbs in each of the following cases.

    i. The parallel circuit

    ii. The series circuit

a) i) $R_1 = \dfrac{V^2}{P} = \dfrac{(120V)^2}{30W}$

$= 480\,\Omega$

$I_1 = V_1/R_1 = (120V)(480\,\Omega)$

$= .25\,A$

ii) $R_2 = \dfrac{V^2}{P} = \dfrac{(120V)^2}{40W}$

$= 360\,\Omega$

$I_2 = V_2/R_2 = (120V)/360\,\Omega$

$= .33\,A$

b) i) R_1 stays same

$R_1 = 480\,\Omega$

$I_T = I_1 = I_2 = \dfrac{V_I}{R_T} = \dfrac{V_T}{R_1 + R_2}$

$= \dfrac{120V}{(480\,\Omega + 360\,\Omega)}$

$= .14\,A$

ii) $R_2 = 360\,\Omega$

$I_T = I_1 = I_2 = .14\,A$

d) i) $P_T = P_1 + P_2 = 30W + 40W = 70W$

ii) $P_T = \dfrac{V^2}{R_T} = \dfrac{V^2}{R_1 + R_2} = \dfrac{(120V)^2}{480\,\Omega + 360\,\Omega} = 17W$