Soln

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2013**

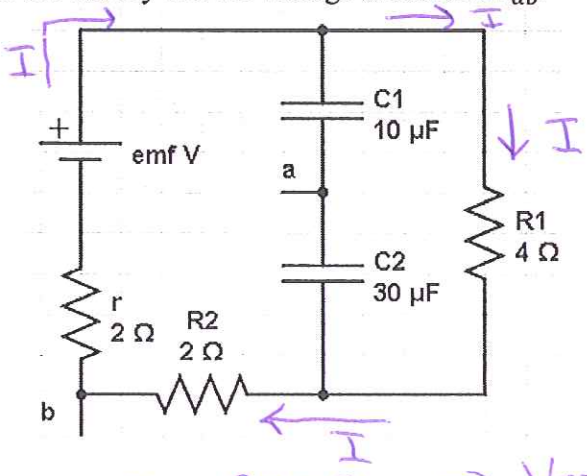
College of Arts and Sciences

Section 1 **Quiz 5** **14 March 2013**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

In the following circuit the capacitors are fully charged and the charge of the C1 is $30\mu C$. Determine the e.m.f of the battery and the voltage difference V_{ab}.



connected in series $\begin{cases} C_1 = 10\,\mu F & Q_1 = 30\,\mu C \Rightarrow V_{C_1} = \frac{Q_1}{C_1} = 3V \\ C_2 = 30\,\mu F & Q_2 = 30\,\mu C \Rightarrow V_{C_2} = \frac{Q_2}{C_2} = 1V \end{cases}$

Since capacitors are fully charged we assume that the no current flows through the capacitors. So,

$V_{emf} = I(r + R_1 + R_2)$

Also we know, $V_{C_1} + V_{C_2} = V_{R_1} = IR_1$

$\Rightarrow 4V = I(4\Omega) \Rightarrow I = 1A$

$\rightarrow V_{emf} = (1A)(2\Omega + 2\Omega + 4\Omega) = 8V$

$V_{ab} = V_{C_2} + V_{R_2} = 1V + (1A)(2\Omega) = 3V$

$V_{R_2} = IR_2$

Soln

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Section 2 **Quiz 5** **14 March 2013**

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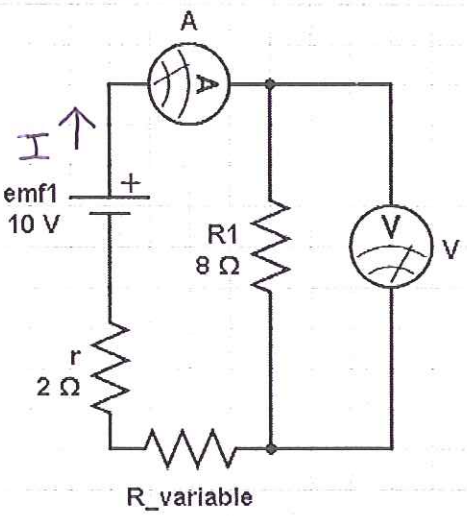
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

In the following circuit, the battery has an internal resistance 2Ω. The resistor R is variable such that its resistance can range from 0 to ∞. Determine the maximum and minimum readings that the ampermeter and the voltmeter show as R changes in the full range. Plot the reading of the voltmeter as a function of R values qualitatively.



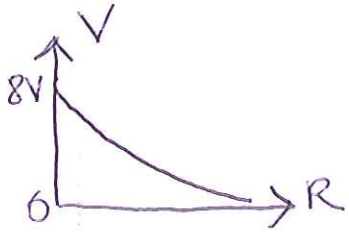
$10V - I(r + R_1 + R) = 0$

$10V = I(10\Omega + R)$

(A) reads ⇒ $\underbrace{I(R)}_{\text{function of } R} = \frac{10V}{(10\Omega + R)}$ $I_{max} = 1A$ $I_{min} = 0A$

(V) reads ⇒ $V_{R_1} = I(R)\,R_1$

$= \frac{80V\Omega}{(10\Omega + R)}$ $V_{max} = 8V$ $V_{min} = 0V$



Soln –

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Section 3 **Quiz 5** **14 March 2013**

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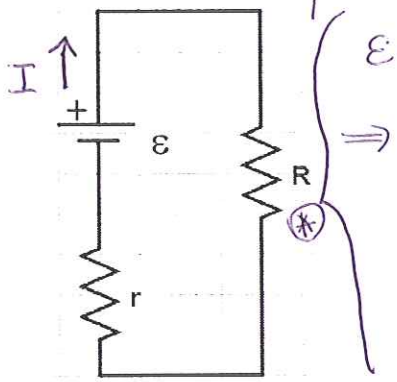
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Given the following circuit where the internal resistance of the battery is smaller than the resistor in the circuit (r < R). Show that when the value of R is doubled, the power dissipated in the battery decreases.



$\mathcal{E} - I_1 r - I_1 R = 0$

$\Rightarrow I_1 = \frac{\mathcal{E}}{r+R}$ (when resistance is R)

$I_2 = \frac{\mathcal{E}}{r+2R}$ (when resistance is 2R)

When resistance = R, power dissipated by battery:

$P_1 = I_1^2 r$

When resistance = 2R, power " " " :

$P_2 = I_2^2 r$

Since $I_2 < I_1$ by *

$P_2 < P_1$

Soln

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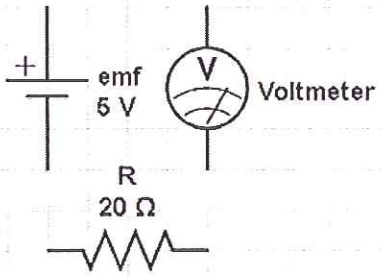
Section 4 **Quiz 5** **14 March 2013**

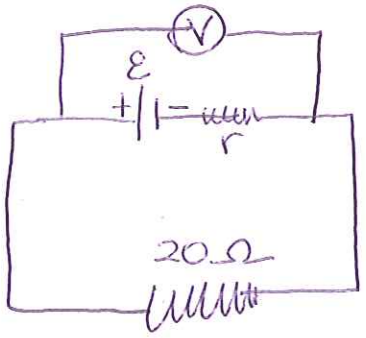
Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

You are given the following circuit elements and instruments. The battery has an unknown internal resistance. The voltmeter is ideal. (a) Design a circuit to determine the internal resistance of the battery. (b) Calculate the power output of the battery if the voltmeter in your circuit measures 4 V potential difference.



(a)



(b) $4V = \mathcal{E} - Ir$

$= (20\Omega)(I)$

$\Rightarrow I = \frac{1}{5}A = 0.2A$

$4V = 5V - (0.2)r$

$r = 5\Omega$

$P_\mathcal{E} = \mathcal{E} I = (5V)(0.2A) = 1W$

$P_r = I^2 r = 0.2 W$

$(0.2A)^2 \quad 5\Omega$

$P_{out} = P_\mathcal{E} - P_r = 0.8W$

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Section 5 **Quiz 5** **14 March 2013**

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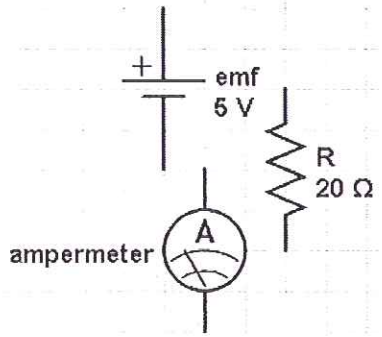
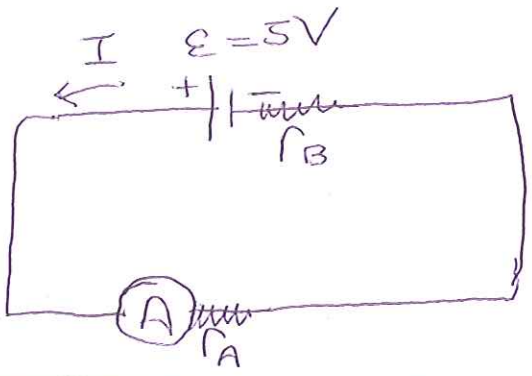
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

You are given the following circuit elements and instruments. The battery has an unknown internal resistance. The internal resistance of the ampermeter is 0.1Ω. (a) Design a circuit to determine the internal resistance of the battery. (b) Calculate the power output of the battery if the ampermeter indicates a current of 0.2A in your circuit.



(a, b)



$r_A = 0.1\,\Omega$ (internal resistance of (A))

r_B = unknown (internal resistance of battery)

$R = 20\,\Omega$

$\mathcal{E} = 5V$

Note that $P_{\mathcal{E}} - P_{r_B} = P_R + P_{r_A}$ also!

(b) $I = 0.2\,A$

$P_{\mathcal{E}} = (5V)(0.2A) = 1W$

$P_{r_B} = I^2 r_B = (0.2A)^2 (4.9\Omega) = 0.196\,W \simeq 0.2W$

$P_{output} = P_{\mathcal{E}} - P_{r_B} \simeq 0.8W$

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Section 6 **Quiz 5** **14 March 2013**

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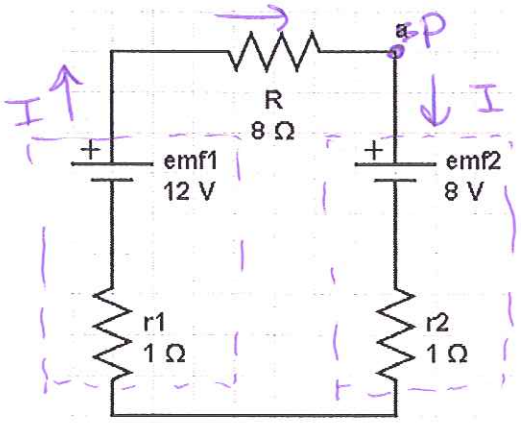
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

In the circuit shown in the figure, r1 and r2 are the internal resistance of the batteries with emf1 and emf2, respectively. R is a resistor connected to the circuit. (a) calculate the power input to the battery being charged, (b) plot the change of electric potential in a loop starting from point P as the zero level of potential and moving clockwise in the circuit.



(a) First, we find I

$$-8V - Ir_2 - Ir_1 + 12V - IR = 0$$

$$4V = (10\Omega)\, I \Rightarrow I = 0.4A$$

$$P_{input} = P_{\varepsilon_2} + P_{r_2} = \varepsilon_2 I + I^2 r_2$$

$$= (8V)(0.4A) + (0.4A)^2 \cdot 1\Omega$$

$$= 3.2W + 0.16W$$

$$= 3.36W$$