A Level Physics

ELECTRICAL CIRCUITS:
Complete Circuits 1

Name:

Total Marks: /30
1. Define electrical work, $W$, in terms of potential difference, $V$, and charge, $Q$. Using this relationship, show that $P = I^2 R$.

(b) The P.D. across a 5.0 Ω resistor is measured as 6.0 V. What power is it dissipating?

(c) An LED is connected in series with an ammeter and a power supply. A voltmeter is connected across the LED. They read 2.2 A and 4.6 V. If it is left on for 1 hour and 15 minutes, how much work is done by the LED?
(d) Sketch how the electrical work done by the resistor at a given point in time would vary with the resistance of the resistor. Assume the P.D. across the resistor is constant.
2. This question exploits Kirchoff’s laws to determine the resistances of several components in Figure 1.

Tom notes that the the bulb has an effective resistance of 5.0 Ω, that the voltmeter reads 2.0 V and that the ammeter reads 3.5 A.

(a) State Kirchoff’s First Circuit Law. What implications does it have for the charge entering and leaving a circuit junction?

(b) State Kirchoff’s Second Circuit Law.

(c) Calculate $R_1$.  

Figure 1: A circuit containing two resistors, a voltmeter, an ammeter, a cell and a bulb.
(d) Calculate $R_2$.  

(e) Calculate the power dissipated by the bulb. 

(f) The bulb dissipates 75% of its power as heat and converts the rest to light. What is the efficiency of this circuit as a means of lighting?
3. Based on the conservation of charge and of energy, it is possible to derive several laws that dictate how the total effective resistance in a circuit varies when a combination of resistors are used in series and/or parallel.

(a) Use Kirchoff’s and Ohm’s laws to derive an expression for the total effective resistance of two resistors, \( R_{1-2} \), in series. [2]

(b) Using a similar technique, show that for two resistors in parallel, \( \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \). [3]

(c) Two resistors (1.0 \( \Omega \) and 2.0 \( \Omega \)) connected in parallel are linked in series to a 3.0 \( \Omega \) resistor. All of this is in parallel with a fourth resistor. If the total effective resistance is 1.0 \( \Omega \), what is the resistance of the fourth resistor? [3]
4. Draw the symbols for the following circuit components:

(a) An LED. [1]

(b) A variable resistor. [1]

(c) A thermistor. [1]

(d) An LDR. [1]