MEGA LECTURE

AQA, Edexcel, OCR

A Level

A Level Physics

ELECTRICAL CIRCUITS:

Complete Circuits 2

Name:

M M E

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Total Marks: /30

1. This question is about the power supplied to a circuit.

Total for Question 1: 13

(a) Explain the terms *terminal P.D.*, *lost volts* and *internal resistance*. [3]

(b) Outline an experiment that could be performed to investigate the internal resistance of a power supply. Include details of the apparatus used, the measurements taken and any data analysis performed. [4]

Jeremy is provided with two cells, each with an emf, ϵ, of 6 V and an internal resistance, r, of 0.4 Ω. Any power supply he constructs will be connected to a 10 Ω resistor, through which he wishes to maximise the current.

(c) Jeremy does not know how best to combine his cells. Calculate ϵ_{total} and I for each of the following arrangements below and determine his best course of action. [4]

i. A single cell.

ii. Two cells connected in parallel.

iii. Two cells connected in series.

(d) Give an example of when low and when high internal resistances might be desirable. [2]

2. Many cordless hair-dryers have more than one setting. One way in which this can be achieved is by using a potential divider circuit: when the user changes the setting, the resistance of a variable resistor is changed and, as a consequence, the power output to the dryer changes. A simple circuit that could be used for this is shown in Figure 1.

Total for Question 2: 17

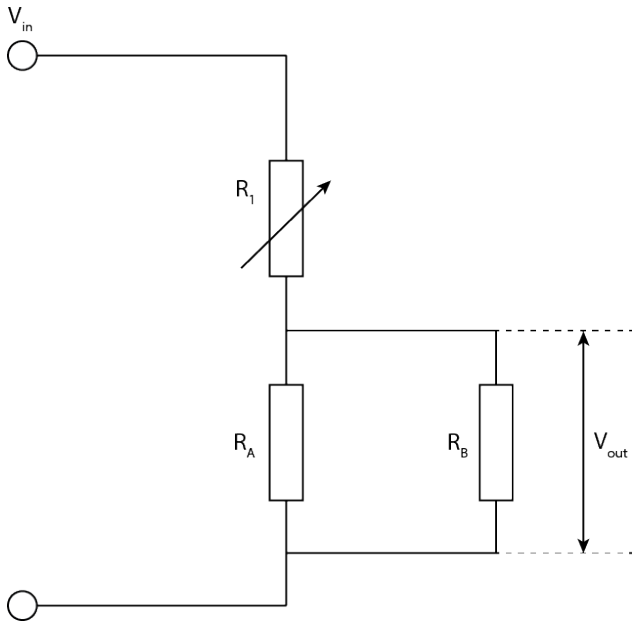

Figure 1: A circuit containing three components and a power supply. R_B is the resistance of the hair-drying mechanism.

(a) Using Ohm's Law, it is possible to show that the potential differences and resistances are linked by the equation [2]

$$\frac{V_1}{V_{out}} = \frac{R_1}{R_2}$$

where R_2 is the combined resistance of resistors A and B. Use this knowledge to show that

$$V_{out} = \frac{V_{in} R_2}{R_1 + R_2}$$

(b) Given that $R_A = 5\ \Omega$ and $R_B = 100\ \Omega$, calculate R_2. [1]

(c) The low, medium and high settings on the hair-dryer correspond to values for V_{out} of 6, 8 and 10 V, respectively. For each case, calculate R_1. [3]

Elaine is using the hair-dryer on its 'high' setting. To fully dry her hair, each square metre of hair surface requires 3 kj. Her hair has a surface area of 0.1 m^2.

(d) Calculate the power dissipated across R_B and hence the minimum amount of time required to dry Elaine's hair. Why is this a lower bound on the amount of time taken? [4]

(e) How would your answer changes if R_B were lowered? Why is this? [2]

So far you have explored how potential dividers can be used to modulate the power output, given a fixed power input. They can also be exploited in sensing circuits.

(f) Design a potential divider circuit which decreases V_{out} as temperature rises. [2]

(g) A machine used by the highways agency to re-paint faded white lines on the road network relies on an LDR sensing circuit to stay on the right course. The circuit comprises an LDR connected in series to a 500 Ω resistor and a 30 V power supply. The paint feeder will only dispense paint when V_{out} exceeds 28 V. Calculate the maximum resistance of the LDR when lines are being painted. [3]