H2 Physics Revision Topic : DC Circuits

Structured Questions Name: ______________________

1 A battery of electromotive force (e.m.f.) 3.0 V and negligible internal resistance is connected to a potentiometer, as shown in Fig. 4.1.

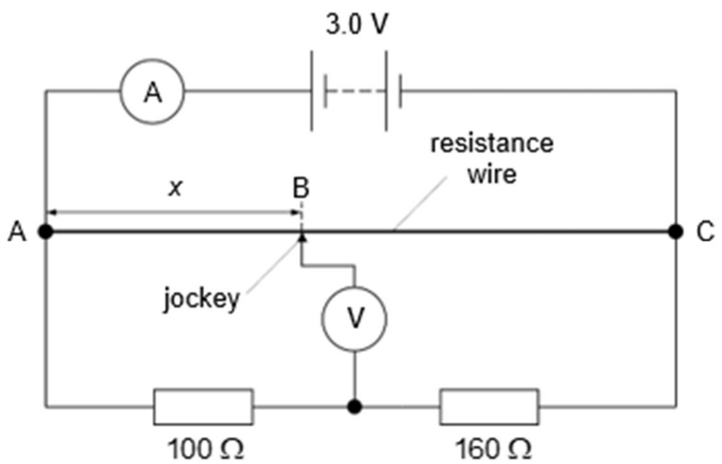

Fig. 4.1

The potentiometer consists of a 90 cm length of resistance wire AC. It is connected in parallel with a 100 Ω resistor and a 160 Ω resistor.

The jockey is in contact with the resistance wire at position B and the distance between A and B is *x*.

(a) **(i)** The jockey is adjusted until the voltmeter reading is zero.

Determine the value of *x*.

x = ... cm [2]

(ii) The ammeter reading is 234 mA.

Show that the resistance of wire AC is 13.5 Ω.

[2]

1 **(iii)** State and explain the change, if any, to the resistance determined in **(a)(ii)** if the battery has internal resistance.

....

....

....

....

.... [2]

(b) An ideal diode is connected to the circuit and the battery is replaced by a 50 Hz sinusoidal alternating current (a.c.) power supply of peak voltage 12 V, as shown in Fig. 4.2.

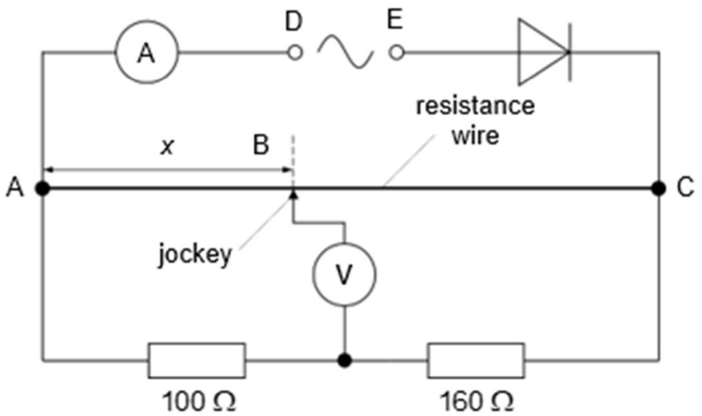

Fig. 4.2

(i) Determine the mean power dissipated in the resistance wire AC.

mean power = ... W [2]

1

(ii) Junctions D and E are connected to a cathode-ray oscilloscope (c.r.o.). The vertical scale of the c.r.o. is set to 4 V per division and the time-base is set to 5 ms per division.

Sketch the trace on the screen of the c.r.o. in Fig. 4.3.

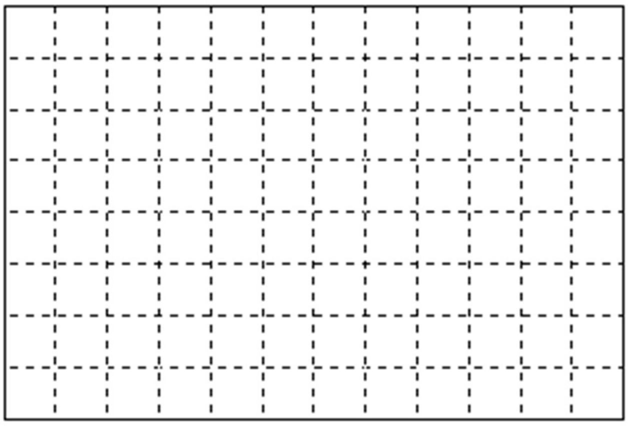

Fig. 4.3

[1]

2 **(a)** A light-dependent resistor (LDR) is connected to a variable resistor R_1 and a fixed resistor R_2, as shown in Fig. 6.1.

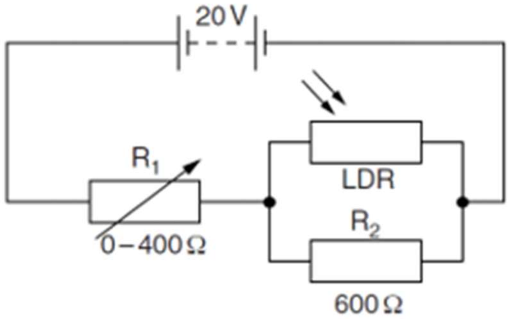

Fig. 6.1

When the light intensity is varied, the resistance of the LDR changes from 5.0 kΩ to 1.2 kΩ.

(i) For the maximum light intensity, calculate the total resistance of R_2 and the LDR.

total resistance = ... Ω [2]

(ii) Fig 6.2 shows the circuit when the LDR is removed.

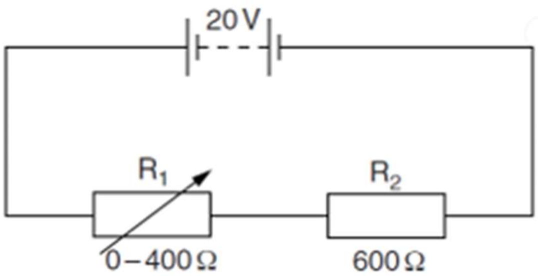

Fig. 6.2

The resistance of R_1 is varied from 0 to 400 Ω in the circuits of Fig. 6.1 and Fig. 6.2. State and explain the difference, if any, between the minimum potential difference across R_2 in each circuit. Numerical values are not required.

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....

....

.... [3]

2 **(b)** In Fig. 6.3, XZ is a uniform metre wire and has a resistance of 10.0 Ω. E is a power supply of electromotive force (e.m.f.) 2.0 V with negligible internal resistance. The resistor R_1 has a resistance of 15.0 Ω and the resistor R_2 has a resistance of 5.0 Ω.

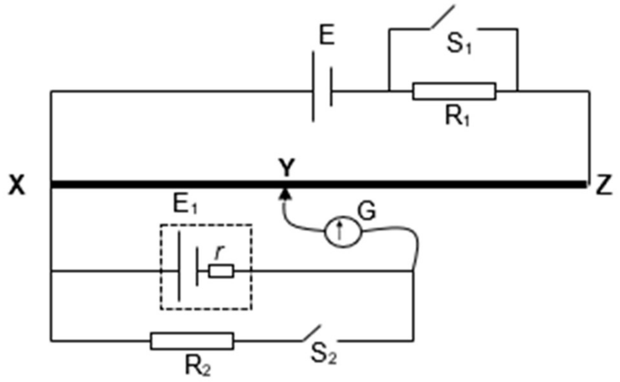

Fig. 6.3

With both switches S_1 and S_2 open, length YZ is 37.5 cm when galvanometer G registers null deflection.

When S_1 and S_2 are closed, length YZ is 90.0 cm when galvanometer G registers null deflection.

(i) Show that the e.m.f. of cell E_1 is 0.50 V.

[3]

(ii) Determine the internal resistance r of cell E_1.

r = ………………………………Ω [3]

[Total: 11]

3 **(a)** A cell of e.m.f. 2.50 V and internal resistance r is connected to two resistive wires in series as shown in Fig. 5.1.

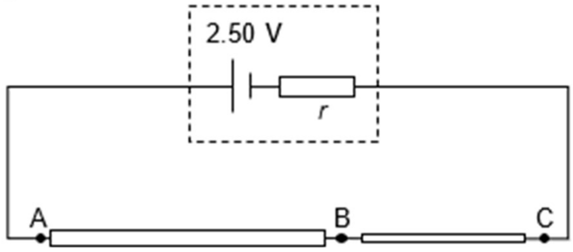

Fig. 5.1

The wires are made of the same material but have different lengths and diameters. Wire AB is 50.0 cm long and has a diameter d, whereas wire BC is 30.0 cm long and has a diameter 0.30 d. The connecting wires are assumed to have no resistance.

Show that $\dfrac{R_{AB}}{R_{BC}} = 0.15$.

[2]

(b) An ammeter is added to the circuit in **(a)**, along with a voltmeter connected across wire BC as shown in Fig. 5.2.

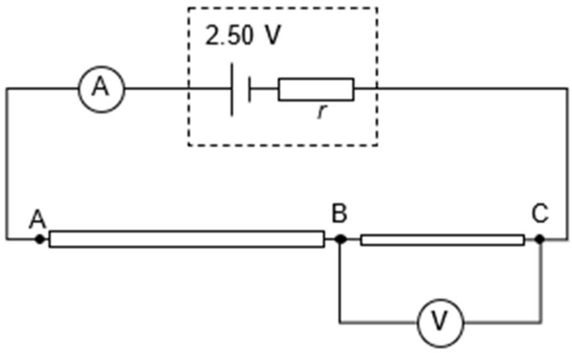

Fig. 5.2

If the ammeter shows a reading of 0.400 A and the voltmeter gives a reading of 2.00 V,

(i) show that the terminal potential difference of the cell is 2.30 V, 3

terminal potential difference = …………………….V [2]

(ii) determine the internal resistance *r* of the 2.50 V cell,

r = ……………………Ω [2]

(iii) calculate the efficiency of the circuit.

efficiency = …………………..% [2]

(c) Suggest and explain whether your answer in **(b)(ii)** is an overestimate or underestimate if the ammeter is not ideal.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

4 **(a)** A circuit suitable for temperature measurement includes the use of a thermistor as shown in Fig. 6.1. Any change in temperature will cause a change in the value of the thermistor R_T so that there is a significant change in potential difference between X and Y which is connected to a voltmeter. A cell of electromotive force (e.m.f) E supplies current to the circuit.

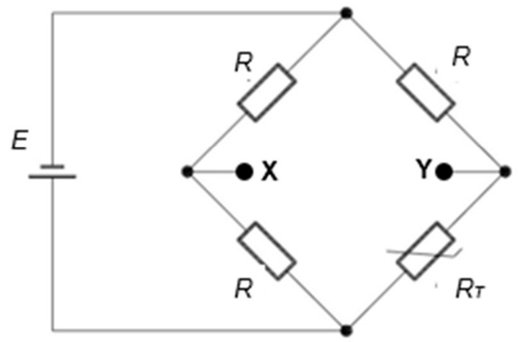

Fig. 6.1

(i) Distinguish between electromotive force (e.m.f) and potential difference.

....

....

.... [2]

(ii) Show that the potential difference between X and Y is given as

$$V_{XY} = \frac{R - R_T}{2(R + R_T)}E$$

[2]

4 **(c)** Another cell of e.m.f. E_1 is then connected in a simple series circuit, which is connected to a potentiometer as shown in Fig. 6.2. The potentiometer consists of a battery of e.m.f. E_2, a variable resistor and a uniform slide-wire of length L. The balance length, L_Y, is achieved by sliding the key along the slide-wire till the galvanometer shows a null deflection.

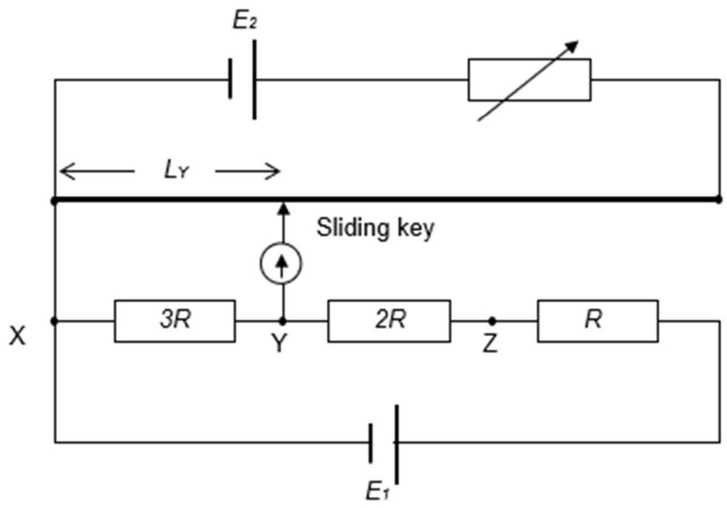

Fig. 6.2

(i) Explain in detail how a *decrease* in the resistance of the variable resistor will affect the magnitude of L_Y.

....

....

....

.... [2]

(ii) A balance length of L_Z is found when one end of the wire attached to the galvanometer is connected to Z. Calculate the ratio of $L_Y : L_Z$.

ratio = ... [2]

4 **(iii)** State and explain any change in the answer to **(c)(ii)** if the internal resistance of the cell E_1 is not negligible.

....

....

....

.... [2]

[Total: 10]

5 A cell of constant e.m.f. E and internal resistance r is connected to a 100.0 cm length of a high-resistivity wire XY at points X and J, where J is a movable contact. A voltmeter is connected across X and J. The circuit is shown in **Fig. 4.1**. The poorly-constructed voltmeter has a finite resistance R_V. An ammeter with negligible resistance is connected in series with the cell to measure the current I.

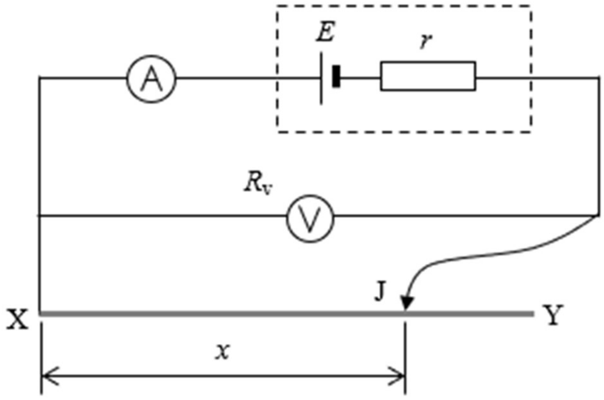

Fig. 4.1

By adjusting the distance x between X and the movable contact J, two sets of data were recorded with high accuracy, as shown in **Fig. 4.2**.

Distance XJ x / cm	Voltmeter reading V / V	Ammeter reading I / A
50.0	5.66	0.724
100.0	5.96	0.405

Fig. 4.2

(a) Use the data in **Fig. 4.2** to determine the e.m.f. E and internal resistance r of the cell.

E = …………………….. V

r = ………………… Ω [3]

5 **(b)** Determine the effective resistance between points X and J when x = 100.0 cm.

Effective resistance = ………………… Ω [1]

(c) By using the result from **(b)** and the effective resistance between X and J when x = 50.0 cm, calculate the resistance R_v of the voltmeter and the resistance R of the wire XY.

R_v = …………………… Ω

R = ………………… Ω [3]

The voltmeter is now removed and the ammeter is replaced by a galvanometer. A second cell of unknown e.m.f. E_c and negligible internal resistance is now connected across the wire XY, as shown in **Fig. 4.3**.

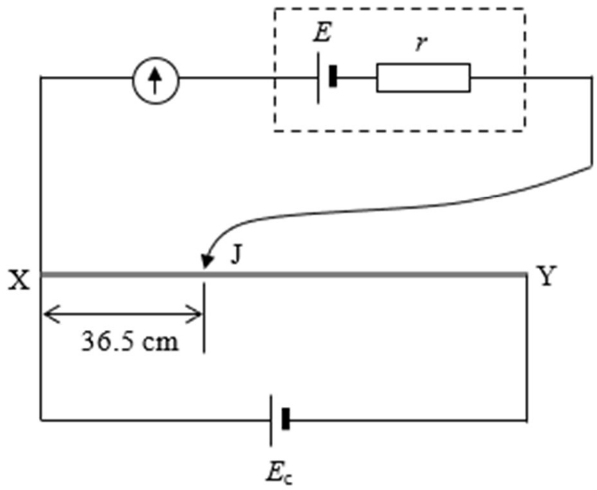

Fig. 4.3

5 The movable contact J is adjusted and the galvanometer indicates zero current when the length x between X and J is 36.5 cm.

(d) Determine the e.m.f. E_c of the second cell.

E_c = …………………….. V [3]