Practical circuits: 12

TOPIC-Internal resistance, potential dividers, potentiometer circuits

0 1 A battery connected in series with a resistor R of resistance 5.0 Ω is shown in Fig. 6.1.

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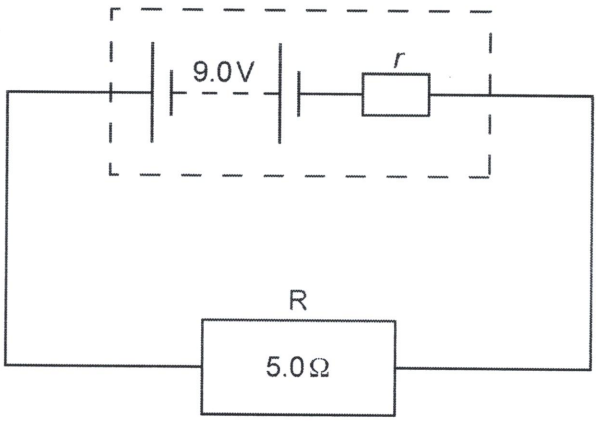

Fig. 6.1

The electromotive force (e.m.f.) of the battery is 9.0V and the internal resistance is *r*.
The potential difference (p.d.) across the battery terminals is 6.9V.

(a) Use energy considerations to explain why the p.d. across the battery is not equal to the e.m.f. of the battery.

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.....

..... [2]

(b) Calculate

(i) the current in the circuit,

current = ... A [2]

(ii) the internal resistance *r*.

r = ... Ω [2]

(c) Calculate, for the battery in the circuit,

For Examiner's Use

(i) the total power produced,

power = ... W [2]

(ii) the efficiency.

efficiency = ... [2]

0 2 5 **(a)** Explain why the terminal potential difference (p.d.) of a cell with internal resistance may be less than the electromotive force (e.m.f.) of the cell.

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.....[2]

(b) A battery of e.m.f. 4.5 V and internal resistance r is connected in series with a resistor of resistance 6.0 Ω, as shown in Fig. 5.1.

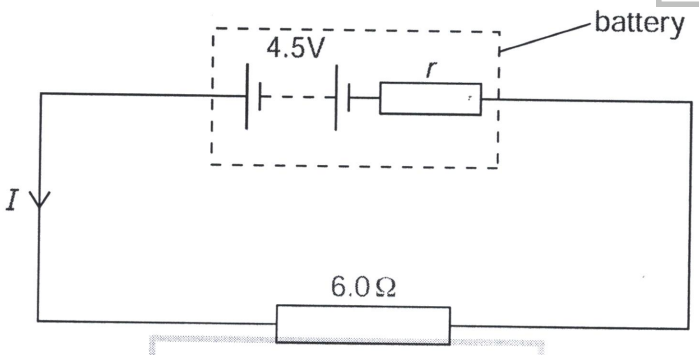

Fig. 5.1

The current I in the circuit is 0.65 A.

Determine

(i) the internal resistance r of the battery,

r = ... Ω [2]

(ii) the terminal p.d. of the battery,

p.d. = ... V [2]

(iii) the power dissipated in the resistor,

power = ... W [2]

(iv) the efficiency of the battery.

efficiency = ... [2]

(c) A second resistor of resistance 20 Ω is connected in parallel with the 6.0 Ω resistor in Fig. 5.1.

Describe and explain qualitatively the change in the heating effect within the battery.

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.....

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.....[3]

0 3 A cell has electromotive force (e.m.f.) E and internal resistance r. It is connected in series with a variable resistor R, as shown in Fig. 6.1.

For Examiner's Use

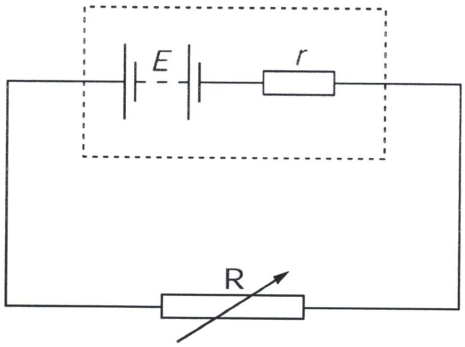

Fig. 6.1

(a) Define electromotive force (e.m.f.).

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.....

..... [2]

(b) The variable resistor R has resistance X. Show that

$$\frac{\text{power dissipated in resistor R}}{\text{power produced in cell}} = \frac{X}{X + r}.$$

[3]

(c) The variation with resistance X of the power P_R dissipated in R is shown in Fig. 6.2.

For Examiner's Use

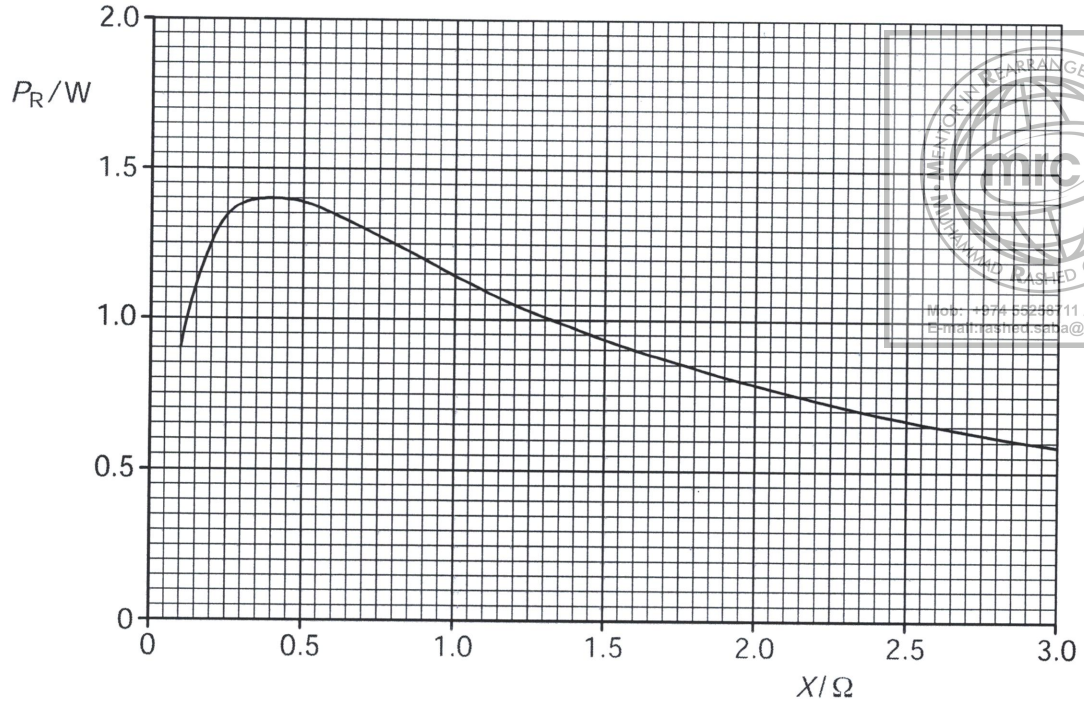

Fig. 6.2

(i) Use Fig. 6.2 to state, for maximum power dissipation in resistor R, the magnitude of this power and the resistance of R.

maximum power = ... W

resistance = ... Ω

[2]

(ii) The cell has e.m.f. 1.5 V.
Use your answers in **(i)** to calculate the internal resistance of the cell.

internal resistance = ... Ω [3]

(d) In Fig. 6.2, it can be seen that, for larger values of X, the power dissipation decreases. Use the relationship in **(b)** to suggest one advantage, despite the lower power output, of using the cell in a circuit where the resistance X is larger than the internal resistance of the cell.

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..... [1]

0 4 A potential divider circuit consists of two resistors of resistances P and Q, as shown in Fig. 7.1.

For Examiner's Use

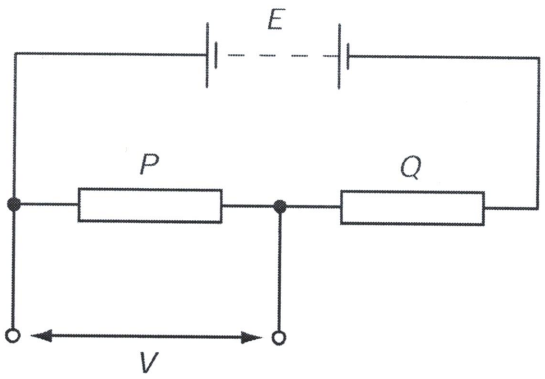

Fig. 7.1

The battery has e.m.f. E and negligible internal resistance.

(a) Deduce that the potential difference V across the resistor of resistance P is given by the expression

$$V = \frac{P}{P+Q} E.$$

[2]

(b) The resistances P and Q are 2000 Ω and 5000 Ω respectively.
A voltmeter is connected in parallel with the 2000 Ω resistor and a thermistor is connected in parallel with the 5000 Ω resistor, as shown in Fig. 7.2.

For Examiner's Use

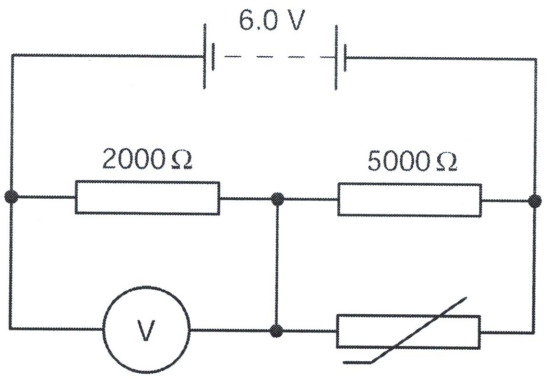

Fig. 7.2

The battery has e.m.f. 6.0 V. The voltmeter has infinite resistance.

(i) State and explain qualitatively the change in the reading of the voltmeter as the temperature of the thermistor is raised.

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.....

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..... [3]

(ii) The voltmeter reads 3.6 V when the temperature of the thermistor is 19 °C.
Calculate the resistance of the thermistor at 19 °C.

resistance = ... Ω [4]

0 5 A battery of electromotive force 12V and negligible internal resistance is connected to two resistors and a light-dependent resistor (LDR), as shown in Fig. 4.1.

For Examiner's Use

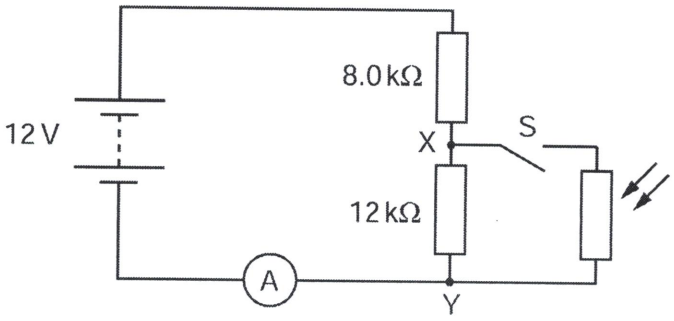

Fig. 4.1

An ammeter is connected in series with the battery. The LDR and switch S are connected across the points XY.

(a) The switch S is open. Calculate the potential difference (p.d.) across XY.

p. d. = ... V [3]

(b) The switch S is closed. The resistance of the LDR is 4.0 kΩ. Calculate the current in the ammeter.

current = ... A [3]

(c) The switch S remains closed. The intensity of the light on the LDR is increased. State and explain the change to

For Examiner's Use

(i) the ammeter reading,

.....

.....

..... [2]

(ii) the p.d. across XY.

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..... [2]