10. D.C. Circuits

10.1 Practical circuits

Paper 2

Question Paper

1 **(c)** The electromotive force (e.m.f.) of the cell in Fig. 6.1 is 1.50 V.

The values of R_1 and R_2 are 10 Ω and 15 Ω respectively. The terminal p.d. of the cell is 1.35 V.

Calculate the internal resistance r of the cell.

r = ... Ω [3]

(d) A resistor of resistance R_3 is added to the circuit in Fig. 6.1, so that the circuit is as shown in Fig. 6.2.

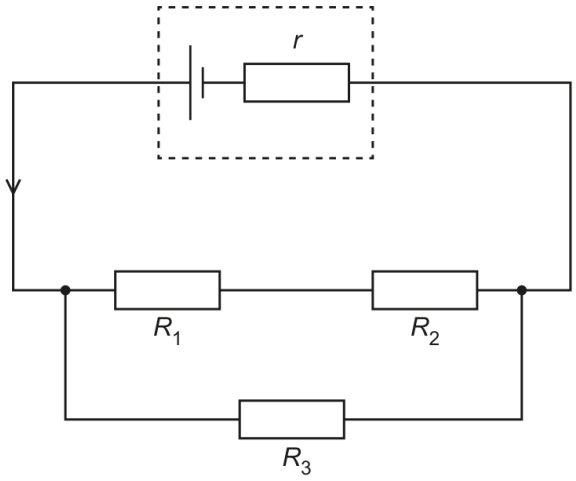


Fig. 6.2

State and explain the effect, if any, of this change on:

(ii) the terminal p.d. of the cell.

.....

.....

..... [2]

2 **(a)** Fig. 7.1 shows two resistors connected in series with a cell of electromotive force (e.m.f.) 1.50 V and internal resistance 0.28 Ω.

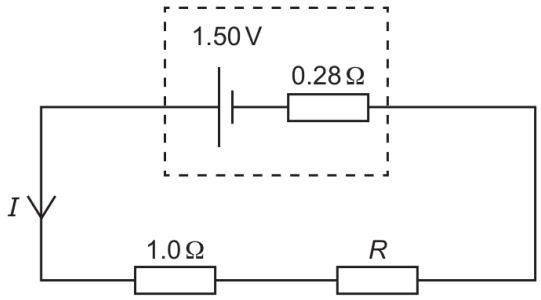


Fig. 7.1

One of the resistors has resistance 1.0 Ω. The other resistor has resistance *R*.
The terminal potential difference (p.d.) across the cell is 1.36 V.

(i) Show that the current I in the circuit is 0.50 A.

[2]

(b) The circuit in Fig. 7.1 is disconnected and the two resistors are reconnected to the cell, now in parallel with each other.

(i) On Fig. 7.2, complete the circuit diagram to show this arrangement.

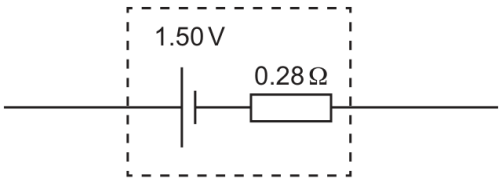


Fig. 7.2

[1]

(ii) Explain, without calculation, whether the terminal p.d. across the cell is now less than, equal to or greater than 1.36 V.

.....

.....

..... [2]

3 **(b)** A power supply, three resistors and a component X are connected in the circuit shown in Fig. 5.1.

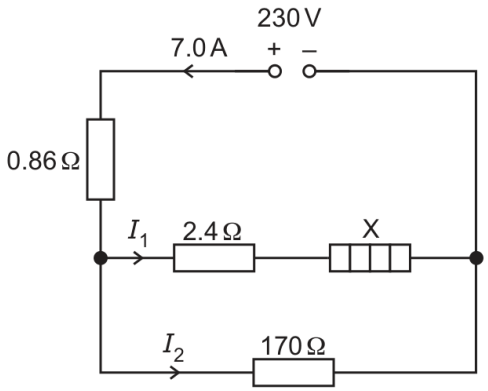


Fig. 5.1

The power supply has an electromotive force (e.m.f.) of 230 V and negligible internal resistance. The current in the power supply is 7.0 A.

(i) Identify component X.

..... [1]

4 A battery of electromotive force (e.m.f.) 9.6 V and negligible internal resistance is connected in series with two fixed resistors and a thermistor, as shown in Fig. 7.1.

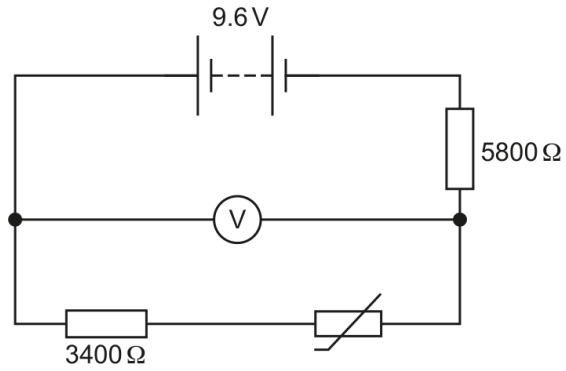


Fig. 7.1

The fixed resistors have resistances of 3400 Ω and 5800 Ω. The reading on the voltmeter in the circuit is 6.0 V.

(c) The initial energy stored in the battery is 2.6×10^4 J.

Assume that the e.m.f. of the battery is constant.

Determine the final energy stored in the battery after a charge of 330 C has moved through it.

final stored energy = ... J [2]

5 **(c)** A battery of electromotive force (e.m.f.) 9.0 V and internal resistance *r* is connected to two resistors P and Q, as shown in Fig. 6.2.

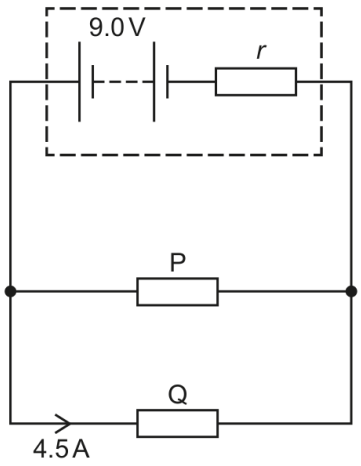


Fig. 6.2

A total charge of 650 C moves through resistor P in a time interval of 540 s. During this time resistor P dissipates 4800 J of energy. The current in resistor Q is 4.5 A. Assume that the e.m.f. of the battery remains constant.

Calculate:

(iii) the internal resistance *r* of the battery.

r = ... Ω [2]

6 **(c)** A battery of electromotive force (e.m.f.) E and internal resistance r is connected to a variable resistor of resistance R, as shown in Fig. 5.1.

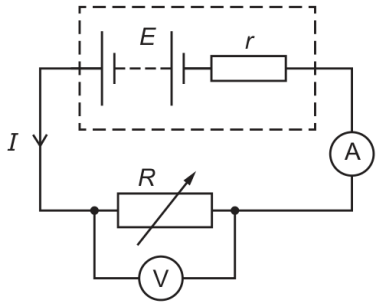


Fig. 5.1

An ammeter measures the current I in the circuit. A voltmeter measures the potential difference V across the variable resistor.

The resistance R is now varied to change the values of I and V.

The variation with I of V is shown in Fig. 5.2.

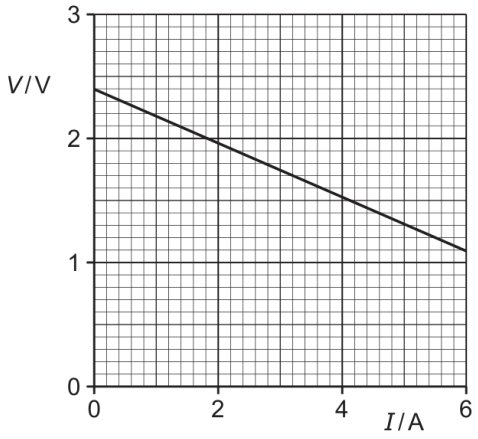


Fig. 5.2

(i) Use Fig. 5.2 to state the e.m.f. E of the battery.

E = ... V [1]

(iii) State what is represented by the value of the gradient of the graph.

..... [1]

7 **(c)** The battery in **(b)** is replaced with another battery of the same e.m.f. *E* but with an internal resistance that is not negligible.

State and explain the change, if any, in the total power produced by the battery.

.....

.....

..... [2]

8 **(a)** A battery of electromotive force (e.m.f.) 7.8 V and internal resistance *r* is connected to a filament lamp, as shown in Fig. 6.1.

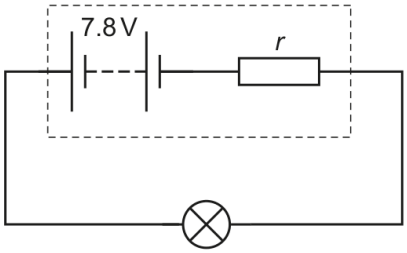


Fig. 6.1

A total charge of 750 C moves through the battery in a time interval of 1500 s. During this time the filament lamp dissipates 5.7 kJ of energy. The e.m.f. of the battery remains constant.

(i) Explain, in terms of energy and without a calculation, why the potential difference across the lamp must be less than the e.m.f. of the battery.

.....

..... [1]

(ii) Calculate:

1. the current in the circuit

current = ... A [2]

2. the potential difference across the lamp

potential difference = ... V [2]

3. the internal resistance of the battery.

internal resistance = ... Ω [2]

9 **(c)** A cell of electromotive force (e.m.f.) E and internal resistance r is connected to a variable resistor of resistance R, as shown in Fig. 7.1.

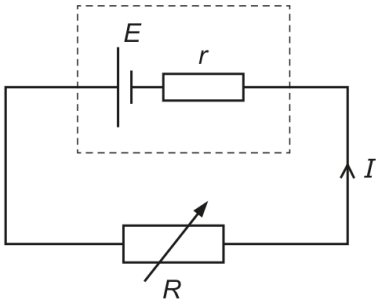


Fig. 7.1

The current in the circuit is I.

(i) State, in terms of energy, why the potential difference across the variable resistor is less than the e.m.f. of the cell.

.....

..... [1]

(ii) State an expression for E in terms of I, R and r.

E = ... [1]

10 **(b)** A battery of electromotive force (e.m.f.) 8.0 V and internal resistance *r* is connected to three resistors X, Y and Z, as shown in Fig. 6.2.

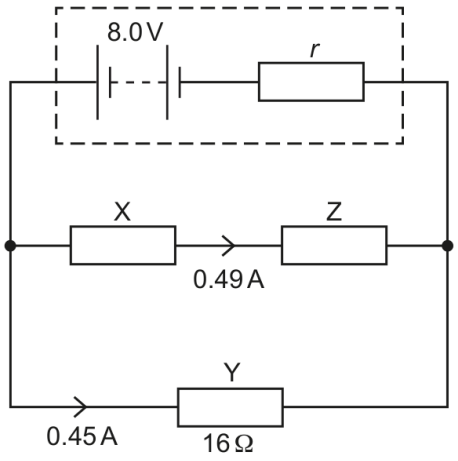


Fig. 6.2

Resistor Y has a resistance of 16 Ω. The current in resistor X is 0.49 A and the current in resistor Y is 0.45 A.

Calculate:

(ii) the internal resistance *r* of the battery.

r = ... Ω [2]

(d) Resistor Z in Fig. 6.2 is replaced by a new resistor of smaller resistance.

State and explain the effect, if any, on the terminal potential difference of the battery.

.....

.....

..... [2]

11 A battery of electromotive force (e.m.f.) E and internal resistance r is connected to a variable resistor of resistance R, as shown in Fig. 6.1.

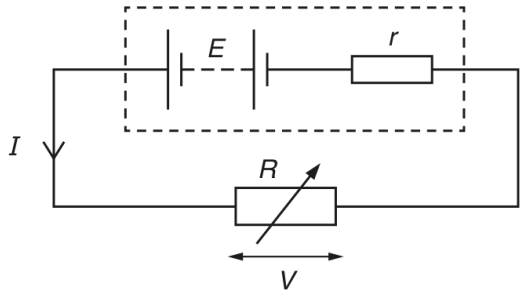


Fig. 6.1

The current in the circuit is I and the potential difference across the variable resistor is V.

(a) Explain, in terms of energy, why V is less than E.

.....

.....[1]

(b) State an equation relating E, I, r and V.

.....[1]

(c) The resistance R of the variable resistor is varied. The variation with I of V is shown in Fig. 6.2.

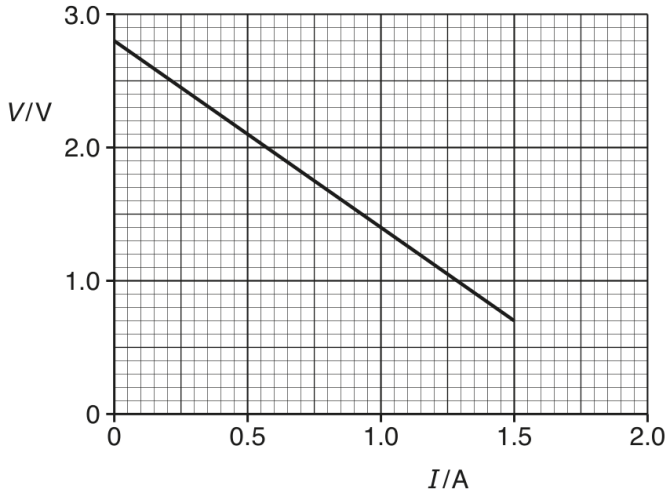


Fig. 6.2

Use Fig. 6.2 to:

(i) explain how it may be deduced that the e.m.f. of the battery is 2.8 V

.....

.....[1]

(ii) calculate the internal resistance *r*.

r = ... Ω [2]

(d) The battery stores 9.2 kJ of energy. The variable resistor is adjusted so that *V* = 2.1 V. Use Fig. 6.2 to:

(iii) determine the time taken for the energy in the battery to become equal to 1.6 kJ. (Assume that the e.m.f. of the battery and the current in the battery remain constant.)

time taken = ... s [3]

12 (b) A battery of electromotive force (e.m.f.) 5.6 V and internal resistance r is connected to two external resistors, as shown in Fig. 5.1.

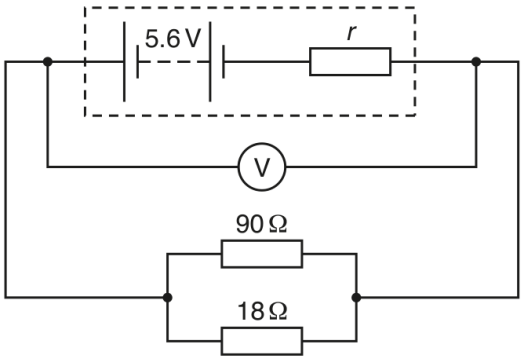


Fig. 5.1

The reading on the voltmeter is 4.8 V.

(ii) Show that the internal resistance r is 2.5 Ω.

[2]