www.mrc-papers.com

CLASSIFIED

International Examinations Papers

Mob: +974 55249797 / 55258711
E-mail:rashed.saba@gmail.com

Kirchhoff's laws: 10

TOPIC-First and second law, application and combination of resistor

01 Fig. 5.1 shows a 12 V power supply with negligible internal resistance connected to a uniform metal wire AB. The wire has length 1.00 m and resistance 10 Ω. Two resistors of resistance 4.0 Ω and 2.0 Ω are connected in series across the wire.

For Examiner's Use

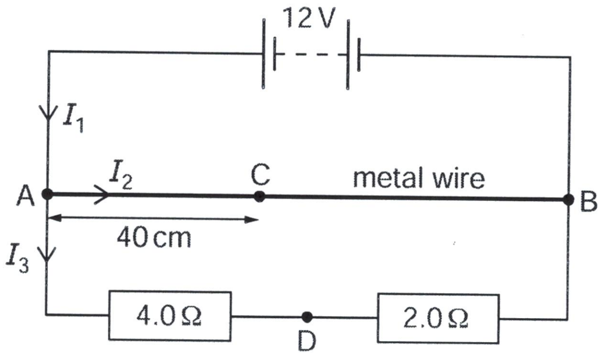

Fig. 5.1

Currents I_1, I_2 and I_3 in the circuit are as shown in Fig. 5.1.

(a) **(i)** Use Kirchhoff's first law to state a relationship between I_1, I_2 and I_3.

.... [1]

(ii) Calculate I_1.

I_1 = ... A [3]

(iii) Calculate the ratio *x*, where

$$x = \frac{\text{power in metal wire}}{\text{power in series resistors}}.$$

x = ... [3]

(b) Calculate the potential difference (p.d.) between the points C and D, as shown in Fig. 5.1. The distance AC is 40 cm and D is the point between the two series resistors.

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

02 **(a)** Distinguish between the electromotive force (e.m.f.) of a cell and the potential difference (p.d.) across a resistor.

For Examiner's Use

....

....

....

.... [3]

(b) Fig. 7.1. is an electrical circuit containing two cells of e.m.f. E_1 and E_2.

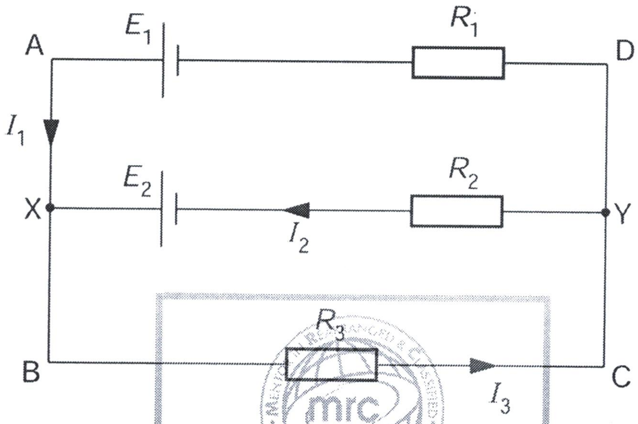

Fig. 7.1

The cells are connected to resistors of resistance R_1, R_2 and R_3 and the currents in the branches of the circuit are I_1, I_2 and I_3, as shown.

(i) Use Kirchhoff's first law to write down an expression relating I_1, I_2 and I_3.

.... [1]

(ii) Use Kirchhoff's second law to write down an expression relating

1. E_2, R_2, R_3, I_2 and I_3 in the loop XBCYX,

.... [1]

2. E_1, E_2, R_1, R_2, I_1 and I_2 in the loop AXYDA.

.... [1]

3 A network of resistors, each of resistance *R*, is shown in Fig. 7.1.

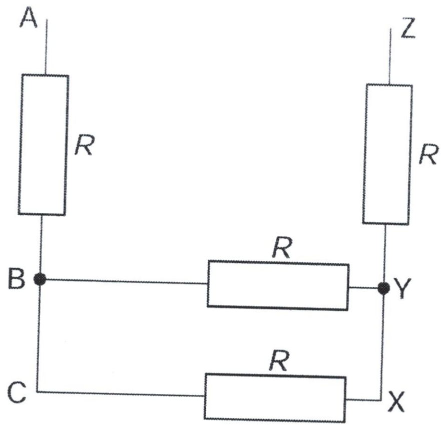

Fig. 7.1

(a) Calculate the total resistance, in terms of *R*, between points

(i) A and C,

resistance = ... [1]

(ii) B and X,

resistance = ... [1]

(iii) A and Z.

resistance = ... [1]

(b) Two cells of e.m.f. E_1 and E_2 and negligible internal resistance are connected into the network in **(a)**, as shown in Fig. 7.2.

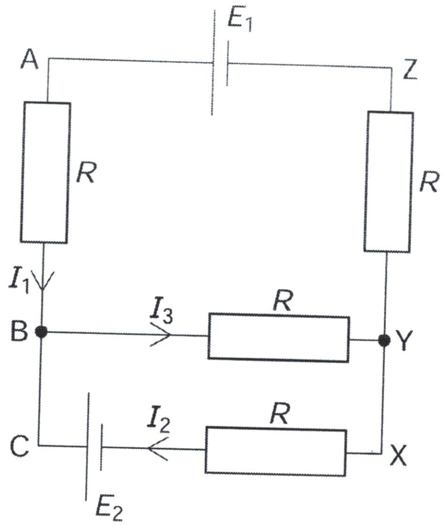

Fig. 7.2

The currents in the network are as indicated in Fig. 7.2.

Use Kirchhoff's laws to state the relation

(i) between currents I_1, I_2 and I_3,

.... [1]

(ii) between E_2, R, I_2 and I_3 in loop BCXYB,

.... [1]

(iii) between E_1, E_2, R, I_1 and I_2 in loop ABCXYZA.

.... [1]

04 A circuit used to measure the power transfer from a battery is shown in Fig. 4.1. The power is transferred to a variable resistor of resistance R.

For Examiner's Use

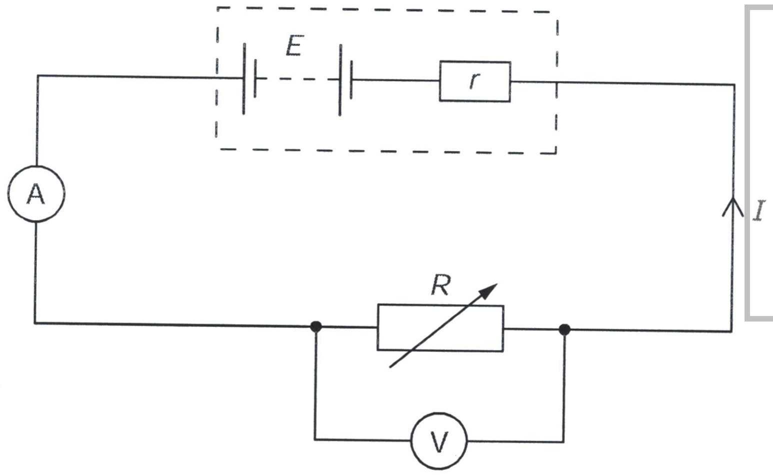

Fig. 4.1

The battery has an electromotive force (e.m.f.) E and an internal resistance r. There is a potential difference (p.d.) V across R. The current in the circuit is I.

(a) By reference to the circuit shown in Fig. 4.1, distinguish between the definitions of e.m.f. and p.d.

....

....

....

.... [3]

(b) Using Kirchhoff's second law, determine an expression for the current I in the circuit.

[1]

(c) The variation with current I of the p.d. V across R is shown in Fig. 4.2.

For Examiner's Use

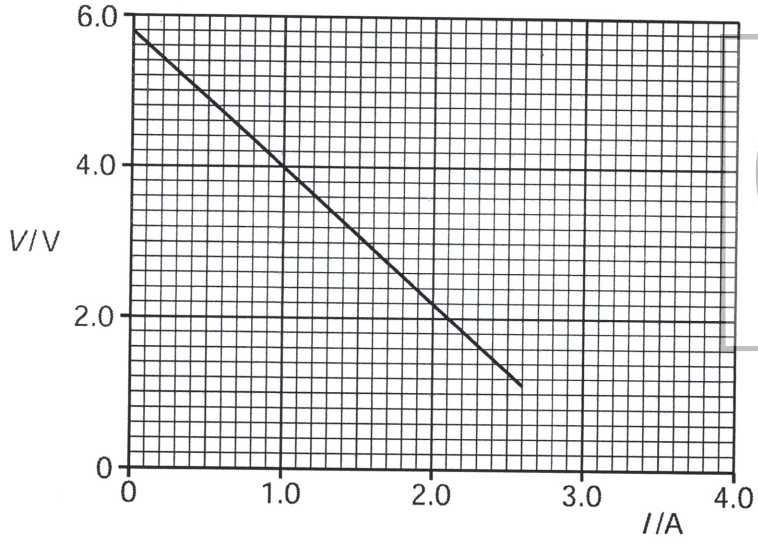

Fig. 4.2

Use Fig. 4.2 to determine

(i) the e.m.f. E,

E = ... V [1]

(ii) the internal resistance r.

r = ... Ω [2]

(d) **(i)** Using data from Fig. 4.2, calculate the power transferred to R for a current of 1.6 A.

power = ... W [2]

(ii) Use your answers from **(c)(i)** and **(d)(i)** to calculate the efficiency of the battery for a current of 1.6 A.

efficiency = ... % [2]

05 **(a)** A network of resistors, each of resistance R, is shown in Fig. 7.1.

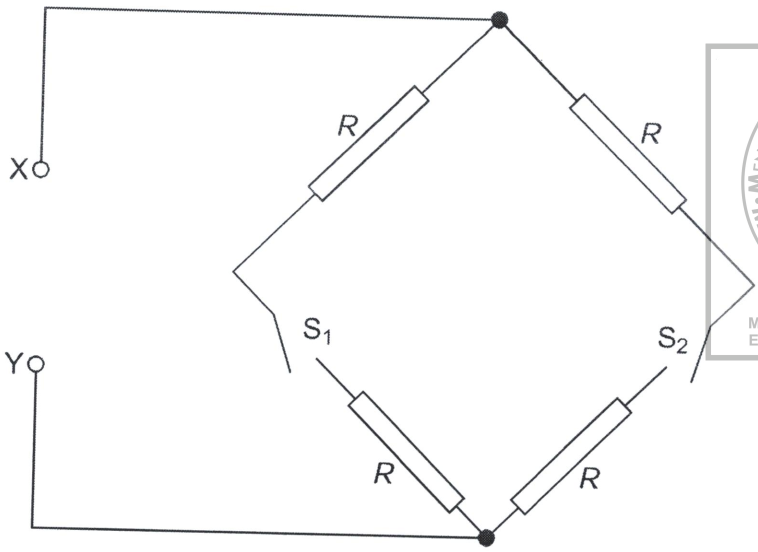

Fig. 7.1

Switches S_1 and S_2 may be 'open' or 'closed'.

Complete Fig. 7.2 by calculating the resistance, in terms of R, between points X and Y for the switches in the positions shown.

switch S_1	switch S_2	resistance between points X and Y
open	open	....
open	closed	....
closed	closed	....

Fig. 7.2

[3]

(b) Two cells of e.m.f. E_1 and E_2 and negligible internal resistance are connected into a network of resistors, as shown in Fig. 7.3.

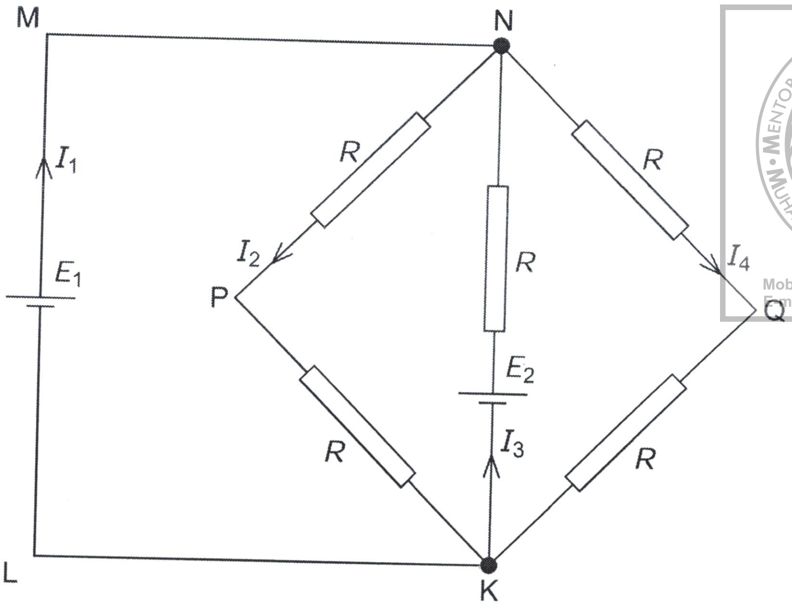

Fig. 7.3

The currents in the network are as indicated in Fig. 7.3.

Use Kirchhoff's laws to state the relation

(i) between currents I_1, I_2, I_3 and I_4,

.... [1]

(ii) between E_1, E_2, R, and I_3 in loop NKLMN,

.... [1]

(iii) between E_2, R, I_3 and I_4 in loop NKQN.

.... [1]

06 (a) For a cell, explain the terms

For Examiner's Use

(i) *electromotive force* (e.m.f.),

....

.... [1]

(ii) *internal resistance*.

....

.... [1]

(b) The circuit of Fig. 5.1 shows two batteries A and B and a resistor R connected in series.

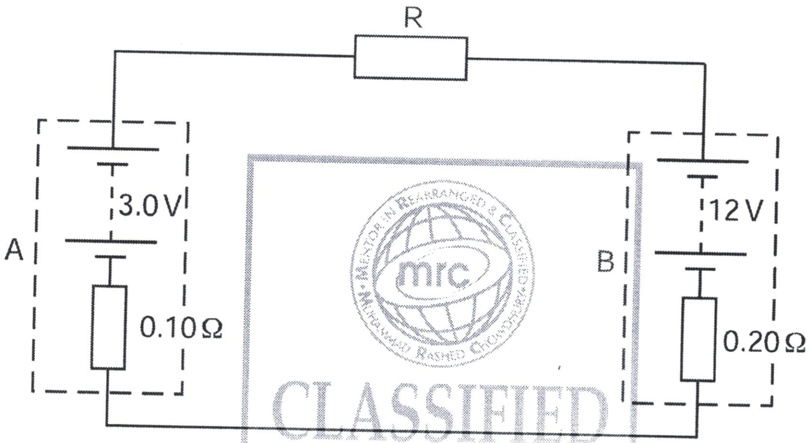

Fig. 5.1

Battery A has an e.m.f. of 3.0V and an internal resistance of 0.10Ω. Battery B has an e.m.f. of 12V and an internal resistance of 0.20Ω. Resistor R has a resistance of 3.3Ω.

(i) Apply Kirchhoff's second law to calculate the current in the circuit.

current = ... A [2]

(ii) Calculate the power transformed by battery B.

power = ... W [2]

For Examiner's Use

(iii) Calculate the total energy lost per second in resistor R and the internal resistances.

energy lost per second = ... $J s^{-1}$ [2]

(c) The circuit of Fig. 5.1 may be used to store energy in battery A. Suggest how your answers in **(b)** support this statement.

....

....

.... [1]

07 (a) (i) State Kirchhoff's second law.

....

.... [1]

(ii) Kirchhoff's second law is linked to the conservation of a certain quantity. State this quantity.

.... [1]

(b) The circuit shown in Fig. 5.1 is used to compare potential differences.

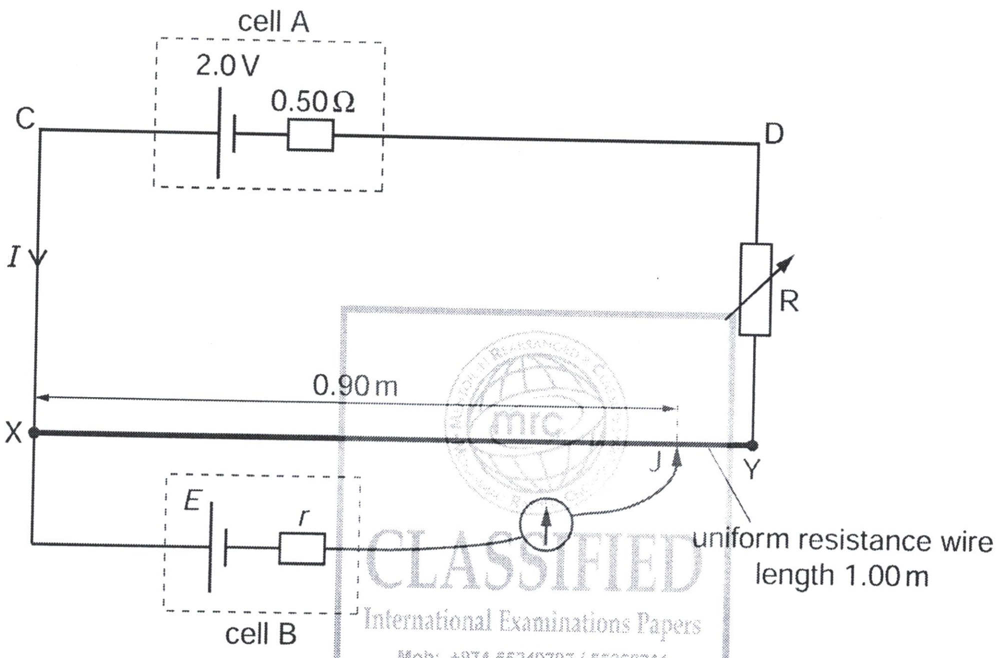

Fig. 5.1

The uniform resistance wire XY has length 1.00 m and resistance 4.0 Ω. Cell A has e.m.f. 2.0 V and internal resistance 0.50 Ω. The current through cell A is I. Cell B has e.m.f. E and internal resistance r.

The current through cell B is made zero when the movable connection J is adjusted so that the length of XJ is 0.90 m. The variable resistor R has resistance 2.5 Ω.

(i) Apply Kirchhoff's second law to the circuit CXYDC to determine the current I.

I = ... A [2]

(ii) Calculate the potential difference across the length of wire XJ.

For Examiner's Use

potential difference = ... V [2]

(iii) Use your answer in **(ii)** to state the value of *E*.

E = ... V [1]

(iv) State why the value of the internal resistance of cell B is not required for the determination of *E*.

....

.... [1]

0 8 A battery of electromotive force (e.m.f.) 12 V and internal resistance *r* is connected in series to two resistors, each of constant resistance *X*, as shown in Fig. 5.1.

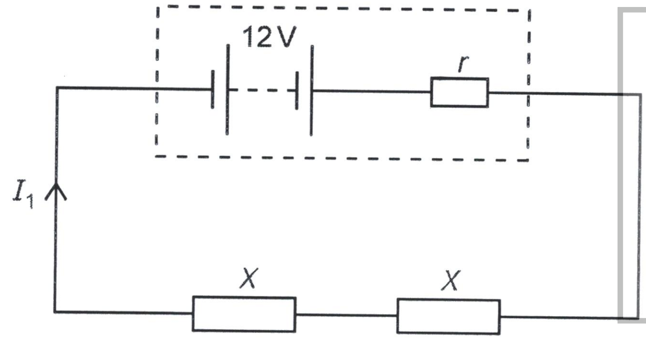

Fig. 5.1

The current I_1 supplied by the battery is 1.2 A.

The same battery is now connected to the same two resistors in parallel, as shown in Fig. 5.2.

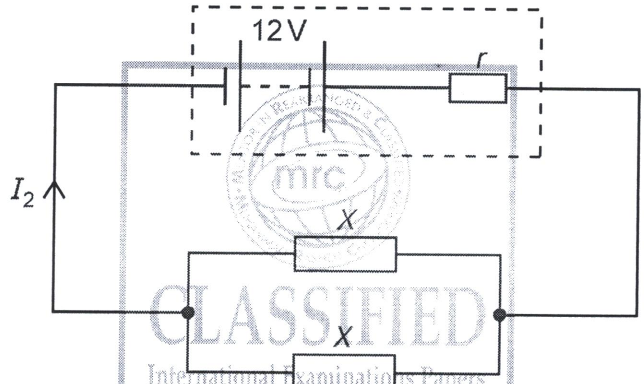

Fig. 5.2

The current I_2 supplied by the battery is 3.0 A.

(a) **(i)** Show that the combined resistance of the two resistors, each of resistance *X*, is four times greater in Fig. 5.1 than in Fig. 5.2.

[2]

(ii) Explain why I_2 is not four times greater than I_1.

....

....

....[2]

(iii) Using Kirchhoff's second law, state equations, in terms of e.m.f., current, X and r, for

1. the circuit of Fig. 5.1,

....

2. the circuit of Fig. 5.2.

....
[2]

(iv) Use the equations in **(iii)** to calculate the resistance X.

X = ... Ω [1]

(b) Calculate the ratio

$$\frac{\text{power transformed in one resistor of resistance } X \text{ in Fig. 5.1}}{\text{power transformed in one resistor of resistance } X \text{ in Fig. 5.2}}.$$

ratio = ...[2]

(c) The resistors in Fig. 5.1 and Fig. 5.2 are replaced by identical 12V filament lamps.

Explain why the resistance of each lamp, when connected in series, is not the same as the resistance of each lamp when connected in parallel.

....

....

....

....[2]