Practical Circuits & Kirchoff's Law

Question paper 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	D.C. Circuits
Sub Topic	Practical Circuits & Kirchoff's Law
Paper Type	Theory
Booklet	Question paper 1

Time Allowed: **75 minutes**

Score: **/62**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 The variation with potential difference (p.d.) V of current I for a semiconductor diode is shown in Fig. 5.1.

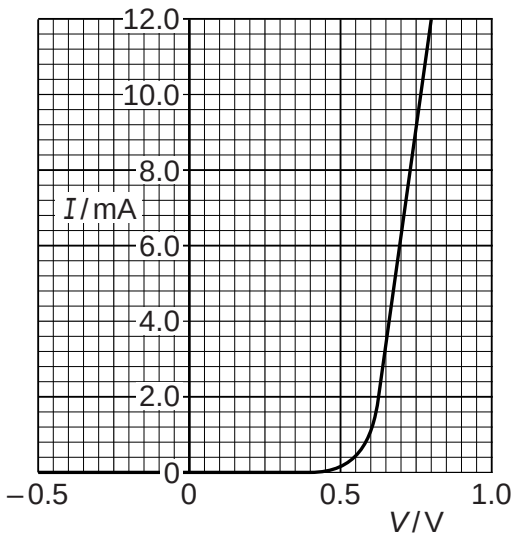

Fig. 5.1

(a) Use Fig. 5.1 to describe the variation of the resistance of the diode between $V = -0.5\,V$ and $V = 0.8\,V$.

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.....[2]

(b) On Fig. 5.2, sketch the variation with p.d. V of current I for a filament lamp. Numerical values are not required.

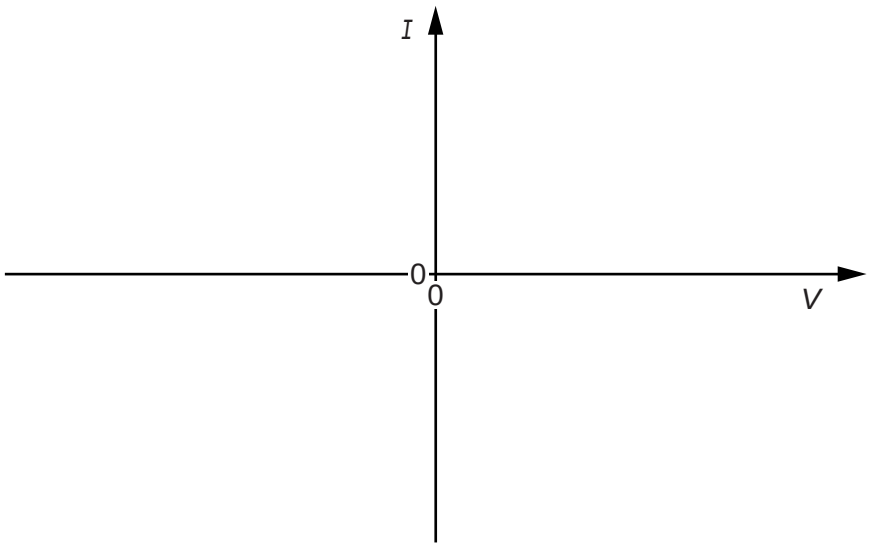

Fig. 5.2

[2]

(c) Fig. 5.3 shows a power supply of electromotive force (e.m.f.) 12 V and internal resistance 0.50 Ω connected to a filament lamp and switch.

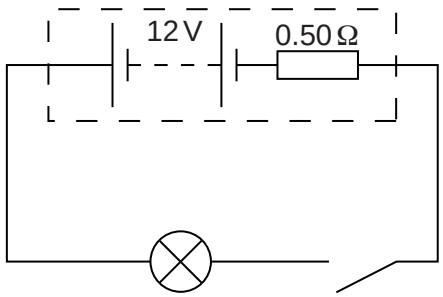

Fig. 5.3

The filament lamp has a power of 36 W when the p.d. across it is 12 V.

(i) Calculate the resistance of the lamp when the p.d. across it is 12 V.

resistance = ... Ω [1]

(ii) The switch is closed and the current in the lamp is 2.8 A. Calculate the resistance of the lamp.

resistance = ... Ω [3]

(d) Explain how the two values of resistance calculated in **(c)** provide evidence for the shape of the sketch you have drawn in **(b)**.

.....

.....[1]

2 **(a)** A cell with internal resistance supplies a current. Explain why the terminal potential difference (p.d.) is less than the electromotive force (e.m.f.) of the cell.

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.....

..... [1]

(b) A battery of e.m.f. 12 V and internal resistance 0.50 Ω is connected to a variable resistor X and a resistor Y of constant resistance, as shown in Fig. 7.1.

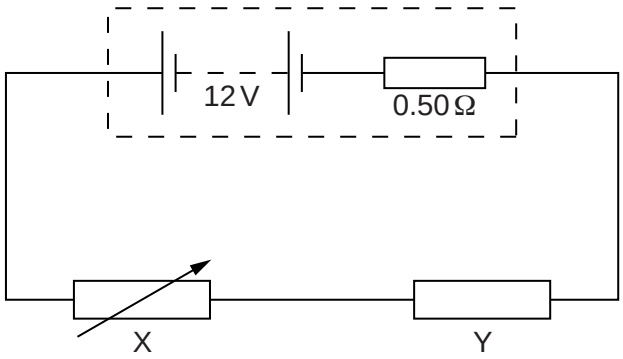

Fig. 7.1

The resistance R of X is increased from 2.0 Ω to 16 Ω. The variation with R of the current I in the circuit is shown in Fig. 7.2.

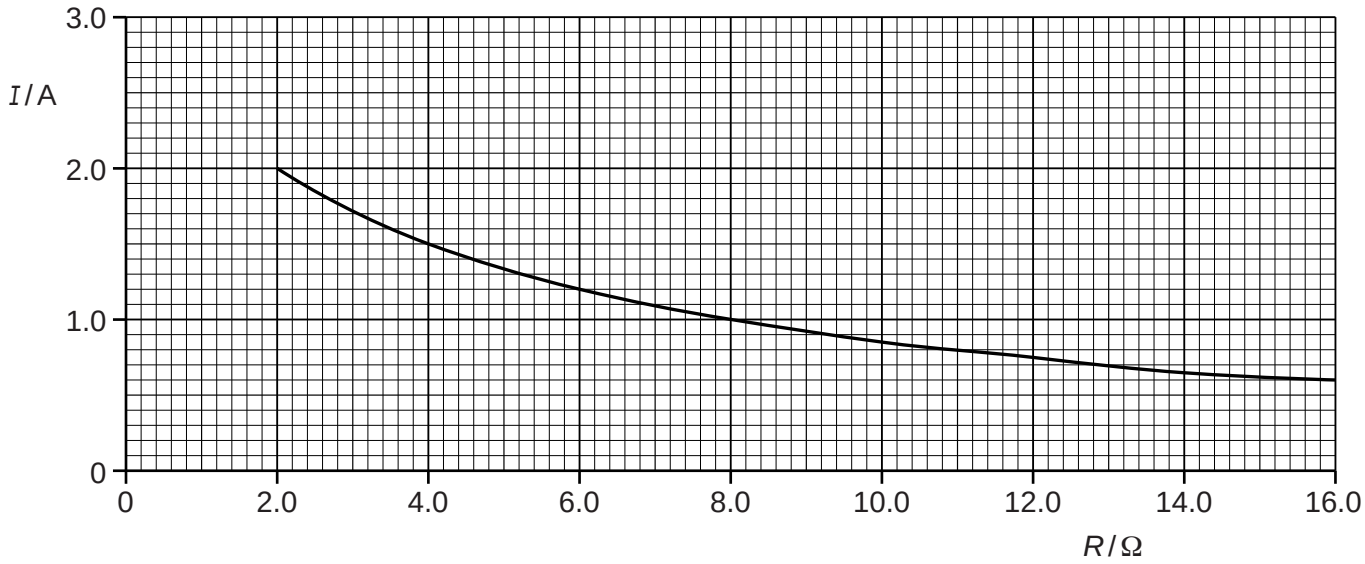

Fig. 7.2

Calculate, for I = 1.2 A,

(i) the p.d. across X,

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

(ii) the resistance of Y,

resistance = ... Ω [3]

(iii) the power dissipated in the battery.

power = ... W [2]

(c) Use Fig. 7.2 to explain the variation in the terminal p.d. of the battery as the resistance R of X is increased.

.....

..... [1]

3 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.

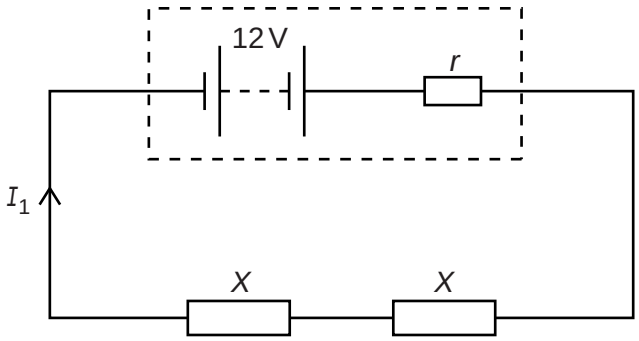

Fig. 5.1

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.

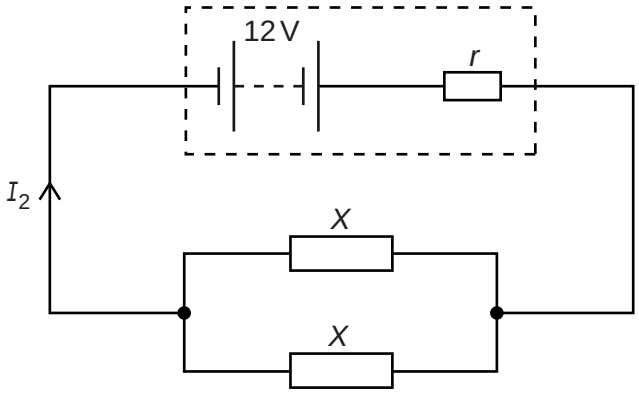

Fig. 5.2

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.

.....

.....

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.....[2]

4 **(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. 4.5V and internal resistance *r* is connected in series with a resistor of resistance 6.0Ω, as shown in Fig. 5.1.

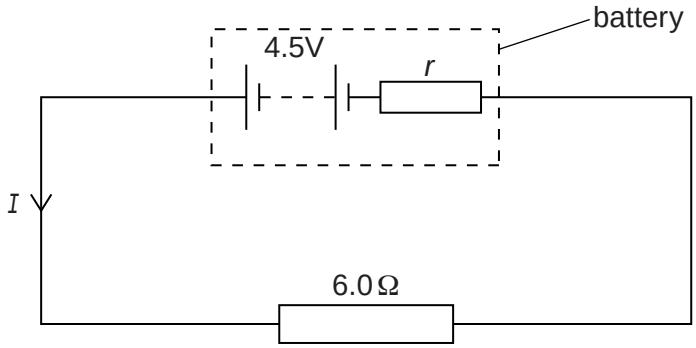

Fig. 5.1

The current *I* in the circuit is 0.65A.

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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.....[3]

5 **(a)** **(i)** Define, for a wave,

1. wavelength λ,

.....

..... [1]

2. frequency f.

.....

..... [1]

(ii) Use your definitions to deduce the relationship between λ, f and the speed v of the wave.

[1]

(b) Plane waves on the surface of water are represented by Fig. 5.1 at one particular instant of time.

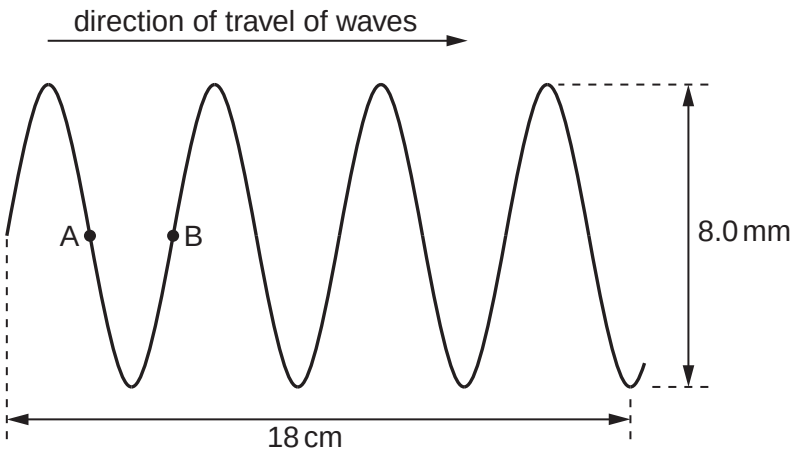

Fig. 5.1 (not to scale)

The waves have frequency 2.5 Hz.

Determine, for the waves,

(i) the amplitude,

amplitude = ... mm [1]

(ii) the speed,

speed = ... $m\,s^{-1}$ [2]

(iii) the phase difference between points A and B.

phase difference = ... unit ..... [1]

(c) The wave in **(b)** was produced in a ripple tank. Describe briefly, with the aid of a sketch diagram, how the wave may be observed.

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.....

.....

[2]

6 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.

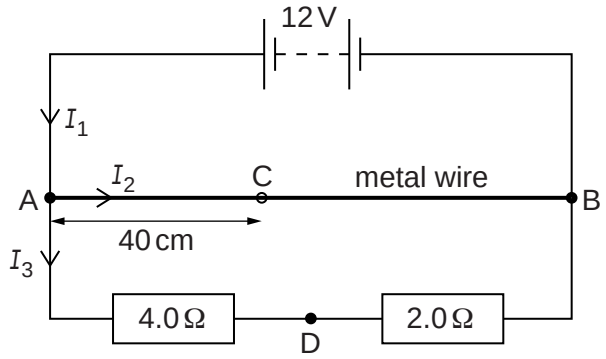

Fig. 5.1

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]