5 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.

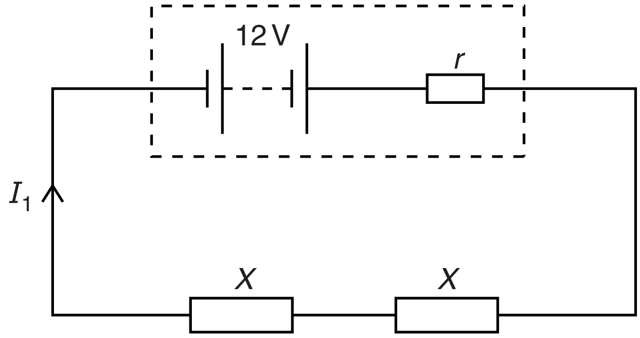

Fig. 5.1

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.

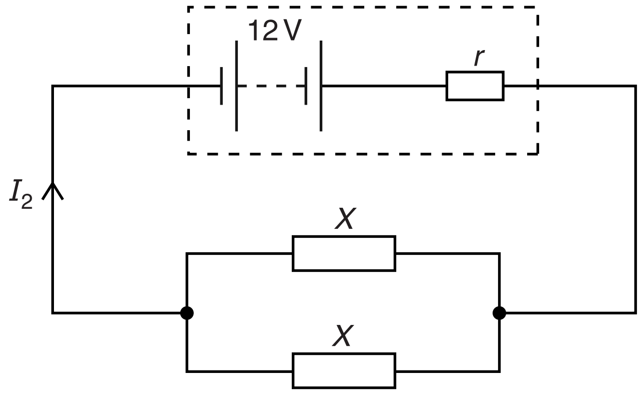

Fig. 5.2

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]

