4 **(a)** Distinguish between electromotive force (e.m.f.) and potential difference (p.d.).

.....

.....

..... [1]

(b) A battery of e.m.f. E_1 and internal resistance r_1 is connected in series with a variable resistor R as shown in Fig. 4.1.

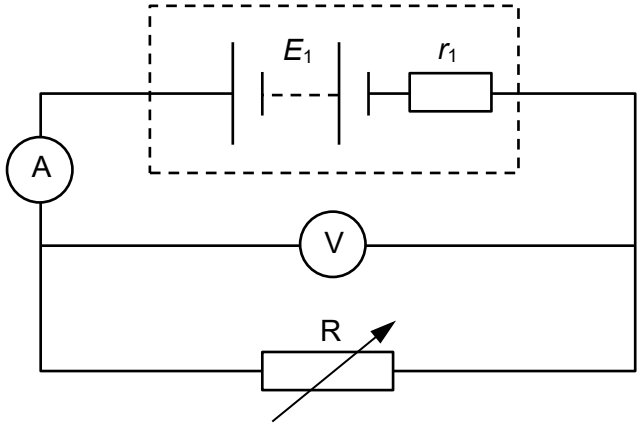

Fig. 4.1

Readings from the ammeter and the voltmeter are taken as the resistance of R is varied. Fig. 4.2 shows the variation with the voltmeter reading V of the ammeter reading I.

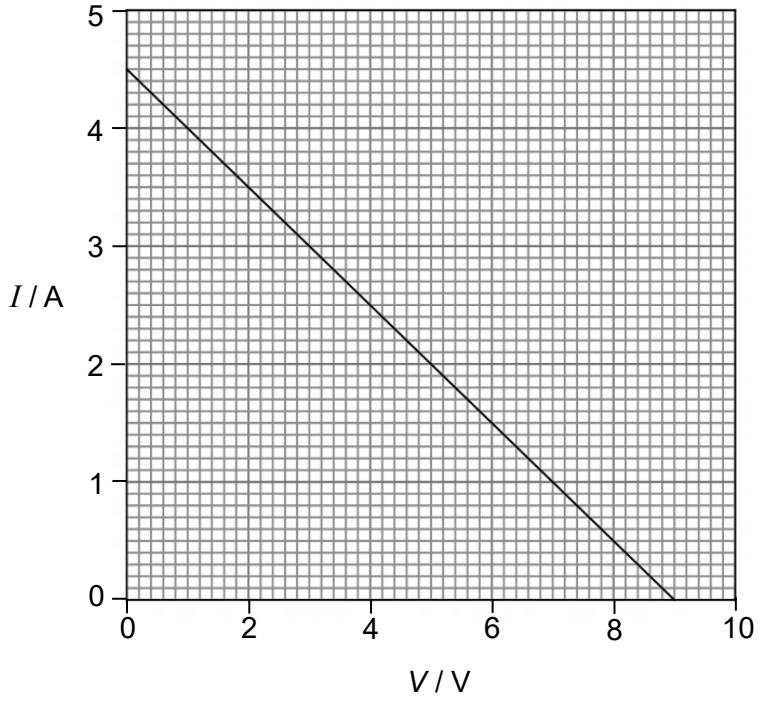

Fig. 4.2

Use Fig 4.2 to determine for the battery,

(i) its e.m.f. E_1,

E_1 = ... V [1]

(ii) its internal resistance r_1.

r_1 = ... Ω [2]

(c) The ammeter and voltmeter are removed and the variable resistor R is set at 4.0 Ω.

A uniform resistance wire XY, a cell C, a switch S, a 5.0 Ω resistor and a galvanometer are connected to the circuit of Fig 4.1, as shown in Fig 4.3. J is a movable electrical connection.

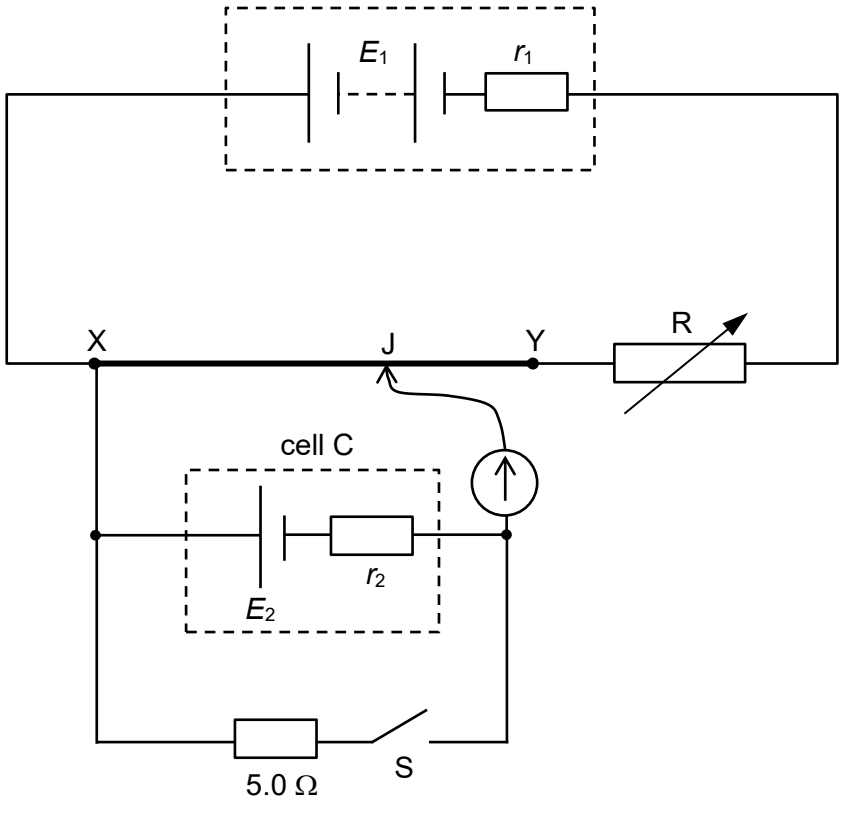

Fig 4.3

The wire XY has length 1.0 m and resistance 4.0 Ω. Cell C has an e.m.f. E_2 and internal resistance r_2.

With switch S opened, the galvanometer shows null deflection when XJ is 0.75 m.
With switch S closed, the galvanometer shows null deflection when XJ is 0.30 m.

(i) Calculate for Cell C,

1. its e.m.f. E_2,

E_2 = ... V [2]

2. its internal resistance r_2.

r_2 ..... Ω [2]

(ii) Another uniform resistance wire PQ is connected across XY as shown in Fig. 4.4. The wire PQ has length 1.0 m and resistance 8.0 Ω. With switch S opened, a new balance length XJ' is found.

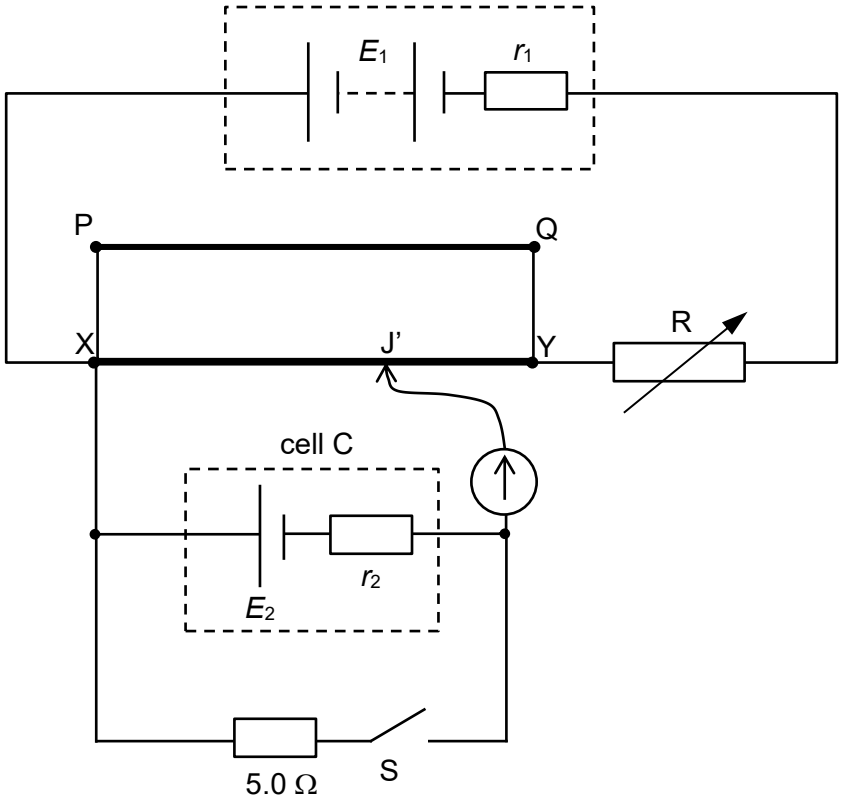

Fig. 4.4

State and explain if XJ' is smaller or larger than 0.75 m.

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.....

..... [2]