

[4]

- (b) Suggest how a big mass damper can help stabilise a building during an earthquake.
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[2]

- 4 A cell of constant e.m.f.  $E$  and internal resistance  $r$  is connected to a 100.0 cm length of a high-resistivity wire XY at points X and J, where J is a movable contact. A voltmeter is connected across X and J. The circuit is shown in Fig. 4.1. The poorly-constructed voltmeter has a finite resistance  $R_v$ . An ammeter with negligible resistance is connected in series with the cell to measure the current  $I$ .

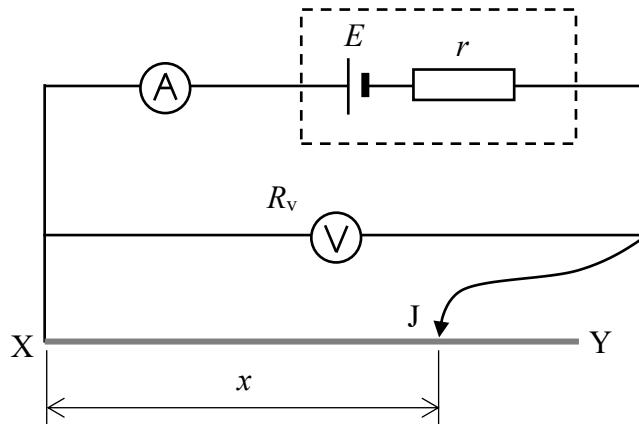


Fig. 4.1

By adjusting the distance  $x$  between X and the movable contact J, two sets of data were recorded with high accuracy, as shown in Fig. 4.2.

Distance XJ $x$ / cm	Voltmeter reading $V$ / V	Ammeter reading $I$ / A
50.0	5.66	0.724
100.0	5.96	0.405

Fig. 4.2

- (a) Use the data in **Fig. 4.2** to determine the e.m.f.  $E$  and internal resistance  $r$  of the cell.

$$E = \dots \text{ V}$$

$$r = \dots \Omega [3]$$

- (b) Determine the effective resistance between points X and J when  $x = 100.0$  cm.

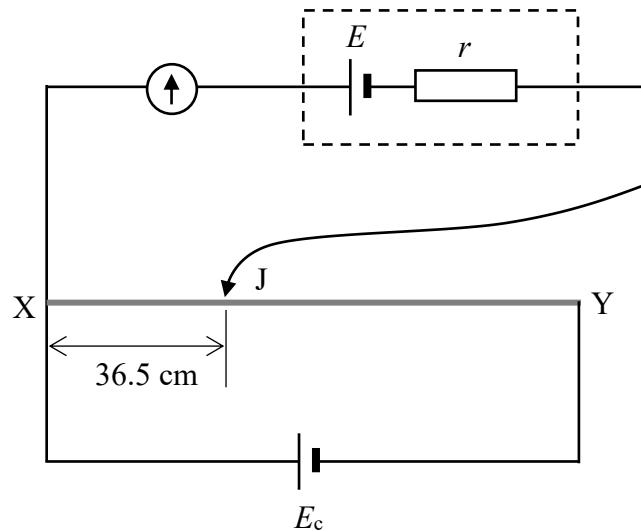
$$\text{Effective resistance} = \dots \Omega [1]$$

- (c) By using the result from (b) and the effective resistance between X and J when  $x = 50.0$  cm, calculate the resistance  $R_v$  of the voltmeter and the resistance  $R$  of the wire XY.

$$R_v = \dots \Omega$$

$$R = \dots \Omega [3]$$

The voltmeter is now removed and the ammeter is replaced by a galvanometer.  
A second cell of unknown e.m.f.  $E_c$  and negligible internal resistance is now connected across the wire XY, as shown in **Fig. 4.3.**



**Fig. 4.3**

The movable contact J is adjusted and the galvanometer indicates zero current when the length  $x$  between X and J is 36.5 cm.

- (d) Determine the e.m.f.  $E_c$  of the second cell.

$$E_c = \dots \text{V} [3]$$

