4 **(a)** A wire has a diameter of 1.10 mm and is 98 m long.

The resistivity of copper is 1.1×10^{-6} Ω m.

(i) Calculate the resistance of this wire.

resistance = …… Ω [1]

(ii) When the wire hangs vertically, suspended from one end, it stretches slightly under its own weight.

State and explain what happens to the resistance of the wire.

……

……

…… [1]

(b) The wire in **(a)** is shortened and 1% of its total length is used to form wire PQ.

(i) Wire PQ is then connected to a cell of e.m.f. E_1 and internal resistance r in series with variable resistor R as shown in Fig. 4.1.

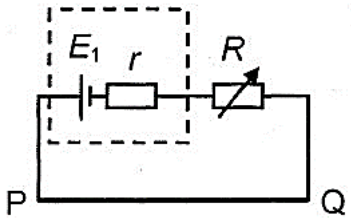

Fig. 4.1

Express the potential difference per unit length of PQ in terms of E_1, r and R.

[3]

(ii) Fig. 4.2 shows a potentiometer circuit that can be used to determine the internal resistance r of cell E_1. A standard cell of e.m.f. E_2 of negligible internal resistance is used in the branch circuit. E_1 and E_2 have e.m.f. of 12.0 V and 1.5 V respectively. When the resistance of the variable resistor is 1.0 Ω, the balanced length is obtained when the length of JQ is twice the length of PJ.

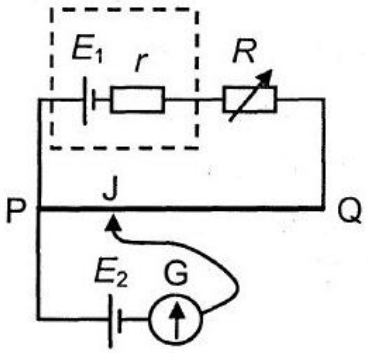

Fig. 4.2

1. Calculate the value of internal resistance, r.

r = ... Ω [3]

2. The resistance of the variable resistor R is now increased. Suggest why the resistance R cannot be higher than a particular value if the potentiometer in Fig. 4.2 is to be able to determine the value of internal resistance r.

.....

.....

.....

..... [2]

[Total: 10]