

- 4 (a) State what is meant by *resistivity* of a material.

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.....  
..... [1]

- (b) A student attempts to measure the resistivity of soil using two parallel copper plates driven into the ground as shown in Fig. 4.1.

Each copper plate has a height of 1.040 m, a width of 0.210 m and a thickness of 0.050 m. The copper plates are driven to a depth of  $d = 0.800$  m and separated by a distance  $x = 0.900$  m.

When the switch is open, the student obtained a steady voltmeter reading of +0.281 V. When the switch is closed, the student obtained a voltmeter reading of +1.398 V and an ammeter reading of 0.31 mA.

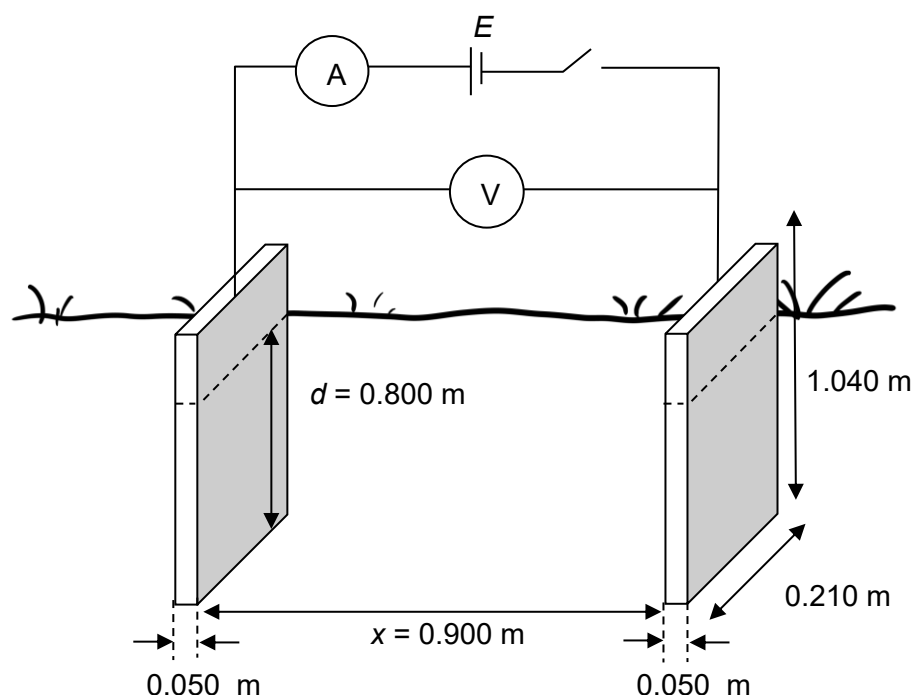


Fig. 4.1

- (i) Show that the resistance of the soil between the copper electrodes is  $3.6 \text{ k}\Omega$ .

[1]

- (ii) Hence, find the resistivity of the soil.

resistivity = .....  $\Omega \text{ m}$  [2]

- (iii) A student suggested using a more precise ammeter to measure the current.

By using the same apparatus, suggest and explain another procedure how the value in **(b)(i)** could be determined to a higher significant figure.

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..... [2]

- (c) A heating device is designed to operate on an a.c. power supply. The device has a resistance of  $6.0 \Omega$ .

- (i) Calculate the average power dissipated in the device when operating at an a.c. supply of voltage  $12.0 \text{ V}$ ,  $50 \text{ Hz}$ .

average power dissipated = .....  $\text{W}$  [1]

- (ii) On Fig. 4.2, draw a graph to show the variation with time  $t$  of the change in power  $P$  dissipated in the device for the a.c. supply in (i). Mark values on both axes.



**Fig. 4.2**

[2]

- (iii) The alternating supply of voltage 12.0 V, 50 Hz is derived from the mains supply of voltage 230 V, 50 Hz using a transformer, assuming 30% of the input energy is lost in the transformer.

Calculate the primary r.m.s. current when the heating device is in use.

primary r.m.s. current = ..... A [2]

- (iv) State an advantage of using alternating current for the transmission of electrical energy.

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