4 A battery of electromotive force (e.m.f.) 3.0 V and negligible internal resistance is connected to a potentiometer, as shown in Fig. 4.1.

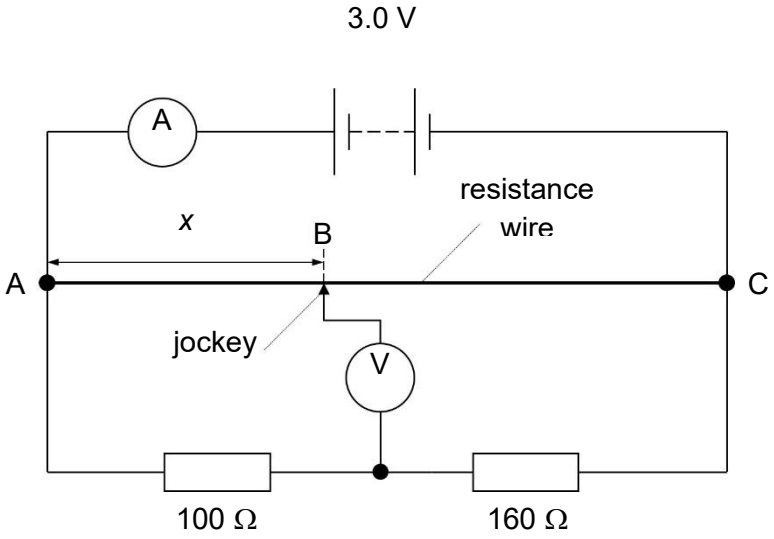

Fig. 4.1

The potentiometer consists of a 90 cm length of resistance wire AC. It is connected in parallel with a 100 Ω resistor and a 160 Ω resistor.

The jockey is in contact with the resistance wire at position B and the distance between A and B is *x*.

(a) (i) The jockey is adjusted until the voltmeter reading is zero.

Determine the value of *x*.

x = …… cm [2]

(ii) The ammeter reading is 234 mA.

Show that the resistance of wire AC is 13.5 Ω.

[2]

(iii) State and explain the change, if any, to the resistance determined in **(a)(ii)** if the battery has internal resistance.

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……..……..……..…….…….

……..……..……..……..…… [2]

(b) An ideal diode is connected to the circuit and the battery is replaced by a 50 Hz sinusoidal alternating current (a.c.) power supply of peak voltage 12 V, as shown in Fig. 4.2.

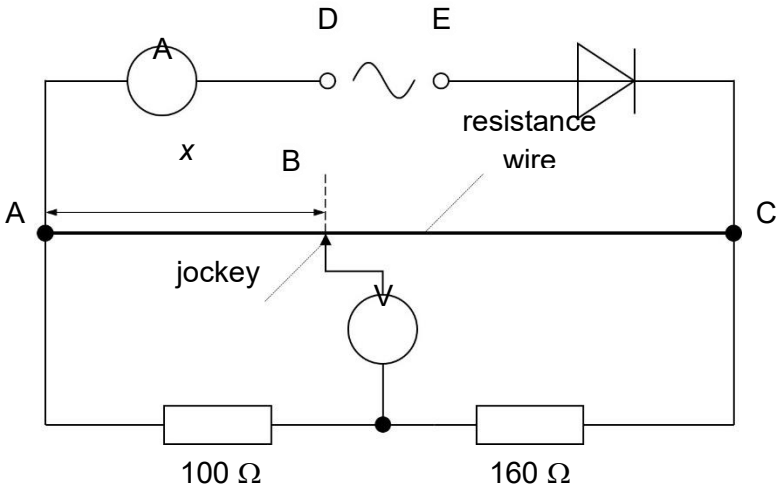

Fig. 4.2

(i) Determine the mean power dissipated in the resistance wire AC.

mean power = …… W [2]

(ii) Junctions D and E are connected to a cathode-ray oscilloscope (c.r.o.). The vertical scale of the c.r.o. is set to 4 V per division and the time-base is set to 5 ms per division.

Sketch the trace on the screen of the c.r.o. in Fig. 4.3.

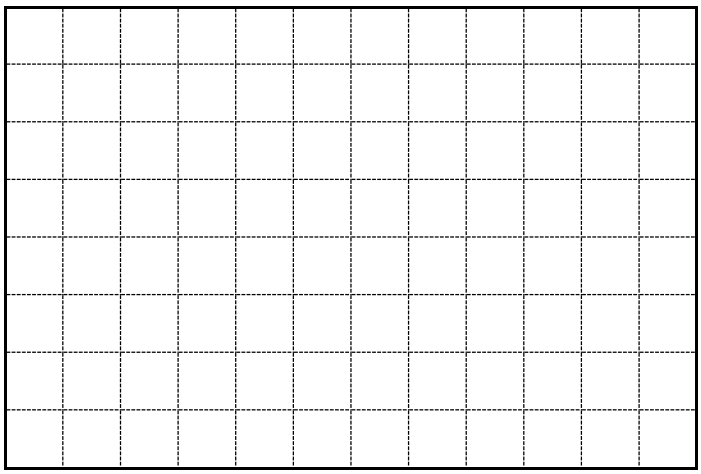

Fig. 4.3

[1]