4 **(a)** Explain what is meant by *internal resistance* of a battery?

……

…… [1]

(b) Fig. 4.1 and Fig. 4.2 shows two circuits X and Y that are used by a student to test a battery of **three** identical cells. In circuit X there is no load resistor. In circuit Y, a load resistor is connected. You can assume that all the meters in the circuits are ideal. The reading of the meters are as shown in the diagrams.

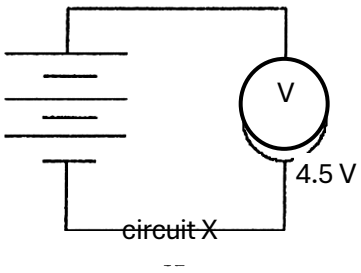

Fig. 4.1

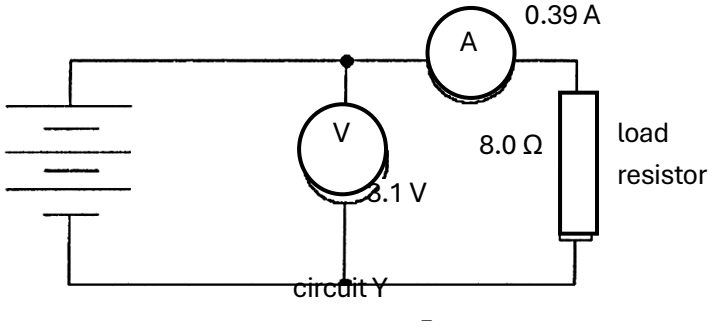

Fig. 4.2

(i) Explain why there is a difference between the voltmeter readings recorded in the two circuits.

……

…… [1]

(ii) Calculate the internal resistance of a *single* cell.

internal resistance = …….. Ω [2]

(iii) When one of the cells in the battery is *reversed* in circuit Y, determine the new reading on the ammeter.

reading on ammeter = …….. A [1]

(c) A battery of e.m.f. 10 V with negligible internal resistance is connected to a light dependent resistor (LDR), and a potentiometer wire *XY* of length 1.20 m and resistance 1.5 kΩ, as shown in Fig. 4.3. When the circuit is placed in normal light, the resistance of the LDR is 2.0 kΩ. There is a battery of unknown e.m.f. *E* and negligible resistance, and other resistors in the circuit.

An ammeter is connected to a point on the potentiometer wire *XY* using a jockey. When the jockey is at point *Z*, the ammeter registers a reading of zero.

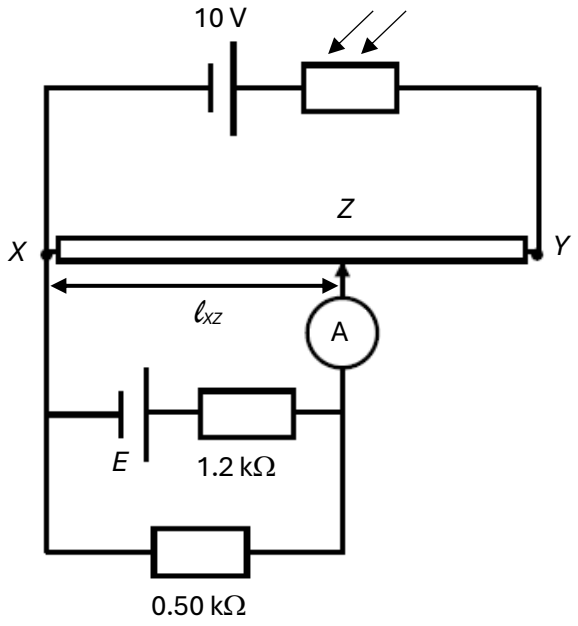

Fig 4.3

(i) Calculate the potential difference across the potentiometer wire XY.

potential difference = …….. V [1]

(ii) Given that the balanced length of potentiometer wire ℓ_{XZ} is 0.45 m, determine the unknown e.m.f *E*.

unknown e.m.f. E = …….. V [3]

(iii) If the circuit is moved into the dark, state and explain the change (if any) to the balanced length ℓ_{XZ}.

……..……...

……..……...

……..……...

……..……...

……..……... [2]

[Total: 11]