3 **(a)** A student wanted to light a lamp, but only had available a 12 V battery of negligible internal resistance. In order to reduce the battery voltage, he connected the circuit as shown in Fig. 3.1. The maximum value of the resistance of the rheostat XY was 1000 Ω.

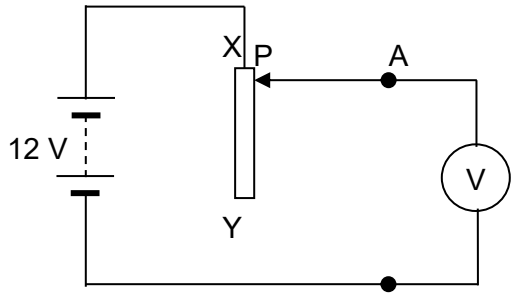

Fig. 3.1

He found that, when the sliding contact P of the rheostat was moved down from X to Y, the voltmeter reading dropped from 12 V to 11 V.

Calculate the resistance of the voltmeter.

resistance = ... Ω [2]

(b) He modified the above circuit into the one shown in Fig. 3.2 below, using the rheostat as a potentiometer, and was now able to adjust the rheostat to give a voltmeter reading of 3.0 V.

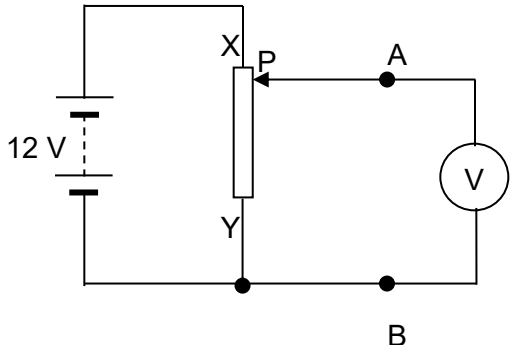

Fig. 3.2

(i) Calculate the current that flows through the voltmeter.

current = ... A [1]

(ii) Assuming that the current in **(i)** is negligible compared with the current through the rheostat, determine how far down from X the sliding contact P would have been moved.

Express your answer as a fraction of the length of XY.

fraction of the length of XY = ... [2]

(iii) The student then removed the voltmeter in Fig.3.2 and then connected a lamp rated at 0.60 W, 3.0 V in its place, but it was very dim.

By calculating the power delivered to the lamp, explain this observation.

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..... [4]

[Total: 9]