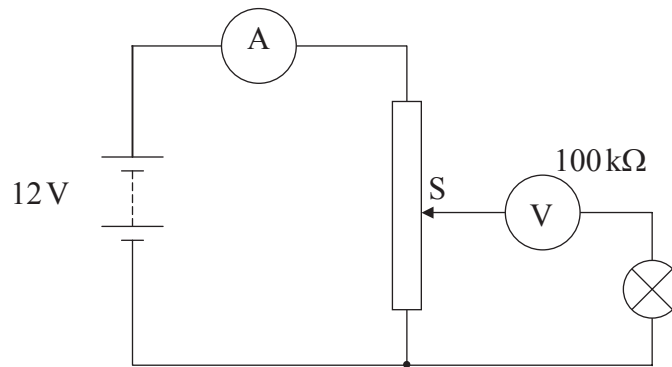


A2. This question is about an electric circuit.

A particular filament lamp is rated at 12 V, 6.0 mA. It just lights when the potential difference across the filament is 6.0 V.

A student sets up an electric circuit to measure the I - V characteristic of the filament lamp.

In the circuit, shown below, the student has connected the voltmeter and the ammeter into the circuit **incorrectly**.



The battery has e.m.f. 12 V and negligible internal resistance. The ammeter has negligible resistance and the resistance of the voltmeter is 100 kΩ. The maximum resistance of the variable resistor is 15 Ω.

(a) Explain, without doing any calculations, whether there is a position of the slide S at which the lamp will be lit. [3]

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(b) Estimate the maximum reading of the ammeter. [2]

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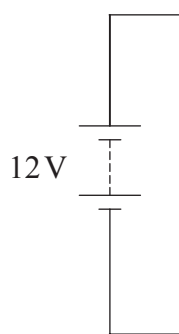
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(This question continues on the following page)

(Question A2 continued)

- (c) Complete the circuit diagram below showing the correct position of the voltmeter and of the ammeter in order to determine the I - V characteristic of the filament lamp. [2]



(Question B3 continued)

Fields and electric charge in conductors

- (d) Describe the concept of drift velocity as applied to the conduction electrons in a conductor. [4]

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- (e) Define *electromotive force* (e.m.f.). [1]

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- (f) A filament lamp is operating at normal brightness.

The potential difference across the lamp is 6.0 V. The current in the filament is 0.20 A. For the filament of this lamp, calculate

- (i) the resistance. [1]

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.....

- (ii) the power dissipated. [1]

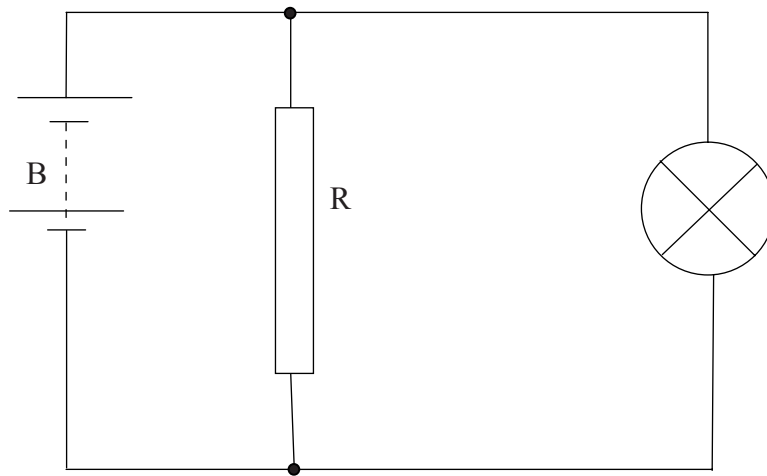
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(Question B3 continued)

- (g) The lamp in (f) is connected in the circuit below. The lamp is still operating at normal brightness.



The battery B has an internal resistance of 5.0Ω and the resistance R of the resistor is 15Ω .

- (i) Calculate the current in the resistor R. [1]

.....

- (ii) Determine the e.m.f. of the battery. [4]

.....

A2. This question is about electric circuits.

(a) (i) Define e.m.f. and state Ohm's law. [2]

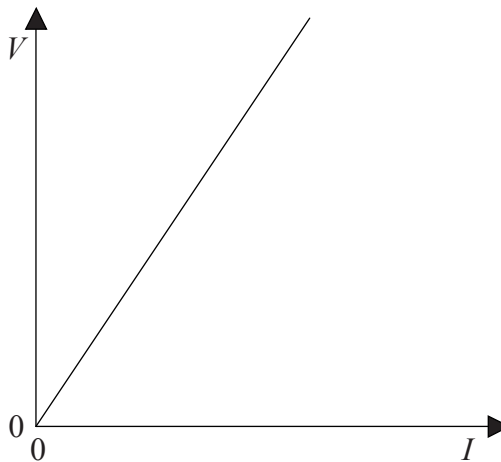
e.m.f.:

.....

Ohm's law:

.....

(ii) The graph below shows the I - V characteristic of a particular electrical component.



State how the resistance of the component is determined from the graph. [1]

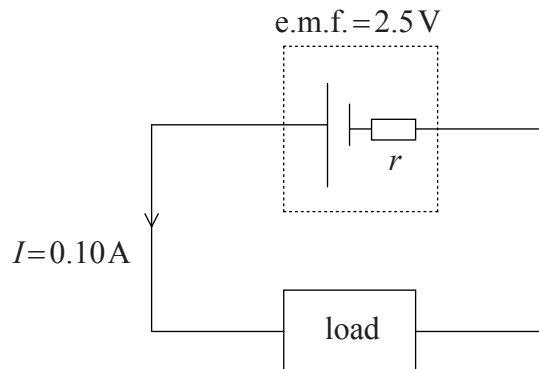
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(Question A2 continued)

- (b) In the circuit below an electrical device (load) is connected in series with a cell of e.m.f. 2.5 V and internal resistance r . The current I in the circuit is 0.10 A.



The power dissipated in the load is 0.23 W.

Calculate

- (i) the total power of the cell. [1]

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- (ii) the resistance of the load. [2]

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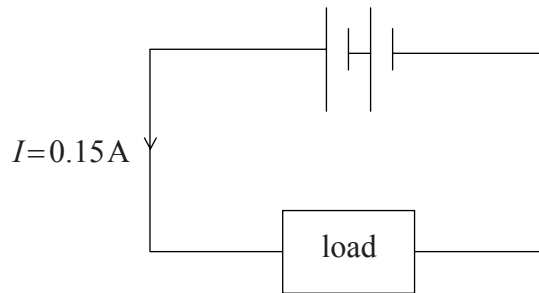
- (iii) the internal resistance r of the cell. [2]

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(This question continues on the following page)

(Question A2 continued)

(c) A second identical cell is connected into the circuit in (b) as shown below.



The current in this circuit is 0.15 A. Deduce that the load is a non-ohmic device.

[4]

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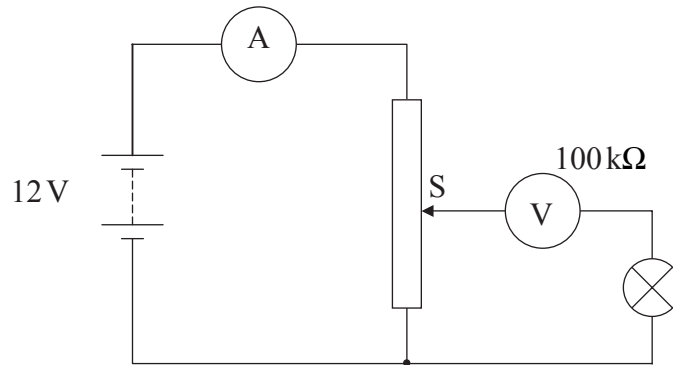
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A2. This question is about an electric circuit

A particular filament lamp is rated at 12 V, 6.0 mA. It just lights when the potential difference across the filament is 6.0 V.

A student sets up an electric circuit to measure the I - V characteristics of the filament lamp.

In the circuit, shown below, the student has connected the voltmeter and the ammeter into the circuit **incorrectly**.



The battery has e.m.f. 12 V and negligible internal resistance. The ammeter has negligible resistance and the resistance of the voltmeter is 100 kΩ.

The maximum resistance of the variable resistor is 15 Ω.

- (a) Explain, without doing any calculations, whether there is a position of the slider S at which the lamp will be lit. [3]

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- (b) Estimate the maximum reading of the ammeter. [2]

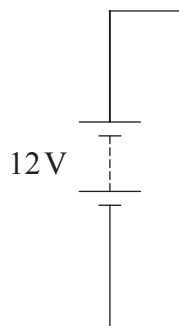
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(Question A2 continued)

- (c) Complete the circuit diagram below showing the correct position of the voltmeter and of the ammeter in order to determine the I - V characteristics of the filament lamp. [2]



(Question B3, part 1 continued)

- (e) The gas in (c) is argon-40 ($^{40}_{18}\text{Ar}$) and $P_1 = 2.00 \times 10^5 \text{ Pa}$, $V_1 = 2.49 \times 10^{-2} \text{ m}^3$, $T_1 = 300 \text{ K}$.

Calculate the mass of the gas.

[4]

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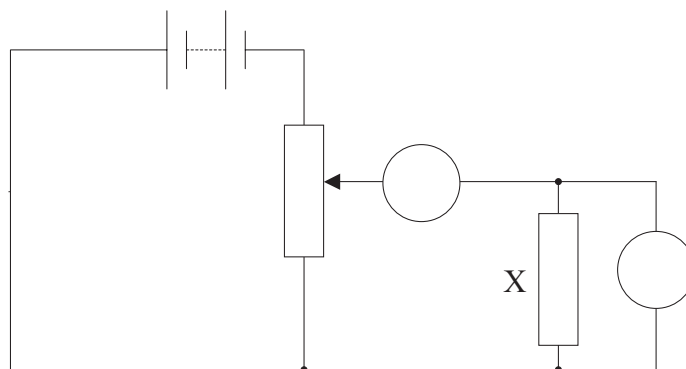
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Part 2 Electric circuits

- (a) The diagram below shows the circuit used to measure the current-voltage (I - V) characteristic of an electrical component X.



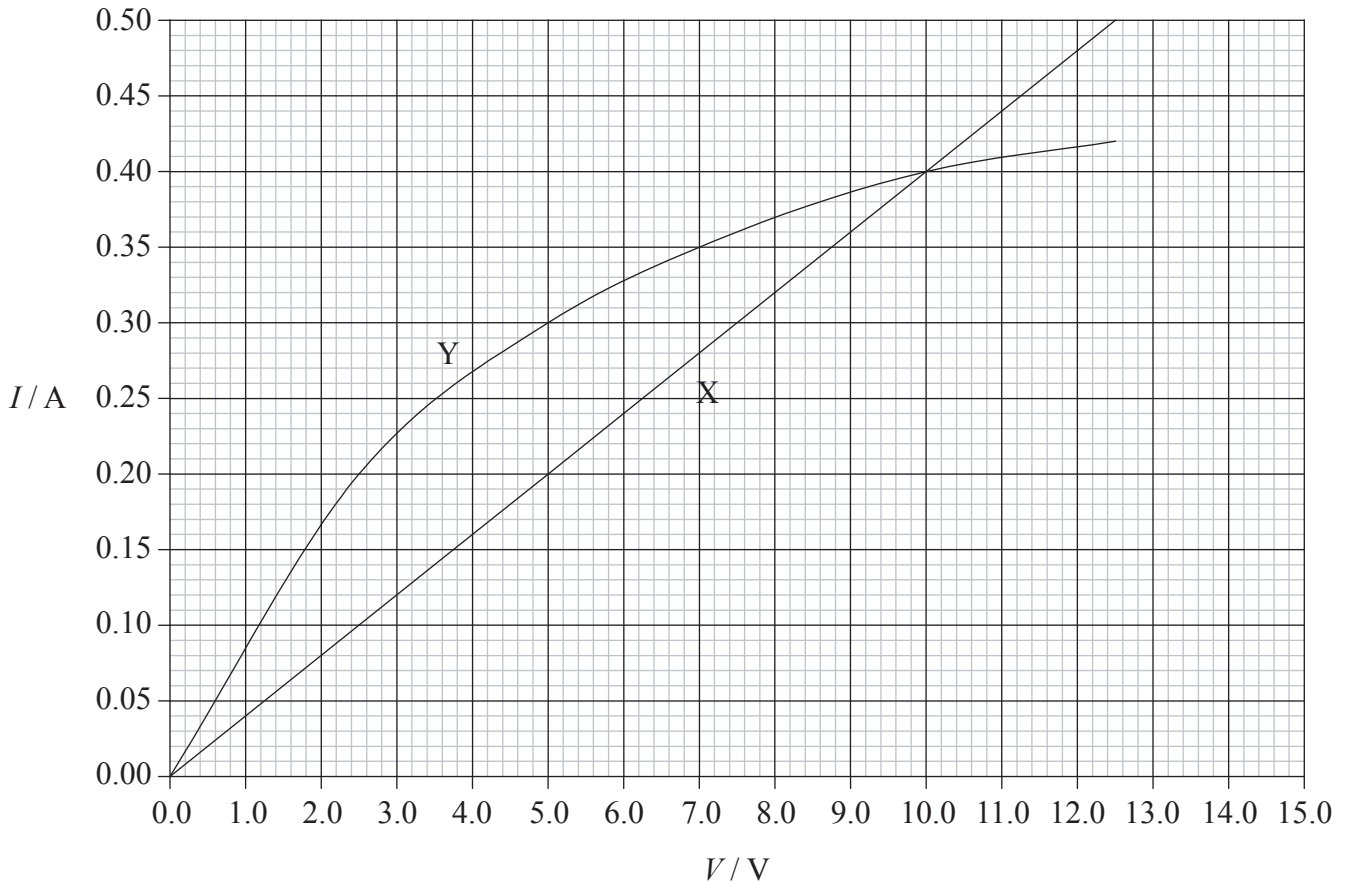
On the diagram above,

- (i) label the ammeter A and the voltmeter V. [1]
- (ii) mark the position of the contact of the potentiometer that will produce a reading of zero on the voltmeter. Label this position P. [1]

(This question continues on the following page)

(Question B3, part 2 continued)

- (b) The graph below shows the current-voltage (I - V) characteristics of two different conductors X and Y.



- (i) State the value of the current for which the resistance of X is the same as the resistance of Y and determine the value of this resistance. [2]

Current:

Resistance:

- (ii) Describe and suggest an explanation for the I - V characteristic of conductor Y. [3]

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(This question continues on the following page)

(Question B3, part 2 continued)

- (c) The two conductors X and Y are connected in series with a cell of negligible internal resistance. The current in the conductors is 0.20 A.

Use the graph in (b) to determine

- (i) the resistance of Y for this value of current. [1]

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.....

- (ii) the e.m.f. of the cell. [2]

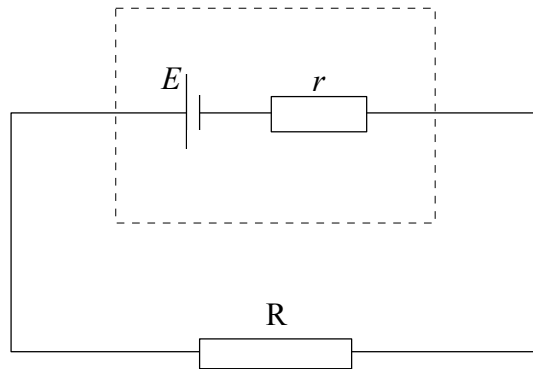
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(Question B1 continued)

Current electricity

A cell of electromotive force (e.m.f.) E and internal resistance r is connected in series with a resistor R , as shown below.



The cell supplies $8.1 \times 10^3 \text{ J}$ of energy when $5.8 \times 10^3 \text{ C}$ of charge moves completely round the circuit. The current in the circuit is constant.

(c) (i) Calculate the e.m.f. E of the cell. [2]

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(ii) The resistor R has resistance 6.0Ω . The potential difference between its terminals is 1.2 V . Determine the internal resistance r of the cell. [3]

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(iii) Calculate the total energy transfer in the resistor R . [2]

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(This question continues on the following page)

A3. This question is about a filament lamp.

- (a) On the axes below, draw a sketch-graph to show the variation with potential difference V of the current I in a typical filament lamp (the I – V characteristic). (*Note: this is a sketch-graph; you do not need to add any values to the axes.*) [1]



- (b) (i) Explain how the resistance of the filament is determined from the graph. [1]

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- (ii) Explain whether the graph you have sketched indicates ohmic behaviour **or** non-ohmic behaviour. [1]

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A filament lamp operates at maximum brightness when connected to a 6.0 V supply. At maximum brightness, the current in the filament is 120 mA.

- (c) (i) Calculate the resistance of the filament when it is operating at maximum brightness. [1]

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- (ii) You have available a 24 V supply and a collection of resistors of a suitable power rating and with different values of resistance. Calculate the resistance of the resistor that is required to be connected in series with the supply such that the voltage across the filament lamp will be 6.0 V. [2]

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