1.

4. *(a)* Define the *potential difference* between two points in an electric circuit. [2]

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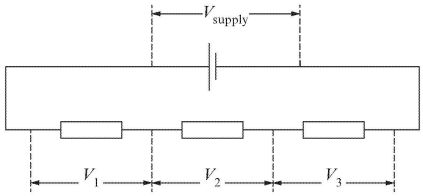
(b) Three resistors are connected as shown.



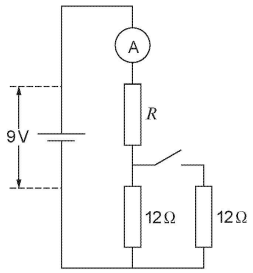
(i) Complete the equation that relates **all** of the potential differences in the circuit: [1]

V_{supply} = ...

(ii) The equation you wrote down in *(b)*(i) is an example of which conservation law? [1]

.....

(c)



(i) In the circuit shown, with the **switch open**, the ammeter reads 0.5 A. Show that $R = 6\,\Omega$. [2]

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(ii) The switch is now **closed**.

(I) Calculate the (new) potential difference across R. [2]

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(II) Calculate the (new) current through the ammeter. [2]

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(III) More $12\,\Omega$ resistors can be connected in parallel with the $12\,\Omega$ resistors. Determine the **total** number of $12\,\Omega$ resistors needed for the current through the ammeter to be 1.2 A. [4]

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2. *(a)* Derive, giving a labelled diagram, the relationship between the current I through a metal wire of cross sectional area A, the drift velocity, v, of the free electrons, each of charge e, and the number, n, of free electrons per unit volume of the metal. [4]
($I = nAve$).

(b) Calculate the drift velocity of free electrons in a copper wire of cross sectional area $1.7 \times 10^{-6}\text{m}^2$ when a current of 2.0A flows. [$n_{copper} = 1.0 \times 10^{29}\text{m}^{-3}$]. [2]

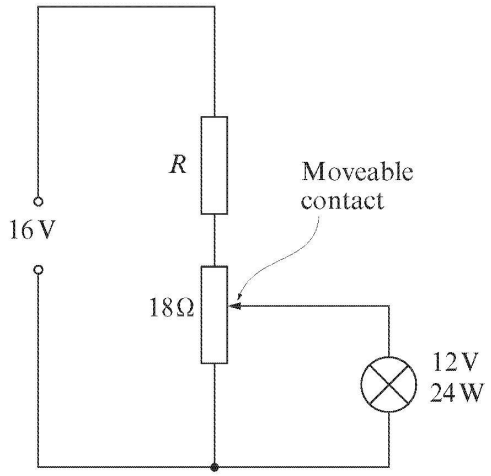
(c) A potential difference is required across the copper wire in order for the current to flow. The size of the current depends on the wire's *resistance*. Explain in terms of free electrons, how this resistance arises. [2]

(d) The copper wire in *(b)* is of length 2.5 m. When it carries a current of 2.0 A, it dissipates energy at the rate of 0.1 W. Calculate its resistivity. [4]

(e) A second copper wire has the same volume as the wire in *(d)*, but is longer.
Complete the table below indicating whether the quantity given is **bigger**, **smaller** or **the same** for this longer wire. [3]

Quantity	For the longer wire this quantity is ...
Cross-sectional Area	
n, number of free electrons/unit volume	
Resistivity	

3. A student uses the circuit below to produce a current-voltage graph for a 12 V, 24 W filament lamp.



(a) Show clearly on the diagram the correct positions for the voltmeter and ammeter. [2]

(b) When the lamp is working normally, calculate

(i) the current flowing through it; [1]

.....

.....

.....

(ii) its resistance. [1]

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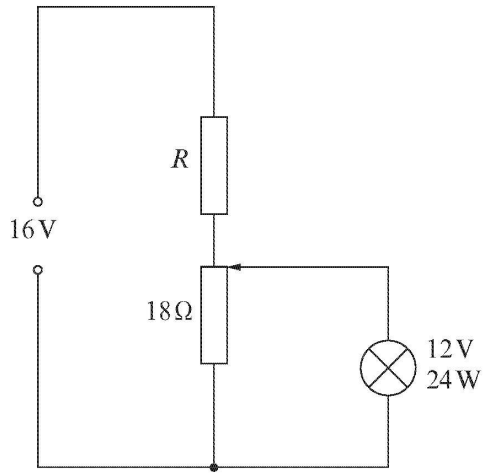
(c) The value of R is chosen so that the voltage across the lamp can be varied between 0 V and 12 V. The circuit below shows the position of the moveable contact when the lamp is operating normally (i.e. at 12 V).



Calculate the required value of R. [4]

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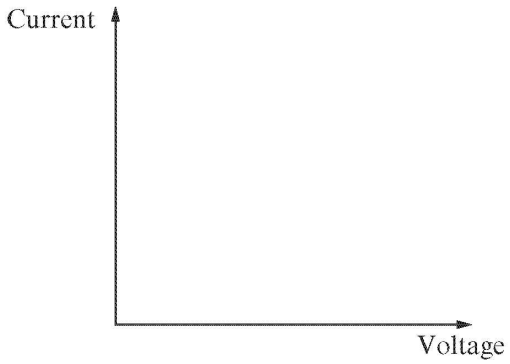
(d) Sketch on the axes below the current-voltage graph expected for the filament lamp. [2]



4. *(a)* (i) State Ohm's law. [2]

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(ii) What can be said about the resistance of a conductor that obeys Ohm's law? [1]

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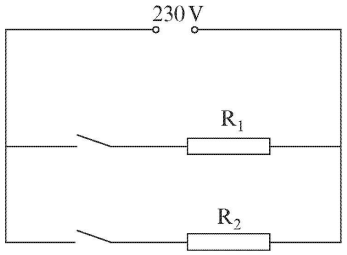
(b) The heating circuit of a hairdryer consists of two heating elements R_1 and R_2 connected in parallel as shown. The elements are made from wire of the same material of resistivity $95 \times 10^{-8}\Omega$m and diameter 1.4×10^{-4}m.



(i) The length of wire used to make R_1 is 3.2m. Show that the resistance of R_1 is approximately 200Ω. [3]

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(ii) Calculate the power output from the heating circuit with only R_1 switched on. [1]

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(iii) With both elements switched on the **total resistance** is only a third of the resistance of R_1 on its own. Calculate the resistance of R_2. [3]

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(iv) Explain which element, R_1 **or** R_2, would provide the greater power output from the heating circuit. [2]

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(v) Calculate the total current with both elements switched on. [1]

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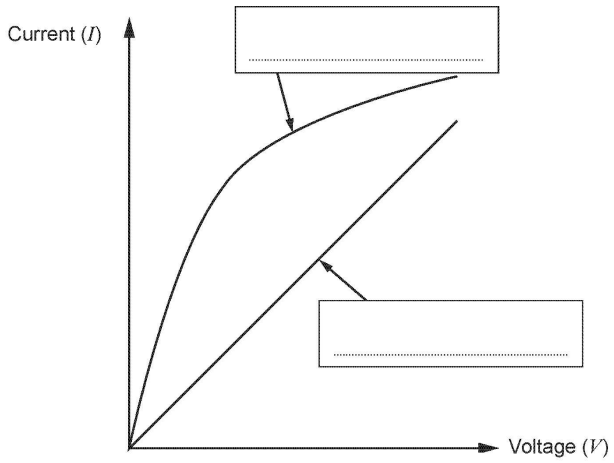
.....

5.

(a) Graphs are drawn for a metal wire at constant temperature and for the filament of a lamp.



(i) Complete the boxes, labelling the graphs with the component they represent. [1]

(ii) Suggest reasons for the different shapes of the two graphs. [5]

(b) X and Y are two lamps.

(i) Lamp X is labelled at 12 V, 24 W. Calculate the current in the lamp when it operates at its rated voltage. [1]

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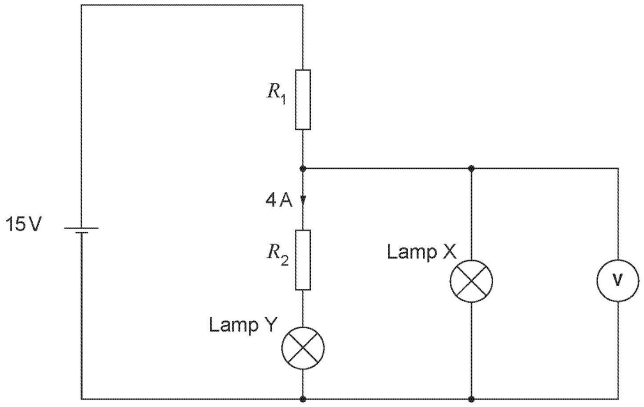
(ii) Lamp Y is labelled at 6 V, 4 A. In the following circuit, the values of R_1 and R_2 are chosen so that **both lamps operate at their rated voltages**.



(I) State the reading on the voltmeter. ..... [1]

(II) Calculate the pd across R_2. [1]

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(III) Calculate R_2. [1]

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(IV) Calculate R_1. [3]

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