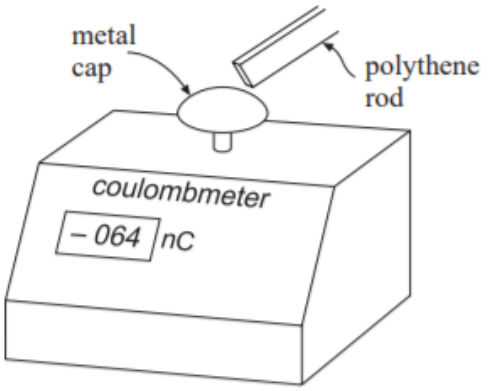
Electricity Past Paper Questions WJEC Eduqas Physics A Level

1.

A polythene rod is rubbed with a duster. The rod is then scraped across the metal cap of a digital coulombmeter as shown in the diagram (a coulombmeter is a device for measuring electrical charge).



(a) (i) Explain why the reading on the coulombmeter is negative. [1]

.....

.....

.....

.....

(ii) State the sign of the charge acquired by the duster. Explain your reasoning. [2]

.....

.....

.....

(b) The coulombmeter is now discharged by connecting a wire from the metal cap to the ground. The coulombmeter reading falls to zero.

(i) Calculate the number of charged particles that flow from the coulombmeter. [2]

.....

.....

.....

(ii) Calculate the time taken for this number of charged particles to flow past a point in the wire if the mean discharge current is 2 μA. [2]

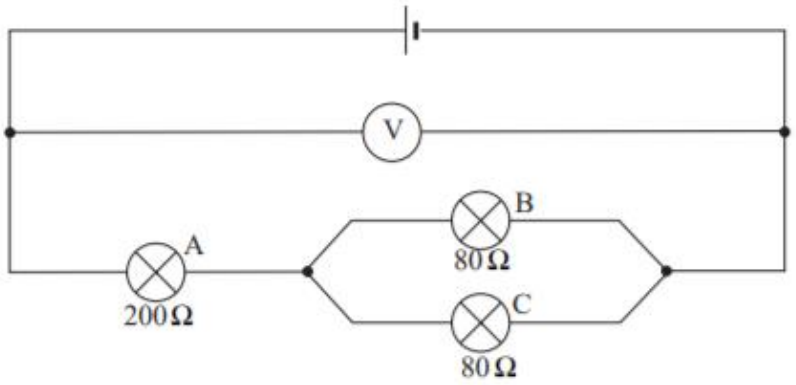
.....

.....

2.

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

(b) In the circuit below the voltmeter reads 9 V and the resistance of the bulbs are as shown.



(i) Calculate the effective resistance of the bulb combination. [3]

(ii) Calculate the current through

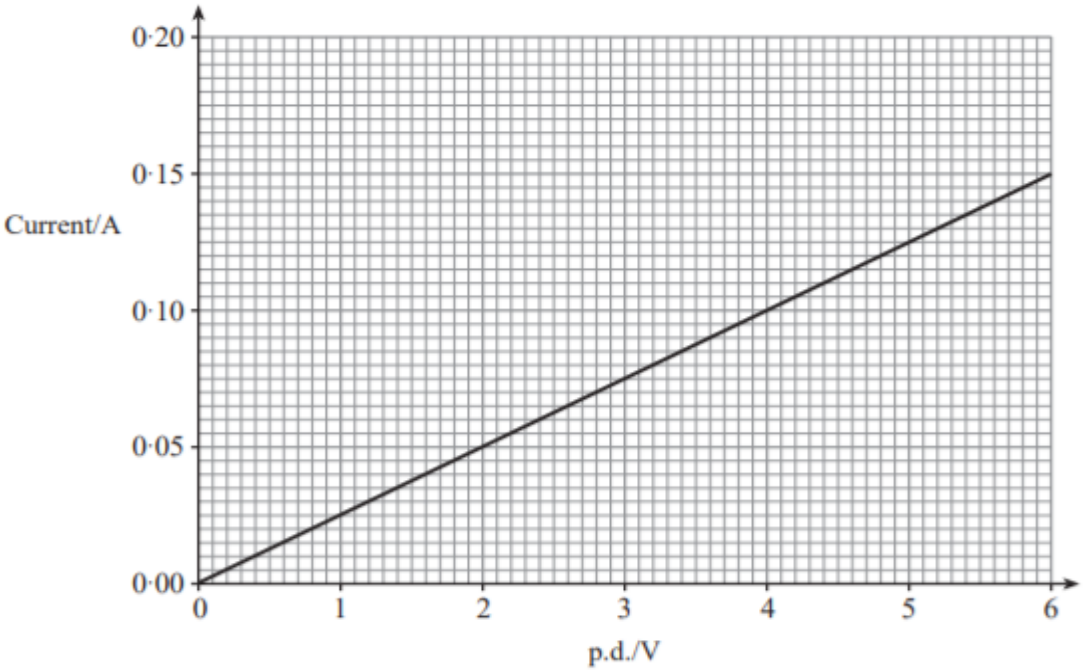
(I) bulb A; [2]

(II) bulb C. [1]

(iii) Calculate the ratio of the power dissipated in bulbs A and C and compare the brightness of the bulbs. [4]

3.

A graph of current against potential difference (p.d.) is given for a piece of metal wire.



(a) Calculate the resistance of the wire. [1]

(b) What does the graph tell us about the temperature of the wire as the p.d. across it is increased? Explain your answer. [2]

(c) The wire has a length of 2·5 m and a **diameter** of $2{\cdot}0 \times 10^{-4}$ m. Calculate the resistivity of the metal. [3]

(d) Draw on the same graph-grid the current against p.d. graph for a wire, made of the same metal and of the same diameter ($2{\cdot}0 \times 10^{-4}$ m) but of length 7·5 m. [2]

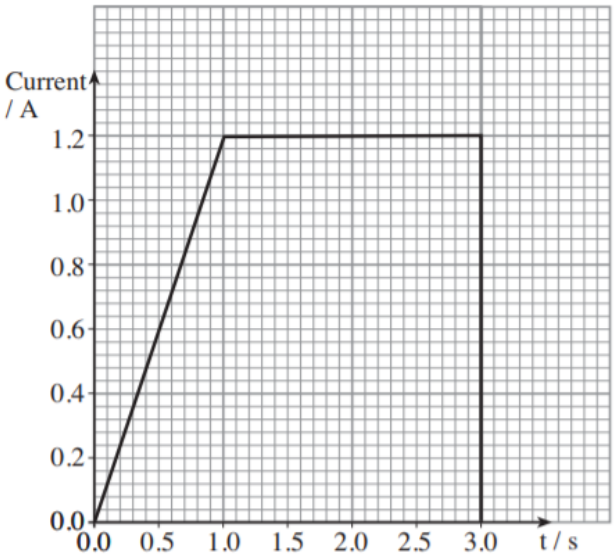
4.

1. *(a)* Explain what is meant by an electric current. [1]

.....

.....

(b) The current through a conductor changes with time over a period of 3.0 s as shown.



(i) By considering the area under the graph calculate the total charge passing through the conductor in this time. [2]

.....

.....

.....

.....

(ii) Calculate the total number of electrons flowing past a point in the conductor in this time. [2]

.....

.....

.....

(iii) Calculate the drift velocity of the electrons at $t = 1.5$ s. Take the cross-sectional area of the conductor to be $2.0 \times 10^{-6} m^2$ and the number of free electrons per m^3 to be $1.0 \times 10^{29} m^{-3}$. [3]

.....

.....

5.

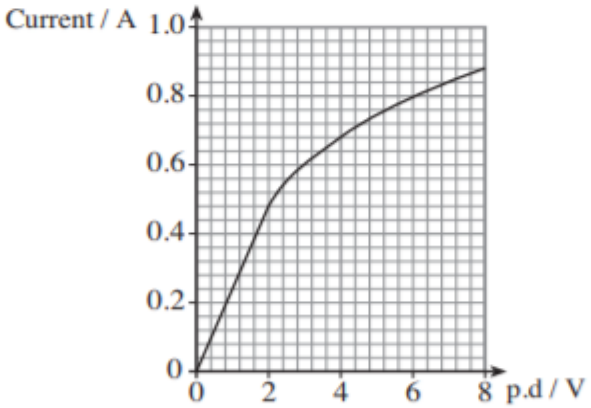
(a) Explain how electrical resistance arises in metal conductors. [3]

.....

.....

.....

(b) A current-voltage graph for a filament lamp is shown.



(i) Describe how the **resistance** of the lamp changes as the voltage across it increases over the range

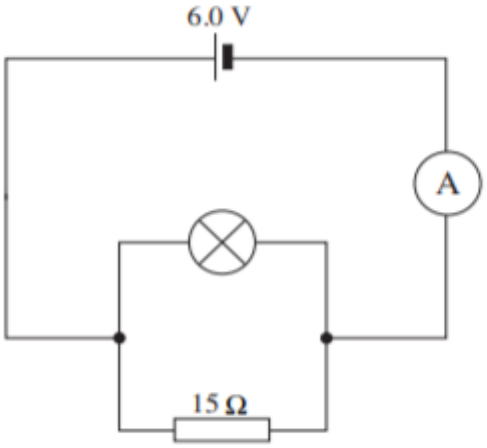
(I) 0 V – 2 V; [1]

.....

(II) 2 V – 8 V. [1]

.....

(ii) The lamp is connected in parallel to a 15Ω resistor and to a 6 V supply as shown. Calculate the current through the ammeter. [4]



.....

.....

.....

.....

.....

.....

(iii) Calculate the power dissipated in the circuit. [2]

.....

.....

6.

(a) (i) Draw a labelled diagram of the apparatus you could use to determine the relationship between the resistance and length of a wire. [3]

(ii) State what measurements you need to make. [2]

.....

.....

.....

(iii) What further measurement would you need to make to determine the resistivity of the metal and what apparatus would you use to make this measurement? [1]

.....

(iv) Explain how a value of the resistivity is determined from your measurements. [3]

.....

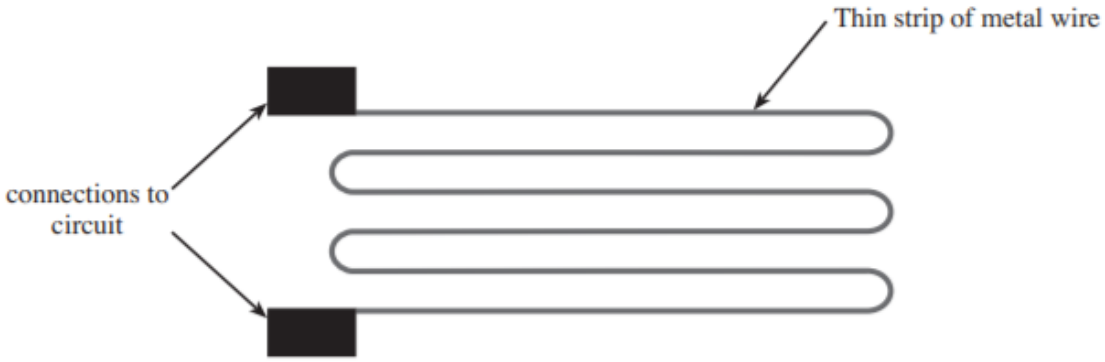
.....

.....

.....

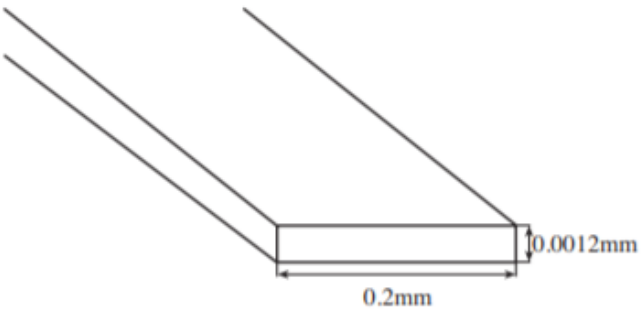
.....

(b) A strain gauge is a device used to monitor distortions in structures such as bridges and buildings. It consists of a thin strip of metal wire as shown which is then attached to the structure under test.



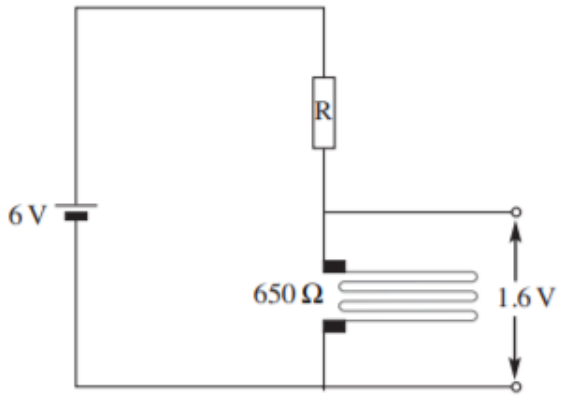
(i) When the structure extends, the wire in the strain gauge gets **thinner** and **longer** thus changing its resistance. Using the resistivity equation explain whether the resistance of the strain gauge increases or decreases when the structure extends. [4]

(ii) Calculate the resistivity of the metal in a strain gauge which has a resistance of 650 Ω and a total length of 32 cm. The thin metal strip is 0.2 mm wide and 0.0012 mm thick as shown. [2]



Thin metal strip (magnified - not to scale)

(iii) The changing resistance of a strain gauge is monitored using a potential divider circuit. The gauge is placed in series with a fixed resistor R as shown. Calculate the value of R which will give a p.d. of 1.6 V across the strain gauge. [3]



7.

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

.....

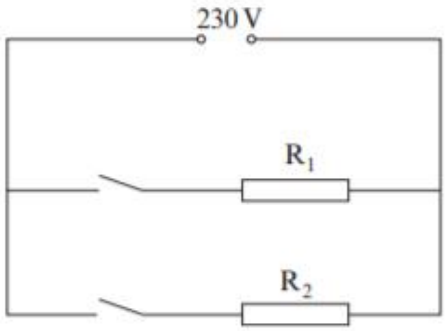
.....

.....

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

.....

(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 3.2 m. Show that the resistance of R_1 is approximately 200 Ω. [3]

.....

.....

.....

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

.....

.....

(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]

.....

.....

.....

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

.....

.....

.....

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

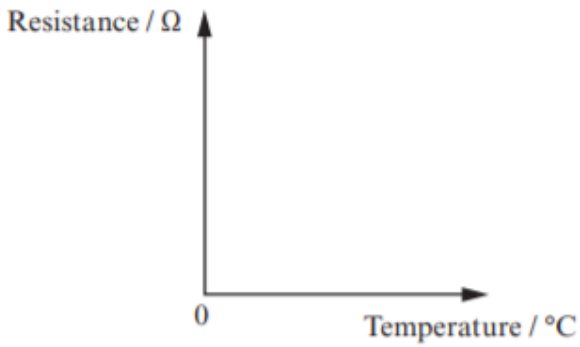
.....

.....

8.

(a) (i) Draw a labelled diagram of the apparatus you would use to determine the relationship between the resistance and temperature of a metal wire. [3]

(ii) Sketch, on the axis below, a graph of the results you would expect from the experiment. [2]



(b) (i) Explain in terms of particles how electrical resistance arises in metal conductors. [3]

.....

.....

.....

.....

.....

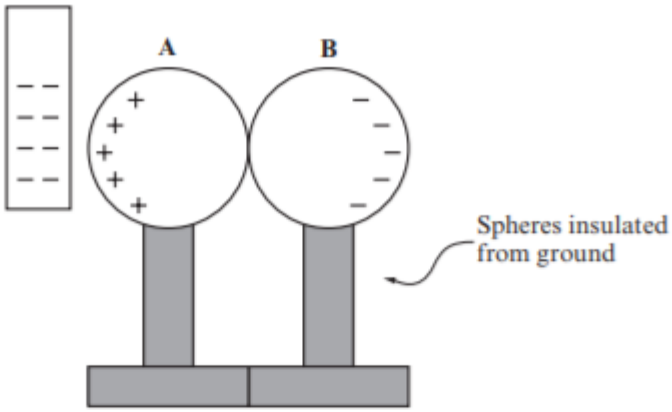
(ii) Hence suggest an explanation for your results to the experiment in part *(a)*. [2]

.....

.....

9.

Two insulated metal spheres, **A** and **B** are placed in contact with each other. When a negatively charged rod is brought near, the charges become distributed on the metal spheres as shown.



(a) (i) State the particle which carries the negative charge. [1]

.....

(ii) Explain why the charges become distributed as shown. [3]

.....

.....

.....

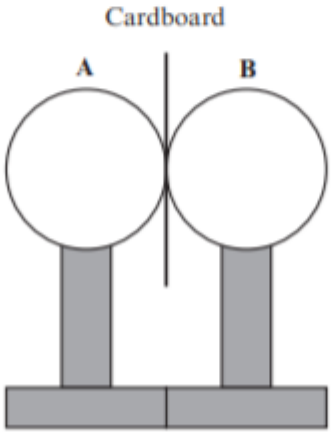
.....

.....

(iii) The following procedure is carried out:

- A thin insulating piece of cardboard is placed in between the spheres.
- The negatively charged rod is then removed.

Sketch the distribution of charges now on both spheres. [2]



(b) (i) In another process, a negatively charged rod is rubbed against one of the spheres and in doing so places approximately 300×10^9 free negative charges onto the sphere. Calculate the charge on the sphere. [1]

.....

.....

.....

(ii) The sphere is discharged in a time of 20 ps by connecting a wire from it to the ground. Calculate the mean current. [2]

.....

.....

.....

.....

.....

10.

(a) (i) Define resistance. [1]

.....

.....

(ii) The unit of resistance is the ohm (Ω). Show that it is possible to express the Ω as [3]

$$J\,s\,C^{-2}$$

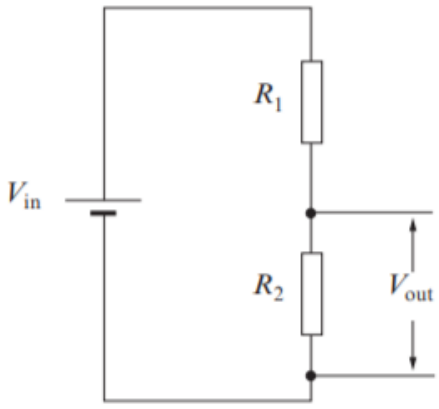
.....

.....

.....

.....

(b) The diagram shows a potential divider.



(i) Write down an equation for the current through resistors R_1 and R_2 when the input pd V_{in} is applied as shown. [1]

.....

.....

.....

(ii) Hence show that the output pd V_{out} is given by the equation [2]

$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

.....

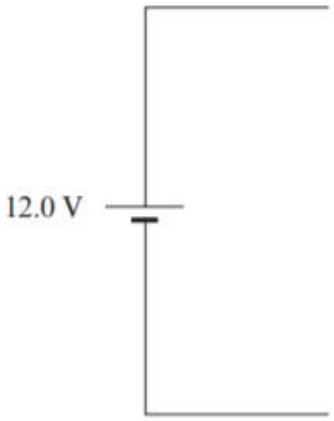
.....

.....

(c) Three resistors are available with values 40 Ω, 40 Ω and 80 Ω.

(i) Draw a diagram showing how **two** of these resistors can be connected together to give a combined resistance of 20 Ω. [2]

(ii) Hence, using all three of the resistors, complete the following potential divider circuit for which V_{out} = 2.4 V when V_{in} = 12.0 V. Clearly label the resistor values and V_{out} on your diagram. [2]



11.

A power cable has a resistance of 11.2Ω and is made of an alloy of aluminium of resistivity $2.8 \times 10^{-8}\,\Omega\,m$. It is used to link a power station to a town 160 km away.

(a) (i) Show that the cross-sectional area of the cable is $4.0 \times 10^{-4}\,m^2$. [1]

.....

.....

(ii) Calculate the current in the cable given that the pd across it is 2.0 kV. [1]

.....

(iii) Calculate the mean drift velocity of the free electrons in the cable given that there are 6.0×10^{28} atoms per m^3 of aluminium and each atom contributes 3 free electrons. [3]

.....

.....

.....

(b) A small portion of the cable is damaged. As a result its cross-sectional area is less than that of the rest of the cable, as shown in the diagram.

(i) State how the current in the thinner portion compares with the current in the rest of the cable. [1]

.....

(ii) State how the mean drift velocity of free electrons in the thinner portion compares with that in the rest of the cable. Justify your answer. [2]

.....

.....

.....

(iii) Hence suggest, in terms of particles, why the damaged part of the cable will be prone to overheating. [2]

.....

.....