

HW Two

X Ray diffraction and Resistivity

39 min
39 marks

1. (a) Use a diagram to show what is meant by diffraction.

(2)

- (b) X-ray diffraction images such as the one shown below led scientists to the first understanding of the structure of DNA. The image shown is a negative on photographic film. The dark bands correspond to maximum X-ray detection.

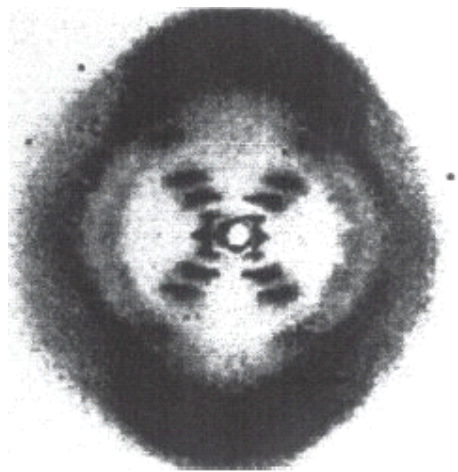


Figure 1

Use diagrams to explain how two X-ray waves overlap to produce maximum intensity.

(2)

- (c) State two pieces of information about the structure of DNA that can be deduced from Figure 1.

1

2

(2)

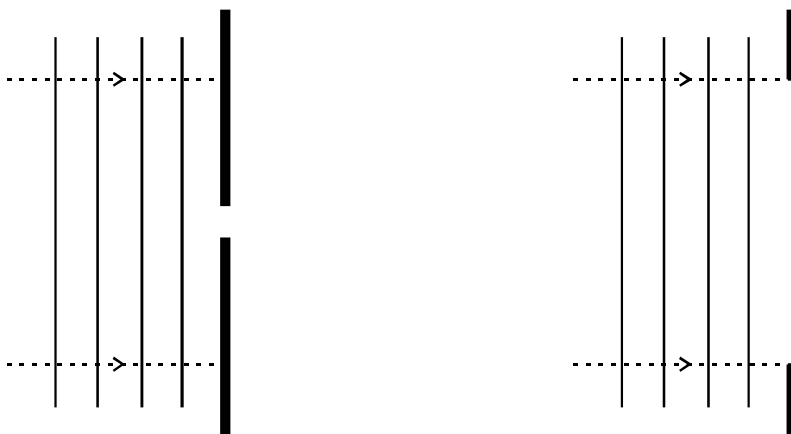
- (d) Electrons can also be used to produce diffraction patterns and hence to study materials in this way.

What does this tell you about the behaviour of electrons when passing through such materials?

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(1)
(Total 7 marks)

2. Each of the diagrams below shows a series of wavefronts, one wavelength apart, approaching a gap between two barriers in a ripple tank.



What is a wavefront?

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(1)

Add further wavefronts to each diagram to show what happens as the waves pass through each gap.

(3)

The station BBC Radio 4 broadcasts both on the Long Wave band at 198 kHz and on VHF at approximately 94 MHz. In mountainous parts of the country, reception is better on Long Wave than on VHF. Suggest why.

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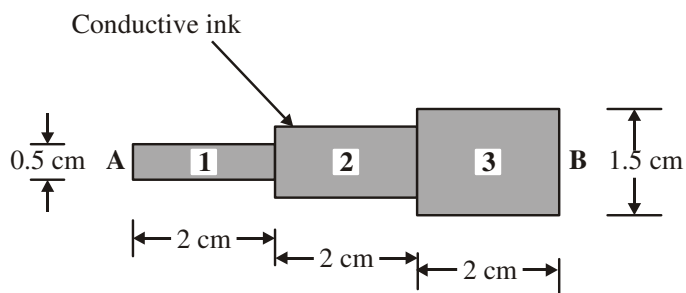
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(2)

(Total 6 marks)

3. Disposable battery testers are sometimes placed on the packaging of battery packs. When placed across the battery terminals, the tester changes colour, depending on the amount of current that the battery provides.

To make a battery tester, you start with a layer of conductive ink that gets wider from one side to the other. The battery terminals are placed at **A** and **B**.



This ink is 0.02 mm thick on one such tester. Show that the resistance of section 1 above is about 30 Ω. The resistivity ρ of the ink is $1.6 \times 10^{-4} \Omega \text{ m}$.

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(3)

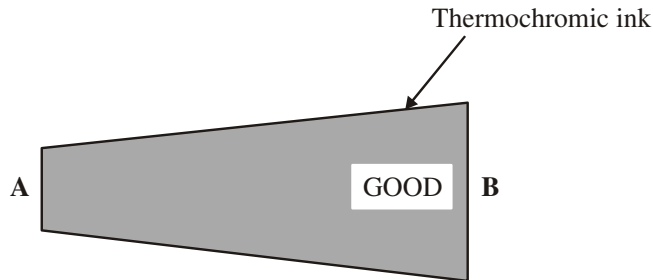
Section 2 is 1.0 cm wide. Determine the total resistance between points **A** and **B**.

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Total resistance =

(3)

The conductive ink is red. This is covered by a layer of thermochromic ink, which gradually changes from black to transparent when warmed.



In use, the tester is placed across the battery terminals. Current then flows in the conductive ink. The thermochromic ink becomes transparent, allowing the colour underneath to become visible.

Why does the thermochromic ink become warm?

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(1)

If the battery is low on charge, the thermochromic ink becomes transparent only in section 1 of the tester. Explain why.

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(2)
(Total 9 marks)

4. A student is asked to carry out an experiment to find the resistivity of the material of a length of resistance wire. Draw an appropriate circuit diagram.

(2)

List all the measurements the student should take to find the resistivity.

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(3)

How should these measurements be used to find the resistivity?

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(3)

Suggest two precautions the student should take to ensure an accurate result.

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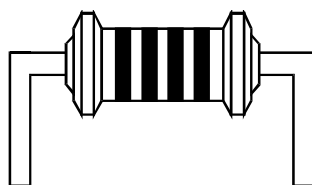
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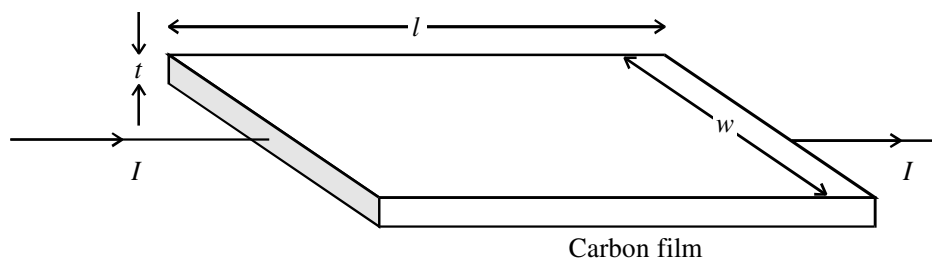
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(2)
(Total 10 marks)

5. The diagram shows a type of resistor commonly used in electronic circuits.



It consists of a thin film of carbon wrapped around a cylindrical insulator. The diagram below (not to scale) shows a typical **film** of carbon, resistivity ρ , before it is wrapped round the insulator.



Show that the resistance R of the carbon film is given by

$$R = \frac{\rho l}{wt}$$

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(2)

This film has length $l = 8.0$ mm, width $w = 3.0$ mm and thickness $t = 0.0010$ mm (i.e. $t = 1.0 \times 10^{-6}$ m). If the resistivity of carbon is $6.0 \times 10^{-5} \Omega\text{m}$, calculate the resistance of the carbon film.

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Resistance = (3)

Show that the resistance of a square piece of carbon film of uniform thickness is independent of the length of the sides of the square.

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(2)
(Total 7 marks)