

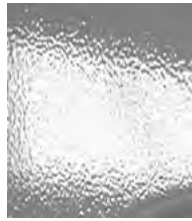
1 A table tennis ball is held under water. When the ball is released it rises to the surface of the water.

Explain why.

(3)

**(Total for Question = 3 marks)**

- 2 The viscosity of paint determines how smoothly and easily the paint can be applied. If the viscosity is too high, the finish will appear bumpy and if the viscosity is too low, the paint will run.



Paint viscosity too high

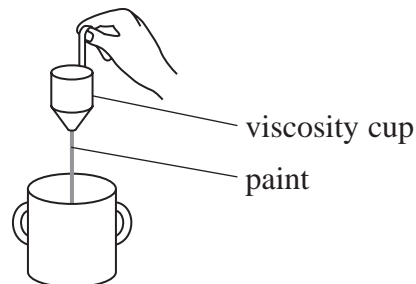


Paint viscosity too low

- (a) State what is meant by viscosity.

(1)

- (b) Before paint is applied, its viscosity can be checked using a viscosity cup. A viscosity cup has a small hole at the bottom for the paint to drain through.



The cup is filled with the paint to a fixed level and the time for the paint to drain from the bottom of the cup is measured. The time to drain the cup can then be converted to a viscosity using a table supplied by the paint manufacturer.

- (i) Explain why this method can be used to determine the viscosity of the paint.

(2)

- (ii) The time taken for the paint to drain from the cup was 17 s. The following day the same paint took 24 s to drain from the cup.

Suggest why the times were different.

(1)

(c) The viscosity cup is a basic way of measuring viscosity.

Suggest **two** possible sources of error with this method and state how each error would affect the time being measured.

(4)

Error 1

Error 2

**(Total for Question = 8 marks)**

- \*3 An experiment investigating the nature of electrons involves firing a beam of electrons through a thin sheet of crystalline material towards a fluorescent screen.

Explain what the results of this experiment demonstrate about the nature of electrons.

(3)

**(Total for Question 12 = 3 marks)**

- 4 Bees have eyes that can detect polarised light. This ability helps them to navigate because scattering of sunlight by particles in the air causes polarisation of the light. When the Sun is low in the sky, light scattered at an angle  $90^\circ$  relative to the position of the Sun is strongly vertically polarised.

Explain what is meant by vertically polarised.

(3)

**(Total for Question = 3 marks)**

5 (a) State what is meant by the principle of superposition of waves.

(2)

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(b) Electromagnetic waves involve oscillating electric fields.

A student made the following notes about the polarisation of electromagnetic waves.  
The notes contain a number of errors.

*Electromagnetic waves are transverse, with oscillations parallel to the direction of motion.*

*When they pass through a polarising filter all the components of the oscillations perpendicular to the filter's plane of polarisation are rotated.*

*The oscillations of the polarised wave are all in the same plane which is perpendicular to the direction of energy transfer.*

Copy the passage, correcting the errors.

(4)

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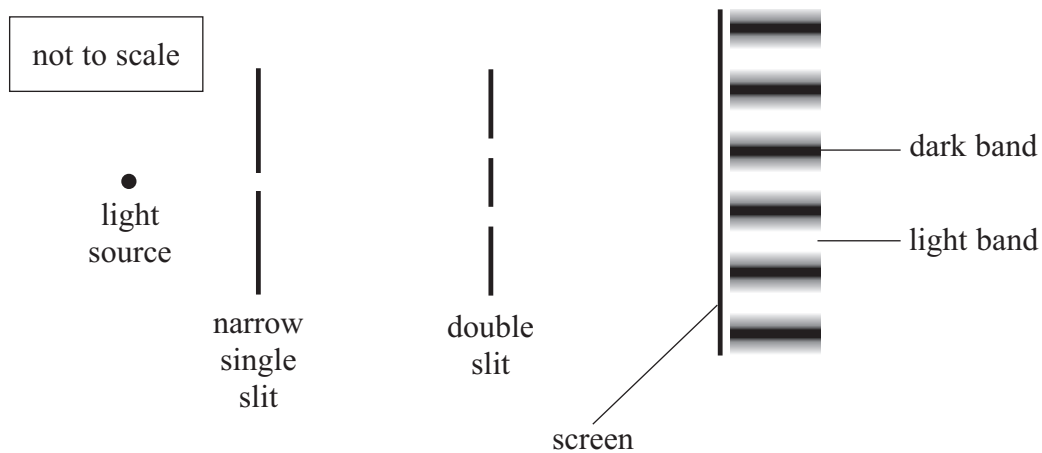
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(c) The arrangement in the diagram demonstrates the effect of superposition. When a monochromatic light source is used, a series of dark and light bands is formed on the screen.



\*(i) Explain how the dark and light bands are formed by light reaching the screen from the two slits of the double slit.

(3)

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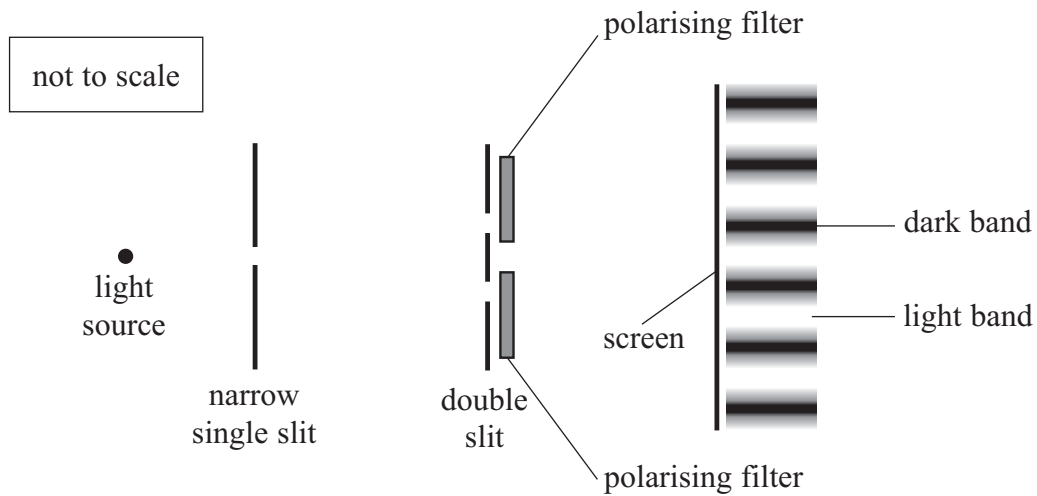
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- (ii) Polarising filters are placed behind the slits as shown. When the planes of polarisation are parallel, the pattern of light and dark bands is still seen.



If one polarising filter is rotated through  $90^\circ$  there are no dark bands and the screen is illuminated evenly.

Explain why there are no dark bands when one filter has a plane of polarisation at  $90^\circ$  to that of the other filter.

(3)

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**(Total for Question 12 marks)**

6 Iceland spar is a crystalline form of calcite. An incident ray of unpolarised light is separated into two plane polarised rays by a sample of Iceland spar. The two rays of polarised light follow different paths.

(a) Explain the difference between polarised and unpolarised light.

(3)



- \* (b) The photograph shows how the separate paths of light produce two images of an object behind the sample.



When a polarising filter is placed on the sample shown in the photograph only one image of 6PH02/01 is seen.

Explain why only one image is seen and describe what would be seen as the filter is rotated through  $360^\circ$ .

(4)

**(Total for Question = 7 marks)**

- 7 Films made to be watched in three dimensions (3D) are produced by projecting two slightly different images on to the screen, one to be seen by each eye.

In one technique the images are polarised. The viewers wear special glasses where the lenses are replaced by two separate plane polarising filters.

(a) Explain what is meant by plane polarised light.

(3)

(b) The light from the screen reaching each eye passes through a different filter so each eye sees a different image. The filter for one eye has a plane of polarisation of  $45^\circ$  and the filter for the other eye has a plane of polarisation of  $135^\circ$ .

Explain this choice of angles.

(2)

- (c) One complaint about 3D films seen through polarising filters is that they appear darker compared to ordinary films.

Suggest why this is the case.

(2)

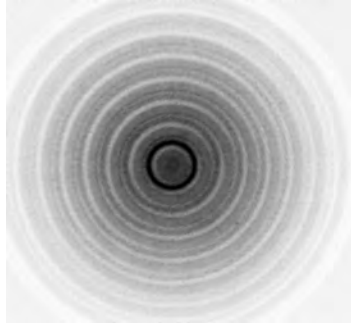
- (d) 3D film viewing is no longer done with plane polarised glasses because these require the viewers to keep their heads exactly level for the whole film. Tilting of the head causes partial viewing of the left image by the right eye and vice versa.

Explain why one eye would see a faint image intended for the other eye if the head is tilted slightly.

(2)

**(Total for Question = 9 marks)**

8 The diagram shows a diffraction pattern.



(a) Explain what is meant by diffraction.

(2)

(b) This diffraction pattern is produced by electrons passing through a thin sheet of graphite.

(i) State what this suggests about the behaviour of electrons.

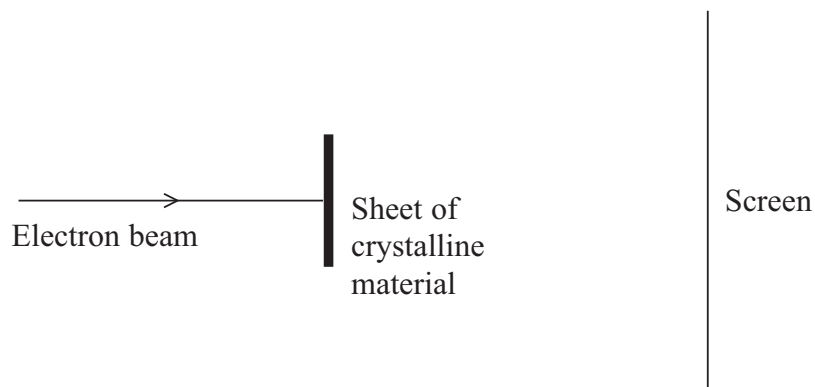
(1)

(ii) Suggest why substantial diffraction occurs.

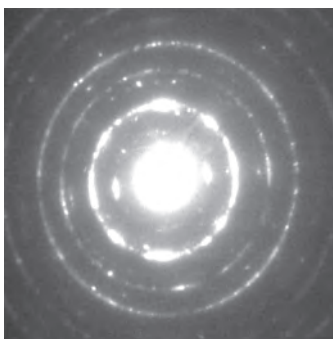
(1)

**(Total for Question = 4 marks)**

9 The diagram shows a beam of electrons being fired towards a thin sheet of crystalline material. The screen detects electrons after they have passed through the sheet.



The photograph shows the positions at which electrons strike the screen.



Explain what can be deduced about the behaviour of electrons from the formation of this pattern.

(3)

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**(Total for Question 3 marks)**