1 (a) Light from the Sun is unpolarised.

Explain what is meant by unpolarised.

(2)

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*(b) When a ray of light from the Sun is incident on a block of ice, most of the light is refracted into the ice. Some of it is reflected. The light that is reflected is partially plane polarised.

Describe a test to confirm that the reflected ray is partially plane polarised.

(3)

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(c) Some skiers wear sunglasses with polarising lenses. These sunglasses reduce the amount of reflected light entering their eyes.

Suggest how these sunglasses work.

(2)

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(Total for Question 7 marks)

2 If you look into a fish pond on a bright sunny day, you sometimes cannot see the fish because of the glare of light reflected off the surface. When the sunlight is reflected off the surface of the water it is partially plane-polarised.

(a) State the difference between plane-polarised and unpolarised light.

(1)

(b) Explain how Polaroid sunglasses can enable the fish to be seen.

(3)

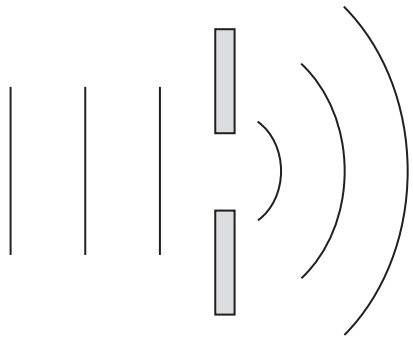
(c) State why sound waves cannot be polarised.

(1)

(Total for Question = 5 marks)

3 Wavefronts of light change shape when they pass around an edge or through a slit. This means that the light bends and the effect is called diffraction. The longer the wavelength of light, the more the light bends.

(a) The diagram on the left shows red light passing through a slit and undergoing diffraction.



Red light

Blue light

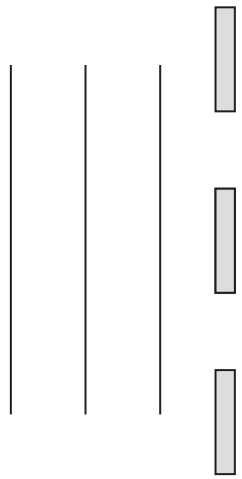
On the diagram on the right, show the same effect for blue light.

(2)

(b) If the red light passes through two slits that are close together, the waves spread out, overlap and add together to produce a pattern of light and dark bands.

Complete the diagram below to show how two overlapping waves produce the pattern of light and dark bands.

(4)



(c) (i) The spacing between two dark bands in the pattern produced is inversely proportional to the distance between the two slits. Red light is shone through two slits that are separated by 1.2 mm and the dark bands in the pattern are 0.60 mm apart.

Calculate how far apart the dark bands will be if the distance between the two slits is reduced to 0.40 mm.

(2)

Distance between dark bands =

(ii) Describe the effect on the pattern if the distance between the two slits is gradually increased to 1 cm.

(2)

(Total for Question = 10 marks)

***4** A student looks at the sunlight reflected off a puddle of water. She puts a polarising (Polaroid) filter in front of her eye. As she rotates the filter the puddle appears darker then lighter.

Explain this observation.

(3)

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(Total for Question = 3 marks)

5 Dentists often use a white composite material for fillings for teeth. This material is applied as a liquid and then hardened using blue light.

The photograph shows a light gun, used by dentists, that emits the blue light.

© Zhengzhou Smile Dental Equipment Co., Ltd.

(a) The light gun emits light of radiation flux 8000 W m^{-2}.

A particular tooth needs a filling of cross-sectional area 1.5×10^{-5} m^2. It requires 2.3 J of incident light energy to harden the filling.

Calculate the time for which the light must be applied.

(3)

Time =

(b) The light gun is supplied with a rechargeable battery of capacity 1.4 amp hours. When in use, the output potential difference of the battery is 3.7 V.

(i) Assuming the potential difference is constant, show that the maximum energy supplied by the battery is about 20 000 J.

(2)

(ii) Assuming each filling requires 2.3 J of incident light energy, a fully charged battery can be used to power the light gun to harden 210 fillings.

Calculate the efficiency of the light gun at supplying the energy stored in the battery to the fillings.

(3)

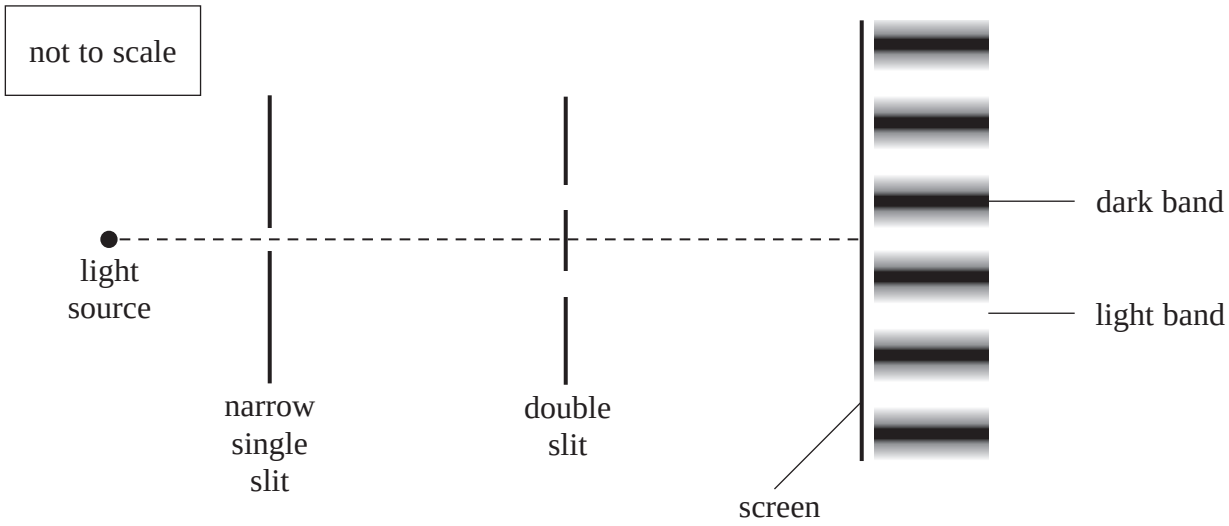
Efficiency =

(Total for Question = 8 marks)

6 In the 17th century, Isaac Newton suggested that light was made up of very small particles which he called corpuscles.

Newton's theory was favoured in England throughout the 18th century because of his great reputation although scientists elsewhere applied the wave theory.

In 1801 Thomas Young demonstrated his double slit experiment. Monochromatic light from a narrow single slit was passed through a double slit and a pattern of light and dark bands was seen on a screen, as shown in the diagram.



*(a) Explain how the light and dark bands are formed in the double slit experiment.

(4)

(b) The observation of light and dark bands with the double slit experiment depends on the light from the slits being coherent.

Explain why coherence is necessary to observe the light and dark bands.

(2)

(c) State why Young's experiment disproved Newton's corpuscular theory.

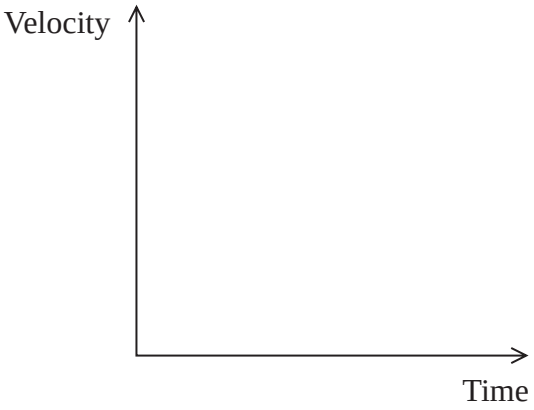
(1)

(Total for Question = 7 marks)

7 Raindrops reach terminal velocity within a few metres of starting to fall.

(a) (i) On the axes below, sketch a velocity-time graph for the motion of a raindrop.

(2)



(ii) Explain why terminal velocity is reached.

(3)

(iii) Suggest why the upthrust acting on a raindrop is often considered to be negligible.

(1)

(b) After reaching terminal velocity, a raindrop took 2.6 minutes to fall 1100 m to the ground.

(i) Calculate the terminal velocity of the raindrop.

(2)

(ii) Calculate the radius of the raindrop. You may assume that Stokes' law applies to the raindrop.

viscosity of air = 1.8×10^{-5} Pa s
density of water = 1.0×10^{3} kg m^{-3}

(3)

Radius of raindrop =

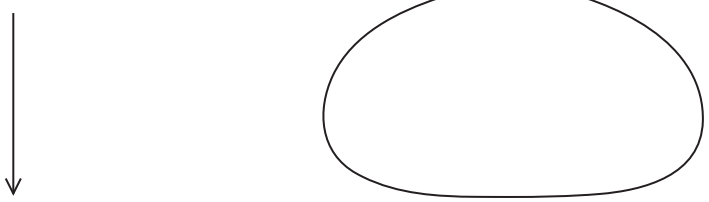
(c) The shape of the raindrop depends on its velocity.

Once at terminal velocity the raindrop is flat at the bottom due to laminar air flow around it and remains curved at the top due to turbulent air flow.

Add to the diagram below to show the air flow around the falling raindrop.

(2)

Direction of motion of raindrop



(Total for Question = 13 marks)