



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Centre Number

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Candidate Number

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Physics

Assessment Unit AS 2

assessing

Module 2: Waves, Photons
and Astronomy



SPH21

[SPH21]

FRIDAY 17 MAY, MORNING

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete in black ink only. **Do not write with a gel pen.**

Answer **all ten** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question.

Your attention is drawn to the Data and Formulae Sheet which is inside this question paper.

You may use an electronic calculator.

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28SPH2101

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28SPH2102



1 The speed of a star travelling directly away from our solar system is $2.6 \times 10^7 \text{ m s}^{-1}$.

(a) Calculate the red shift parameter z for the star.

$z =$ _____ [1]

(b) A line of the spectrum of light observed from a hydrogen source on earth is measured to be 486 nm.

Calculate the wavelength of this line when it is observed from a hydrogen source on the star.

Wavelength = _____ nm [3]

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28SPH2103

2 (a) State Snell's law.

[2]

(b) Describe an experiment, the results of which can be used to graphically confirm Snell's law.

(i) Draw a labelled diagram of the apparatus and how it is set up.
Mark and label any angles that you will refer to in your description in (ii).

[3]



3 (a) Fig. 3.1 shows a graphical representation of a wave.

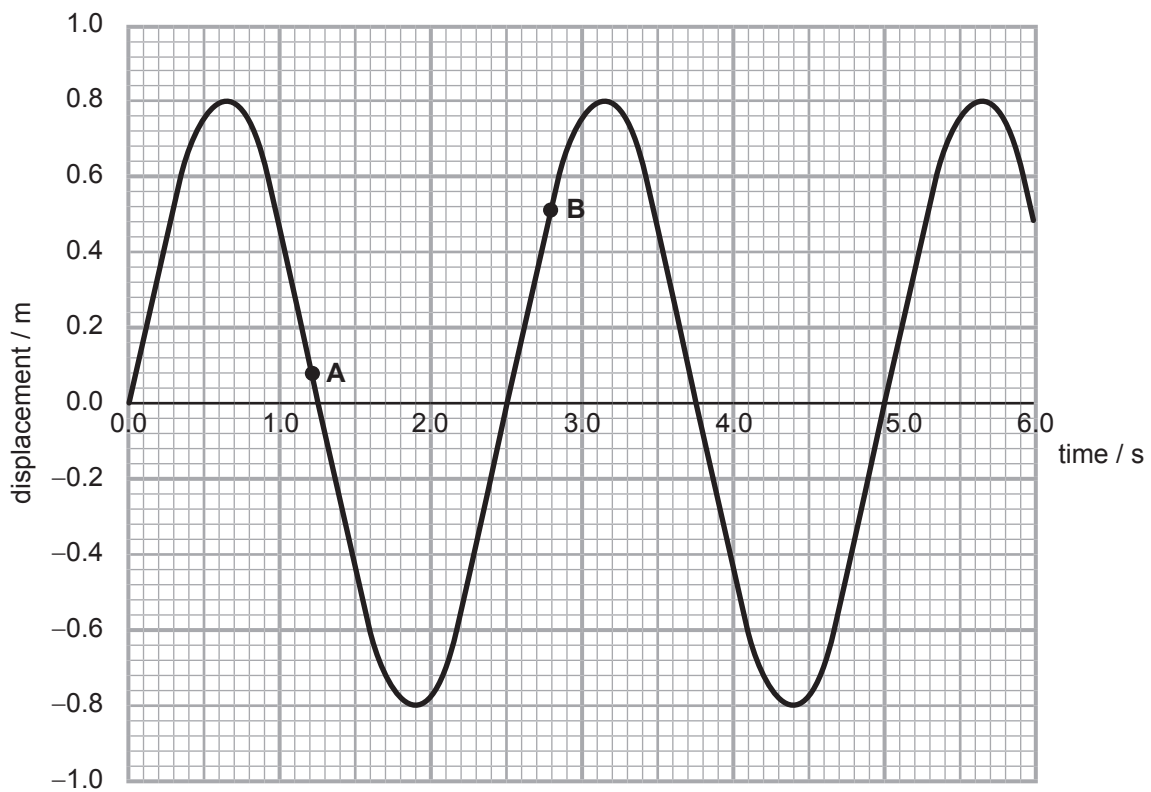


Fig. 3.1

(i) In Table 3.1, tick the correct box to show whether each statement about the wave is true, false, or you cannot tell whether it is true or false.

Table 3.1

Statement	True	False	Cannot tell
It is a transverse wave			
The amplitude of the wave is 16 cm			
The wavelength is 2.5 mm			
The frequency of the wave is 0.4 Hz			

[4]



- (ii) Two points **A** and **B** have been marked on the wave in **Fig. 3.1**. Calculate the phase difference between the two points **A** and **B**. Give the unit for your answer.

Phase difference = _____

Unit = _____

[6]



- (b) When a sound wave passes through a material the particles are arranged into a series of compressions and rarefactions as illustrated in **Fig. 3.2**. The distance between adjacent compressions is equal to the wavelength.

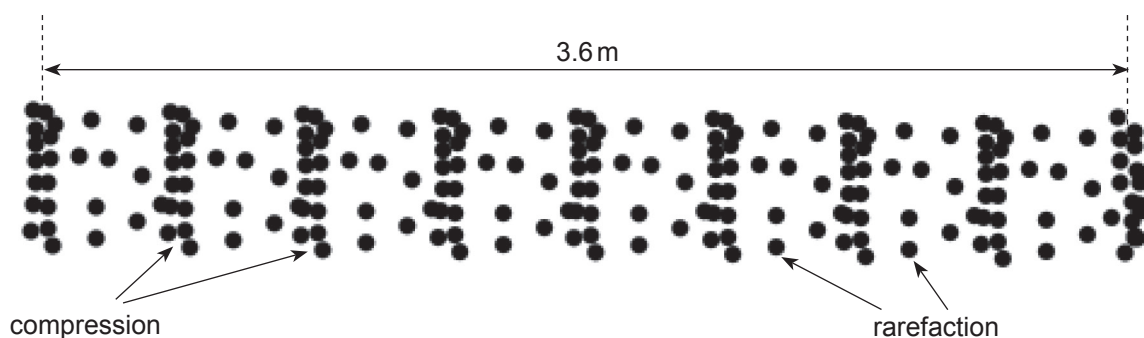


Fig. 3.2

- (i) Explain why sound is classified as a longitudinal wave.

[1]

- (ii) The sound wave takes a time of 4.2 ms to pass along 3.6 m of the material as shown in **Fig. 3.2**. Calculate the frequency of the sound.

Frequency = _____ Hz [5]





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28SPH2109

- 4 (a) Fig. 4.1 shows an overhead representation of apparatus set up to demonstrate Young's slits experiment. The separation of the slits is 0.22 mm and the screen has a width of 0.30 m. The laser is aligned opposite the centre of the screen.

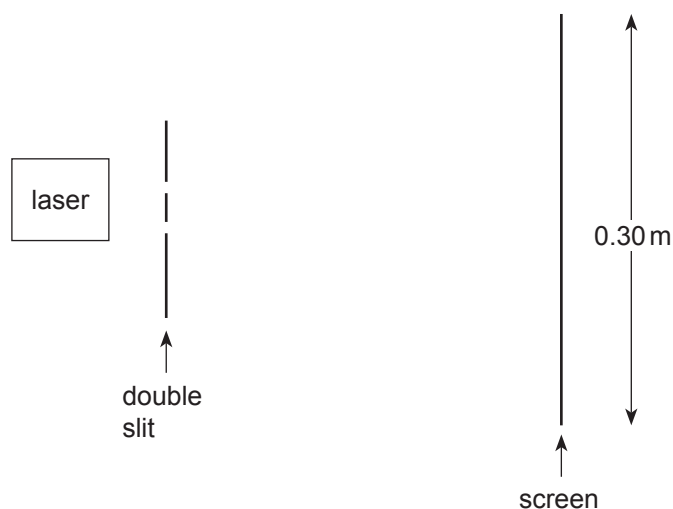


Fig. 4.1

The distance from the slits to the screen is adjusted until 15 bright spots are observed along the width of the screen. This happens when the distance from the slits to the screen is 8.25 m.

Calculate the wavelength of the laser light used. Give your answer in nanometres.

Wavelength = _____ nm

[4]



(b) The double slit is replaced with a diffraction grating with 2×10^5 lines per metre and the grating to screen distance adjusted to 0.75 m. Calculate the number of bright fringes that are displayed on the screen of width 0.30 m.

Number of fringes = _____

[6]

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28SPH2111

5 A person has a near point of 25 cm and a far point of 450 cm.

(a) What defect of vision does the person suffer from? Explain what causes the defect and how it can be corrected using a suitable lens. You may draw diagrams to help explain your answer.

[5]



(b) (i) Calculate the power of the lens that would be needed to correct this person's far point.

Power = _____ D [2]

(ii) Calculate this person's near point when this lens is used.

Near point = _____ cm [2]

[Turn over

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28SPH2113

- 6 (a) On the topic of wave-particle duality Einstein said, 'It seems as though we must use sometimes the one theory and sometimes the other, while at times we may use either.'

Explain this quote using examples of phenomena associated with light.

[4]

- (b) Calculate the de Broglie wavelength of a proton travelling at a speed of $2.60 \times 10^5 \text{ m s}^{-1}$.

Wavelength = _____ m

[3]



- 7 (a) What is the difference between a progressive wave and a standing wave in terms of energy?

[2]

- (b) (i) A progressive wave travelling at a speed of 8 m s^{-1} is sent along a string of length 1 m fixed at both ends. The wave is reflected back to produce a standing wave. The frequency of the vibration creating the wave is 16 Hz .

On **Fig. 7.1**, draw the standing wave pattern that is produced. [3]



Fig. 7.1

- (ii) Calculate the lowest frequency of vibration that would cause a standing wave to be produced on the string.

Frequency = _____ Hz

[2]

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- 8 When white light is shone through a glass prism it is dispersed into the colours of the visible spectrum as illustrated in **Fig. 8.1**.

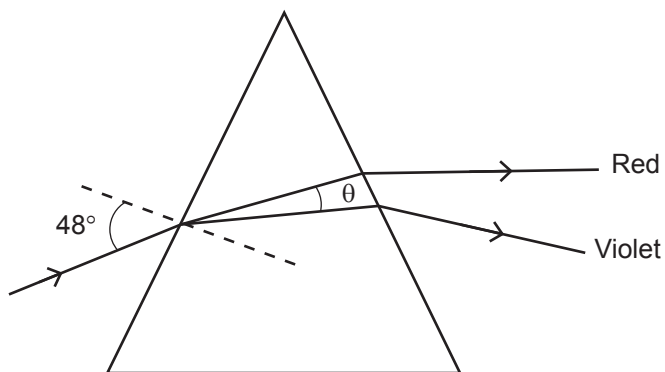


Fig. 8.1

- (a) Explain how this phenomenon illustrates that refractive index depends on the wavelength of light used.

[3]



(b) Fig. 8.2 shows the variation in refractive index for different wavelengths of light in one type of glass.

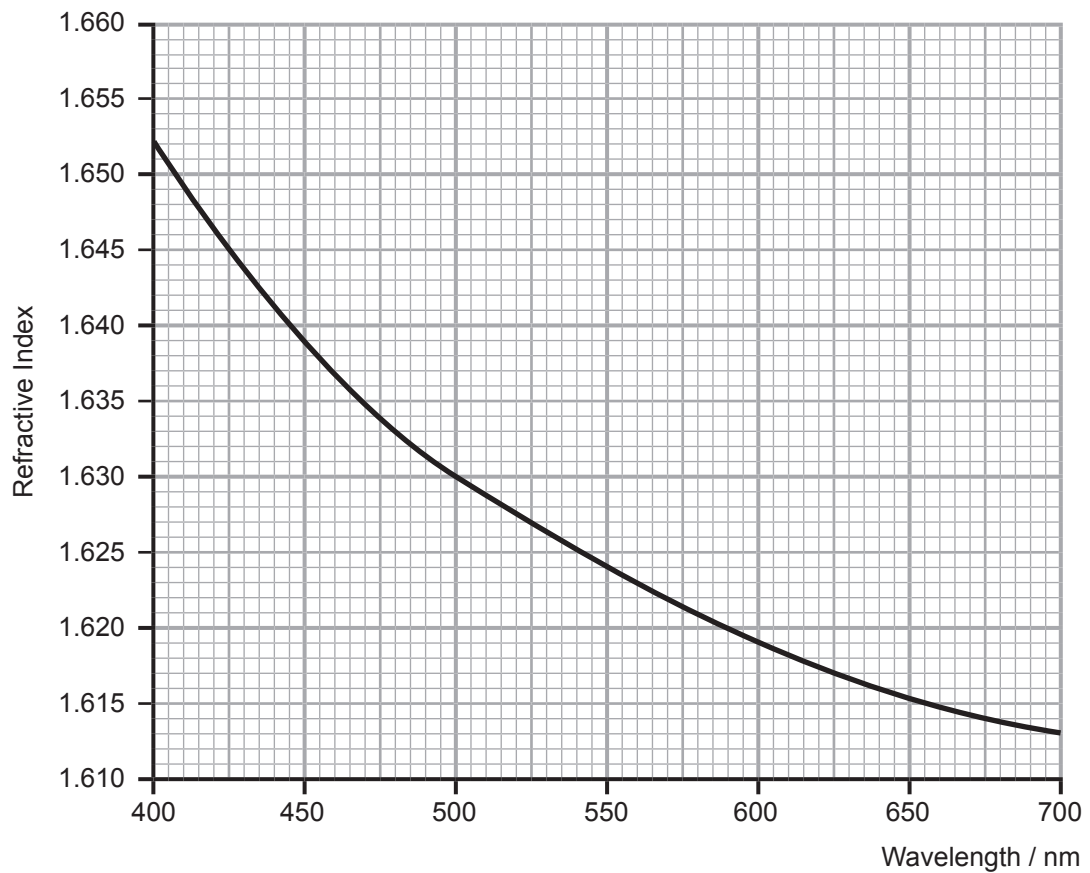


Fig. 8.2

Use data from Fig. 8.2 to calculate the angle θ shown in Fig. 8.1. Give your answer to one decimal place.

$\theta = \text{_____}^\circ$

[5]



(c) Calculate the critical angle of light with a wavelength of 500 nm for this glass.
Give your answer to one decimal place.

Critical angle = _____ °

[3]



9 (a) Explain why X-rays are suitable for examining internal structures in the body.

[2]

(b) In order to produce X-rays, electrons are emitted by thermionic emission from a filament. Describe the process by which these electrons cause emission of X-rays.

[4]





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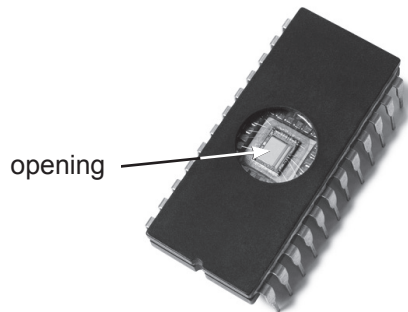
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28SPH2121

- 10 An EPROM (Erasable Programmable Read Only Memory) chip, shown in **Fig. 10.1**, was an invention that allowed programmers to make changes to code without buying new chips. The photoelectric effect causes data to be erased when ultraviolet (UV) radiation falls on the opening in the top surface.



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Fig. 10.1

- (a) Explain what is meant by the photoelectric effect.

[3]



(b) The wavelength of UV radiation used is 2.54×10^{-7} m and its intensity (power per unit area) is 28.0 W m^{-2} . The area of the window that the radiation is incident on is $1.20 \times 10^{-9} \text{ m}^2$.

(i) Calculate the energy of a photon of the UV radiation used.

Energy = _____ J [3]

(ii) The energy needed to erase the data is $36.0 \mu\text{J}$. Calculate the time it would take to erase the data. Give your answer in minutes.

Time taken = _____ minutes [4]

(iii) How many photons fall on the window during this time?

Number of photons = _____ [1]

[Turn over

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28SPH2123

- (iv) The work function of the material that the chip is made from is 2.20 eV. Calculate the maximum speed of an emitted electron.

Speed = _____ m s⁻¹ [4]

- (c) If the UV radiation is replaced by sunlight of the same intensity:

1. Will the time taken to erase the data increase, decrease or stay the same?

2. Will the maximum speed of a photoelectron increase, decrease or stay the same?

_____ [2]





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Sources:

Fig. 3.2.....Examiner

Fig.10.1.....© Getty Images

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Question Number	Marks
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