Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2015

Centre Number

Candidate Number

Physics

Assessment Unit AS 2
assessing
Module 2: Waves, Photons and Medical Physics

AY121

[AY121]
THURSDAY 18 JUNE, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all nine** questions.
Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.
Quality of written communication will be assessed in Question **9**.
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.

For Examiner's use only		
Question Number	**Marks**	**Remark**
1		
2		
3		
4		
5		
6		
7		
8		
9		
Total Marks		

Examiner Only	
Marks	Remark

1 **(a)** **Fig. 1.1** shows part of the electromagnetic spectrum. Complete **Fig. 1.1** to show the missing regions of the spectrum in the correct order.

Radio Waves	Gamma

Fig. 1.1

[2]

(b) A local radio station broadcasts at a frequency of 94.5 MHz. Calculate the wavelength at which the radio station broadcasts.

Wavelength = _____ m [2]

(c) State 3 differences between an electromagnetic wave and a sound wave.

_____

_____

_____

_____

_____ [3]

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(Questions continue overleaf)

Examiner Only	
Marks	Remark

2 **(a)** A ray of light is directed through water towards air at an angle of incidence of 0° at the surface. Describe what happens to the ray of light after reaching the surface of the water as the angle of incidence is increased from 0° towards 90°.

[You may draw a diagram in the space provided.]

[5]

Examiner Only	
Marks	Remark

(b) (i) As a ray of light travelling from air enters the cornea of the eye it is refracted as shown in **Fig. 2.1**. This is to allow the light to be focused on the retina.

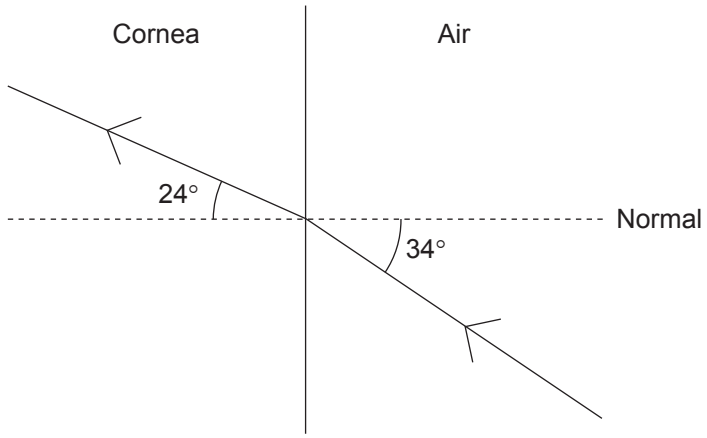

Fig. 2.1

Calculate the refractive index of the cornea and show that it is 1.4 to 2 significant figures.

[3]

(ii) Water has a refractive index of 1.3. With reference to your answer in **(b)(i)** explain why images are not focused when your eyes are open underwater.

_____

_____ [2]

Examiner Only	
Marks	Remark

3 A student carried out an experiment to measure the focal length of a converging lens using the apparatus shown in **Fig. 3.1**.

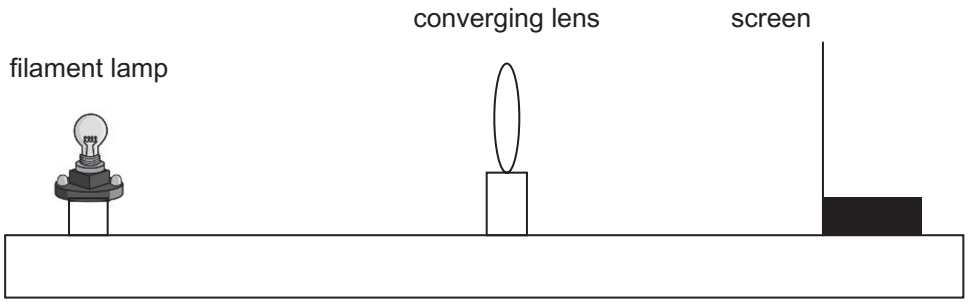

Fig. 3.1

The student measured the image distance v for three different object distances u. The measurements recorded are shown in **Table 3.1**.

Table 3.1

	Set 1	Set 2	Set 3
u/cm	15.0	30.0	40.0
v/cm	32.2	15.7	13.8

(a) (i) Describe how the image was located and the image distance measured.

_____

_____

_____

_____

_____ [3]

(ii) If the object used was 5 cm in height, what is the minimum height of screen required to display the images produced?

Height = _____ cm [3]

(b) Use all of the data in **Table 3.1** to calculate an accurate value for the focal length of the lens.

Examiner Only

Marks	Remark

Focal length = _____ cm [3]

(c) If the student had placed the object 5 cm from the lens describe what would happen when she tried to locate the image. Explain your answer.

_____

_____

_____ [2]

Examiner Only	
Marks	Remark

4 **(a)** State the principle of superposition.

_____

_____

_____ [2]

(b) **(i)** **Fig. 4.1** shows two waves of the same type, travelling in opposite directions that meet in the same medium at the same time.

Give one reason why the two waves will not create a standing wave pattern.

_____

_____ [1]

(ii) On **Fig. 4.1** sketch the resultant wave that will be produced when the two waves meet.

[3]

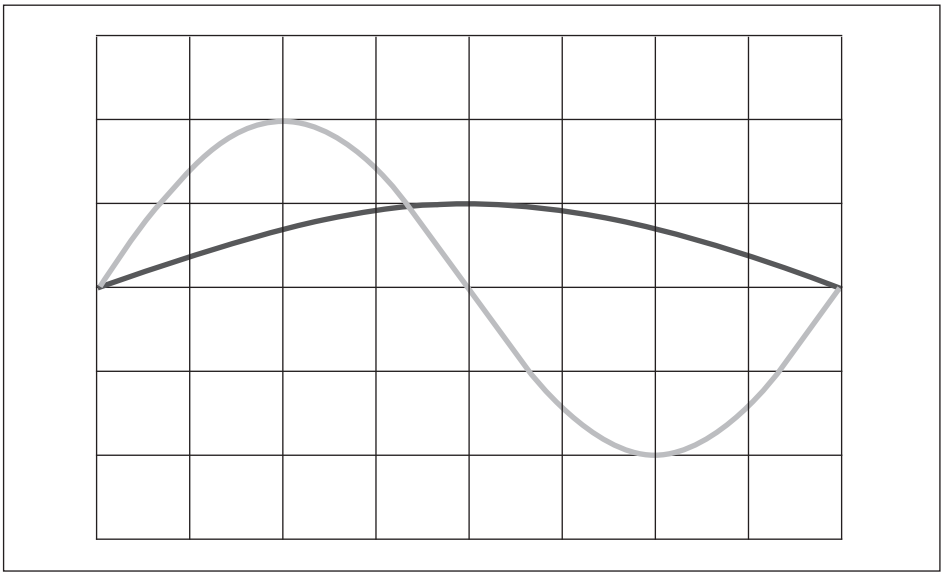

Fig. 4.1

(c) The appearance of a standing wave as produced on a stretched string is as shown in **Fig. 4.2**.

Fig. 4.2

(i) How many nodes and antinodes are there in the standing wave in **Fig. 4.2**?

Number of nodes = _____

Number of antinodes = _____ [1]

(ii) The frequency of vibration of the string to set up this standing wave is 70 Hz. The distance between two adjacent nodes is 15 cm. Calculate the lowest frequency of vibration that would set up a standing wave in this string.

Frequency = _____ Hz [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

5 **Fig. 5.1** shows the pattern produced on a screen when coherent light of wavelength 650 nm was directed towards a double slit. The distance between the slits was 0.2 mm.

Fig. 5.1

(a) What term describes the phenomenon that causes the dark fringes to be formed?

_____ [1]

(b) **(i)** By taking suitable measurements from **Fig. 5.1**, determine an accurate value for the fringe spacing.

Fringe spacing = _____ mm [2]

(ii) Calculate the distance from the slits to the screen.

Distance from slits to screen = _____ m [2]

Examiner Only	
Marks	Remark

6 **(a)** **(i)** The frequency of a pure note that is played on a musical instrument can be determined using a cathode ray oscilloscope, CRO.

What other piece of apparatus is required to allow the frequency to be determined?

_____ [1]

(ii) Describe what will be observed on the CRO screen and explain how this enables the frequency of the sound to be determined.

_____

_____

_____

_____

_____

_____

_____

_____ [4]

(b) Explain what is meant by diffraction and state the condition required for maximum diffraction.

_____

_____

_____

_____ [2]

7 **(a)** What do the letters CT stand for in a CT scan?

_____ [1]

(b) State one similarity and one difference between the radiation used in producing a conventional X-ray photograph and that used in carrying out a CT scan.

Similarity: _____

_____

Difference: _____

_____ [2]

(c) State one example of a person who would be unsuitable for diagnosis using CT scanning and explain why they would be unsuitable.

_____

_____

_____ [2]

(d) What is the role of the computer in the production of a CT scan?

_____

_____ [1]

Examiner Only	
Marks	Remark

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(Questions continue overleaf)

Examiner Only	
Marks	Remark

8 **(a)** **(i)** State what a photon is and describe how a photon can be produced by an electron within an atom.

_____

_____

_____ [2]

(ii) Most microscopes use photons of light to form an image. Light microscopes cannot get an image of objects that are smaller than the wavelength of the light that is used.

Calculate the size of the smallest objects that can be seen with visible light photons of energy 4.97×10^{-19} J.

Size of the smallest objects = _____ m [3]

Examiner Only	
Marks	Remark

(iii) The visible light photons in **(ii)** fall on an atom with an electron in an energy level of –4.23 eV as shown in **Fig. 8.1** causing it to move to energy level B.

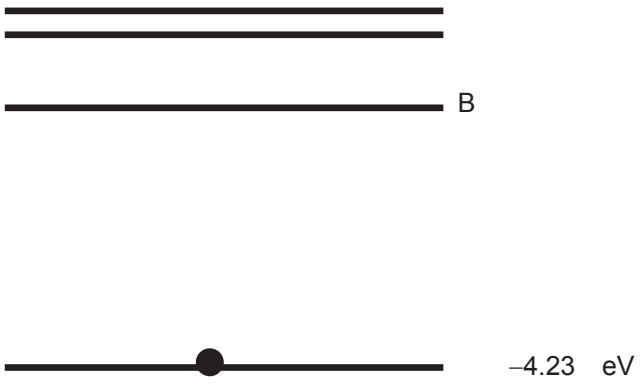

Fig. 8.1

Calculate the energy of energy level B in eV.

Energy level B = _____ eV [3]

(b) (i) Lasers have widespread uses in industry and medicine. State one medical use of lasers.

_____ [1]

(ii) Three of the properties of laser light that make it useful are that it is coherent, monochromatic and collimated. Explain what each of these terms means **in this context**.

Coherent: _____

_____

Monochromatic: _____

_____

Collimated: _____

_____ [3]

9 According to wave-particle duality, electromagnetic radiation can either behave as a wave or as a particle. Describe the evidence which supports the dual nature of electromagnetic radiation.

[6]

Quality of written communication [2]

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

182515

GCE (Advanced Subsidiary) Physics

Data and Formulae Sheet

Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall on the Earth's surface	$g = 9.81$ m s^{-2}
electron volt	1 eV $= 1.60 \times 10^{-19}$ J

Useful formulae

The following equations may be useful in answering some of the questions in the examination:

Mechanics

Conservation of energy	$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs$ for a constant force
Hooke's Law	$F = kx$ (spring constant k)

Sound

Sound intensity level/dB	$= 10 \lg_{10} \frac{I}{I_0}$

Waves

Two-source interference	$\lambda = \frac{ay}{d}$

Light

Lens formula	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$
Magnification	$m = \frac{v}{u}$

Electricity

Terminal potential difference	$V = E - Ir$ (e.m.f. E; Internal Resistance r)
Potential divider	$V_{out} = \frac{R_1 V_{in}}{R_1 + R_2}$

Particles and photons

de Broglie equation	$\lambda = \frac{h}{p}$