New Specification

Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY
General Certificate of Education
2010

Physics

Assessment Unit AS 2

assessing

Module 2: Waves, Photons and Medical Physics

[AY121]

AY121

FRIDAY 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** 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 **7**.
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
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total Marks	

Examiner Only	
Marks	Remark

1 **(a)** **(i)** A beam of light is polarised. Explain the meaning of the term polarised.

_____

_____

_____

_____ [1]

(ii) Describe how you would confirm that a beam of light is polarised.

_____

_____

_____

_____ [2]

(iii) Sound waves are longitudinal. Explain why these waves cannot be polarised.

_____

_____ [1]

(b) A loudspeaker at an open air music festival vibrates at 512 Hz. The sound emitted by the loudspeaker takes 0.510 s to reach a person who is standing 170 m from the loudspeaker.
Calculate the wavelength of the sound emitted from the loudspeaker.

Wavelength = _____ m [4]

Examiner Only	
Marks	Remark

2 **(a)** In an experiment to measure the refractive index of glass, a series of results for a range of angles of incidence and their corresponding angles of refraction has been obtained.
Describe how these results may be processed to obtain an accurate value for the refractive index of glass.

_____

_____

_____

_____

_____

_____ [3]

(b) A ray of light travels from inside a block of transparent material to air. The refractive index of the material of the block is 1.38. The ray emerges from the block into the air at an angle of 43.0º to the normal. Calculate the minimum increase in the angle of the ray inside the block, to cause this ray to undergo total internal reflection.

Increase = _____º [5]

Examiner Only	
Marks	Remark

3 **(a)** **Fig. 3.1** shows a converging lens and its focal points on the principal axis of the lens. The larger squares on the grid are one cm squares.

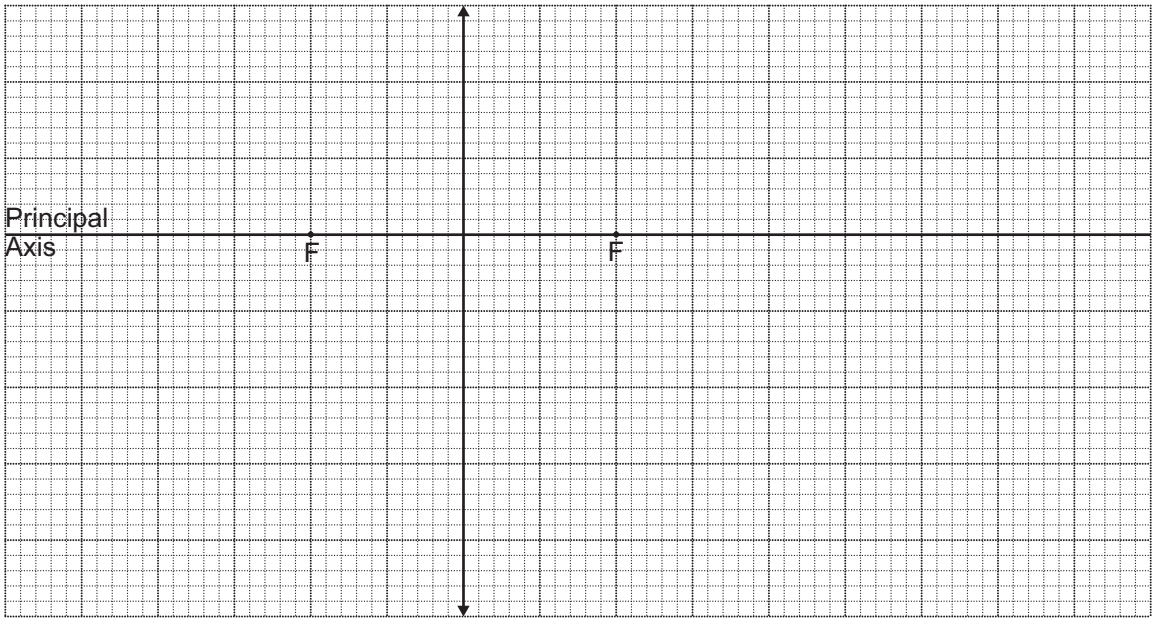


Fig. 3.1

(i) On **Fig. 3.1** draw an upright arrow (↑) to represent an object at a suitable position on the principal axis of the lens so that a magnified real image of the object may be formed.
Draw an accurate ray diagram to show how the image of the object you inserted is formed.
Label this image IG. [3]

(ii) Make accurate measurements from your ray diagram to verify the formula for magnification $m = v/u$.
INDICATE CLEARLY the measurements you take. Write down their values and show how they are used in your verification of the formula.

_____

_____

_____ [5]

Examiner Only	
Marks	Remark

4 **(a)** **(i)** Draw a well labelled sketch in the space below, of the apparatus used to conduct a Young's slits experiment to demonstrate interference.

[2]

(ii) In the box provided below, sketch carefully a diagram of the interference pattern obtained in the experiment.

[2]

(b) **(i)** In a Young's slits interference experiment light of wavelength 550 nm is used.
The separation of the slits is 0.910 mm and the central bright fringe of the pattern obtained is 1.80 m from the slits. At what distance from the central bright fringe of the pattern would the next bright fringe appear?

Distance = _____ m [2]

(ii) Suggest the colour of illuminating light required to make the distance calculated in **(b)(i)** a maximum.

Colour _____ [1]

(iii) State the **general experimental requirement** to obtain the best observation of the **interference pattern produced**.

_____

_____ [1]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

5 **(a)** When certain waves pass through an aperture, diffraction occurs. This means the waves

are distorted	☐
are slowed down	☐
have their wavelength reduced	☐
are spread out	☐
have their frequency increased	☐

Tick (✓) above the appropriate box or boxes which apply. [1]

(b) A parallel beam of light of width about one metre passes normally through an open doorway which is just less than one metre wide. Explain whether or not noticeable diffraction is observed.

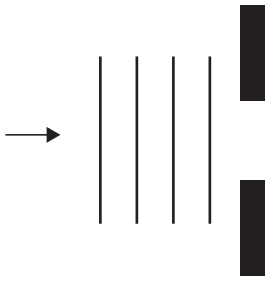
_____

_____

_____ [2]

(c) **Fig. 5.1** shows scaled diagrams of parallel wavefronts of different wavelengths incident on apertures of the same size. Carefully complete the diagrams to show four wavefronts after they emerge from the apertures.

(i)



(ii)

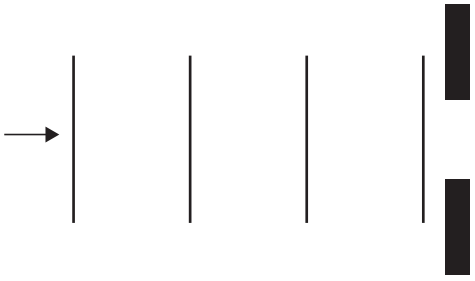


Fig. 5.1

[4]

Examiner Only	
Marks	Remark

6 (a) (i) The frequency of a pure note emitted from a vibrating tuning fork, may be determined using a cathode ray oscilloscope and another item of apparatus.
State the other item of apparatus needed for this method of frequency determination.

_____ [1]

(ii) **Fig. 6.1** shows the trace displayed on the screen of a cathode ray oscilloscope due to the sound of a pure note. The larger squares on the grid are one cm squares.

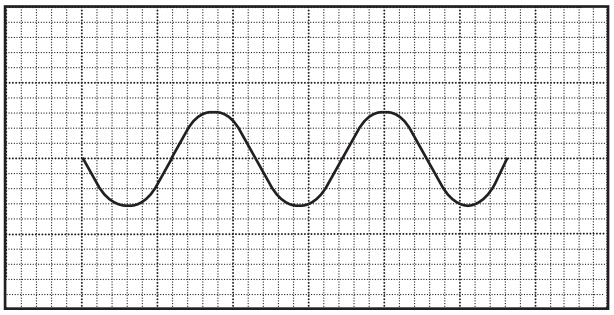


Fig. 6.1

The time base setting of the cathode ray oscilloscope is $2.00\,\text{ms}\,\text{cm}^{-1}$.
Calculate the frequency of the pure note.

Frequency = _____ Hz [4]

(b) **Fig. 6.2** shows a simplified graph of the intensity response of the average human ear over a range of frequencies.

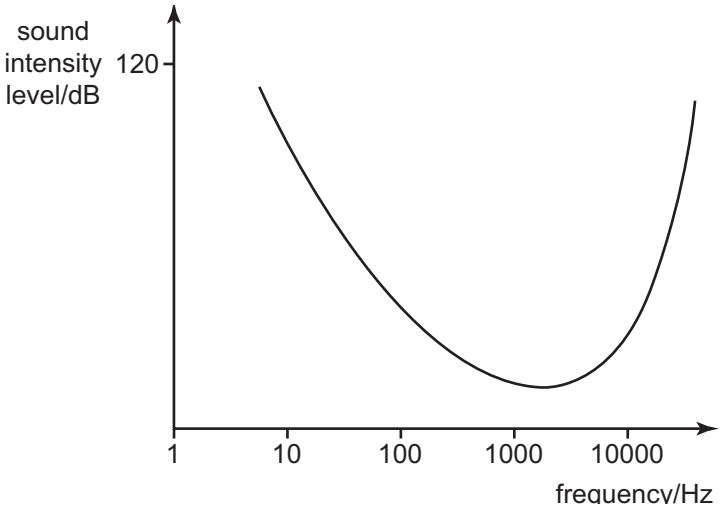


Fig. 6.2

(i) State the approximate frequency at which the ear has the highest sensitivity.

Frequency = _____ Hz [1]

(ii) State the minimum intensity level detectable by the ear at its highest sensitivity.

Intensity level = _____ dB [1]

(iii) On **Fig. 6.2** shade the region of the graph which represents the sound which is not detected by the human ear. [1]

Examiner Only

Marks	Remark

In part (b) of this question you should answer in continuous prose. You will be assessed on the quality of your written communication.

Examiner Only	
Marks	Remark

7 **(a)** The following sentence is a brief but incomplete description of a medical flexible endoscope.

It is a medical instrument which passes light through _____

_____ to illuminate internal organs of the body and transfer

_____ of these to a medical observer.

Certain specific words have been omitted in the description.
In the spaces provided insert suitable words to complete the description.
State one additional function frequently included in another channel of an endoscope.

_____ [3]

(b) Coherent and non-coherent are terms used when describing the structure of an endoscope.
Describe the meaning of these terms and their relevance as they are applied in the context of a medical endoscope.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

Quality of written communication [2]

Examiner Only	
Marks	Remark

8 **(a)** Photons of light are incident on the surface of a photo-emissive metal. State two conditions for photoelectrons to be emitted from the metal surface.

1. _____ [1]

2. _____ [1]

(b) The work function of a certain metal is 3.84×10^{-19} J. It is illuminated with blue light of wavelength 450 nm.
Calculate the energy of a blue light photon, then state and explain if photoelectric emission will occur from this metal with this illumination.

_____

_____ [3]

Examiner Only	
Marks	Remark

9 **(a)** The emission spectra of atoms provides evidence that electrons exist in discrete energy levels in atoms.
Explain briefly what is meant by this statement.

_____

_____

_____

_____

_____

_____ [3]

(b) **Fig. 9.1** shows some of the energy levels in the hydrogen atom.

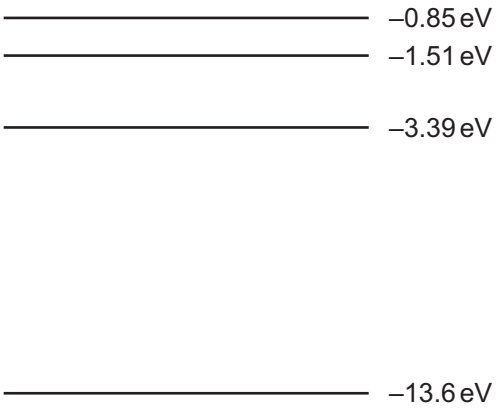


Fig. 9.1

Calculate the lowest frequency of radiation emitted when an electron makes an appropriate transition between two of the levels shown.

Frequency = _____ Hz [5]

Examiner Only	
Marks	Remark

10 (a) (i) State the meaning of a de Broglie wavelength.

_____

_____ [1]

(ii) An electron is accelerated from a low to a high velocity with no change in its mass.
On **Fig. 10.1** sketch a graph to show how the de Broglie wavelength λ of the electron varies with its velocity v.

Fig. 10.1

[2]

(b) The de Broglie wavelength of a proton in a particle accelerator is 1.13×10^{-13} m.
Calculate the velocity of the proton.

Velocity = _____ $m\,s^{-1}$ [3]

THIS IS THE END OF THE QUESTION PAPER

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 = 1.60×10^{-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	$\lambda = \frac{h}{p}$