New Specification

Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY
General Certificate of Education
January 2010

Physics

Assessment Unit AS 2

assessing

Module 2: Waves, Photons and Medical Physics

[AY121]

AY121

MONDAY 18 JANUARY, AFTERNOON

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 **2**.
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)** **Fig. 1.1** shows graphs of displacement against time for two waves A and B.

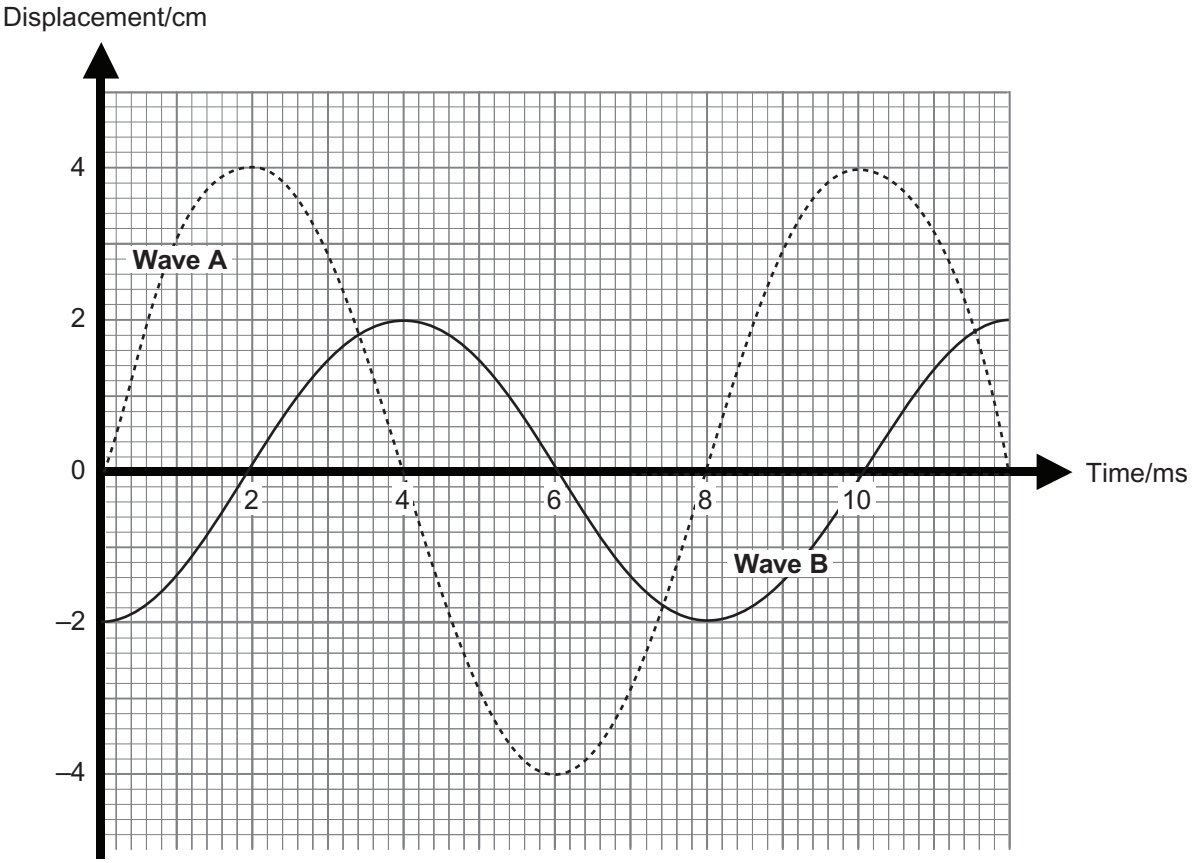

Fig 1.1

(i) State the amplitude of A.

Amplitude = _____ cm [1]

(ii) Calculate the frequency of Wave A.

Frequency = _____ Hz [2]

(b) Are the graphs in **Fig. 1.1** useful in classifying the waves as transverse? Explain your answer.

_____

_____

_____ [1]

(c) **(i)** Waves A and B are not in phase. Explain what is meant by **in phase**.

_____

_____

_____ [1]

(ii) What is the phase difference between wave A and wave B?

Phase difference = _____° [3]

Examiner Only	
Marks	Remark

Where appropriate in this question you should answer in continuous prose. You will be assessed on the quality of your written communication.

Examiner Only	
Marks	Remark

2 Describe an experiment to determine the focal length of a converging lens. Your description should include

(a) a fully labelled diagram of the apparatus you intend to use, [1]

(b) an outline of the method employed, [3]

(c) the results to be taken, [1]

(d) an analysis of how the results can be used to obtain a value of the focal length of the converging lens. [2]

Quality of written communication [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

3 **Fig. 3.1** shows the outline ABCD of a rectangular block made of glass of refractive index 1.46.

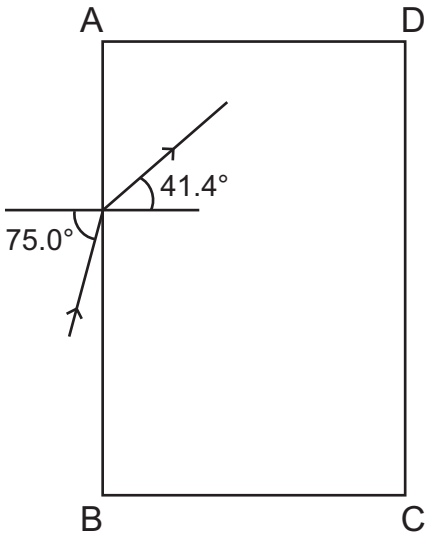

Fig. 3.1

A ray of light is incident at an angle of incidence of 75.0° on side AB. The angle of refraction for this ray is 41.4°. The refracted ray meets face AD.

(a) Calculate the angle of incidence of this ray when it meets face AD.

Angle of incidence = _____ ° [1]

(b) Calculate the critical angle for a ray in this glass meeting the glass/air boundary. (Reminder: the refractive index of the glass is 1.46.)

Critical angle = _____ ° [2]

(c) Use your answers to **(i)** and **(ii)** to deduce what will happen to the ray when it meets face AD.

_____ [1]

(d) On **Fig. 3.1**, continue the path of the ray until it has left the glass block. [1]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

4 Monochromatic light is incident on a narrow slit S_1 as shown in **Fig. 4.1**. After passing through S_1 the light falls on the narrow slits S_2 and S_3. On passing through the slits S_2 and S_3 there is interference in the region beyond.

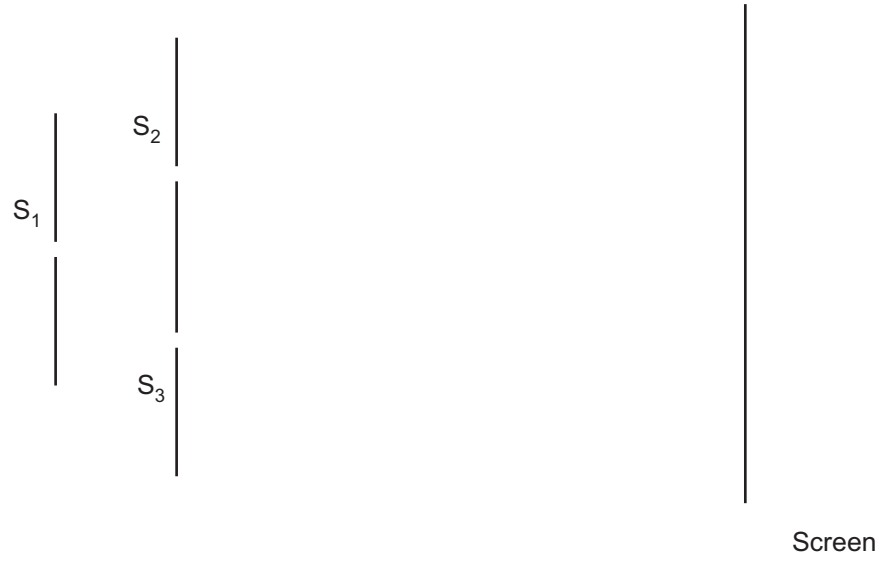

Fig. 4.1

(a) (i) Explain the meaning of the term **interference**.

_____

_____ [1]

(ii) What essential condition must exist for an interference pattern?

_____

_____ [1]

(iii) What other condition should exist for there to be a good contrast between the bright and dark fringes in the pattern?

_____

_____

_____ [1]

(b) The screen is now moved closer to the slits so that the distance between the screen and the slits S_1 and S_2 is half its previous value. State and explain **two** differences between the interference pattern now observed on the screen and the original pattern.

1. Difference _____

   Explanation _____

   _____

   _____

2. Difference _____

   Explanation _____

   _____

   _____ [4]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

5 At point X, 20 m from a loudspeaker the intensity of the sound is $9.9 \times 10^{-5}\,\text{Wm}^{-2}$.

(a) Calculate the sound intensity level at X.

Intensity level = _____ dB [3]

(b) Sound from the loudspeaker is now amplified. This increases the sound intensity level at X by 6.0 dB from the value obtained in **(a)**.

(i) Calculate the new sound intensity level at X.

Intensity level = _____ dB [1]

(ii) Calculate the corresponding factor by which the sound intensity at X is increased.

Factor = _____ [2]

Examiner Only	
Marks	Remark

6 A student carries out an experiment to find the speed of sound in air using a resonance tube. The experimental setup is shown in **Fig. 6.1**.

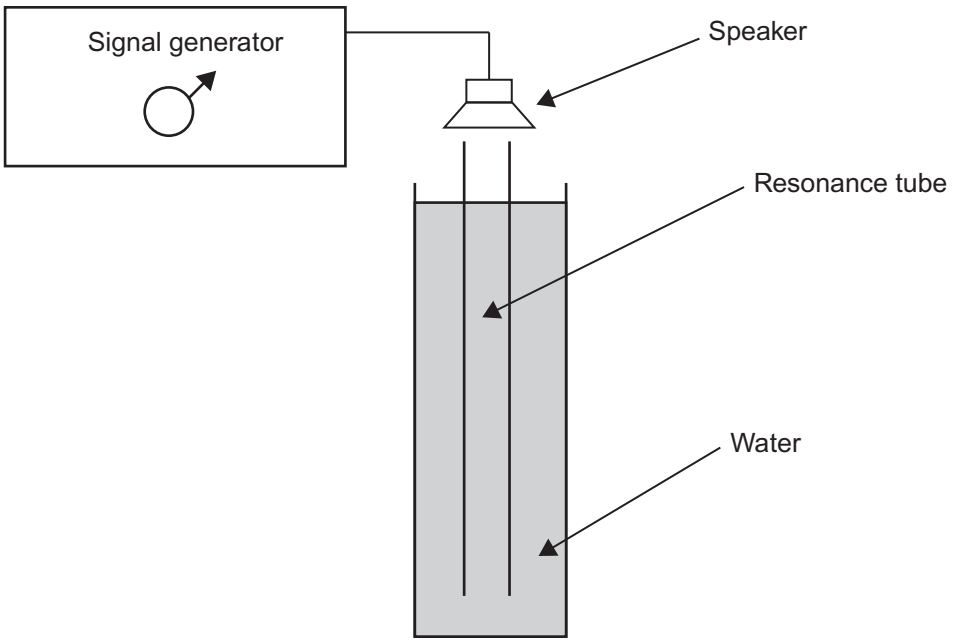

Fig. 6.1

The student sets the dial of the signal generator at 200 Hz and switches on the generator.

(a) Briefly describe the procedure which must be adopted by the student in order to obtain the first position of resonance.

_____

_____

_____

_____

_____ [2]

(b) (i) If the length of the air column for the first position of resonance is found to be 38 cm, calculate the speed of sound in air.

Speed of sound _____ $m\,s^{-1}$ [3]

(ii) Explain why it would be good experimental practice for the student to repeat the experiment for other frequencies.

_____

_____

_____ [1]

(iii) To obtain a second frequency the student adjusts the setting on the signal generator. Unfortunately he adjusts the wrong dial on the signal generator and turns a dial which multiplies the frequency value by ten. Explain why this would make it difficult to take a reading for the first position of resonance.

_____

_____

_____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

7 Ultrasound can be used in non-invasive examinations of internal structures of the human body. One such investigation uses ultrasonic A scans to measure the thickness of a bone. A pulse of ultrasound is partially reflected at the front surface of the bone and then again at the back surface of the bone. The pulse echoes from the bone are converted into electrical signals which are displayed on a CRO screen. The resulting output on the CRO screen is shown in **Fig 7.1** where the pulse labelled **X** is for the first reflection and **Y** is for the second reflection.

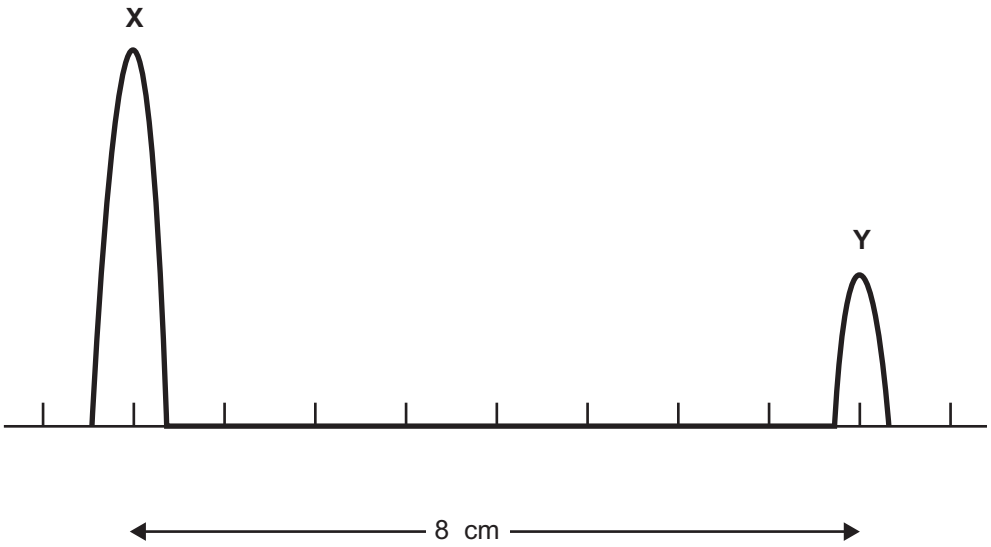

Fig. 7.1

The time base on the CRO is set to 1 μs per cm.

(a) (i) Explain why the pulse **X** is of greater amplitude than pulse **Y**.

_____

_____

_____ [2]

(ii) If the speed of ultrasound in bone is 4000 m s^{-1}, calculate the thickness of the bone.

Thickness = _____ cm [3]

(b) Another type of ultrasound scan employed in imaging is the two-dimensional B scan.

(i) State two ways in which the technique for the B scan differs from that of the A scan.

_____

_____

_____ [2]

(ii) Describe very briefly one medical use of the B scan and what information can be gained from the procedure.

_____

_____

_____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

8 When electromagnetic radiation of a certain wavelength is incident on a clean metal surface, photoelectrons are emitted.

(a) Explain why the photoelectrons are given off.

_____

_____ [2]

(b) The work function of the metal is 1.85 eV.

(i) Explain the meaning of the term **work function**.

_____

_____ [2]

(ii) Convert this value of the work function into joules.

Work function = _____ J [1]

(iii) Calculate the minimum frequency of incident radiation for photoelectrons to be emitted.

Frequency = _____ Hz [2]

Examiner Only	
Marks	Remark

9 The electron in a particular hydrogen atom is in the ground state. It can be excited to a higher energy level by absorbing energy from incident radiation of suitable wavelength.

(a) (i) What is an energy level?

_____

_____ [1]

(ii) Explain what is meant by "**in the ground state**".

_____

_____ [1]

(b) **Fig. 9.1** shows the lowest two energy levels for the hydrogen atom.

_____ –3.34 eV

_____ –13.6 eV

Fig. 9.1

(i) Explain why the energy levels are negative.

_____

_____

_____

_____ [2]

(ii) Calculate the wavelength of the incident radiation which will excite the electron in the ground state to the next energy level.

Wavelength = _____ m [3]

(c) Explain why hydrogen does not absorb visible light when its electron is in the ground state.

_____

_____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

10 Electromagnetic wave phenomena can be explained by the wave model, the photon model or both.

(a) State one phenomenon, other than diffraction, which can only be explained by the wave model.

_____ [1]

(b) **(i)** Electron diffraction shows that electrons can behave as waves. Describe how this can be demonstrated experimentally.
The space below is for any diagram you may choose to draw to aid your description.

_____

_____

_____

_____

_____

_____ [3]

(ii) Describe and explain the effect on the electron diffraction pattern if the incident electrons have a smaller velocity.

_____

_____

_____

_____

_____

_____ [3]

THIS IS THE END OF THE QUESTION PAPER