Candidate Name	Centre Number	Candidate Number
		2

General Certificate of Education
Advanced Subsidiary/Advanced

541/01

PHYSICS

ASSESSMENT UNIT PH1: WAVES, LIGHT AND BASICS

P.M. FRIDAY, 11 January 2008
(1 hour 30 minutes)

For Examiner's use only.	
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Total	

ADDITIONAL MATERIALS

In addition to this examination paper, you may require a calculator.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

You are advised to spend not more than 45 minutes on questions 1 to 5.

INFORMATION FOR CANDIDATES

The total number of marks available for this paper is 90.

The number of marks is given in brackets at the end of each question or part question.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

Your attention is drawn to the table of "Mathematical Data and Relationships" on the back page of this paper.

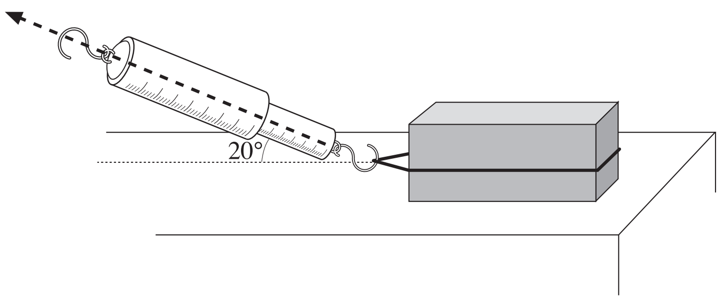
No certificate will be awarded to a candidate detected in any unfair practice during the examination.

Fundamental Constants

Avogadro constant	N_A	=	$6{\cdot}0 \times 10^{23}$ mol^{-1}
Fundamental electronic charge	e	=	$1{\cdot}6 \times 10^{-19}$ C
Mass of an electron	m_e	=	$9{\cdot}1 \times 10^{-31}$ kg
Mass of a proton	m_p	=	$1{\cdot}67 \times 10^{-27}$ kg
Molar gas constant	R	=	$8{\cdot}3$ J mol^{-1} K^{-1}
Acceleration due to gravity at sea level	g	=	$9{\cdot}8$ m s^{-2}
[Gravitational field strength at sea level	g	=	$9{\cdot}8$ N kg^{-1}]
Universal constant of gravitation	G	=	$6{\cdot}7 \times 10^{-11}$ N m^{2} kg^{-2}
Planck constant	h	=	$6{\cdot}6 \times 10^{-34}$ J s
Unified mass unit	1 u	=	$1{\cdot}66 \times 10^{-27}$ kg
Boltzmann constant	k	=	$1{\cdot}38 \times 10^{-23}$ J K^{-1}
Speed of light *in vacuo*	c	=	$3{\cdot}0 \times 10^{8}$ m s^{-1}
Permittivity of free space	ε_o	=	$8{\cdot}9 \times 10^{-12}$ F m^{-1}
Permeability of free space	μ_o	=	$4\pi \times 10^{-7}$ H m^{-1}

Examiner only

1. A uniform building brick is pulled along rough ground by a newtonmeter as shown in the diagram.



(a) (i) Define *centre of gravity*. [1]

(ii) Mark, with an **X** on the upper surface, the point directly above the centre of gravity of the brick. [1]

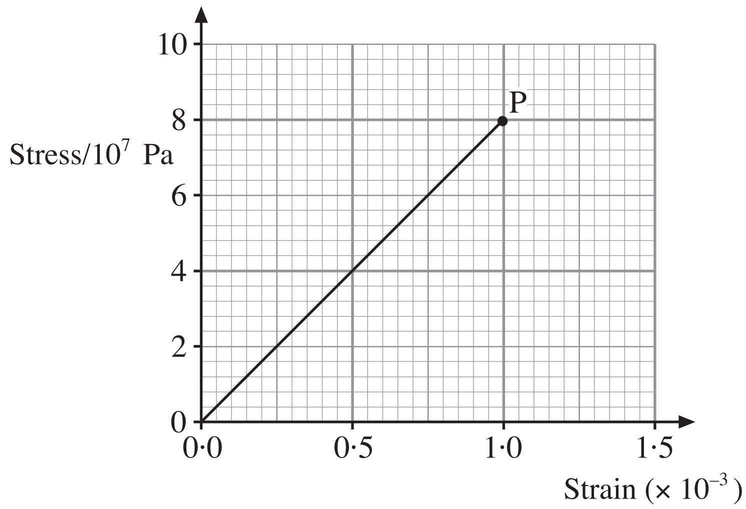
(b) When the brick is pulled at **constant speed** the reading on the newtonmeter is 8·2 N. Giving your reasoning, determine the force of friction between the brick and the ground. [3]

(c) (i) Calculate the vertical component of the 8·2 N force. [2]

(ii) Hence determine the force that the brick exerts on the ground and state the direction of this force. [The weight of the brick is 25·0 N] [3]

Examiner only

2. *(a)* A **complete** stress-strain graph for a thin specimen of glass is shown, indicating the **full** range of strain possible for the specimen.



(i) Explain why there are no units given on the strain axis. [1]

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(ii) Determine the Young modulus for this glass. [2]

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(iii) Is the deformation of glass shown by the graph elastic or plastic? Explain your answer. [2]

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(iv) What happens at point **P**? [1]

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(b) (i) Glass is a brittle material. Briefly describe the process by which glass fractures. [2]

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(ii) Car windscreens are made from pre-stressed glass. During production, jets of air are used to cool the hot glass which causes the outside to contract and harden while the inside remains soft. Later, the inside cools and contracts, putting the outside surfaces under compression. Explain how this process makes the windscreen less likely to fracture. [2]

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3. *(a)* (i) The Sun emits light which is *unpolarised*. Explain what is meant by the term *unpolarised*. [1]

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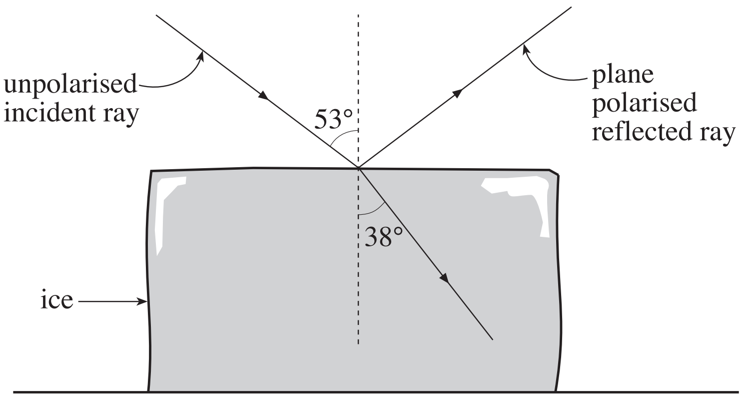
(ii) When a ray of light from the Sun is incident on a block of ice most of it is refracted, but part of it is also reflected as shown in the diagram. The light that is reflected is plane polarised.



Describe in detail a simple laboratory test to confirm that the reflected ray is plane polarised. [4]

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(iii) Skiers wear sunglasses with polarizing lenses to reduce the glare caused by light reflected from the snow. Using the information from part (ii) suggest how the sunglasses work. [3]

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(b) Use the information given in the diagram to determine the refractive index of the ice. [2]

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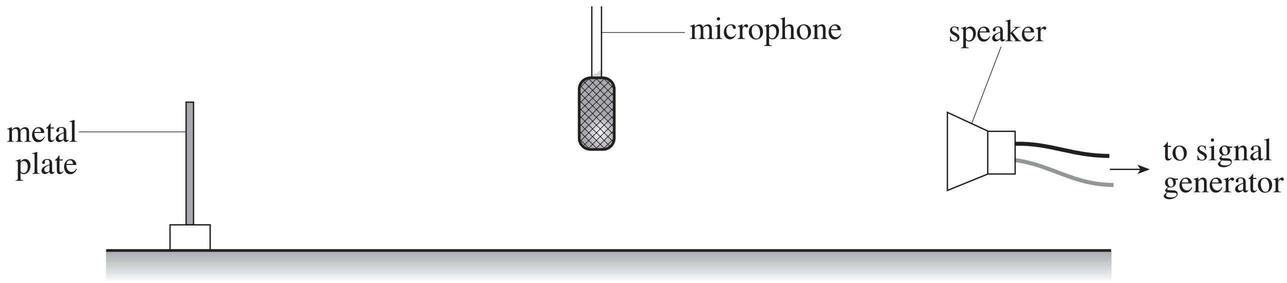
4. The following apparatus is set up to investigate stationary sound waves in air.



(a) Explain how stationary waves are produced in the space between the speaker and the metal plate. [3]

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(b) (i) Calculate the separation between the nodes when the generator is set to 1700 Hz. (Speed of sound in air = 340 ms^{-1}). [3]

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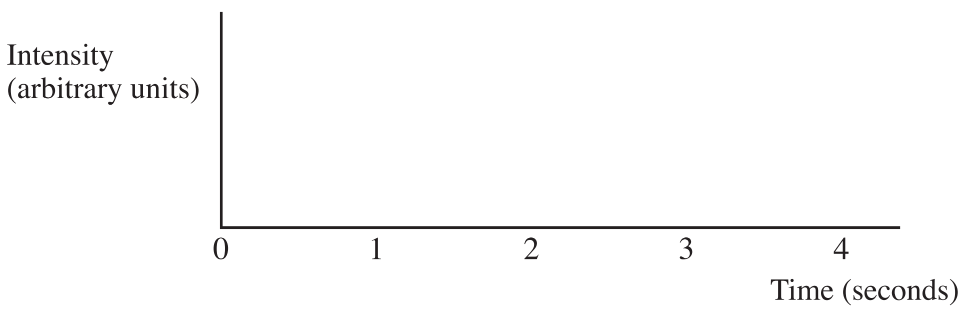
(ii) The microphone initially detects no sound. It is then moved at a speed of 5 cms^{-1} towards the metal plate for 4 seconds. The intensity of the sound detected by the microphone is recorded. **Sketch**, on the grid below, how the intensity varies over the 4 seconds. You are not expected to calculate values of intensity. [3]



(iii) What are the points of maximum intensity called? [1]

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5. *(a)* *Velocity is a vector*. Explain what is meant by this statement. [1]

(b) A ball is projected vertically upwards from ground level with an initial velocity of $11 \cdot 8\,\mathrm{ms^{-1}}$. Referring to the data on page 2 and ignoring air resistance, calculate

(i) the maximum height reached; [3]

(ii) the time of flight, i.e. the total time taken to reach ground level again. [2]

(c) Draw a velocity-time graph for the ball's motion. [4]

Examiner only

6. *(a)* Newton realised that forces always act in pairs and from this idea he developed the 3rd law of motion. State Newton's 3rd law of motion. [1]

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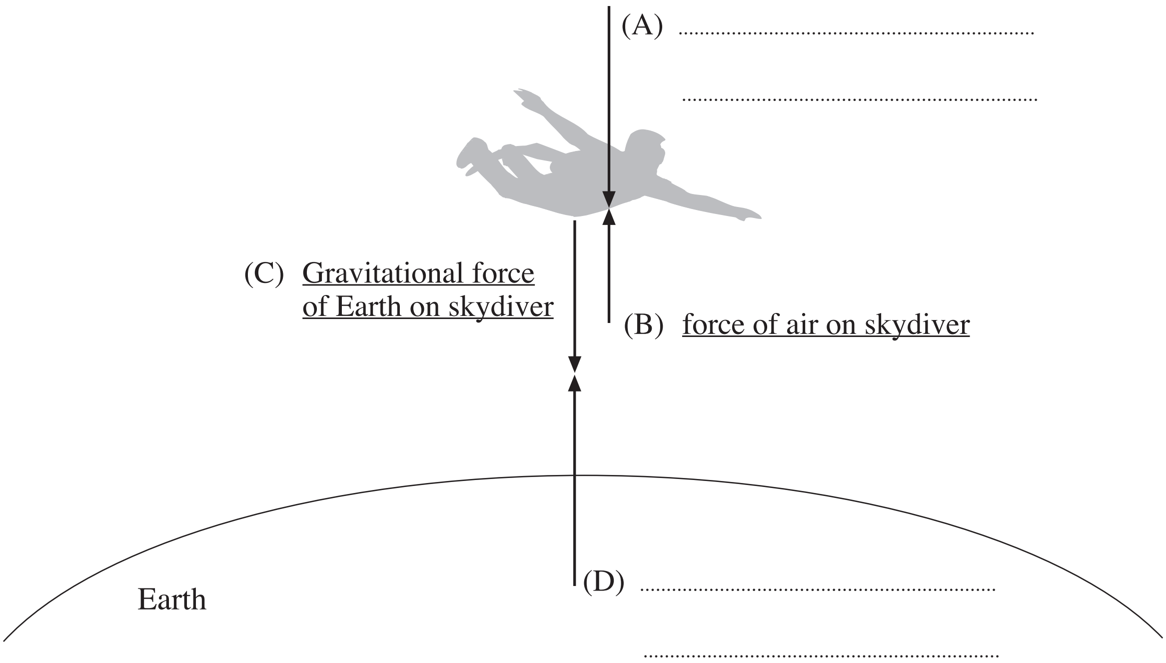
(b) A skydiver falls towards the Earth. The arrows in the diagram represents the main forces acting on the skydiver, the Earth and the air. Two are unlabelled. The diagram is not to scale!



(i) Identify, in the spaces provided, the forces (A) and (D). [2]

(ii) Comment on the effect of force (D) on the Earth. [2]

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(iii) Explain carefully, **referring to the forces involved**, why the skydiver accelerates at the start of his fall and then reaches terminal velocity at some later time. [3]

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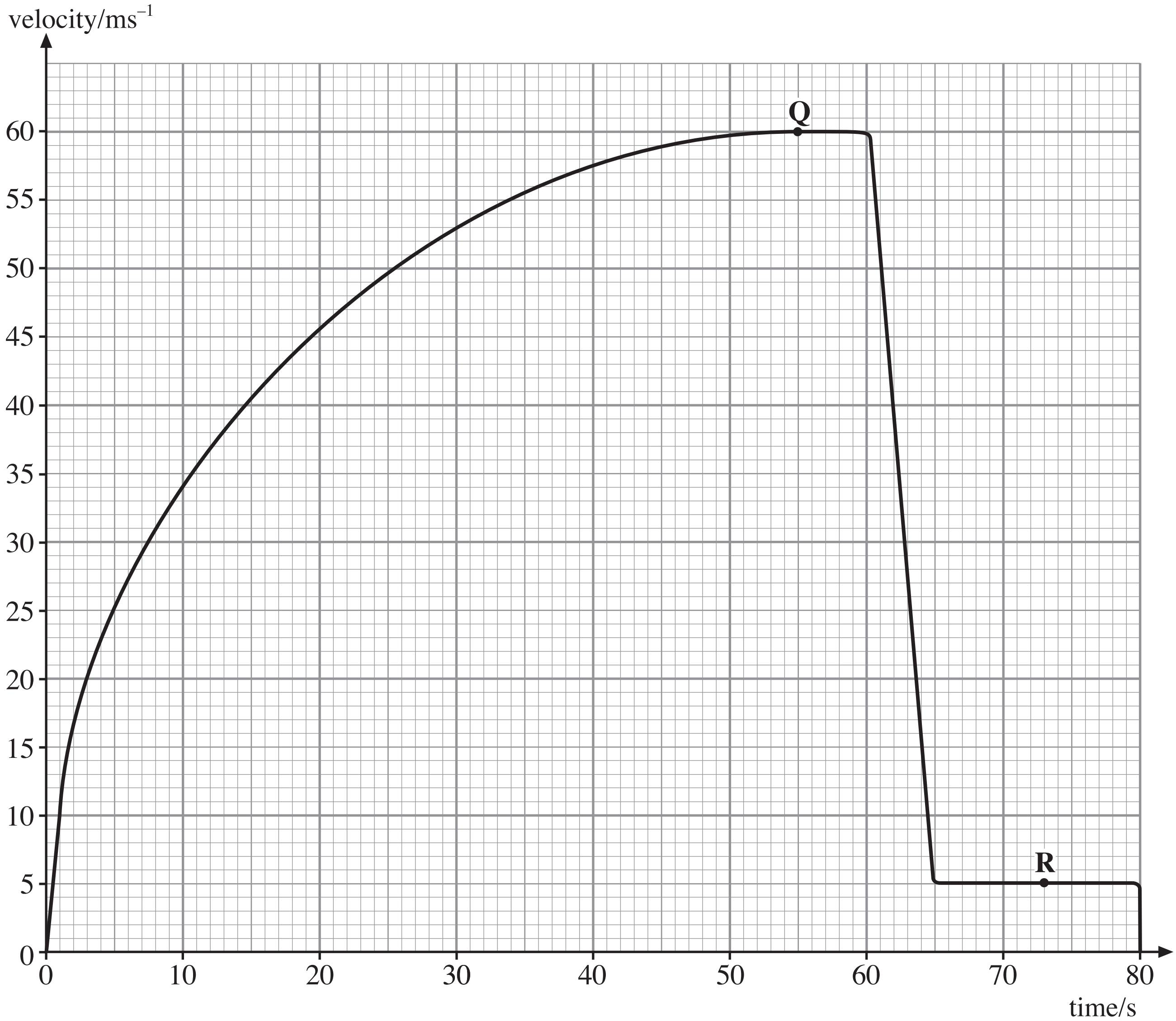
(c) The simplified graph shows how the velocity of the skydiver changes with time during his fall to the ground, including the time when his parachute is open. **Q and R** are two points on the graph which are referred to later in the question.



(i) At a time of 20 seconds the acceleration of the skydiver is $1{\cdot}0\,ms^{-2}$. Given that the total mass of the skydiver and parachute is 70 kg, calculate the force of air resistance at this time. [Refer to the data on page 2]. [4]

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(ii) Calculate the force of air resistance on the skydiver when he is moving at terminal velocity before he opens his parachute e.g at point **Q** on the graph. [2]

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(iii) Using the graph, estimate the skydiver's height above the ground when he opens his parachute. [3]

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(iv) Hence estimate his average speed from the time he opens his parachute to the moment he lands. [2]

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(v) What is the force of air resistance when the skydiver is moving at terminal velocity after he opens the parachute e.g at point **R** on the graph? [1]

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7. *(a)* Figures **A** and **B** show two graphs which refer to the **same transverse wave**.

Figure A (Displacement at given time)

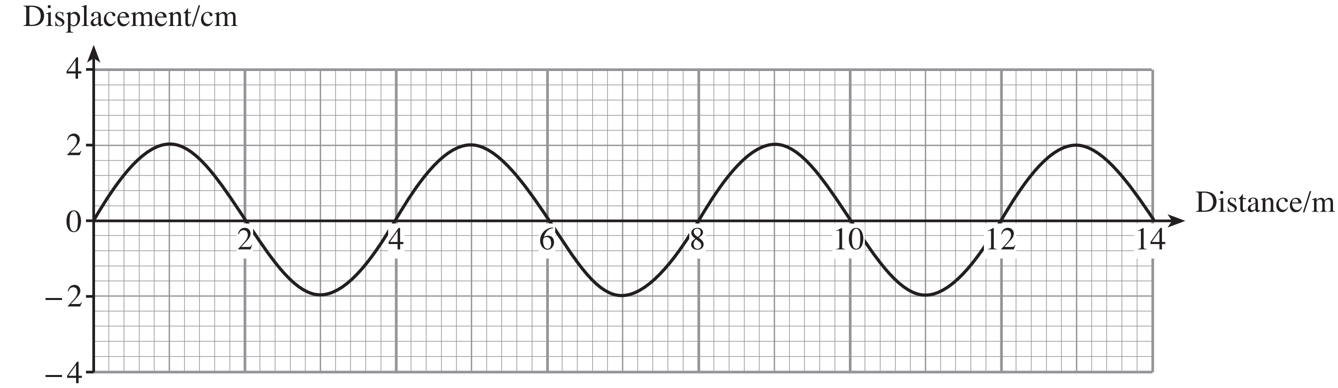
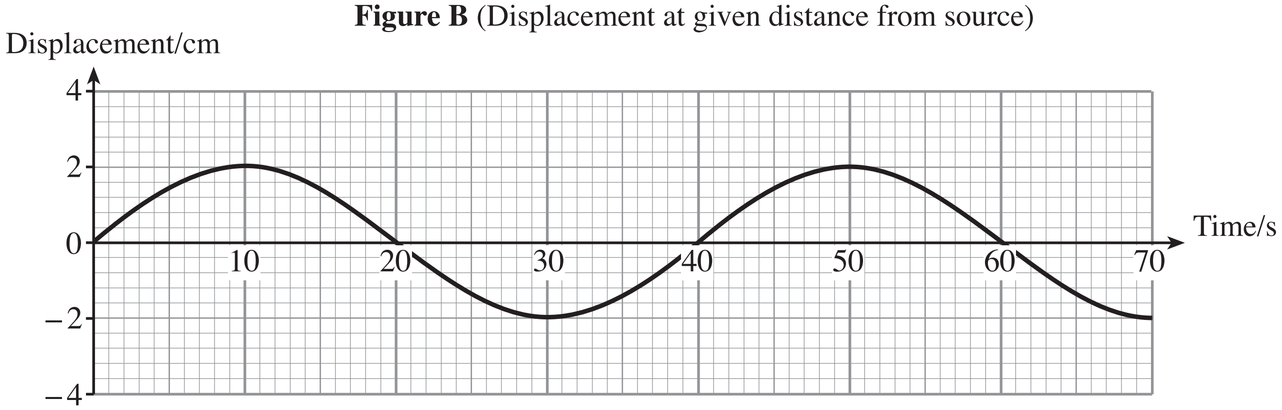


Figure B (Displacement at given distance from source)



(i) Mark clearly two points on **figure A** which are 2·5 wavelengths apart. [1]

(ii) Mark clearly two points on **figure B** which are 90° out of phase. [1]

(iii) Calculate the speed of the wave. [4]

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(iv) Draw another graph in **figure A** to represent a wave of the same frequency but double the speed and half the amplitude. [3]

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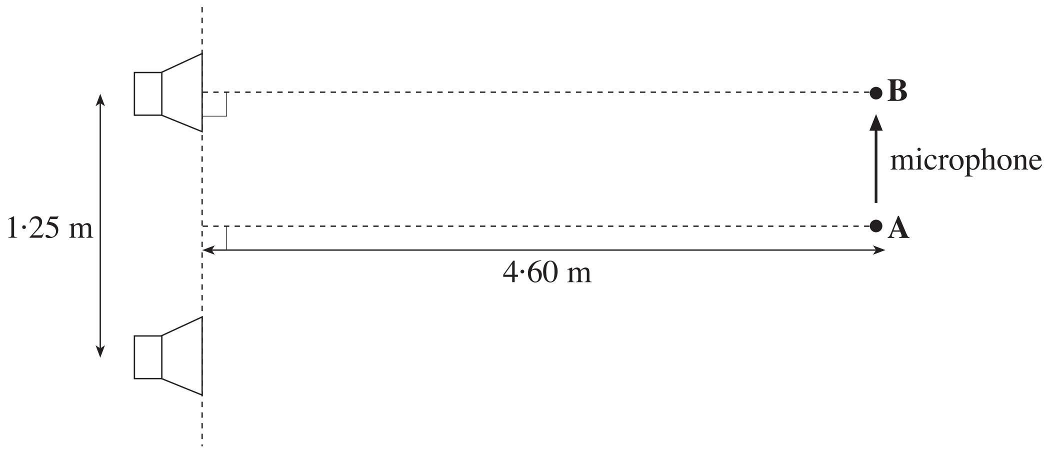
(b) Two speakers are placed 1·25 m apart and are connected to the same signal generator so that they act as *coherent* sources. A microphone is moved perpendicular to the speakers and in the direction shown by the arrow. As it moves it detects a series of maxima and minima of sound intensity. A maximum occurs at **A**, and the **first** minimum at **B**.



(i) State what the microphone detects when it is moved, in the direction of the arrow, beyond **B**. [1]

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(ii) Explain what is meant by *coherent*. [1]

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(iii) The Young double slit formula may be applied to this set-up. Calculate the wavelength of the sound from the sources. [4]

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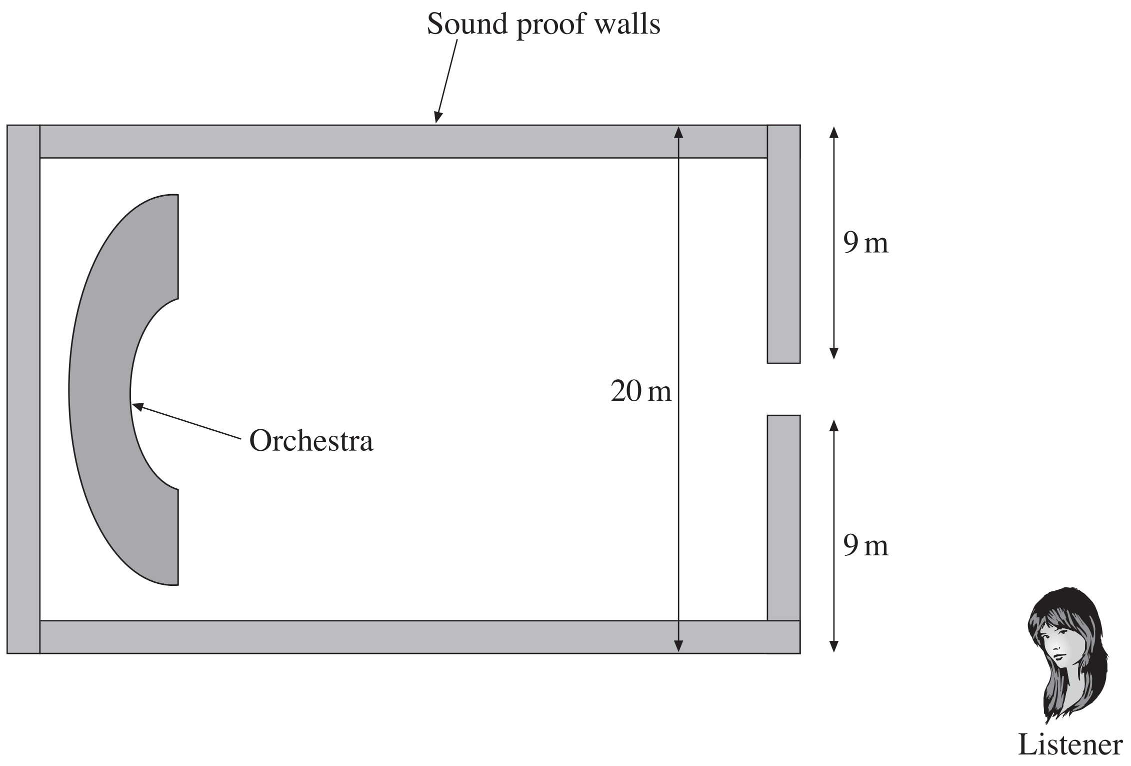
(c) A listener stands outside a concert hall.



(i) She notices that she can hear the orchestra through an open doorway, even though she cannot see the orchestra. Explain how this is possible. [2]

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(ii) She also notices that she can hear the low frequency notes better than the higher notes. Explain why she is able to hear the low notes better. Use the concert hall dimensions to support your answer. Take the speed of sound in the air to be 340 ms^{-1}. [3]

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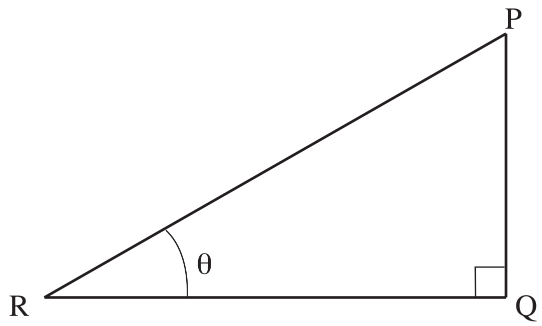
Mathematical Data and Relationships

SI multipliers

Multiple	Prefix	Symbol
10^{-18}	atto	a
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m

Multiple	Prefix	Symbol
10^{-2}	centi	c
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
10^{15}	peta	P

Geometry and trigonometry



$$\sin\theta = \frac{PQ}{PR}, \quad \cos\theta = \frac{QR}{PR}, \quad \tan\theta = \frac{PQ}{QR}, \quad \frac{\sin\theta}{\cos\theta} = \tan\theta$$

$$PR^2 = PQ^2 + QR^2$$

Areas and Volumes

Area of a circle = $\pi r^2 = \frac{\pi d^2}{4}$

Area of a triangle = ½ base × height

Solid	**Surface area**	**Volume**
rectangular block	$2(lh + hb + lb)$	lbh
cylinder	$2\pi r(r + h)$	$\pi r^2 h$
sphere	$4\pi r^2$	$\frac{4}{3}\pi r^3$