Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced Subsidiary/Advanced

CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Addysg Gyffredinol
Uwch Gyfrannol/Uwch

541/01

PHYSICS

ASSESSMENT UNIT PH1: WAVES, LIGHT AND BASICS

A.M. THURSDAY, 12 January 2006

(1 hour 30 minutes)

For Examiner's use only.	
1	
2	
3	
4	
5	
6	
7	
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
Arholwr yn unig

1. *(a)* Define and give the unit for

(i) stress, [1]

....

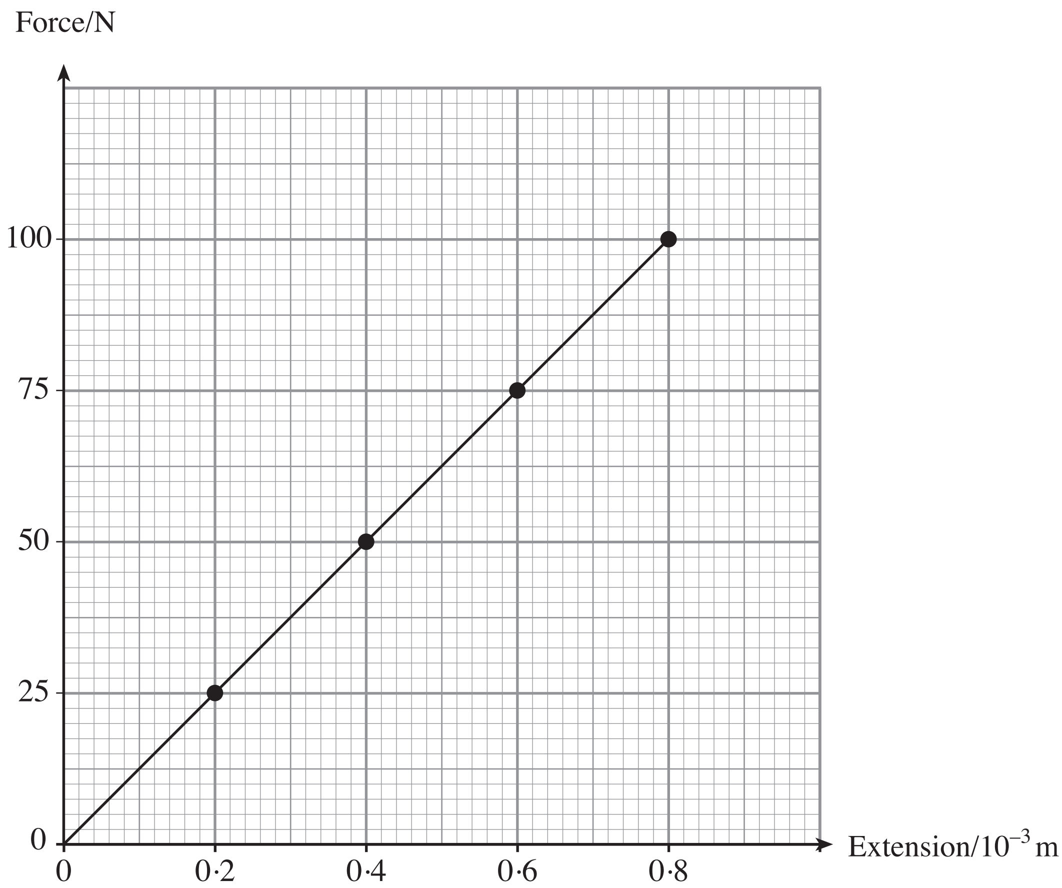
(ii) strain, [1]

....

(iii) the Young modulus. [1]

....

(b) The sketch shows a force-extension graph for a metal specimen.



The specimen is in the form of a wire of original length 2·0 m and **diameter** 1·0 mm. Calculate the Young modulus for the metal. [3]

....

....

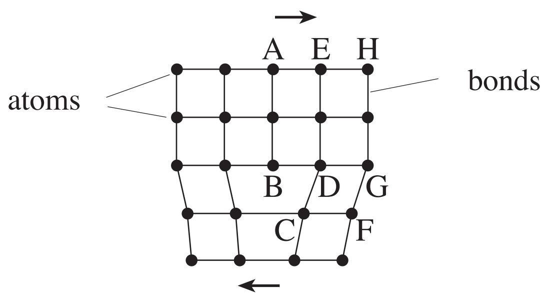
....

....

Turn over.

Examiner only
Arholwr yn unig

(c) The diagram shows the arrangement of atoms in a crystal in the region of a dislocation.



Using the letters given explain how the movement of dislocations can take place in metals when forces are applied as shown by the arrows. Space is provided so that you can illustrate your answer if you wish to do so. [4]

....

....

....

....

....

BLANK PAGE

Examiner only
Arholwr yn unig

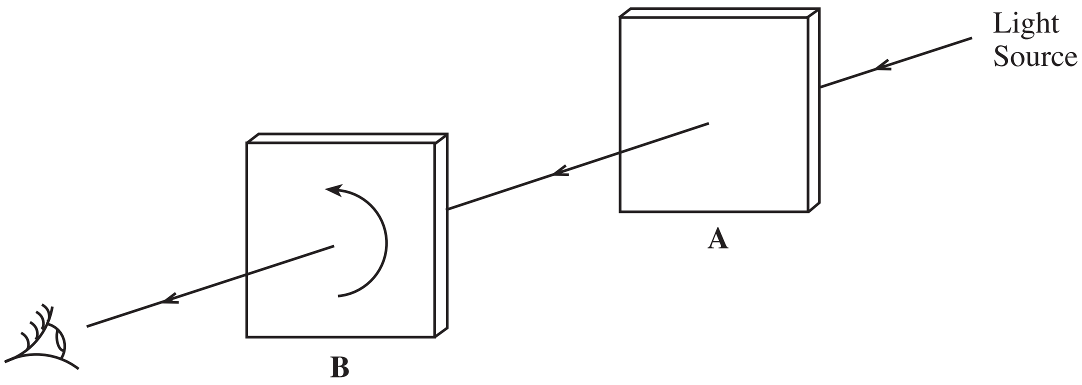
2. *(a)* Distinguish between *polarised* and *unpolarised* light. [2]

....

....

....

(b) A light source appears at its brightest when viewed through two polaroid filters, **A** and **B**, as shown in the diagram.



(i) Describe carefully, by referring to the angle rotated, what is seen when polaroid **B** is rotated slowly in its own plane through 180°. [2]

....

....

(ii) Describe how you would use **one** of the polaroid filters to determine whether the light from the source is polarised or not. [3]

....

....

....

....

(c) (i) The table shows three types of wave. Place a tick (✓) or a cross (×) in the column next to each wave type to indicate whether or not they can be polarised in air. [2]

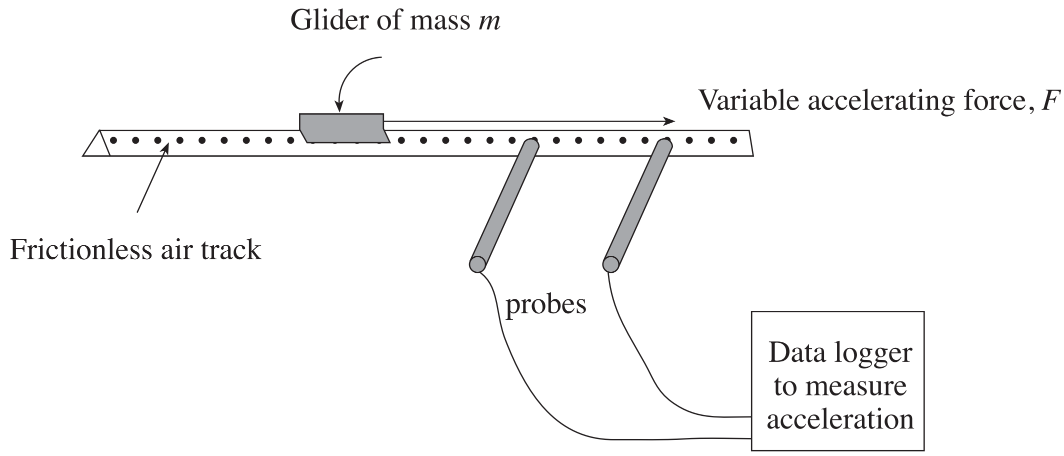
Wave type	Can be polarised (✓) Cannot be polarised (×)
Microwaves	
Ultrasound	
X-rays	

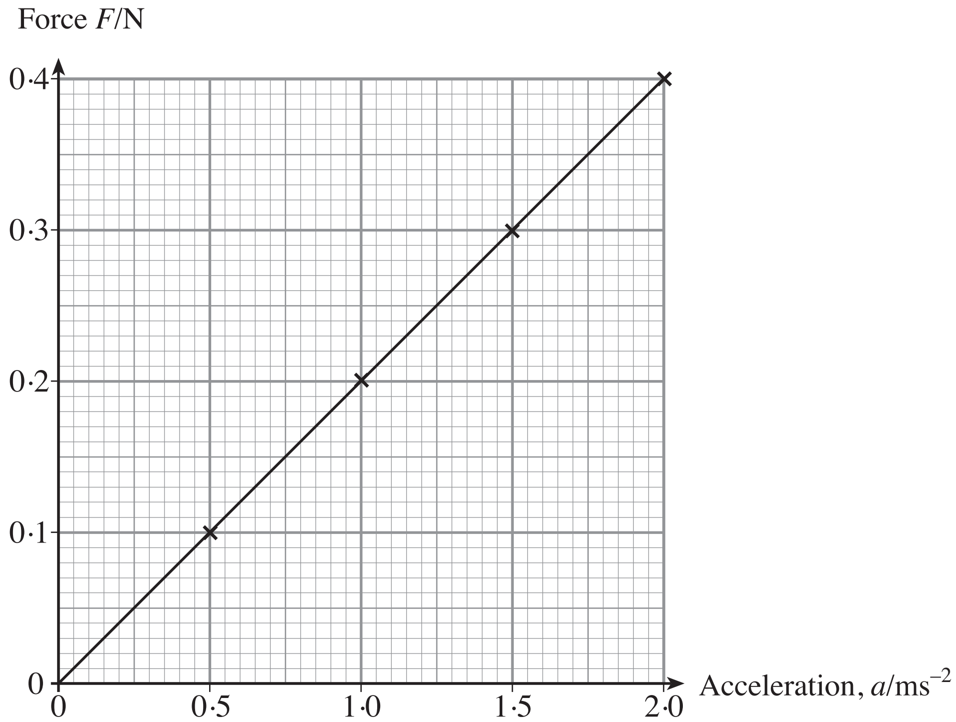
(ii) Give a reason for your answers to *(c)*(i). [1]

....

Examiner only
Arholwr yn unig

3. The diagram shows an experiment carried out to verify that the force acting on a body is proportional to its acceleration. i.e. $F \propto a$. The results obtained are given in the accompanying graph.





(a) (i) How does the graph verify that $F \propto a$? [2]

....

....

(ii) Determine the mass *m* of the glider. [2]

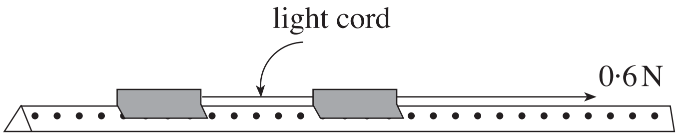
....

....

Examiner only
Arholwr yn unig

(b) Draw a free body diagram to show the forces acting on the glider while it is being accelerated. [3]

(c) A second identical glider is attached to the original glider with a light cord as shown.



Determine the tension in the cord between the two gliders when the accelerating force is 0·6N. [2]

....

....

....

(d) A student incorrectly writes the formula $F = \frac{1}{2}ma$ in an exam. Explain why the method of checking equations using units (or dimensions) would not help the student in this case. [1]

....

Turn over.

Examiner only
Arholwr yn unig

4. *(a)* State the conditions necessary for a body to remain in equilibrium.

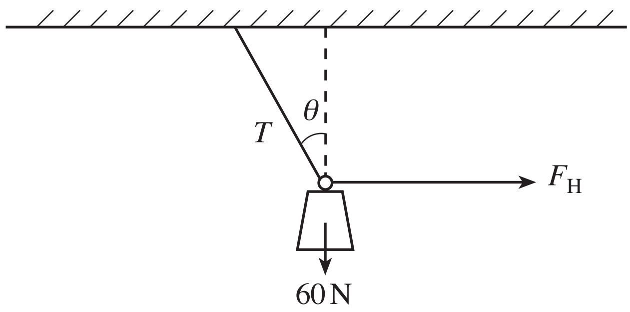
Condition 1: ....

.... [1]

Condition 2: ....

.... [1]

(b) The diagram shows a weight of 60 N suspended in equilibrium from a rigid beam. F_H is a horizontal force.



(i) Calculate the tension T in the string when $\theta = 30°$. [2]

....

....

(ii) Hence, or otherwise, determine the value of the horizontal force F_H. [2]

....

....

(iii) On the diagram, draw an arrow to represent the **direction** of the resultant force due to F_H and the 60 N weight. [1]

(iv) F_H can be varied in magnitude thus varying T and θ. When T is at its **smallest** possible value write down the values of

(I) F_H, [1]

....

(II) θ, [1]

....

(III) T. [1]

....

Examiner only
Arholwr yn unig

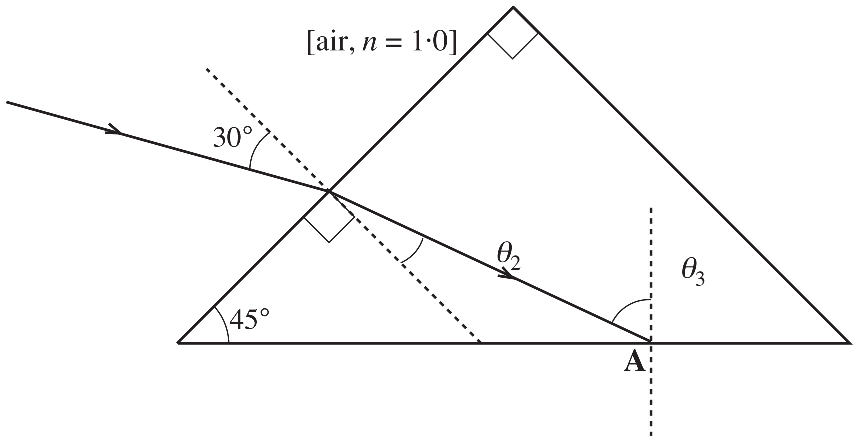
5. The *refractive index* of crown glass is 1·5.

(a) Explain what is meant by refractive index. [1]

....

....

(b) The diagram shows a ray of light entering and travelling through a prism made from crown glass.



(i) Calculate the angle of refraction, θ_2. [2]

....

....

(ii) Calculate the critical angle for crown glass. [2]

....

....

(iii) Find θ_3 and hence show clearly **on the diagram** what happens to the light ray at **A**.[3]

....

....

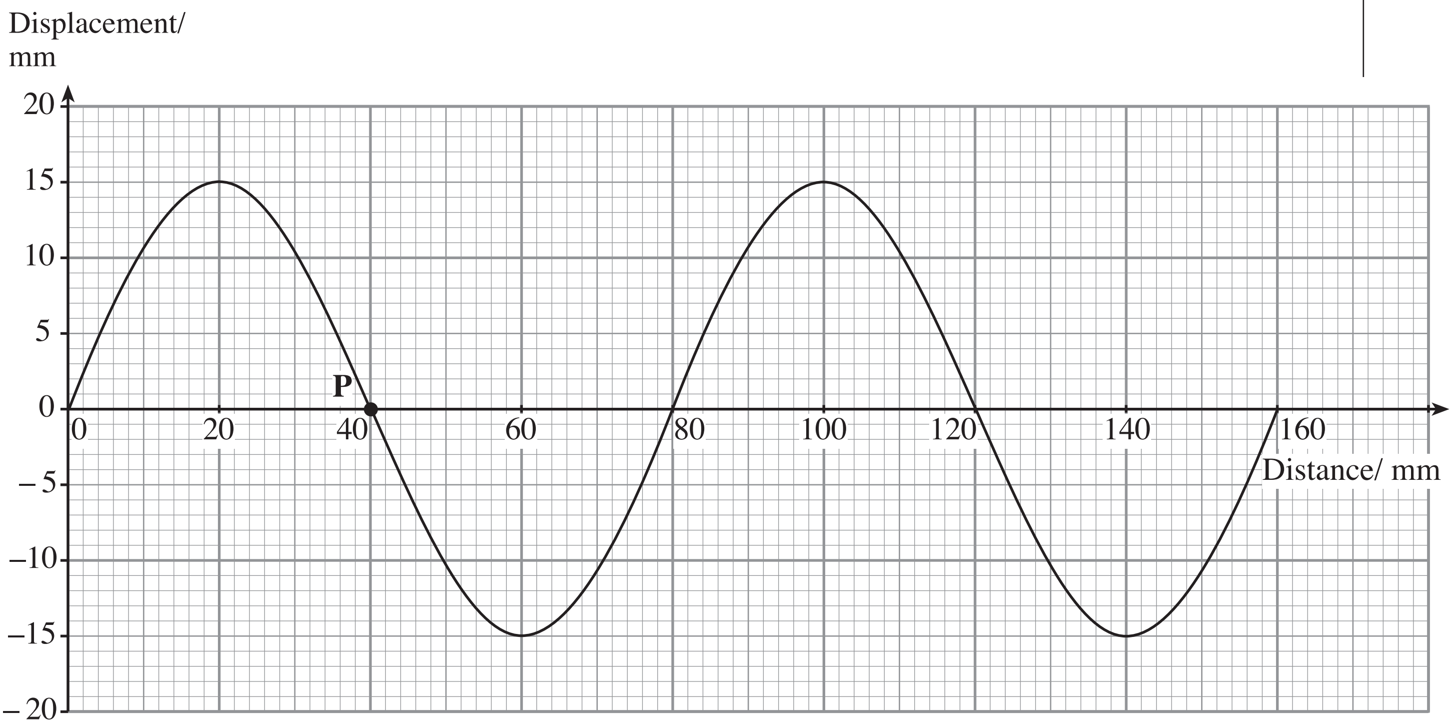
(c) Complete the following table, which shows some of the properties of the light ray used in part *(b)*. [2]

Medium	Speed of the light/ms^{-1}	Frequency of the light/ terahertz
air	$3{\cdot}0 \times 10^8$	
crown glass		500

Turn over.

6. *(a)* List **three** properties of a progressive (sine) wave. [3]

(b) A displacement-distance graph (at a single instant in time) for a progressive wave in a string is shown below. **P** is a particle of the string.



(i) Determine

(I) the amplitude of the wave, [1]

(II) the wavelength of the wave. [1]

(ii) The wave has a frequency of 3·0 Hz. Show that the distance travelled by the wave in 0·050 s is 12 mm. [3]

(iii) Assuming that the wave travels from left to right, draw on the graph the position of the wave 0·050 s later. [2]

(iv) (I) Draw on the wave profile an arrow to show the direction of motion of particle **P** at this time. [1]

(II) Estimate the displacement after 0·050 s of particle **P**. [1]

....

(v) Determine the phase difference (in degrees) between points on the wave that are 260 mm apart. [3]

....

....

....

(c) (i) State the principle of superposition. [2]

....

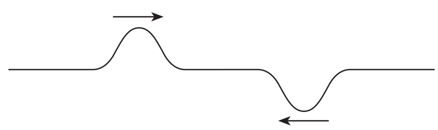
....

....

(ii) Diagrams **A** and **B** show two pulses approaching each other on a length of string. In the spaces beneath, sketch a diagram **in each case** to illustrate the superposition of the pulses as they cross. [2] [1]

Diagram A

Diagram B



7. *(a)* (i) Define acceleration. [1]

....

(ii) $s = \frac{(u+v)t}{2}$ is one equation of uniformly accelerated motion. Use this equation and your answer to *(a)*(i) to show clearly that [3]

$$s = ut + \frac{1}{2}at^2$$

....

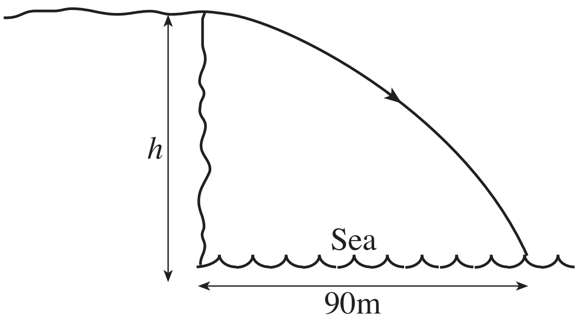
....

....

....

....

(b) Two students carry out an experiment to determine the height of a cliff. One student throws a stone **horizontally** from the cliff top as shown in the diagram. The other student has a stop watch to record the time of flight of the stone. **Ignore air resistance**.[Refer to the data on page 2.]



(i) The stone took 5·0 s to reach the sea. Determine the height (h) of the cliff. [3]

....

....

....

....

(ii) (I) Determine the vertical velocity of the stone at impact. [3]

....

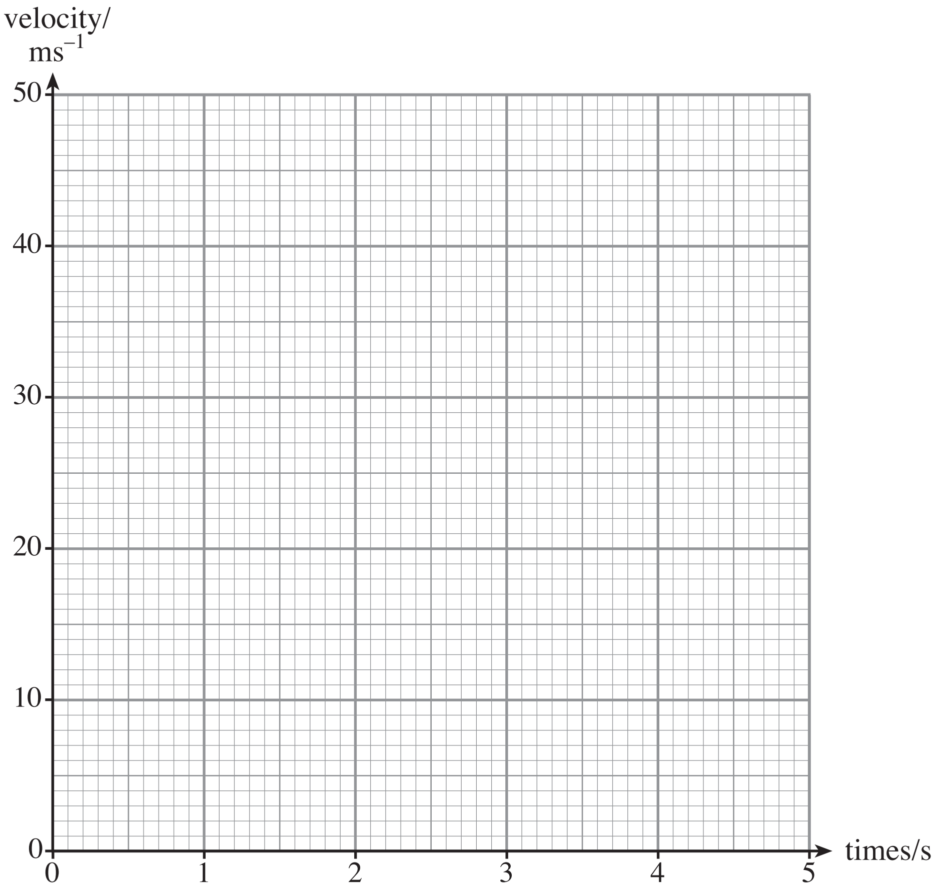
....

....

(II) The stone landed at a point 90 m from the base of the cliff. Calculate the horizontal velocity of the stone. [1]

....

(III) Plot, on the grid below, lines to represent **both** the vertical **and** horizontal velocities of the stone for the time of flight. [2] [1]



(iii) Using the graph (or otherwise) determine the height of the stone above the sea at the instant when the vertical and horizontal velocities are equal in magnitude. [3]

....

....

....

....

(iv) Calculate the resultant velocity of the stone just before impact with the sea. [3]

....

....

....

Turn over.

Examiner only
Arholwr yn unig

Examiner only
Arholwr yn unig

BLANK PAGE

BLANK PAGE

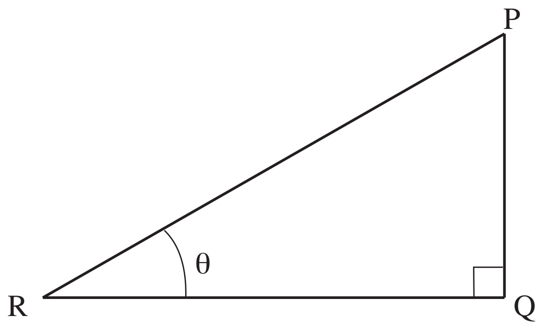
Mathematical Data and Relationships

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	$4\pi r^2$	$\frac{4}{3}\pi r^3$