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. FRIDAY, 9 June 2006

(1 hour 30 minutes)

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.

For Examiner's use only.	
1	
2	
3	
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Total	

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.

SJJ*(541-01)

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
Boltzmann constant	k	=	$1{\cdot}38 \times 10^{-23}$ J K^{-1}
Unified mass unit	1 u	=	$1{\cdot}66 \times 10^{-27}$ kg
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}

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1. *(a)* State Hooke's law. [1]

....

(b) Describe an experiment to confirm Hooke's law for a spring. Draw a labelled diagram of the apparatus. You should state the **measurements** you would make and the **precautions** you would take in order to improve your results. [6]

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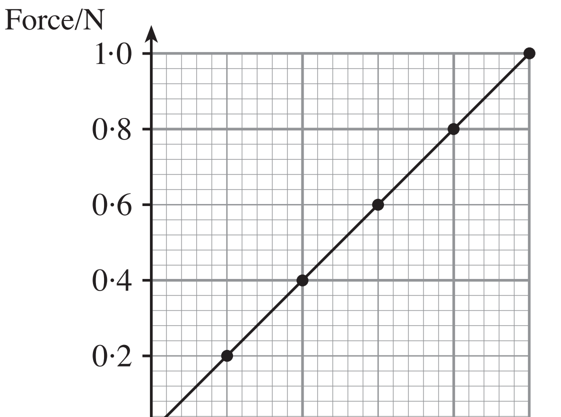
(c) The graph shows the results obtained from such an experiment.



(i) How does the graph verify Hooke's Law? [2]

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(ii) Calculate the spring constant. [1]

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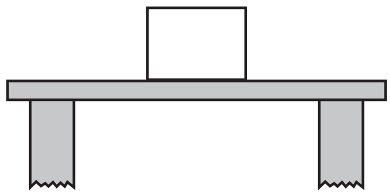
2. *(a)* Newton realised that forces always act in pairs. He used this idea to develop the 3rd law of motion.

(i) State Newton's 3rd law of motion. [1]

....

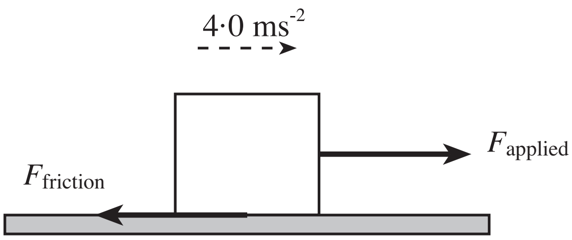
....

(ii) The diagram on the right shows a block of wood resting on a horizontal table. Below, the block of wood and the table are represented as free body diagrams. Draw an arrow on each of the free body diagrams to clearly show the Newton 3rd law pair of forces acting between the **block and the table only**. Name these forces.



[3]

(b) An applied force $F_{applied}$ is now exerted on the block and there is a constant frictional force $F_{friction}$ equal to **half the weight of the block** acting on it (see diagram). The block has a mass of 0·5 kg and its acceleration is 4·0 ms^{-2}.



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(i) Calculate the frictional force $F_{friction}$. [Refer to the data on page 2]. [2]

....

....

(ii) Write down an equation that links the applied force $F_{applied}$, the frictional force $F_{friction}$ and the resultant force $F_{resultant}$. [1]

....

(iii) Hence calculate the applied force $F_{applied}$. [3]

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3. *(a)* A thin glass fibre is 1·60 m long and has **diameter** 0·40 mm. A load of 8·0N is attached to the fibre, which causes it to extend by 2·0 mm. Calculate the Young modulus for the glass. [3]

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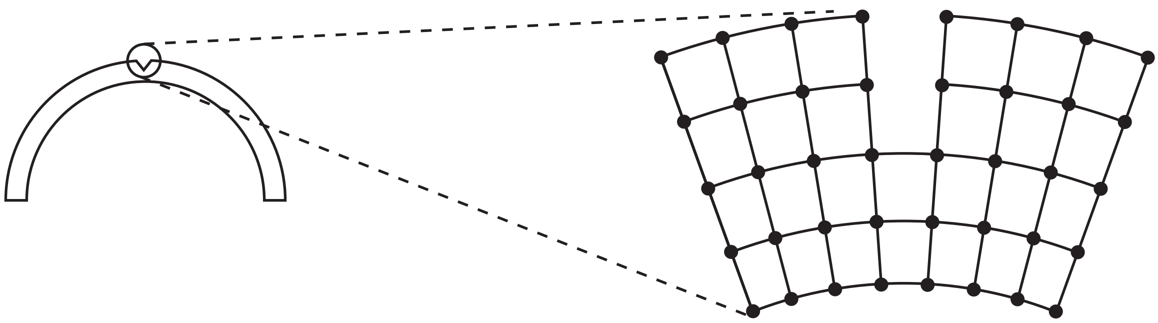
(b) The diagram shows a thin glass rod which, when bent as shown, will break easily. A molecular scale diagram of the arrangement around the region of a surface crack is also shown.



Describe, at the molecular level, how the rod will break. You may add to the diagram(s) if you wish. [4]

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(c) (i) Fibreglass is a composite material made from thin glass fibres encased in a polyester resin. Explain how this arrangement makes fibreglass difficult to break. [1]

....

(ii) Give two properties of fibreglass that make it a suitable material to use for boats. [2]

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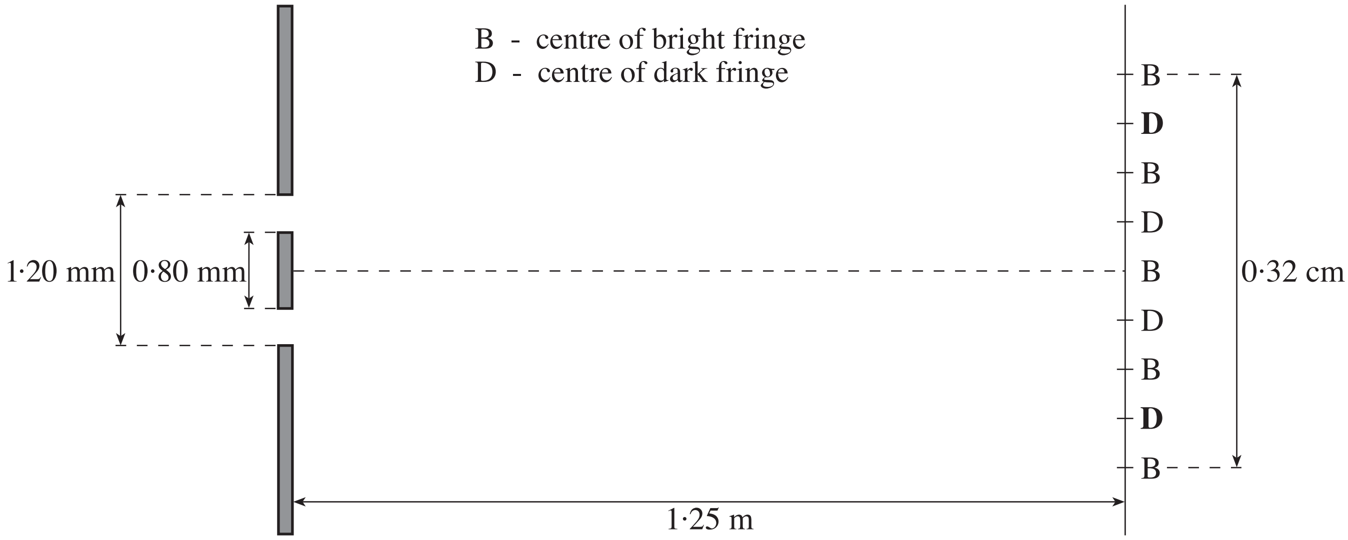
4. A Young's double slit experiment is carried out in order to find the wavelength of a monochromatic source of light. The following measurements are taken.



(a) Use the information given in the diagram to determine the wavelength of the light from the source. [4]

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(b) (i) Name the type of interference that gives rise to the dark fringes. [1]

....

(ii) Explain carefully how the **second** dark fringe is formed (emboldened in the diagram). [3]

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....

....

....

(iii) Calculate the path difference in metres between the waves arriving at the **second** dark fringe. [1]

....

(c) State the historical importance of Young's double slit experiment. [1]

....

5. *(a)* State in words the formula used to calculate the moment of a force about a pivot. [2]

....

....

(b) Diagram 1 shows a beam of wood **(AB)** of weight 40 N pivoted in equilibrium at point **C**.

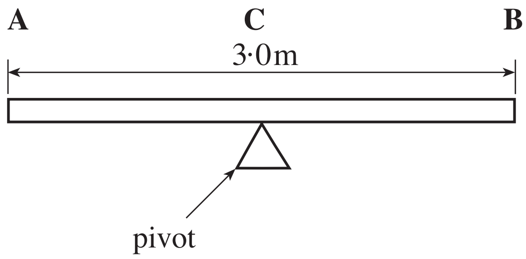

Diagram 1.

(i) Determine the distance **AC**, stating any assumptions you make. [2]

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(ii) A cube of weight 60N is now placed on the beam 1·0m from **C**, between **C** and **A** as shown in diagram 2. The pivot will now have to be moved in order to restore equilibrium.

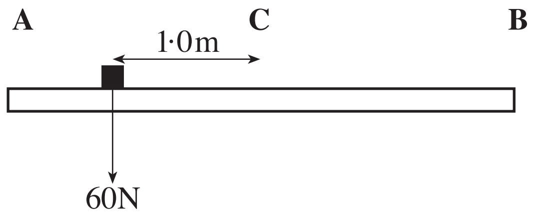

Diagram 2.

(I) **Draw on diagram 2** an approximate (new) position for the pivot so that equilibrium can be restored [1]

(II) Calculate the distance that the pivot has to be moved in order to restore equilibrium. [3]

....

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(iii) (I) What is meant by the term *centre of gravity*? [1]

....

(II) **Draw a vertical arrow** on diagram 2 through the *centre of gravity* of the system, i.e. the beam and the cube. [1]

6. *(a)* When one end of a length of rope is moved from side to side in a direction perpendicular to its length a progressive wave is produced.

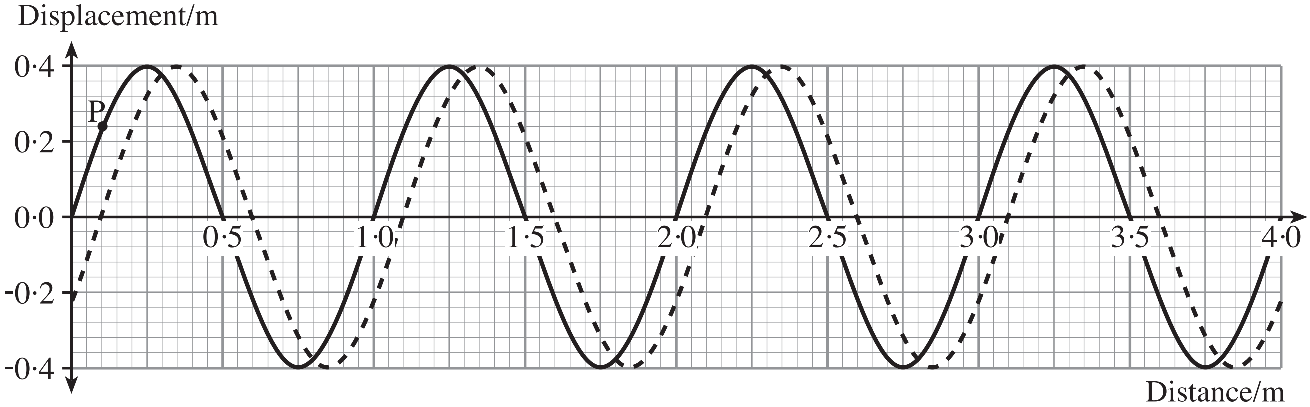
(i) State the type of progressive wave produced. [1]

....

(ii) Give **one** other example of this type of wave. [1]

....

(b) The figure shows a progressive wave travelling **to the right** along a rope. The dark (solid) line represents the position of the wave at t = 0·0s. The dotted line represents the wave a short time later at t = 0·20s. **P** is a particle on the rope.



(i) Draw an arrow on the diagram to show the direction of movement of particle **P** at t = 0·0s. [1]

(ii) Determine the maximum displacement of particle **P**. [1]

....

(iii) Label on the graph with the letter **Q**, the nearest particle that is oscillating in phase with particle **P**. [1]

(iv) Write down the term used to describe the distance **PQ**. [1]

....

(v) Label on the graph with the letter **R**, the particle that is 180° out of phase with particle **P**. [1]

(vi) Calculate

(I) the speed of the wave, [2]

....

....

(II) the frequency of the wave, [2]

....

....

(III) the period of the wave. [1]

....

(vii) Calculate

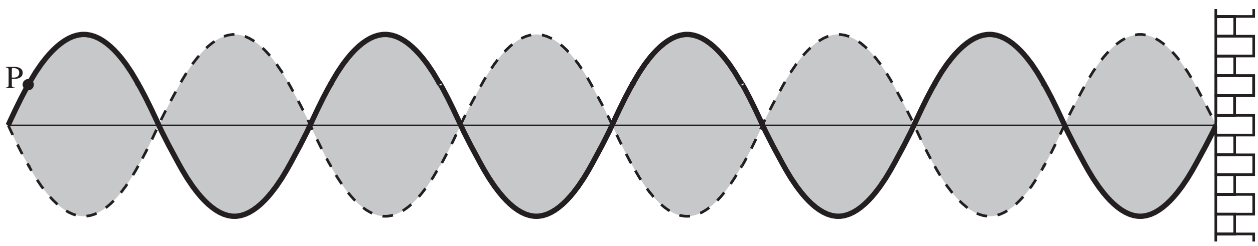
(I) The mean speed of particle **P** over one complete cycle. [2]

....

(II) The mean velocity of particle **P** over one complete cycle. [2]

....

(c) One end of the same rope is now securely attached to a wall as shown. The other end of the rope continues to be moved up and down at the same frequency as before. **Stationary (standing) waves** are set up in the rope as shown. **P** is the same particle as described in part *(b)*.



(i) Label with the letter **S** one particle on the wave that is in phase with **P**. [1]

(ii) Label with the letter **T** one particle on the wave that is out of phase with **P**. [1]

(iii) State how the stationary wave pattern changes when the frequency is doubled. Explain your answer. [2]

....

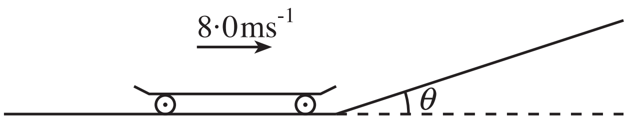
....

7. *(a)* A free fall parachutist drops vertically. The statements in the left hand boxes **describe** her motion at various stages of her descent. The statements in the right hand boxes **explain** the various stages of the descent in term of physical quantities such as velocity and acceleration.

Join the correct description to the correct explanation. [4]

The instant the parachutist starts her descent.	The parachutist is accelerating but her acceleration is decreasing.
The parachutist is descending but has not reached terminal velocity.	The parachutist has stopped accelerating but she continues to travel with constant velocity.
The parachutist has reached terminal velocity.	The parachutist continues to move in one direction, but her acceleration is directed in the opposite direction.
The parachutist has just opened her parachute.	The parachutist's velocity is zero, but her acceleration is a maximum.

(b) A skateboard travelling at a constant velocity of $8{\cdot}0\,ms^{-1}$ approaches an inclined plane as shown.



(i) Show that, when $\theta = 24°$ the skateboard's acceleration is $-4{\cdot}0\,ms^{-2}$.
Ignore friction. [Refer to the constants on page 2]. [2]

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(ii) Calculate the distance travelled by the skateboard up the inclined plane until it comes to rest. [3]

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(iii) Calculate the vertical height moved by the skateboard. [2]

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(iv) Calculate the time taken for the skateboard to come to rest from the moment it starts to move up the inclined plane. [3]

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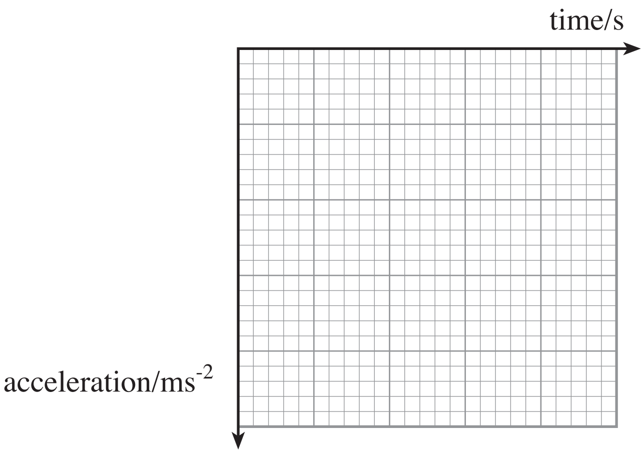
(v) On the axes below, draw an acceleration-time graph for the movement of the skateboard up the inclined plane. You should include numerical values on both axes. The maximum value on the time axis should be the value calculated in *(b)*(iv). [3]



(vi) Calculate the area between the graph line and the time axis. [1]

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(vii) Comment on your answer to *(b)*(vi) stating what this area represents. [2]

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....

Turn over.

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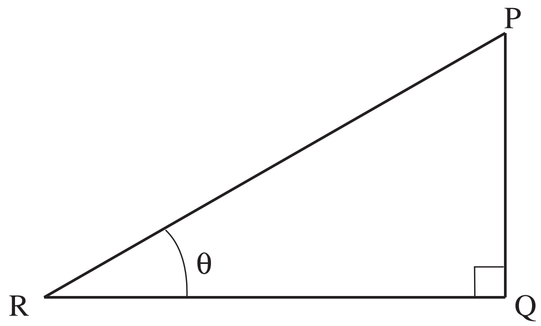
Mathematical Data and Relationships

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