OCR
RECOGNISING ACHIEVEMENT

SPECIMEN

Advanced Subsidiary GCE

PHYSICS B (ADVANCING PHYSICS)

Unit G492: Understanding Processes, Experimentation and Data Handling

Specimen Paper

G492 QP

Candidates answer on the question paper.
Additional Materials:

Data, Formulae and Relationships Booklet
Electronic calculator

Time: 2 hours

Candidate Name

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- ✐ Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **100**.

FOR EXAMINER'S USE		
Section	**Max.**	**Mark**
A	**20**	
B	**40**	
C	**40**	
TOTAL	**100**	

This document consists of **25** printed pages; **3** blank pages and an Insert.

Answer **all** the questions.

Section A

1

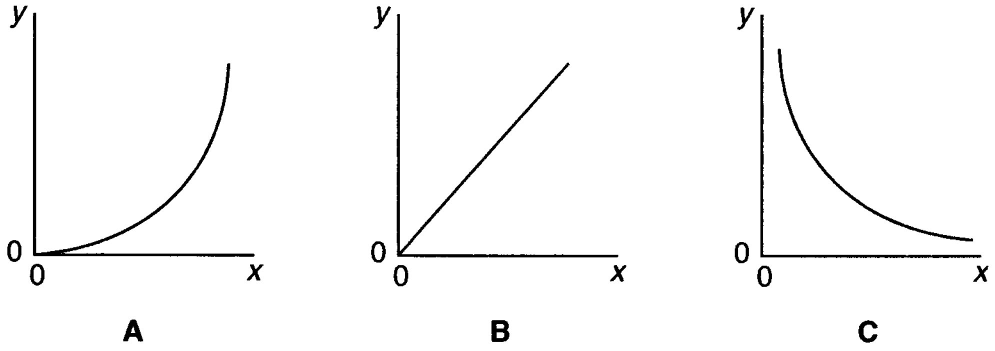


Fig. 1.1

Which graph, **A, B, or C,** in Fig. 1.1, is obtained when the y and x axes represent the two quantities given below?

(a) y-axis: the **acceleration** of objects of the same mass

x-axis: the **resultant force** acting on each object

answer .... **[1]**

(b) y-axis: the **kinetic energy** of a tennis ball

x-axis: the **velocity** of the tennis ball

answer .... **[1]**

2 A narrow beam of light is always reflected from a mirror at an angle *r* equal to the angle of incidence *i*, as shown in Fig. 2.1.

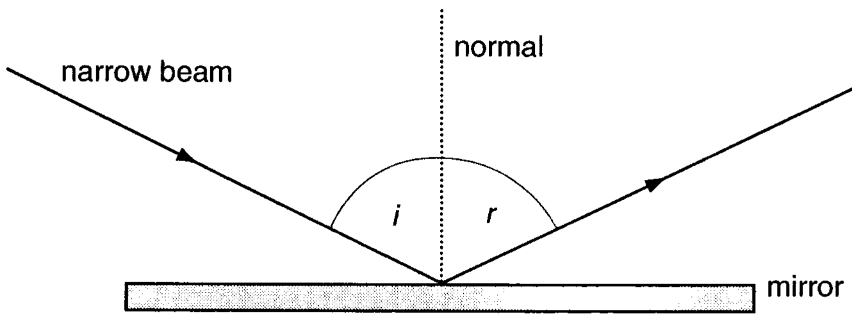


Fig. 2.1

Select from the statements (A, B and C) below the one that is the best explanation of this fact in terms of the quantum behaviour of photons.

A The angles are equal because the photons rebound elastically from the surface.

B Only for paths very close to the observed path do the phasor amplitudes all combine in phase.

C The observed path is the only one along which the momentum of the photon is unchanged. answer

answer... **[1]**

3 Fig. 3.1 shows how the speed of a car changes with time during an emergency stop.

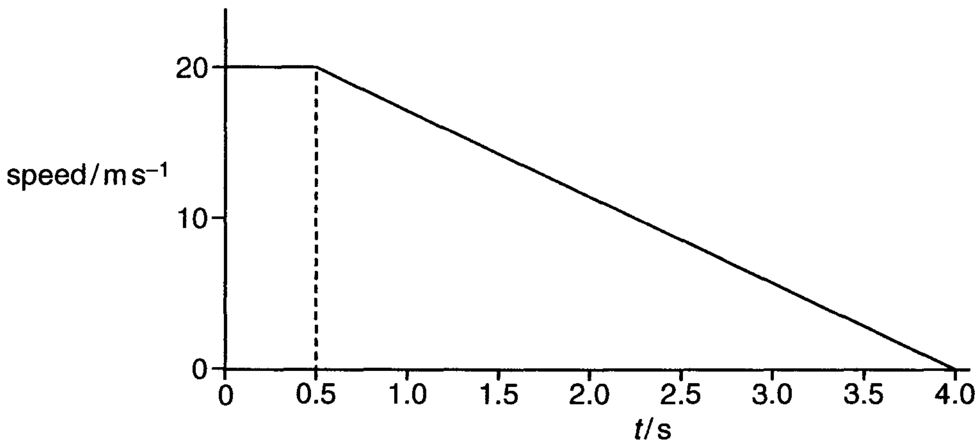


Fig. 3.1

The driver recognises there is a hazard at time t = 0, and the car comes to a halt 4.0 seconds later.

Use the graph to find

(a) the initial speed of the car

initial speed = ... m s^{-1} **[1]**

(b) the time taken for the driver to apply the brakes after seeing the hazard

time = ...s **[1]**

(c) the total stopping distance of the car.

total stopping distance = ... m **[2]**

[Turn Over

4 This question is about a TV remote control device.

(a) The light emitting diode (LED) of a remote control for a TV set emits pulses of radiation of frequency 3.2 x 1014 Hz.

Calculate the energy of each photon of this radiation.

the Planck constant h = 6.6 x 10^{-34} Js

photon energy = ...J **[1]**

(b) The sensor in the TV set will respond to a pulse of radiation from the remote control when the signal power received during the pulse is at least 1.0 x 10^{-7} W.

Calculate the minimum rate at which photons arrive during the pulse.

rate = ... photons per second **[2]**

5 Fig. 5.1 shows a human reflex test.

The tester, **A**, holds the top of a £20 note, while the person being tested, **B**, holds his hand still, with thumb and forefinger apart and level with the bottom of the note.

Without warning, **A** releases the note.

B must grasp it before it has passed through his fingers.

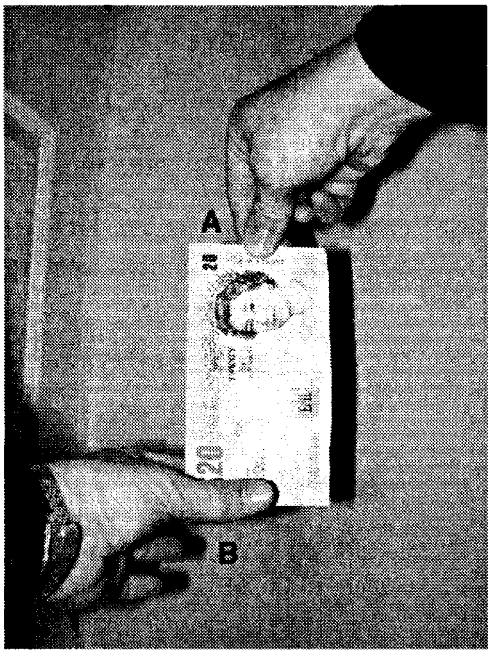


Fig. 5.1

The length of a £20 note is 150 mm.

B has a reaction time of 0.2 s. Can he catch the note?
Neglect any effects of air resistance, and show your working clearly.

$g = 9.8\ \text{ms}^{-2}$

[3]

[Turn Over

6 This question is about a rocket leaving the surface of a distant planet.

(a) A rocket of mass 10 000 kg lifts off from the surface of the planet with an initial acceleration of 3.1 m s^{-2}.

Calculate the resultant force acting on the rocket.

resultant force = ...N **[2]**

(b) The initial thrust on the rocket is 7.5 x 10^4 N.

Fig. 6.1 shows the two forces acting on the rocket at the moment of lift-off.

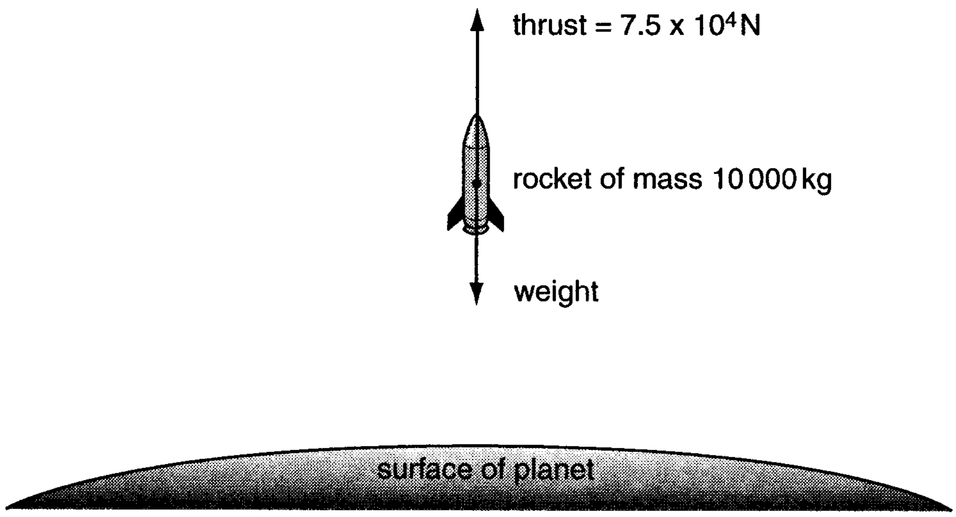


Fig. 6.1

Calculate the initial weight of the rocket.

weight = ...N **[1]**

(c) Calculate the gravitational field strength at the surface of the planet.

gravitational field strength = ... N kg^{-1} **[1]**

7 Fig. 7.1 shows a beam supported on two blocks a distance x apart.

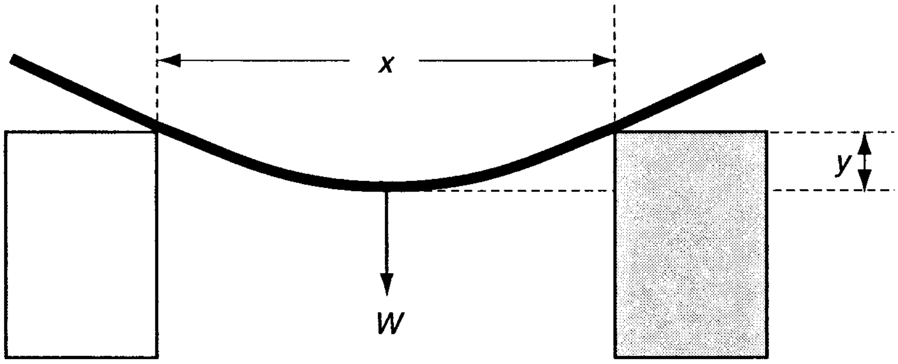


Fig. 7.1

In an experiment, the distance y that the beam sags when a fixed weight W is hung from its centre is measured for different values of the distance x between the blocks.

Here is a set of measurements.

x/ m	y/ m
0.90	0.080
0.70	0.037
0.50	0.014

A student wishes to check if the relationship between y and x in this experiment is of the form $y = kx^2$ where k is a constant.

Propose and carry out a test to check if the **data** support the relationship.

test proposed	***working***

State your conclusion.

....**[3]**

Section A Total [20]

Section B

8 Speed skiing is claimed to be `the fastest non-motorised sport on Earth'.

In this sport, competitors, starting from rest, accelerate under gravity down a very steep slope. They are then timed over the next 100 m length of slope. (Fig. 8.1)

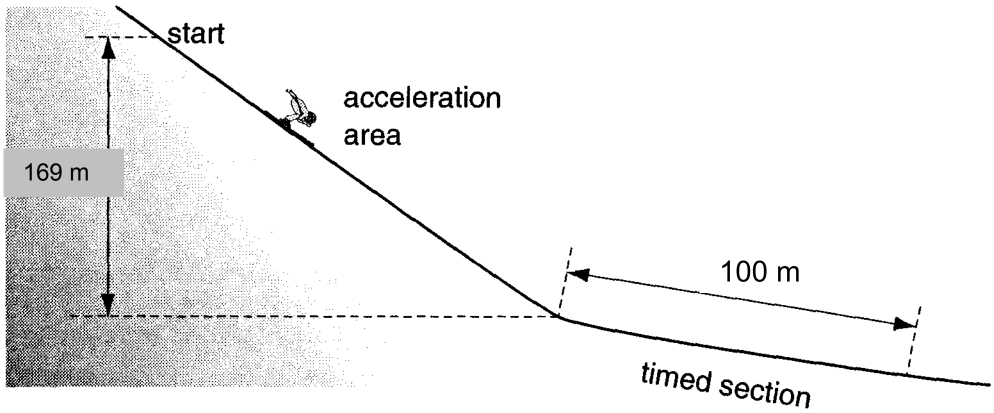


Fig. 8.1

(a) The **vertical** drop in the acceleration area is 169m.

Show that the **maximum** possible speed at which a competitor could enter the timed section is about 60 m s^{-1}.

$g = 9.8$ m s^{-2}

[2]

(b) In a recent competition, a skier completed the 100 m timed section of the course in 2.12 s. Show that his **average** speed through the timed section was in excess of 160 km $hour^{-1}$ (100 m.p.h.).

[2]

(c) The timed section of the course is 100 m long and drops a vertical distance of 26 m. The angle of the slope is 15 degrees to the horizontal.

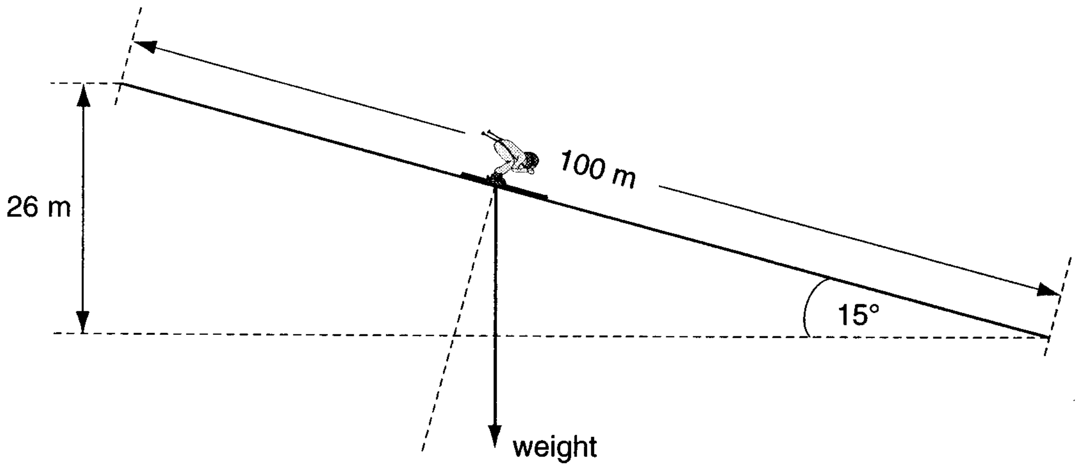


Fig. 8.2

Fig. 8.2 shows a skier of mass 72 kg travelling down the timed section of the course.

(i) Calculate the weight of the skier.

g = 9.8 N kg^{-1}

weight = ...N **[1]**

(ii) By scale drawing or some other method of your choosing, calculate the component of the weight in the direction parallel to the slope.

[2]

(iii) The speed of the skier through the timed section is constant. Explain how this can be so.

[1]

Total [8]

9 This question is about a method of finding the wavelength of light from a laser.

A thin, parallel beam of light of a single wavelength falls on a diffraction grating, as shown in Fig. 9.1.

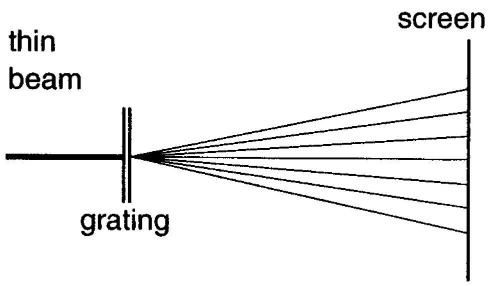


Fig. 9.1

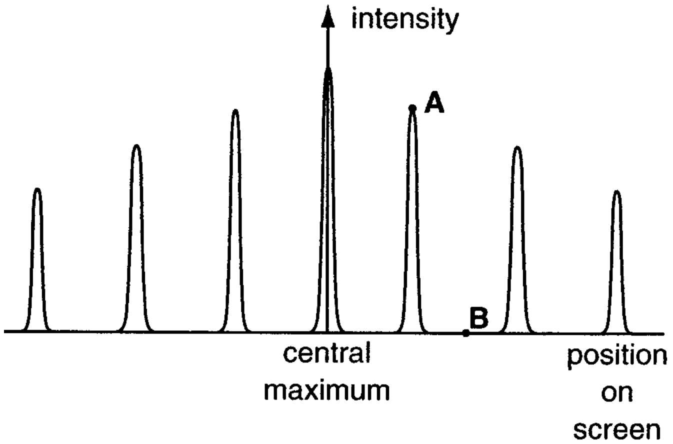


Fig. 9.2

Light passes through the grating and a regular pattern of light and dark regions is observed on the screen.

(a) Fig. 9.2 shows how the intensity pattern varies across the central region of the screen.

(i) Describe the main features of the intensity pattern shown in Fig. 9.2.

[3]

(ii) Explain the difference in intensity between points **A** and **B** in the pattern (Fig. 9.2), using the idea of **superposition** of waves.

[1]

(b) Fig. 9.3 shows the experimental arrangement in more detail.

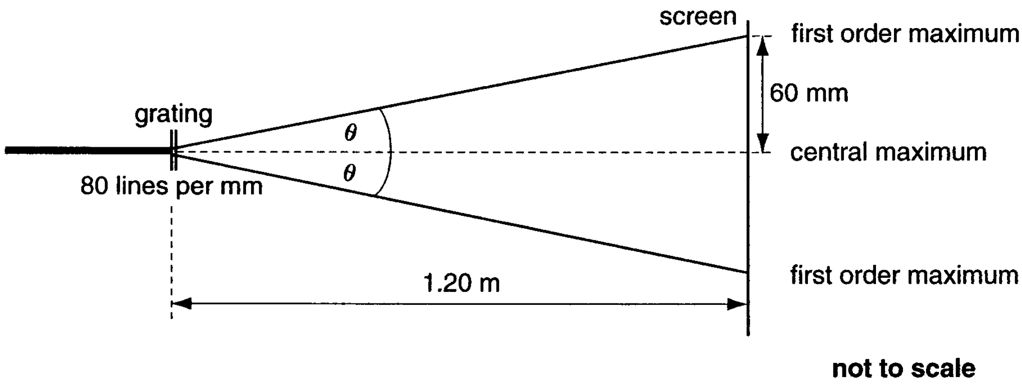


Fig. 9.3

(i) The grating has 80 lines per mm.

Show that the spacing d between the lines on the grating is 1.25×10^{-5} m.

[1]

(ii) The distance between the central maximum and first order maximum is measured on the screen and found to be 60 mm.

The screen is 1.20 m away from the grating.

Calculate the wavelength λ of the light, using the information above.

[4]

(c) Suggest **one** change that could be made to the experimental arrangement to improve the accuracy of the wavelength measurement. Explain your reasoning.

[2]

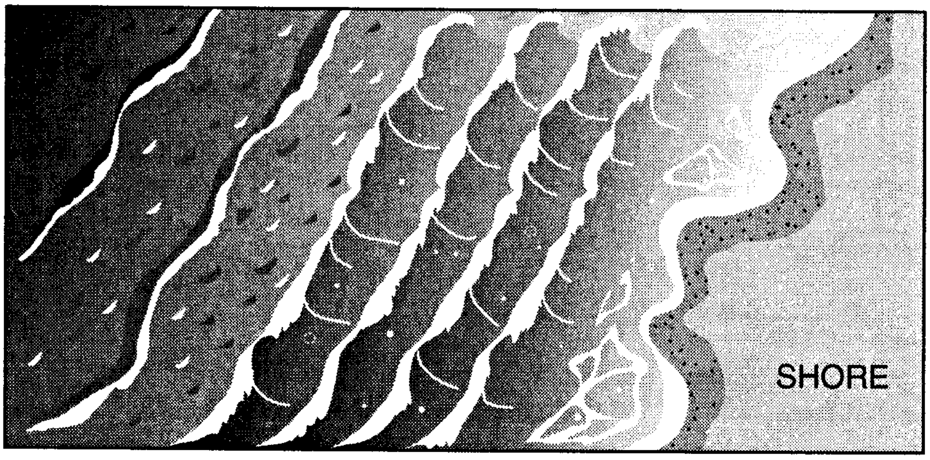
Total [11]

[Turn Over

10 This question is about wave energy.

Fig. 10.1 shows a group of waves travelling across the sea towards a beach.

velocity of group of waves = $12\,\mathrm{m\,s^{-1}}$



each $1\,\mathrm{m^2}$ of the sea surface carries energy towards the shore at $12\,\mathrm{m\,s^{-1}}$

Fig. 10.1

(a) The energy ε carried by every $1\ \mathrm{m^2}$ of surface of the sea is given by

$\varepsilon = \frac{1}{2} g \rho x^2$

where g is the gravitational field strength

ρ is the density of the sea water

and x is the amplitude of the waves in the group.

Show that $\frac{1}{2} g \rho x^2$ has the units $\mathrm{J\ m^{-2}}$. Take the units of g as $\mathrm{N\ kg^{-1}}$.

[2]

(b) Waves with a peak-to-trough height of 1.8 m approach a beach as shown in Fig. 10.2.

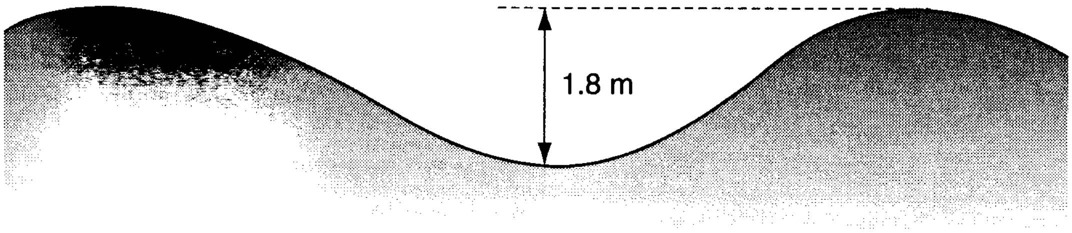


Fig. 10.2

(i) State the amplitude x of these waves.

x = ... m **[1]**

(ii) Calculate the energy ε carried by these waves per m^2 of sea surface, using the equation given in (a).

ρ = 1030 kg m^{-3}

g = 9.8 N kg^{-1}

ε = ... Jm^{-2} **[2]**

(iii) The wave energy is being carried onto the beach with the group of waves shown in Fig. 10.1 at a velocity of 12 m s^{-1}.

Calculate the energy arriving per second on a 0.5 km length of the beach.

Express your answer in megawatt.

energy per second = ... MW **[4]**

(iv) Suggest **one** possible consequence, or use, of this wave power being delivered to the shore.

[1]

Total [10]

[Turn Over

11 This question is about the quantum behaviour of photons.

Yellow light of a single wavelength falls on the vertical surface of a soap film.

Photons of the light reflect from the film and horizontal bands can be seen in the soap film, as shown in Fig. 11.1. The bands are alternately yellow and black.

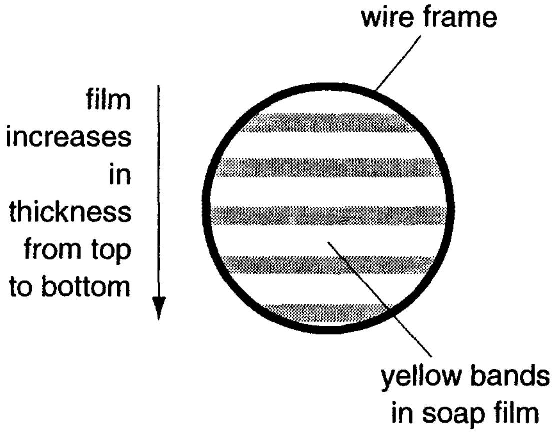


Fig. 11.1

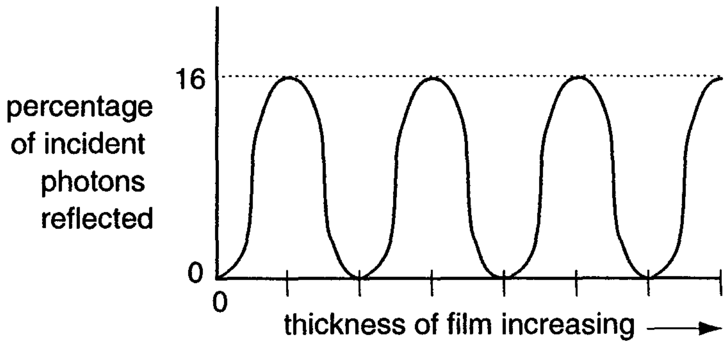


Fig. 11.2

(a) Fig. 11.2 shows how the **percentage** of incident photons **reflected** by the film varies as its thickness changes.

Use the information in Fig. 11.2 to describe in words how the percentage of photons reflected varies with the thickness of the soap film.

✎ *You will be awarded marks for the quality of your written communication.*

[4]

(b) An incident photon can reflect off either the **front** or **back** surface of the soap film to reach the detector. If it does not reflect, it will pass through the film (Fig. 11.3).

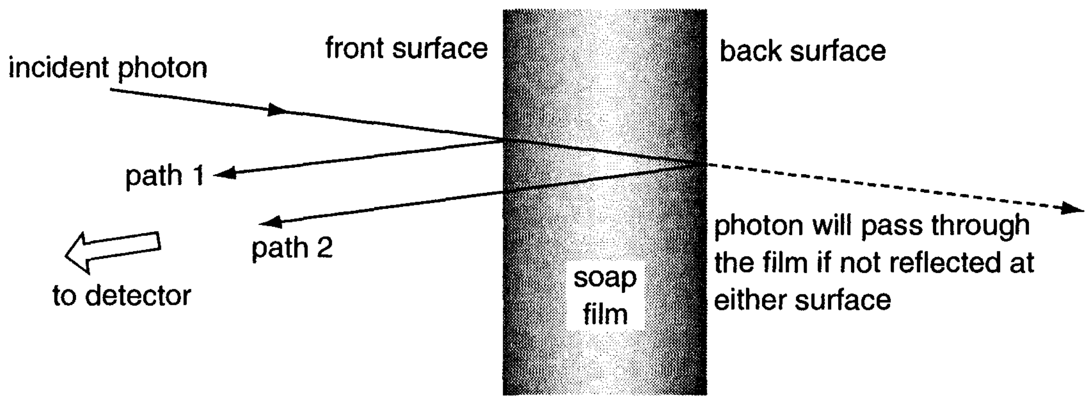
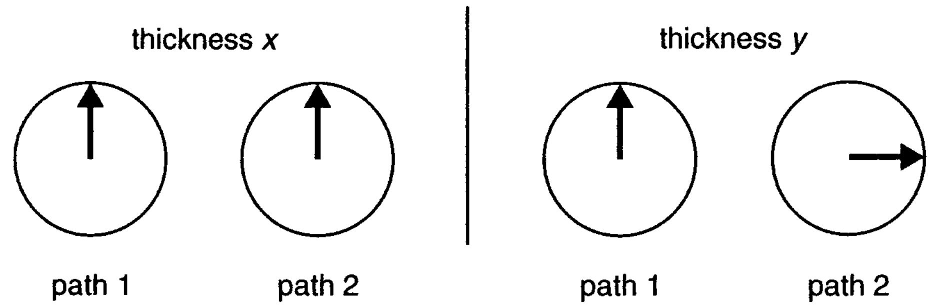


Fig. 11.3

Some photons reach the detector after reflecting from two different places on the film where the film thickness is x and y.

Rotating phasors for the two paths of a photon reaching the detector are shown below, for the two thicknesses of film. (scale: 1 cm represents amplitude 2.0)



(i) By scale drawing or some other method of your choosing, calculate the magnitude of the **resultant** phasor amplitude in each case.

Each phasor has an amplitude of 2.0.

thickness *x*	thickness *y*
resultant phasor amplitude =..................	resultant phasor amplitude = ...

[3]

(ii) Show that the **probability** of photons being reflected from film of thickness x is **twice** that from film of thickness y.

[2]

(iii) At certain thicknesses of film, dark bands are produced indicating that few, if any, photons are reflected there.

How do you account for this?

[2]

Total [11]

Section B Total [40]

[Turn Over

Section C

The questions in this section are based on the Advance Notice material.

12 This question is about uncertainties and errors in measurements in science.

(a) The situations below involve random uncertainty, systematic error or both. In each case, discuss which are present and explain their effect on the measurements made.

(i) Timing an eclipse of the Moon, which lasts about two hours, using a clock which runs slightly 'fast', recording a day as slightly more than 24 hours.

[2]

(ii) Measuring the length of a room with an accurate steel measuring tape.

[2]

(b) For **one** of the two measurements **(i)** and **(ii)** above, suggest how a better measurement could be made.

[2]

Total [6]

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13 The table below gives some measurements of the velocity of light, *c*.

year	**experimenter**	**observed velocity/ km s^{-1}**
1875	Cornu	299 990 ± 200
1880	Michelson	299 910 ± 150
1883	Michelson	299 850 ± 60
1906	Rosa-Dorsey	299 784 ± 10
1928	Middelstaedt	299 778 ± 10
1932	Michelson with others	299 774 ± 4
1941	Anderson	299 776 ± 6
1951	Bergstrand	299 793.1 ± 0.3

The graph opposite shows these measurements.

(a) Explain why the speed of light is difficult to measure.

[2]

(b) The American physicist Albert Michelson was famous for his skills in measurement.

Explain how the table and the Advance Notice article show this.

✎ *You will be awarded marks for the quality of your written communication.*

[4]

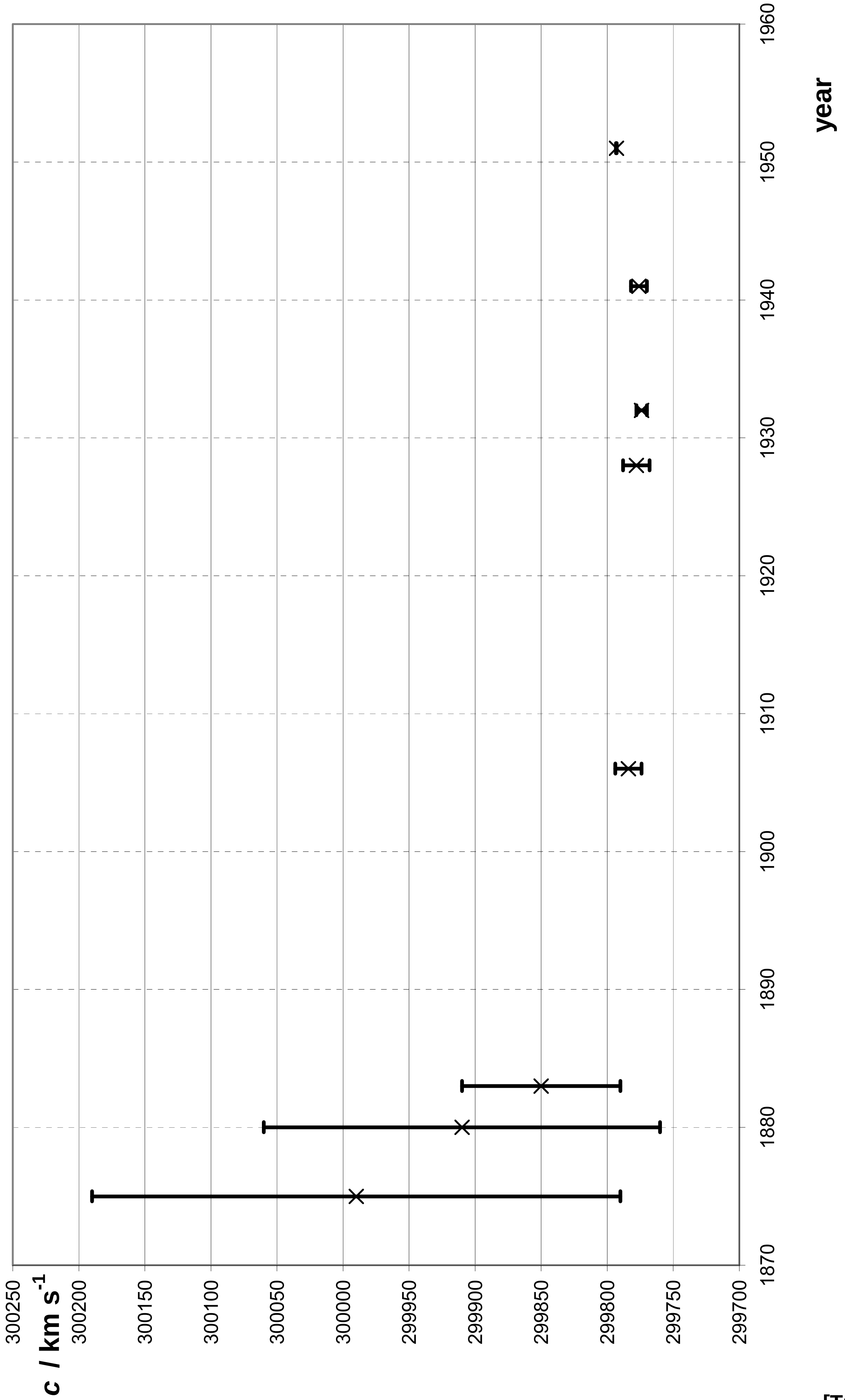
(c) In 1973, the recommended value of the velocity of light was 299 792 458 ± 1 m s^{-1}. explain why it is now defined to be exactly 299 792 458 m s^{-1}.

[1]

(d) The velocity of light is now defined as 299 792.458 km s^{-1}. Draw a horizontal line on your graph to indicate this defined value. Which experimenters appear to have underestimated the uncertainties in their experiments?

[2]

Total [9]


c / km s-1
300250
300200
300150
300100
300050
300000
299950
299900
299850
299800
299750
299700
year
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960

[Turn Over

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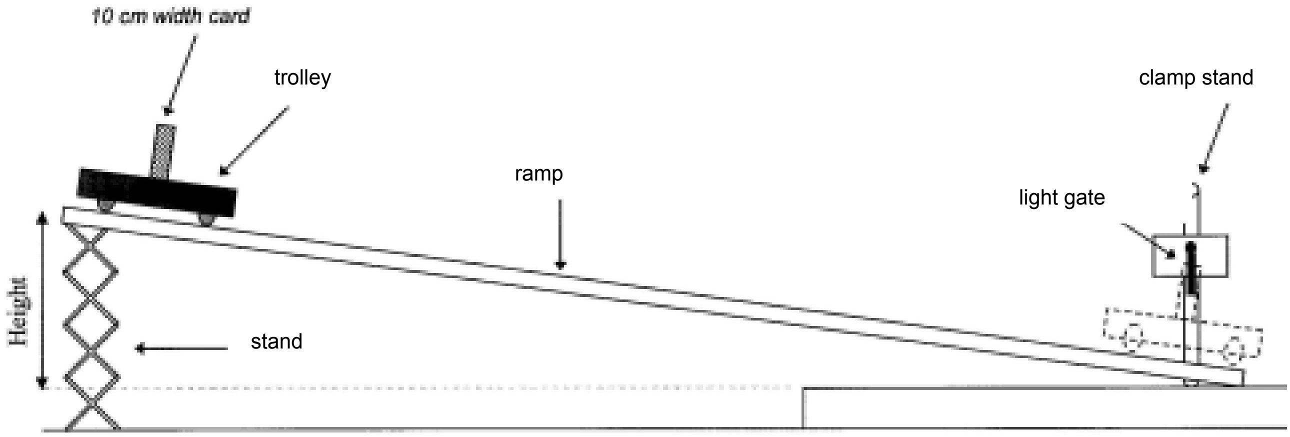
14 This set of data is about the motion of a trolley down a ramp as shown in the diagram below. The experiment was carried out by two AS students, Fiona and Tom.



mass of trolley *m*	0.992 kg
"mask" width *w*	10.0 cm
runway length *s*	1.20 m

One end of the runway was raised to a height *h*. The trolley had a mass of 0.992 kg and had a card 'mask' of width 10.0 cm mounted on it. The time *t* taken for the card mask to pass through a light gate at the bottom of the 1.20 m long ramp was measured.

height *h* / cm	Time *t* / s
4.0	0.164
6.0	0.113
8.0	0.091
10.0	0.078
12.0	0.071
16.0	0.061
20.0	0.053

(a) The trolley was initially released from a height of 4 cm.

(i) Show that angle that the ramp makes with the horizontal when *h* = 4.0 cm is about 2°.

[2]

(ii) In the first measurement, when *h* = 4.0 cm and *t* = 0.164 s, show that the velocity of the trolley as it passed through the light gate was 0.610 m s^{-1}.

[2]

[Turn Over

(iii) Explain clearly why the velocity in **(a)(ii)** can be quoted to **three** significant figures, but not four.

[2]

(b) (i) The height was measured to the nearest 0.1 cm.

Calculate the percentage uncertainty in measuring the height for h = 4.0 cm.

[2]

(ii) Explain why the percentage uncertainty in measuring the height will be reduced as the ramp is raised.

[2]

(iii) Describe how the uncertainty in measuring the time for the trolley with the 10.0 cm card to pass through the light gate could be reduced.

✎ *You will be awarded marks for the quality of your written communication.*

[3]

Total [13]

15 Fiona suggests that the data in their experiment obeys the mathematical model

$$v^2 = kh$$

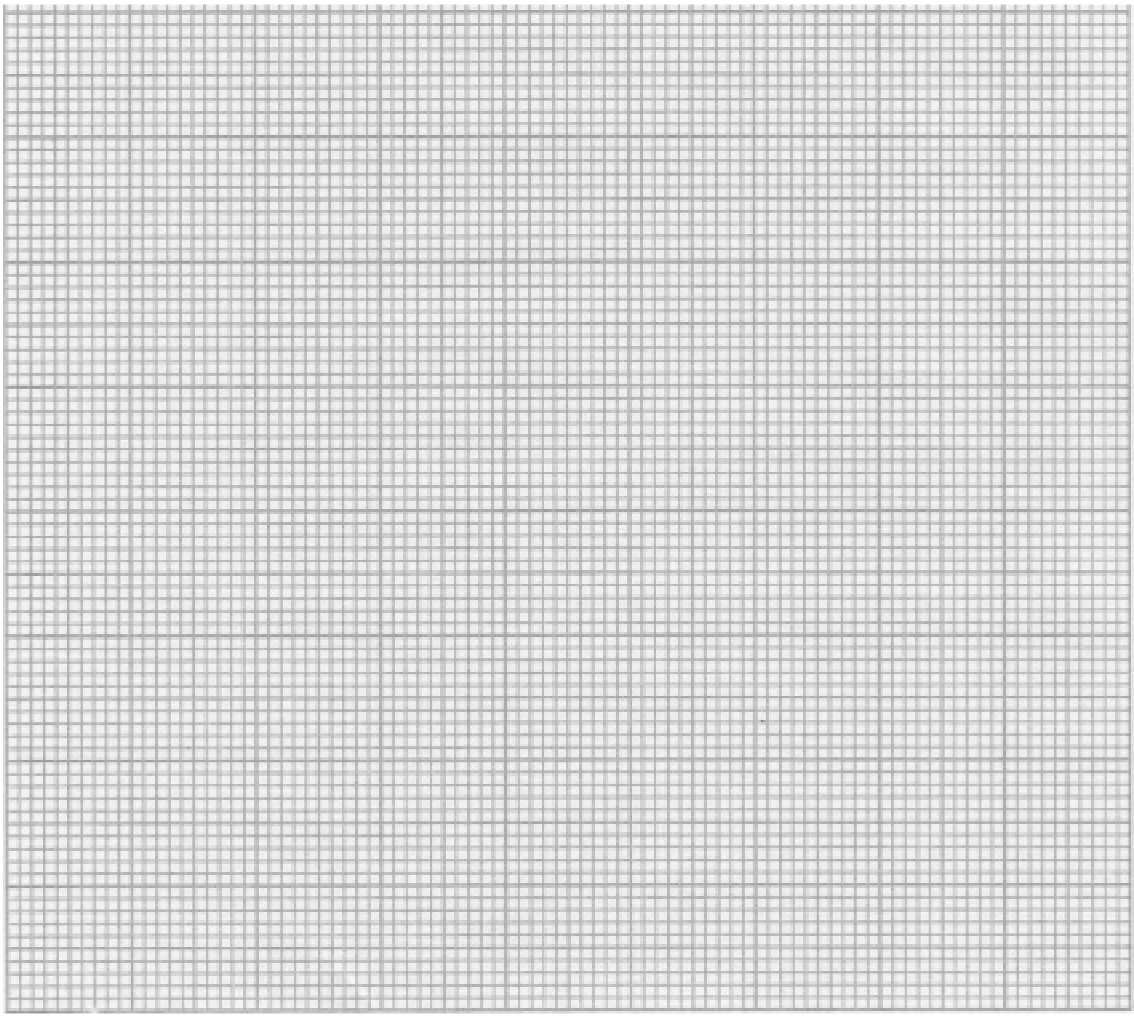
where k is a constant.

height h/cm	time t/s	velocity v/m s^{-1}	(velocity)^2 v^2/m^2 s^{-2}
4.0	0.164	0.61	0.37
6.0	0.113	0.88	0.78
8.0	0.091	1.1	1.2
10.0	0.078	1.3	
12.0	0.071	1.4	
16.0	0.061	1.6	
20.0	0.053	1.9	

(a) **(i)** Calculate values of v^2 and add them to the table above. The first three have been done for you. **[1]**

(ii) Plot a graph of v^2 (vertically) against h (horizontally) on the axes below.

Ensure that the axes are correctly labelled.



[4]

(iii) Does the data support the relationship $v^2 = kh$? Justify your answer.

[2]

(b) Tom expects the kinetic energy gained by the trolley to be equal to the loss of gravitational potential energy.

By considering the loss of gravitational potential energy and gain of kinetic energy when the trolley drops through a height of 4.0 cm, check Tom's theory and account for the results.

g = 9.8 m s^{-2}

[5]

Total [12]

Section C Total [40]

Paper Total [100]

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OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS B (ADVANCING PHYSICS) G492 MS

Unit G492: Understanding Processes and Experimentation and Data Handling

Specimen Mark Scheme

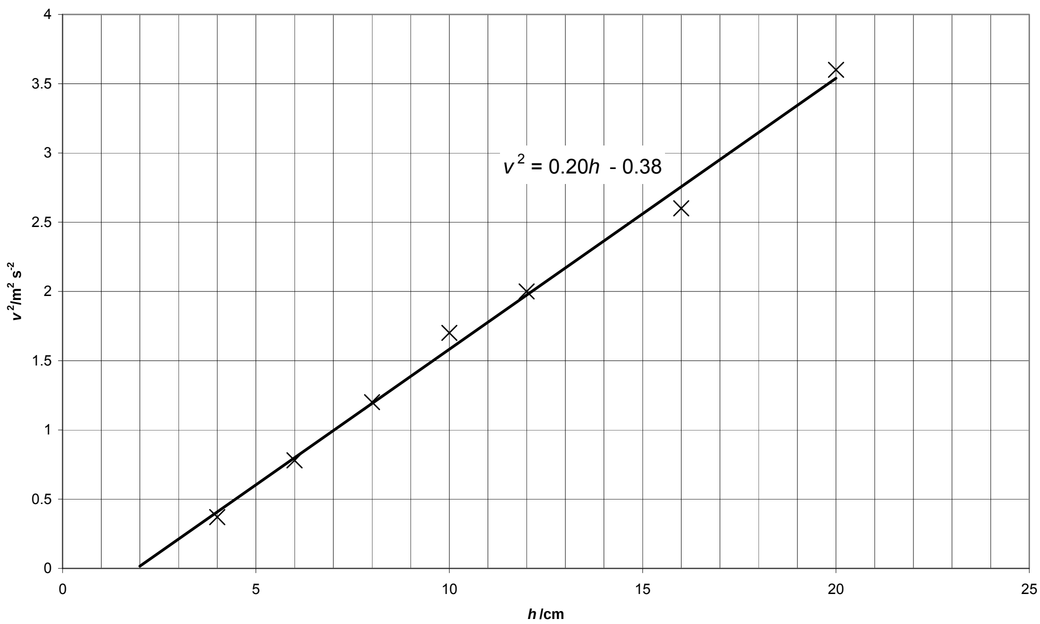
The maximum mark for this paper is 100.

Question Number	Answer	Max Mark
Section A		
1 (a)	B ✓	**[1]**
(b)	A ✓	**[1]**
2	B ✓	**[1]**
3 (a)	20 ✓ (m s^{-1})	**[1]**
(b)	0.5 ✓ (s)	**[1]**
(c)	(20 x 0.5) + ($^1/_2$ x 20 x 3.5) ✓m = 45 (m) ✓e 45 m ✓✓	**[2]**
4 (a)	energy (= 6.6 x 10^{-34} x 3.2 x 10^{14}) = 2.1 x 10^{-19} ✓ (J) 2 or 3 **S.F.** only	**[1]**
(b)	(1.0 x 10^{-7})/(2.1 x 10^{-19}) ✓ = 4.8 x 10^{11} ✓ **ecf** from (a)	**[2]**
5	Either s = $^1/_2at^2$ ⇒ t^2 = (2 x 0.15)/9.8 ⇒ t = 0.18 s ✓m✓e Or directly using t = 0.2 s to find s = 0.196 m ✓method✓evaluation allow g = 10 N kg^{-1}, giving t =0.17 s or s = 200 mm then explaining why he can't catch the note ✓	**[3]**
6(a)	F = 10 000 x 3.1 ✓ = 31 000 ✓ (N)	**[2]**
(b)	weight = 75 000 – 31 000 = 44 000 (N) ✓	**[1]**
(c)	g = 44 000 / 10 000 = 4.4 ✓ (N kg^{-1}) ecf from (b) no ecf if g = 9.8 N kg^{-1} assumed in (b)	**[1]**
7	test proposed e.g. calculate k = y/x^2 to see if constant, ✓ carried out on all data ✓ conclusion based on test: not constant (values 0.099,0.076,0.056) <u>because</u> variation too great/value of k gets progressively smaller, so not random variation✓ test can be implicit in working	**[3]**
	Section A total	**[20]**
8(a)	$v^2 = 2gh$ approach v^2 = 2 × 9.8 × 169 ✓ v = 58✓ (m s^{-1})	[2]
(b)	v = 100/2.12 = 47m s^{-1} ✓ 47m s^{-1} = 47× 60 × 60 /1000 km h^{-1} = 170 km h^{-1} (> 160 km h^{-1})✓	[2]
(c)(i)	weight = 72 x 9.8 = 710 N ✓ (accept 2 or 3 S.F.) Accept use of g = 10 N kg^{-1} to give 720 N	[1]
(ii)	Scale drawing: 15° right-angled triangle with opposite side shown as weight (**ecf** from (c)(i) ✓ hypotenuse correctly measured to scale including ecf to give 180 N ±10 N ✓ **or** 710 sin 15° ✓ = 180N ✓ **ecf** from (c)(i)	[2]
(iii)	balanced forces idea (resultant force = zero) ✓ argued in terms of forces	[1]
	Total	**[8]**
9 (a)(i)	Any three points from: symmetrical about central max central maximum is brightest intensity decreases with 'order' maxima are equally spaced peaks (much) narrower than spacing ✓✓✓	[3]

Section B		
Question Number	**Answer**	**Max Mark**
(ii)	A: constructive interference/waves add/waves superimpose IN PHASE / path difference is a whole number of λ /AW AND B: destructive interference/waves cancel/ waves in ANTIPHASE (out of phase)/ pd is an odd number of half wavelengths ✓	**[1]**
(b)(i)	1 / 80 000 or $(1 \times 10^{-3})/80$ ✓ ($= 1.25 \times 10^{-5}$m)	**[1]**
(ii)	$\tan\theta = 0.06 / 1.2 \Rightarrow \theta = 2.86^\circ$ ✓method✓evaluation AW e.g. Pythagoras and then find $\sin\theta$ from the triangle for ✓✓ allow $\tan\theta$ = **sin** θ if reason given e.g. angles small $\lambda = 1.25 \times 10^{-5} \times \sin 2.9^\circ$ ✓ = 6.3×10^{-7} **m** ✓ **[deduce 2nd mark if no unit]** (allow use of 3° giving 6.5×10^{-7})	**[4]**
(c)	sensible change ✓ justified ✓ e.g. more lines mm^{-1} ✓ larger spacing between maxima to measure ✓ or move screen further ✓ smaller % error in distances✓ measure to higher order ✓ smaller % error in distances✓	**[2]**
	Total	**[11]**
10 **(a)**	$N/kg \times kg/m^3 \times m^2 = N\ m^{-1}$ ✓ (beware fudge) $J = N\ m$ so $J\ m^{-2} = N\ m\ m^{-2} = N\ m^{-1}$ ✓ or reverse working from N=J/m Stages must be **shown** clearly	**[2]**
(b)(i)	0.9 m ✓	**[1]**
(ii)	$\frac{1}{2} \times 9.8 \times 1030 \times (0.9)^2$ ✓ = 4090 ✓ ($J\ m^{-2}$) ~ 4100 **ecf** from (b)(i)	**[2]**
(iii)	4090 x 12 ✓ = 49 000 ≈ 50 kW ✓ (W) (ecf from (b)(ii)) 49 000 x 500 ✓ = 24 500 000 = 24.5 MW ✓ **ecf**	**[4]**
(iv)	lots of damage/erosion / for conversion to electrical power ✓	**[1]**
	Total	**[10]**
11(a)	increases and decreases ✓ (can be stated or implied) Between 0% and 16%✓ One of: cyclic/repeating / equally spaced / no sign of dying out ✓ QWC: spelling, punctuation & grammar✓	**[4]**
(b)(i)	x: resultant phasor amplitude = 4 ✓ y: resultant phasor amplitude = $(4 + 4)^{\frac{1}{2}}$ = 2.8 ✓method✓evaluation (scale drawing tolerance 2.6 to 3.0) for missing scale factor (x=2, y = 1.4) 2 marks max	**[3]**
(ii)	prob related to $(\text{amplitude})^2$ idea ✓ 16 for x, 8 for y ✓ 4 for x, 2 for y ✓ (ecf) from (b)(i)	**[2]**
(iii)	Phasors antiphase ✓ so prob / resultant phasor amplitude =0 ✓ (quantum explanation only) '<u>photons</u>' are out of phase gets no marks	**[2]**
	Total	**[11]**
	Section B total	**[40]**

Section C		
Question Number	**Answer**	**Max Mark**
12(a)(i)	Any two points from: Systematic error (clock 'second' is wrong) ✓ Random uncertainty due to reaction time is negligible ✓ Effect is to give an answer which is too great ✓	**[2]**
(ii)	Any two points from: No/ negligible(e.g. effect of temperature) systematic error ✓ Random uncertainty e.g. alignment problems, varying length at different places✓ Effect is to give greater confidence in the length than is justified by the measurement ✓	**[2]**
(b)	(i) Use more accurate clock /correct for incorrect duration by comparing with accurate time signal✓; get several people to measure simultaneously, and plot data to find mean/median/ reject outliers✓ OR (ii) repeat measurement several times along different parallel lines along the room✓ and plot data to find mean/median/reject outliers✓; NOT just repeat measurement	**[2]**
	Total	**[6]**
13(a)	(very fast therefore) need large distance ✓ very short interval to time✓	**[2]**
(b)	Any three points from: Very large ✓reduction in uncertainties ✓ Progression over many years ✓ Up to two examples of creative approach can be each ✓ if distinct and explained, e.g. octagonal mirror, allowing for effect of air, doing in vacuum QWC: appropriate form and style ✓	**[4]**
(c)	uncertainties in the metre greater than in λ/f measurement ✓	**[1]**
(d)	Horizontal line within one scale division of 299 790 ✓ Michelson, Middelstaedt, Anderson and Bergstrand ✓ All 4 names needed	**[2]**
	Total	**[8]**
14 (a)(i)	Angle = $\sin^{-1}$ (4.0/120) ✓ = 1.9° ≈ 2°✓ Must show a calculated result, not just quote 2°, for the second mark.	**[2]**
(ii)	$v = w/t$ = 0. 100✓/0.164 ✓= 0.610 m s^{-1} (Can be reverse argument from 0.610 m s^{-1})	**[2]**
(iii)	<u>Both</u> measurements used are to 3 S.F.✓ Result cannot be stated to greater precision than least precise datum ✓	**[2]**
(b)(i)	(0.1/4.0)× 100 = 2.5% ✓m✓e	**[2]**
(ii)	Absolute uncertainty in height same ✓ smaller fraction ✓of height	**[2]**
(iii)	Repeat several times ✓and take averages ✓ QWC: clear organisation✓	**[3]**
	Total	**[13]**

Section C		
Question Number	**Answer**	**Max Mark**
15 (a)(i)	$v^2/\mathrm{m^2\,s^{-2}}$ (0.37) (0.78) (1.2) 1.7 2.0 2.6 3.6 All 4 correct for the mark Allow 3 S.F. but not more (values 1.69, 1.96, 2.56 & 3.60 s)	**[1]**
(ii)	Sensible axes labelled with quantity and unit ✓ points✓✓ line✓	**[4]**
(iii)	No as line does not pass through origin✓(graph below) Can be numerical.	**[1]**
(b)	g.p.e. = *mgh* = 0.992 × 9.8 × 0.04 ✓ = 0.39 J ✓ k.e. = ½ mv^2 = ½ × 0.992 × 0.37 ✓= 0.18 J ✓ Work done against resistive forces ✓	**[6]**



Total	**[12]**
Section C total	**[40]**
Paper Total	**[100]**

Assessment Objectives Grid (includes QWC)

Question	AO1	AO2	AO3	QWC	Total
1	2				**2**
2		1			**1**
3	4				**4**
4	2	1			**3**
5	1	2			**3**
6	4				**4**
7		1	2		**3**
8(a)	1	1			**2**
8(b)	1	1			**2**
8(c)	3	1			**4**
9(a)	2	2			**4**
9(b)	5				**5**
9(c)			2		**2**
10(a)		2			**2**
10(b)	4	4			**8**
11(a)	1	2		**1**	**4**
11(b)	3	4			**7**
12(a)			4		**4**
12(b)			2		**2**
13(a)			2		**2**
13(b)			3	**1**	**4**
13(c)			1		**1**
13(d)			2		**2**
14(a)	3		3		**6**
14(b)		1	5	**1**	**7**
15(a)		6	1		**7**
15(b)	3	2			**5**
Totals	**39**	**31**	**27**		**100**