

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

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Pearson Edexcel International Advanced Level

Time 1 hour 20 minutes

Paper
reference

WPH13/01

Physics

International Advanced Subsidiary / Advanced Level

UNIT 3: Practical Skills in Physics I

You must have:

Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- **Show all your working out** in calculations and **include units** where appropriate.

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- The list of data, formulae and relationships is printed at the end of this booklet.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Answer ALL questions.

1 A student investigated how the bounce height of a rubber ball varied with temperature. The student dropped the ball from the same height each time and recorded the bounce height.

The student investigated a range of temperatures of the ball between 0°C and 70°C.

(a) (i) Describe how the student could vary and measure the temperature of the ball. (2)

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(ii) Explain one precaution that the student could take to ensure that when the ball was dropped it was at the correct temperature. (2)

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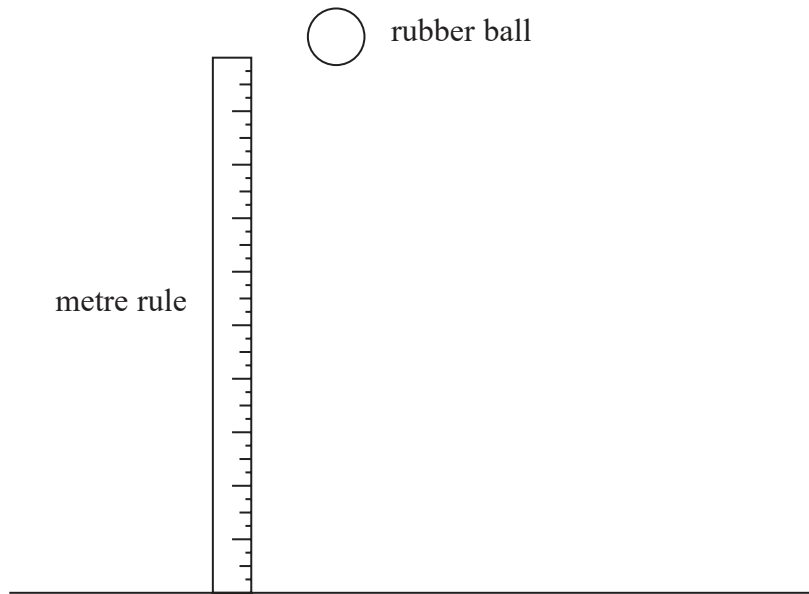


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(b) The student measured the temperature of the ball, then dropped it from a height of 1 m. A metre rule, clamped so that it was vertical, was used to measure the bounce height.



The student recorded the bounce height three times and calculated a mean.

State two other things the student could have done to measure the bounce height accurately.

(2)

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(c) Identify one safety issue with this investigation and how it may be dealt with.

(2)

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(d) The student recorded the results in a table.

Temperature	Mean bounce height/cm
9	10.3
19	15.1
29	20
41	27.2
51	31.2
58	35
69	39.5

Criticise the recording of these results.

(2)

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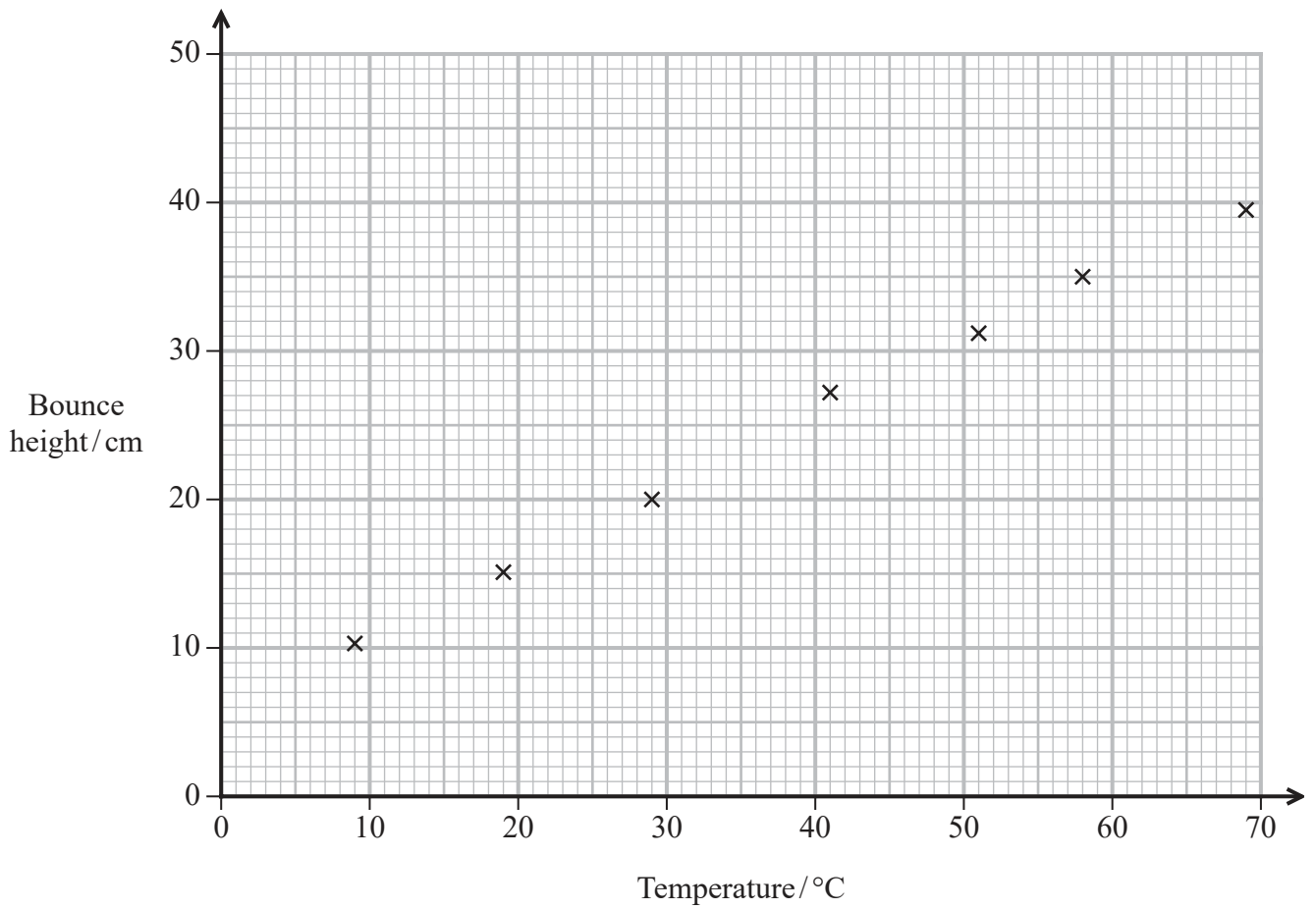
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(e) The student's graph is shown below.



Describe the relationship between bounce height and temperature shown by the graph.

(2)

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- (f) The digital thermometer shown can be used to measure temperature.



(Source: VINCENT MONCORGE/LOOK AT SCIENCES/SCIENCE PHOTO LIBRARY)

digital thermometer

When placed in icy water the reading on this thermometer is 2.1°C .

- (i) Name the type of error shown by this.

(1)

- (ii) State how this type of error can be corrected.

(1)

(Total for Question 1 = 14 marks)

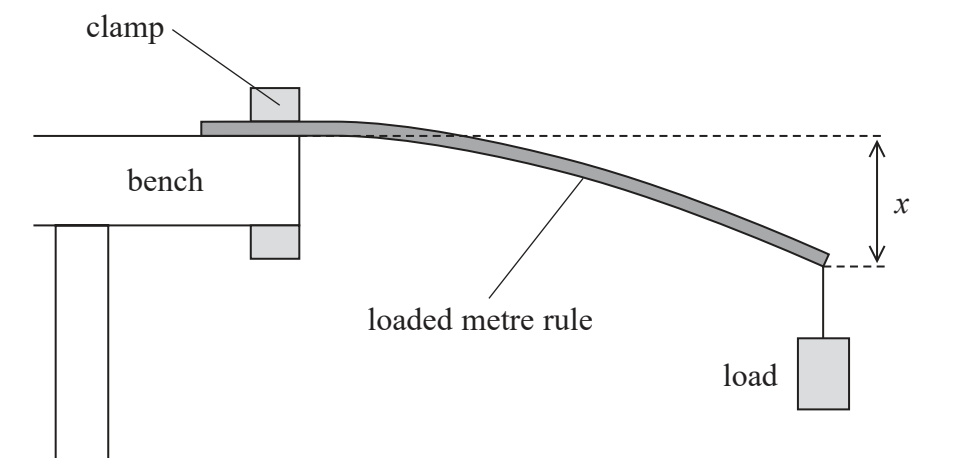


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2 A student clamped a wooden metre rule to a laboratory bench. A load was applied to the end of the metre rule, which deflected a vertical distance x as shown.



(a) Describe how the student should obtain a value for x .

You may add to the diagram if you wish.

(3)

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(b) The thickness of the metre rule is approximately 5 mm.

Describe how the student should measure the thickness of the metre rule as accurately as possible.

(3)

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(c) (i) The table shows four repeated measurements of x .

x/mm			
272	276	279	283

Calculate the mean value for x and the percentage uncertainty in x .

(3)

Mean $x = \dots\dots\dots$ mm

Percentage uncertainty in $x = \dots\dots\dots$ %



(ii) The Young modulus E of the wood is given by

$$E = \frac{4l^3W}{xwt^3}$$

W is the weight of the load = 5.80 N

l is the length from the bench to the end of the metre rule = 0.800 m

w is the width of the metre rule = 3.00 cm

t is the thickness of the metre rule = 5.00 mm

The manufacturer of the metre rule gives the value of E for the wood as $10.8 \times 10^9 \text{ Pa} \pm 4.0\%$

Deduce whether the student's results agree with this value for the Young modulus.

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(Total for Question 2 = 13 marks)

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- 3 A student was researching the photoelectric effect and downloaded some data from a website.

The data included the frequency f of photons incident on a calcium surface and the corresponding maximum kinetic energy E_k of photoelectrons emitted from the calcium.

$f / 10^{15} \text{ Hz}$	$E_k / 10^{-19} \text{ J}$
0.83	0.67
1.21	3.32
1.54	5.68
2.00	8.43
2.39	11.22
2.76	13.81

- (a) The relationship between f and E_k is

$$hf = \phi + E_k$$

Explain why a graph of E_k on the y -axis against f on the x -axis should be a straight line.

(2)

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- (b) Plot a graph of E_k on the y -axis against f on the x -axis.

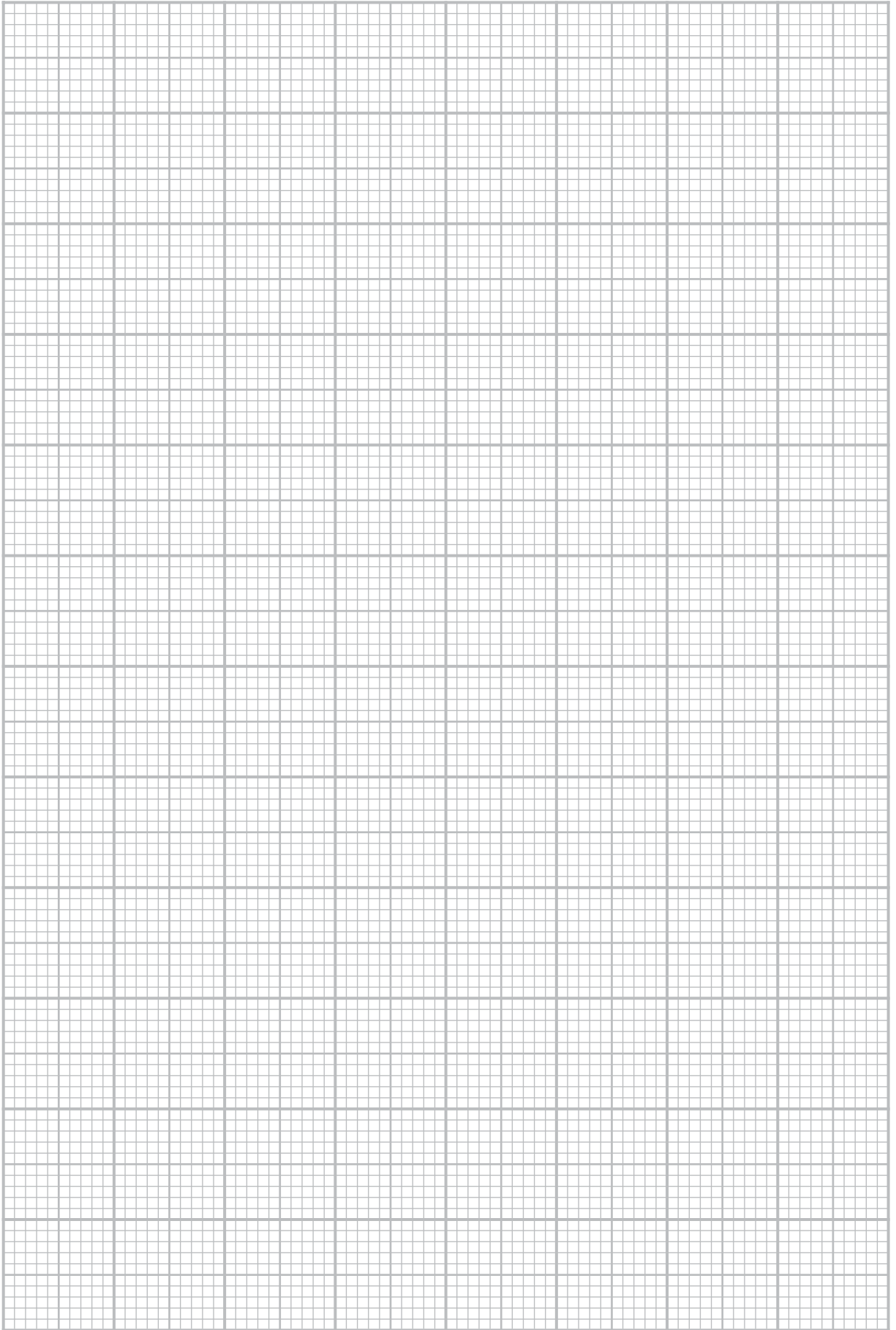
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(c) Determine h and ϕ .

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$h =$

$\phi =$

(Total for Question 3 = 10 marks)

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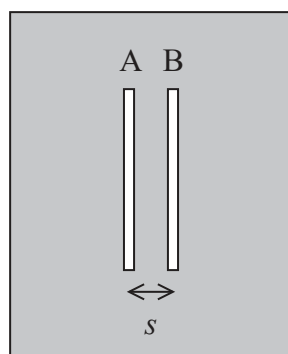


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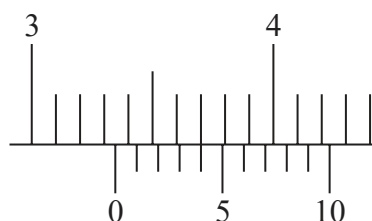
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- 4 A student carried out an experiment to determine the wavelength of laser light. The student passed laser light through the two parallel slits, A and B, as shown.



- (a) The student measured the distance s between the slits using the vernier scale on a travelling microscope. The reading on the vernier scale of the position of slit A was 3.26 cm. The diagram shows the vernier scale for the position of slit B.



- (i) Determine s .

(2)

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$s =$

- (ii) Determine the percentage uncertainty in the measurement of s .

(2)

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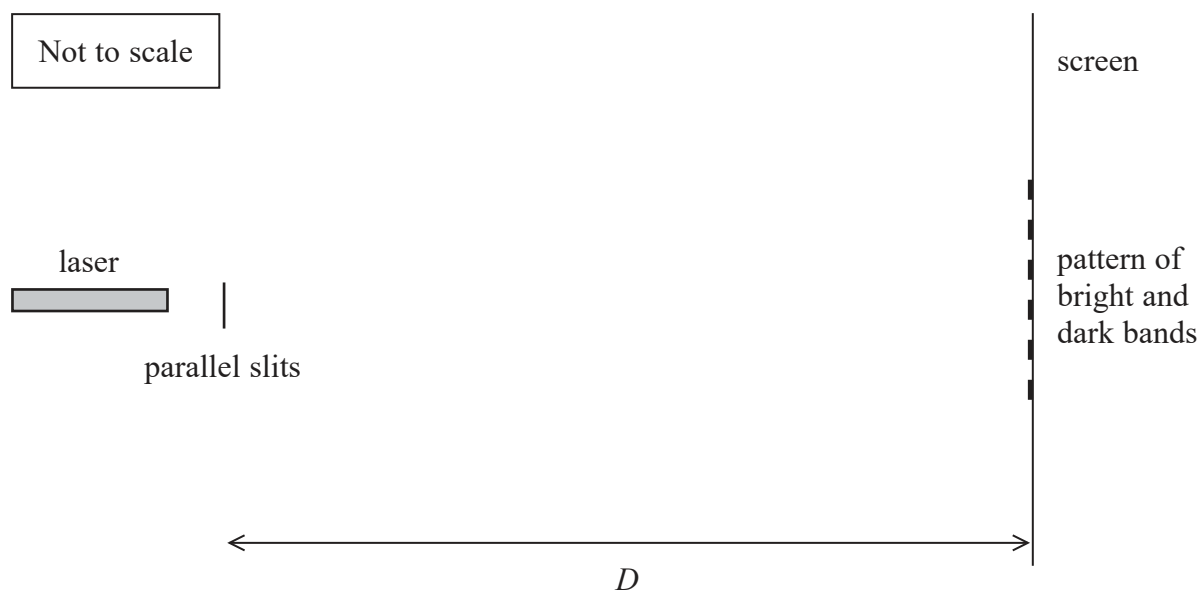
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Percentage uncertainty in $s =$ %



- (b) The student used a laser to direct light through the slits onto a screen as shown. The slits act as coherent sources. The distance between the slits and the screen is D .



The diagram below shows the pattern of equally spaced bright and dark bands produced on the screen.



(Source: Fouad A. Saad/Shutterstock)

The pattern is caused by interference of light arriving at the screen from the two slits.

- (i) The bright bands of light are caused by constructive interference.

Describe how constructive interference occurs.

(2)

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- (ii) To determine the spacing w of the bands, the student measured the distance across several bands.

Explain the advantage of this procedure.

(2)

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- (c) The student repeated the experiment using a different pair of slits. The relationship between w and the wavelength λ of the laser light is given by

$$w = \frac{\lambda D}{s}$$

$$D = 5.4 \text{ m}$$

$$s = 0.30 \text{ mm}$$

distance across 5 bright bands = 6.0 cm

- (i) Determine λ .

(2)

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$\lambda =$

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(ii) D was measured with an uncertainty of 1 cm.

The distance across 5 bands was measured with a metre rule of resolution 1 mm.

The percentage uncertainty in s is 3.2%

Assess which of these values was the most significant source of uncertainty in the value of the wavelength.

(3)

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(Total for Question 4 = 13 marks)

TOTAL FOR PAPER = 50 MARKS

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List of data, formulae and relationships

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$	
Coulomb's law constant	$k = 1/4\pi\epsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
Electron charge	$e = -1.60 \times 10^{-19} \text{ C}$	
Electron mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$	
Electronvolt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	
Gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to Earth's surface)
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$	
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	
Proton mass	$m_p = 1.67 \times 10^{-27} \text{ kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27} \text{ kg}$	

Unit 1

Mechanics

Kinematic equations of motion	$s = \frac{(u + v)t}{2}$
	$v = u + at$
	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$

Forces	$\Sigma F = ma$
	$g = \frac{F}{m}$
	$W = mg$

Momentum	$p = mv$
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Moment of force	moment = Fx
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Work and energy	$\Delta W = F\Delta s$
	$E_k = \frac{1}{2}mv^2$
	$\Delta E_{\text{grav}} = mg\Delta h$

Power	$P = \frac{E}{t}$
	$P = \frac{W}{t}$



Efficiency

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Materials

Density

$$\rho = \frac{m}{V}$$

Stokes' law

$$F = 6\pi\eta rv$$

Hooke's law

$$\Delta F = k\Delta x$$

Elastic strain energy

$$\Delta E_{\text{el}} = \frac{1}{2}F\Delta x$$

Young modulus

$$E = \frac{\sigma}{\varepsilon} \text{ where}$$

$$\text{Stress } \sigma = \frac{F}{A}$$

$$\text{Strain } \varepsilon = \frac{\Delta x}{x}$$

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Unit 2

Waves

Wave speed	$v = f\lambda$
Speed of a transverse wave on a string	$v = \sqrt{\frac{T}{\mu}}$
Intensity of radiation	$I = \frac{P}{A}$
Refractive index	$n_1 \sin \theta_1 = n_2 \sin \theta_2$ $n = \frac{c}{v}$
Critical angle	$\sin C = \frac{1}{n}$
Diffraction grating	$n\lambda = d \sin \theta$

Electricity

Potential difference	$V = \frac{W}{Q}$
Resistance	$R = \frac{V}{I}$
Electrical power, energy	$P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$ $W = VIt$
Resistivity	$R = \frac{\rho l}{A}$
Current	$I = \frac{\Delta Q}{\Delta t}$ $I = nqvA$
Resistors in series	$R = R_1 + R_2 + R_3$
Resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Particle nature of light

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2}mv_{\max}^2$
de Broglie wavelength	$\lambda = \frac{h}{p}$



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