Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

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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P 6 9 4 3 6 A 0 1 2 0

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.

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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.

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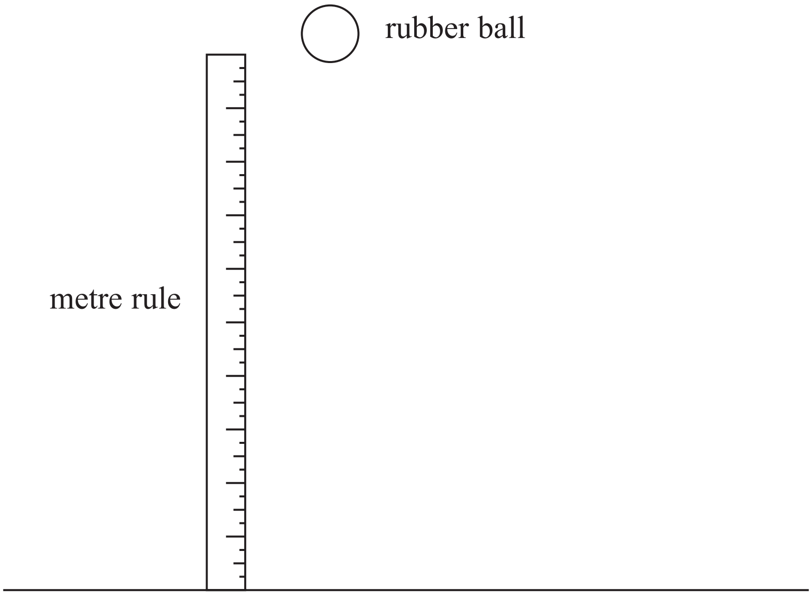
(b) The student measured the temperature of the ball, then dropped it from a height of 1 m. A metre rule, clamped so that it was vertical, was used to measure the bounce height.



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.

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

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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.

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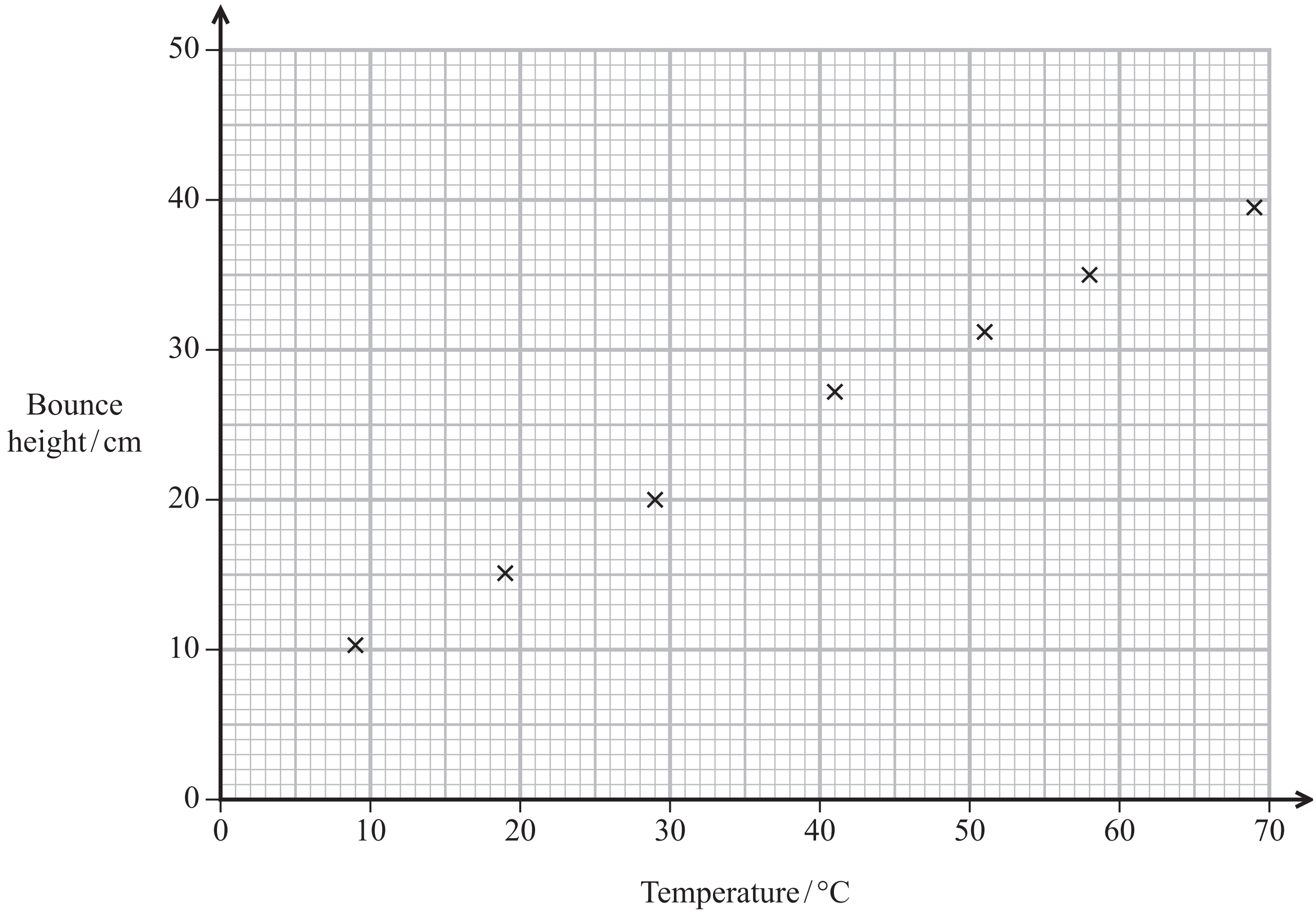
(e) The student's graph is shown below.



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

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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)

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

(1)

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(Total for Question 1 = 14 marks)

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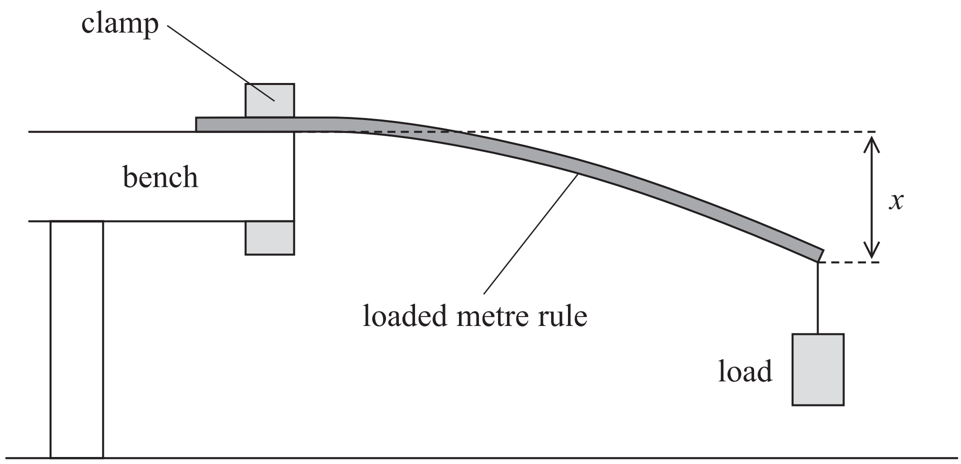
2 A student clamped a wooden metre rule to a laboratory bench. A load was applied to the end of the metre rule, which deflected a vertical distance x as shown.



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

You may add to the diagram if you wish.

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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.

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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.

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Mean x = ... mm

Percentage uncertainty in x = ... %

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(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 10.8×10^9 Pa ± 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.

$f / 10^{15}$ Hz	$E_k / 10^{-19}$ 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.

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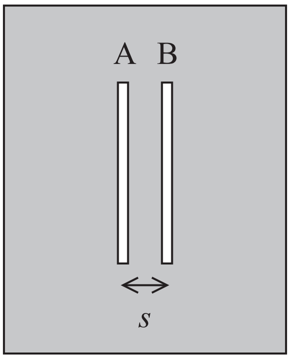
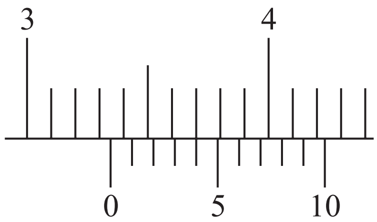
4 A student carried out an experiment to determine the wavelength of laser light. The student passed laser light through the two parallel slits, A and B, as shown.



(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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Percentage uncertainty in s = ... %

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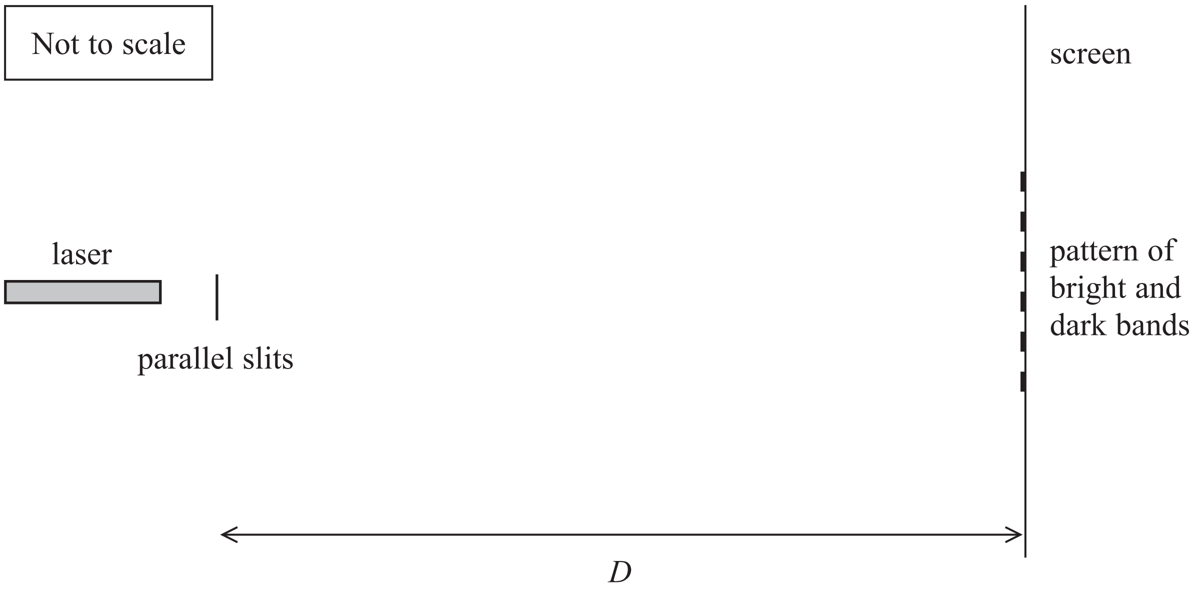
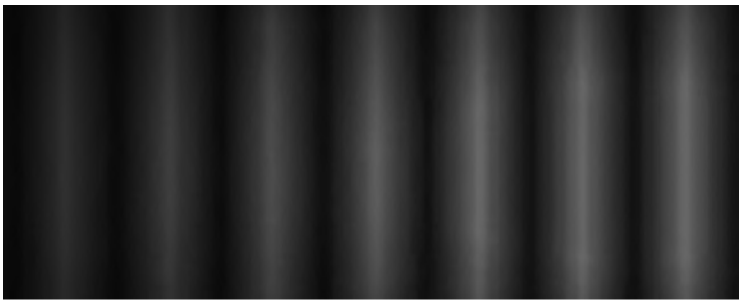
(b) The student used a laser to direct light through the slits onto a screen as shown. The slits act as coherent sources. The distance between the slits and the screen is D.



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.

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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.

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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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λ = ...

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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.

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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	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^{9}\ \text{N m}^2\ \text{C}^{-2}$	
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	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$	
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	$s = \dfrac{(u+v)t}{2}$
	$v = u + at$
	$s = ut + \dfrac{1}{2}at^2$
	$v^2 = u^2 + 2as$
Forces	$\Sigma F = ma$
	$g = \dfrac{F}{m}$
	$W = mg$
Momentum	$p = mv$
Moment of force	$\text{moment} = Fx$
Work and energy	$\Delta W = F\Delta s$
	$E_k = \dfrac{1}{2}mv^2$
	$\Delta E_{grav} = mg\Delta h$
Power	$P = \dfrac{E}{t}$
	$P = \dfrac{W}{t}$

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

Stokes' law $F = 6\pi\eta rv$

Hooke's law $\Delta F = k\Delta x$

Elastic strain energy $\Delta E_{el} = \dfrac{1}{2}F\Delta x$

Young modulus $E = \dfrac{\sigma}{\varepsilon}$ where

Stress $\sigma = \dfrac{F}{A}$

Strain $\varepsilon = \dfrac{\Delta x}{x}$

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Unit 2

Waves

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

Electricity

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

Particle nature of light

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

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