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.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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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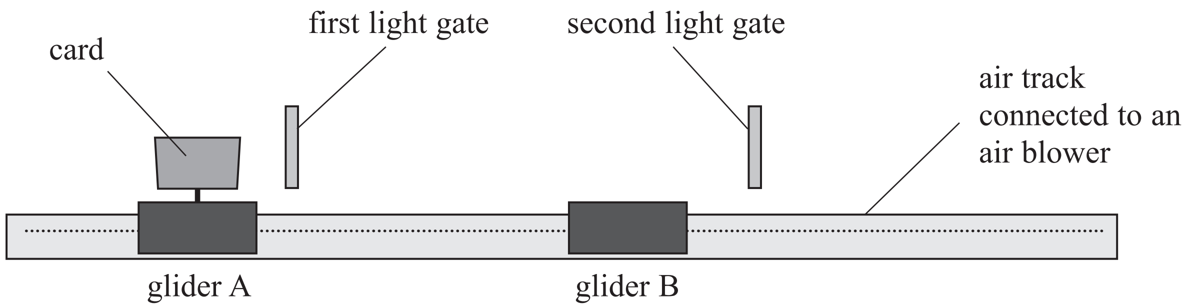
Answer ALL questions.

1 A student used light gates connected to a data logger to investigate the collision between two gliders on a level air track, as shown.



Glider B was initially stationary.

Glider A moved through the first light gate and then collided with glider B.

The two gliders joined together, then moved through the second light gate.

(a) The diagram below shows the actual size of the card that was fixed to glider A.

(i) Determine an accurate value for the length of the card.

(2)

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Length of card = ...

(ii) Calculate the percentage uncertainty in your value.

(2)

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Percentage uncertainty = ...

(b) The student repeated the collision using a card of length 10.5 cm.

The results are shown in the table.

	Mass / kg	**Time / ms**	**Velocity / $m\,s^{-1}$**	**Momentum / $kg\,m\,s^{-1}$**
Glider A moving through first light gate	0.147	108	0.972	0.143
Gliders A and B moving through second light gate	0.274	205		

(i) Calculate the values missing from the table.

(4)

Velocity = ... $m\,s^{-1}$

Momentum = ... $kg\,m\,s^{-1}$

(ii) Determine whether the student's values show that momentum was conserved in this collision.

(2)

(c) In the experiment, the student applied a small force with her hand to start glider A moving.

The student repeated the experiment and calculated the mean values of the time taken to pass through each light gate.

Discuss how this affected the uncertainty in the calculated values of momentum.

(3)

(d) Another student used a stopwatch to measure the time taken for the gliders to travel a known distance.

Explain the advantage of using light gates and a data logger, instead of using a stopwatch.

(2)

(Total for Question 1 = 15 marks)

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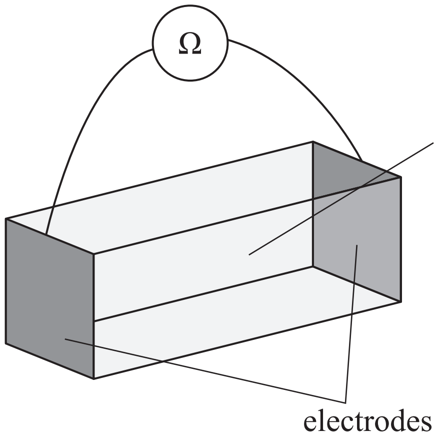
2 A student investigated how dissolving salt in water affects the electrical resistivity of the water.

The student dissolved a known mass m of salt in a known volume of water to make a salt solution.

She filled a container with the salt solution.

The container of length l had an electrode at each end of cross-sectional area A.
She connected an ohmmeter between the two electrodes, as shown.



After measuring the resistance R of the salt solution with the ohmmeter, she calculated the resistivity ρ of the salt solution.

(a) When salt dissolves in water, the salt breaks down into ions. The salt ions are charge carriers.

The student predicted that the resistivity of the salt solution would decrease as m increased.

Justify her prediction.

(3)

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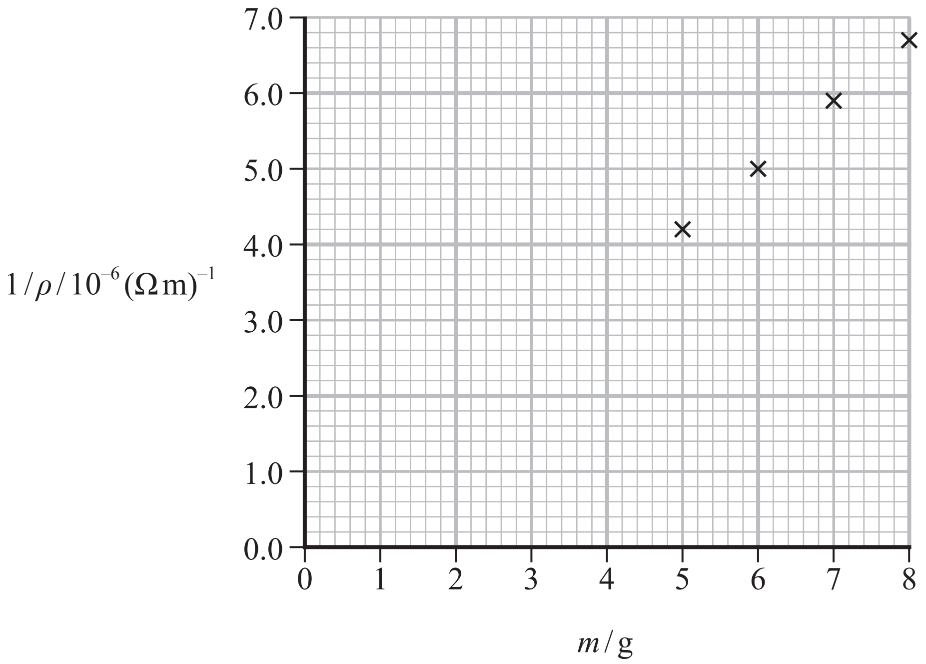
(b) The student repeated the procedure for different values of m and plotted a graph of $1/\rho$ against m.



(i) The student wrote the following conclusion.

The resistivity of the salt solution is inversely proportional to the mass of salt dissolved in the sample.

Explain how the graph supports the student's conclusion.

(3)

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(ii) Give two reasons why the graph may not support the student's conclusion.

(2)

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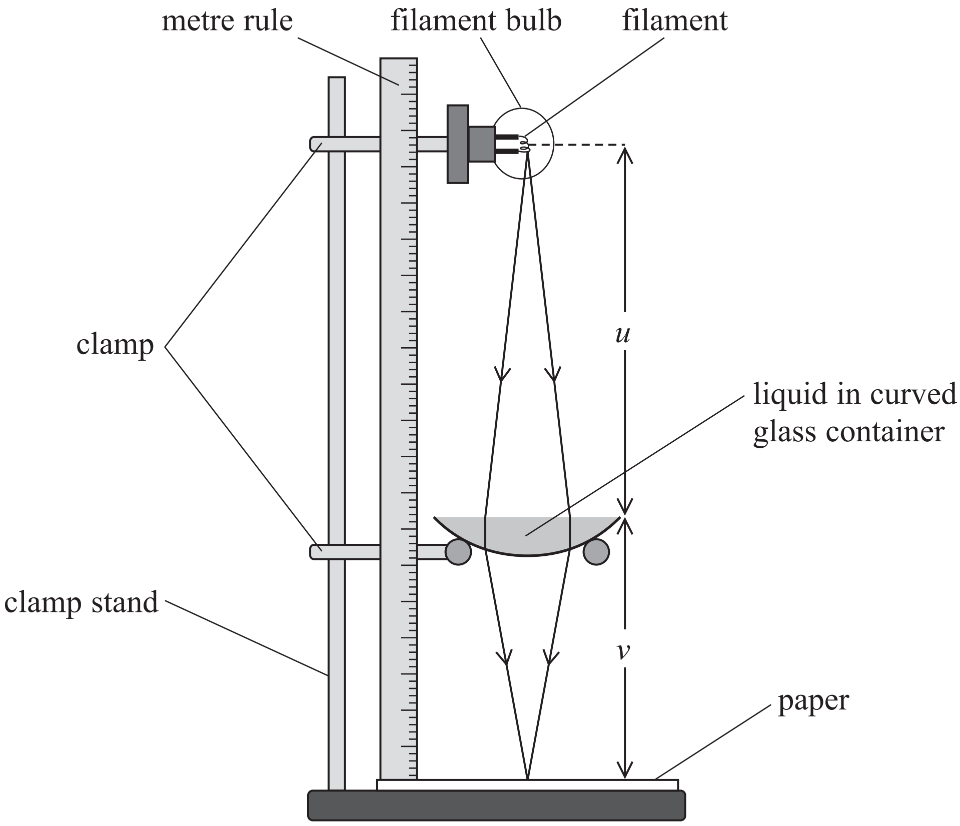
(Total for Question 2 = 8 marks)

3 A student investigated the refractive index of a liquid.

He placed the liquid into a curved glass container so that the liquid acted as a converging lens.

Light from a filament bulb was transmitted through the lens, as shown.



The student adjusted the position of the filament bulb until a clear image of the filament was formed on the paper.

The student calculated the power P of the lens using the distance u between the container and the filament, and the distance v between the container and the paper.

(a) (i) Describe a method to measure u and v.

(3)

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(ii) Identify a possible source of uncertainty in the measurement of u, and how it can be dealt with.

(2)

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(b) The student repeated the experiment for different values of v and recorded his results in a table.

u / m	v / m	P / D
0.832	0.325	4.28
0.724	0.342	4.31
0.615	0.374	

(i) For a lens, P can be calculated using

$$P = \frac{1}{u} + \frac{1}{v}$$

Calculate the value missing from the table.

(2)

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P = ... D

(ii) When surrounded by air, the power of a lens this shape can be calculated using the equation

$$P = \frac{n_{\text{lens}} - n_{\text{air}}}{n_{\text{air}}}\left(\frac{1}{r}\right)$$

where r is the radius of the curve that forms the lens
n_{air} is the refractive index of air
n_{lens} is the refractive index of the liquid.

Determine the value of n_{lens} when $r = 0.070$ m.

(3)

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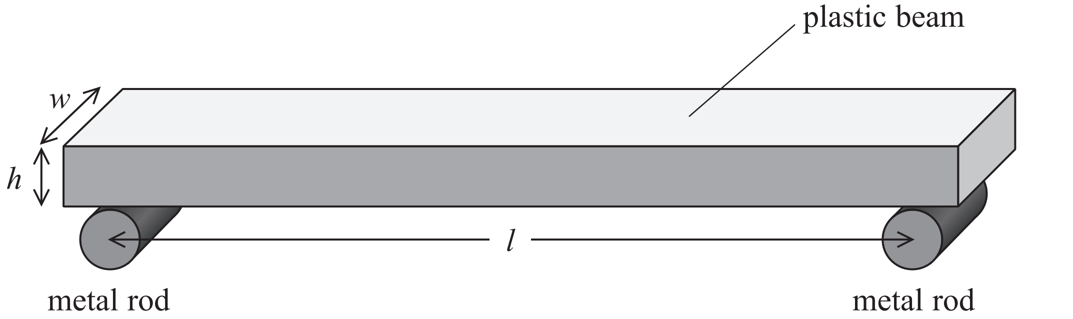
n_{lens} = ...

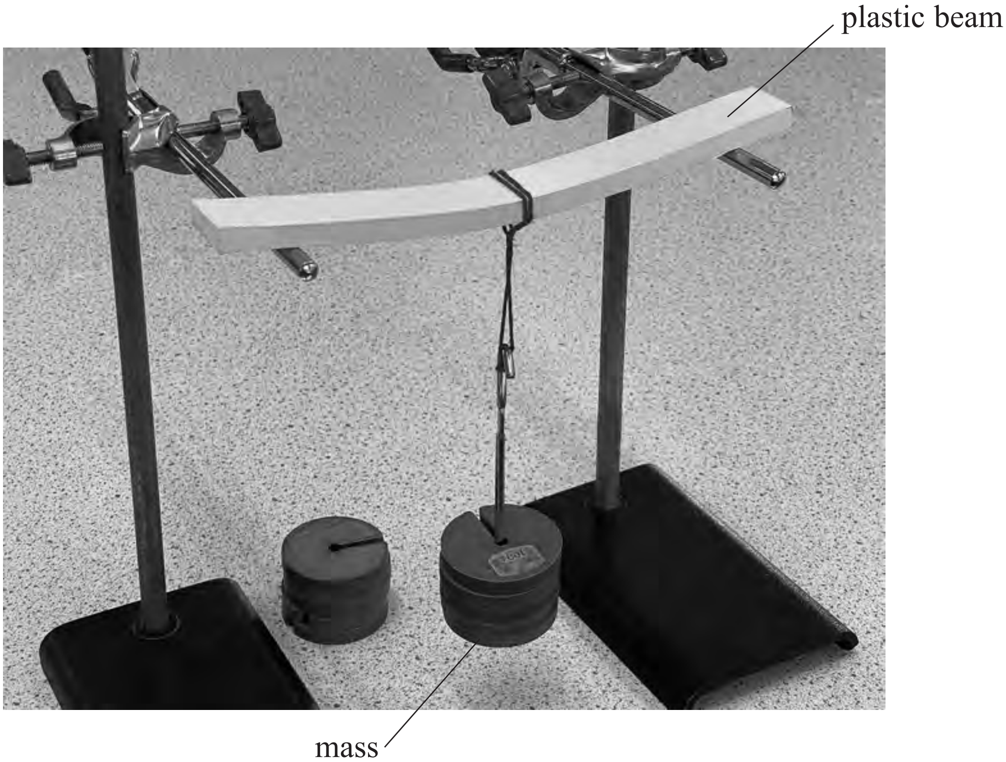
(Total for Question 3 = 10 marks)

4 A student investigated the bending of a plastic beam.

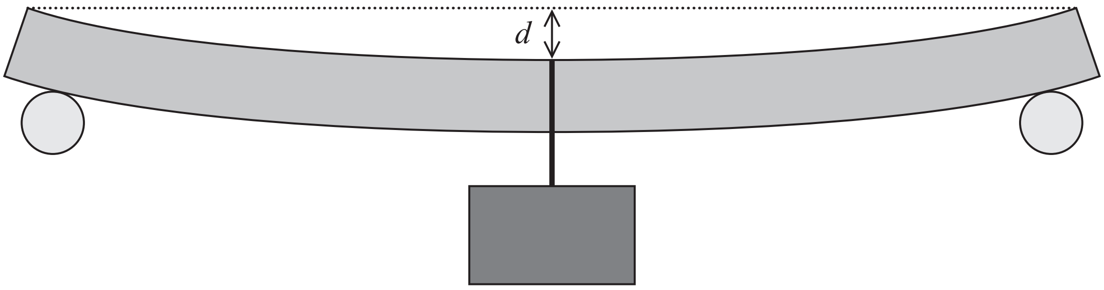
The beam, of width w and height h, was supported at either end by two metal rods a distance l apart, as shown.



She applied a force F to the middle of the plastic beam by hanging a mass from it.



The beam bent downwards as shown.



She measured the vertical distance *d* moved by the middle of the plastic beam and repeated this measurement for increasing values of *F*.

She recorded her results in a table, as shown.

F / N	***d*** / m
4.9	0.0007
9.8	0.0013
14.7	0.002
19.6	0.0027
24.5	0.0033
29.4	0.004

(a) Criticise the recording of these results.

(2)

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(b) Using the grid opposite, plot a graph of *d* on the *y*-axis against *F* on the *x*-axis.

(5)

(c) (i) The 'bending modulus' E of the plastic beam can be calculated using the equation

$$E = \frac{l^3 F}{4wh^3 d}$$

Show that the gradient of the graph is equal to $\frac{l^3}{4wh^3 E}$

(2)

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(ii) Determine the gradient of your graph.

(2)

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Gradient = ...

(iii) The student recorded the following measurements for the plastic beam.

l / cm	30
w / mm	20
h / mm	10

Determine E, in GPa, for the plastic beam.

(2)

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E = ... GPa

(d) The student's teacher suggested that using a plastic beam with a smaller value of h would improve the measurement of d.

Justify the teacher's statement.

(2)

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(e) The student suggested repeating the investigation using a glass rod instead of a plastic beam.

Explain a safety issue that would be caused by using a glass rod.

(2)

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(Total for Question 4 = 17 marks)

TOTAL FOR PAPER = 50 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to Earth's surface)
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 field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to Earth's surface)
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8} \text{ m s}^{-1}$	

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

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_{grav} = mg\Delta h$$

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

Stokes' law $F = 6\pi\eta r v$

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

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	$\lambda = \dfrac{h}{p}$