Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|

Centre Number | Candidate Number

# Pearson Edexcel International Advanced Level

## Wednesday 22 January 2025

Morning (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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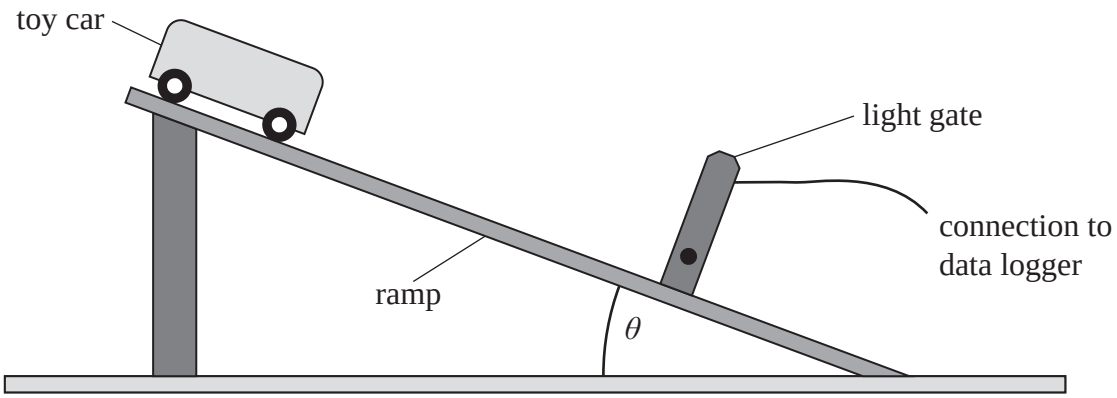
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Pearson

**Answer ALL questions.**

**1** A student investigated how the acceleration of a toy car on a ramp depends on the angle $\theta$ of the ramp.

She placed a light gate connected to a data logger near the bottom of the ramp, as shown.




As the toy car passed through the light gate, the longest part of the toy car interrupted the light beam.
The data logger recorded the time $t$ taken for the toy car to pass through the light gate.

(a) The student measured the length $l$ of the toy car using digital calipers.




Determine the percentage uncertainty in the measurement of $l$.

**(2)**

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Percentage uncertainty in $l$ = .....

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(b) The student adjusted the ramp so that $\theta = 20°$. She released the toy car from the top of the ramp and recorded $t$ from the data logger.

She repeated this several times, as shown in the table.

| ***t* / ms** | 44.7 | 44.6 | 44.9 | 45.2 | 44.5 |
|---|---|---|---|---|---|

(i) Determine the mean value of $t$.

**(2)**

Mean value of $t$ = .....

(ii) Determine the percentage uncertainty in the mean value of $t$.

**(2)**

Percentage uncertainty in mean value of $t$ = .....

(c) Describe a method the student could use to determine the acceleration $a$ of the toy car.

**(3)**

**(Total for Question 1 = 9 marks)**

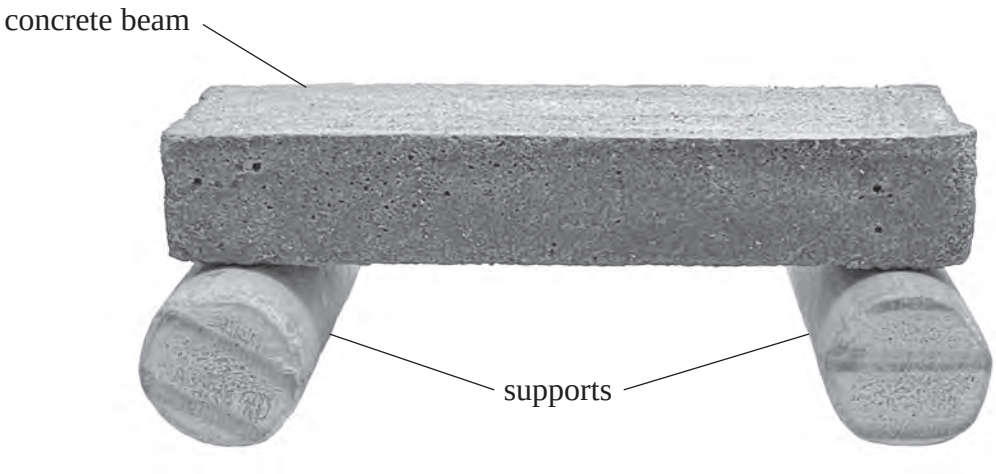
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**2** Concrete is often used to make supporting beams in buildings.

Strands of a material can be added to the concrete mix to produce fibre-reinforced concrete.

A student had some small beams made of fibre-reinforced concrete. Each beam was the same size.

He placed a beam across two supports, as shown.




(a) (i) Describe a method the student could use to determine an accurate value for the maximum force a beam can support.

You should include the use of any additional apparatus needed.

**(4)**

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(ii) Identify a health and safety issue with your method and how the issue may be dealt with.

**(2)**

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(b) The student repeated the experiment using beams that contained different masses of reinforcing fibres. The student's results are shown in the table.

| Mass of fibre / g | Maximum force / N |
|---|---|
| 0 | 8.3 |
| 2 | 10 |
| 4 | 11.3 |
| 5 | 12.75 |

(i) Criticise the recording of these results.

**(2)**

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(ii) The student concluded that the increase in maximum force was proportional to the mass of fibre in the beam.

Explain how the student could justify his conclusion.

**(2)**

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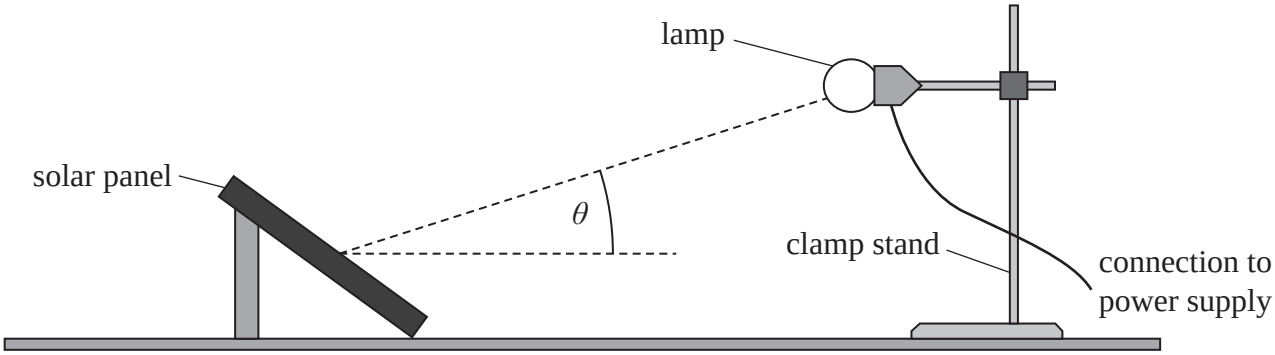
**(Total for Question 2 = 10 marks)**

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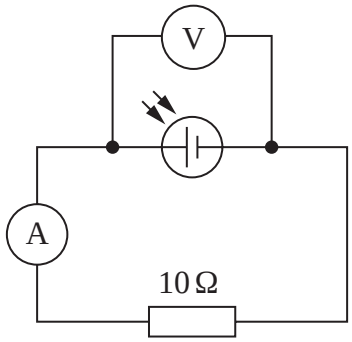
**3** A student investigated how the change in position of the Sun in the sky affects the power output of solar panels.

She fixed a small solar panel at an angle to the horizontal. She used a lamp with an adjustable stand to act as the Sun, as shown.

By changing the angle $\theta$, she modelled the change in the position of the Sun in the sky.




One of the solar cells in the solar panel was connected into a circuit. The circuit also contained a 10 Ω fixed resistor, an ammeter and a voltmeter, as shown below.




(a) The investigation is affected by background light.

(i) Suggest what the student should do to control the background light during the investigation.

**(1)**

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(ii) Suggest **two** other variables the student should control during this investigation.

**(2)**

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(b) The student used a light meter to determine the power $P_{in}$ of the light incident on the solar cell.

She determined the angle $\theta$ for each position of the lamp.

For each angle, she measured the current $I$ and potential difference $V$ for the solar cell.

She calculated the output power $P_{out}$ of the solar cell at each angle. She also calculated the % efficiency of the arrangement.

Her results are shown in the table.

| $\theta$ / ° | $P_{in}$ / mW | $V$ / V | $I$ / mA | $P_{out}$ / mW | % efficiency |
|---|---|---|---|---|---|
| 35 | 46.1 | 0.539 | 22.36 | 12.1 | 26.2 |
| 39 | 46.2 | 0.554 | 22.92 | 12.7 | 27.5 |
| 44 | 46.1 | 0.562 | 23.38 | 13.1 | 28.4 |
| 52 | 46.1 | 0.572 | 23.71 | 13.6 | 29.5 |
| 61 | 46.1 | 0.569 | 23.69 | 13.5 | 29.3 |
| 66 | 46.2 | 0.565 | 23.41 | 13.2 | 28.6 |
| 72 | 46.2 | 0.551 | 22.95 | 12.6 | 27.3 |
| 78 | 46.1 | 0.536 | 22.24 | | |

(i) Calculate the missing values for $P_{out}$ and % efficiency.

**(4)**

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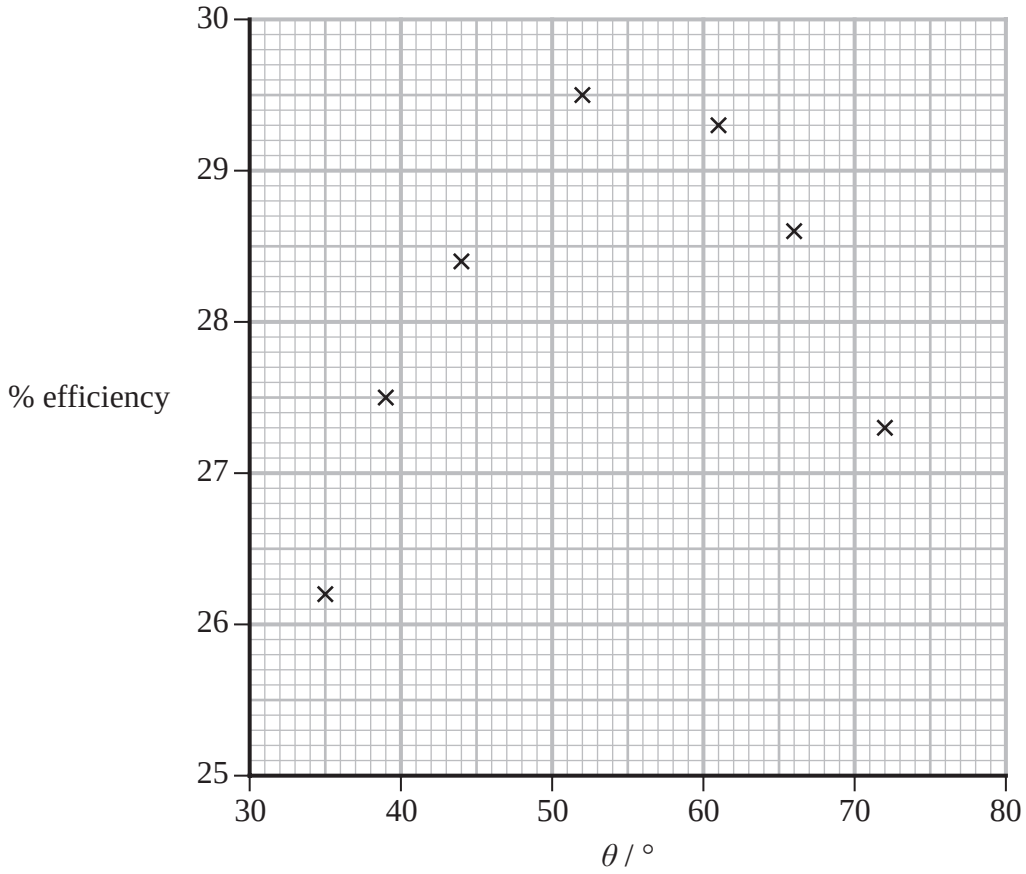
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$P_{out}$ = ..... mW

Efficiency = ..... %

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(ii) The student plotted a graph of % efficiency against $\theta$.




Determine the maximum % efficiency of the arrangement and the corresponding angle $\theta_{max}$.

**(3)**

Maximum efficiency = .....%

$\theta_{max}$ = .....

(c) Explain how the student could collect more data to increase the accuracy in her values of maximum % efficiency and $\theta_{max}$.

**(3)**

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(d) The student only moved the lamp vertically in her investigation. During a day, the Sun moves vertically and horizontally across the sky.

(i) State the direction in which light should be incident on the solar panel for maximum output power.

**(1)**

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(ii) The solar panels at a solar power station are mounted on motorised stands.



(Source: © Daryna Andriianova/Shutterstock)

Explain how this could increase the energy generated during a day.

**(3)**

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**(Total for Question 3 = 17 marks)**

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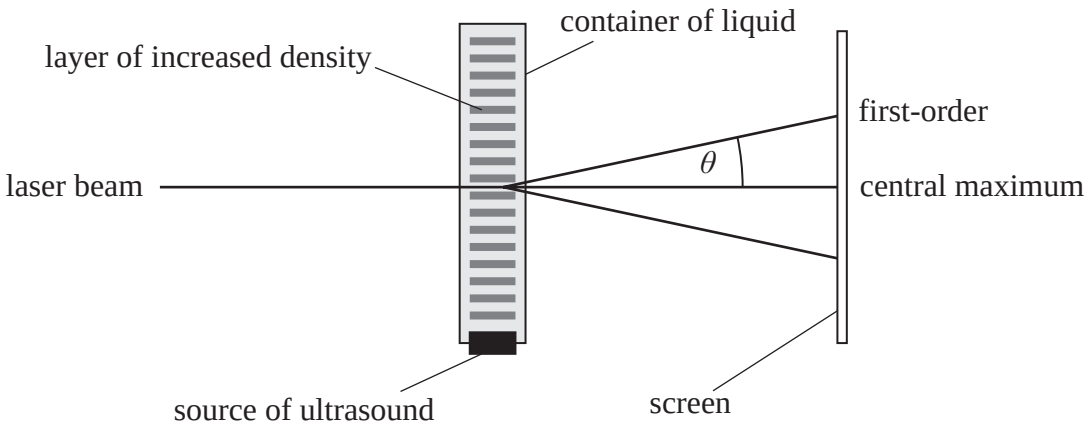
**4** A student used a source of ultrasound to create a standing wave in a narrow container of liquid.

The standing wave created layers of increased density in the liquid.

This caused the liquid to act like a diffraction grating.

The student directed a beam of light from a laser through the container. This produced a diffraction pattern on a screen, as shown.

Not to scale




The student varied the frequency $f$ of the ultrasound.

For each frequency, he measured the distance of the first-order image from the central maximum.

He then calculated the diffraction angle $\theta$ of the first-order image.

His results are shown in the table.

| $f$ / MHz | $\theta$ / ° | |
|---|---|---|
| 2.1 | 0.052 | |
| 3.5 | 0.090 | |
| 4.3 | 0.106 | |
| 5.4 | 0.138 | |
| 6.8 | 0.170 | |
| 8.3 | 0.212 | |

(a) (i) Complete the table with corresponding values of sin $\theta$.

Use the additional column to record your processed data.

**(2)**

(ii) Plot a graph of $f$ on the $y$-axis against sin $\theta$ on the $x$-axis on the grid opposite.

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(b) The student derived the following formula

$$\lambda = \frac{v}{f}\sin\theta$$

where $\lambda$ is the wavelength of the laser light and $v$ is the speed of sound in the liquid.

Explain how a graph of $f$ against $\sin\theta$ can be used to determine $v$.

**(2)**

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(c) (i) Determine the value of $v$ using your graph.

$\lambda = 650\,\text{nm}$

**(3)**

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$v$ = .....

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(ii) The student is told that the liquid is either petroleum, castor oil or glycerol.

The table shows the speed of sound $v$ in these liquids.

| **Liquid** | $v$ / m s$^{-1}$ |
|---|---|
| petroleum | 1330 |
| castor oil | 1474 |
| glycerol | 1904 |

The student estimated the percentage uncertainty in the value of $v$, determined from the graph, to be 5%.

Deduce which liquid was in the container.

**(2)**

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**(Total for Question 4 = 14 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) |
| 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

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

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

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

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

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

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

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

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

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 | $hf = \phi + \frac{1}{2}mv^2_{max}$ |
| de Broglie wavelength | $\lambda = \frac{h}{p}$ |

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