

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

Pearson Edexcel International Advanced Level**Tuesday 23 January 2024**

Afternoon (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

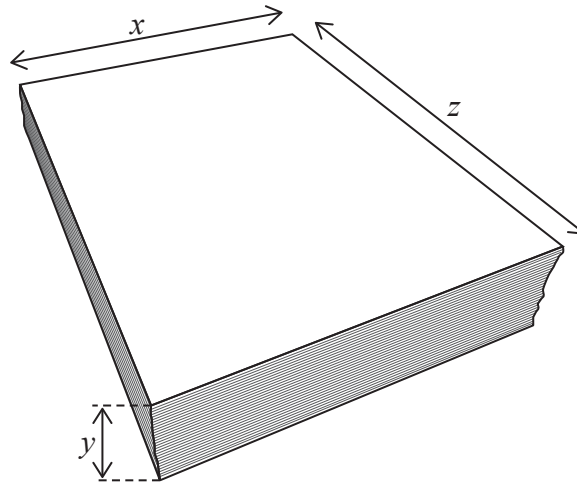
- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Answer ALL questions.

- 1 A student had a stack of 500 sheets of paper. He measured the dimensions shown.



- (a) The student used a balance to determine the mass of the stack of paper. The reading is shown below.

2.070 kg

- (i) State the resolution of the balance.

(1)

- (ii) Determine the percentage uncertainty in the mass of the stack of paper.

(2)

Percentage uncertainty =



- (b) The student used vernier calipers to measure the thickness y of the stack of paper.

Explain **one** technique he should use to determine an accurate value for y .

(2)

- (c) The student used the measurements from the stack of paper to determine the density of the paper.

- (i) Determine the density of the paper in g cm^{-3}

$$x = 210 \text{ mm}$$

$$y = 42.7 \text{ mm}$$

$$z = 297 \text{ mm}$$

(2)

$$\text{Density} = \dots\dots\dots \text{g cm}^{-3}$$

- (ii) Explain why making measurements on the whole stack of paper is better than making measurements on a single sheet of paper.

(2)

(Total for Question 1 = 9 marks)

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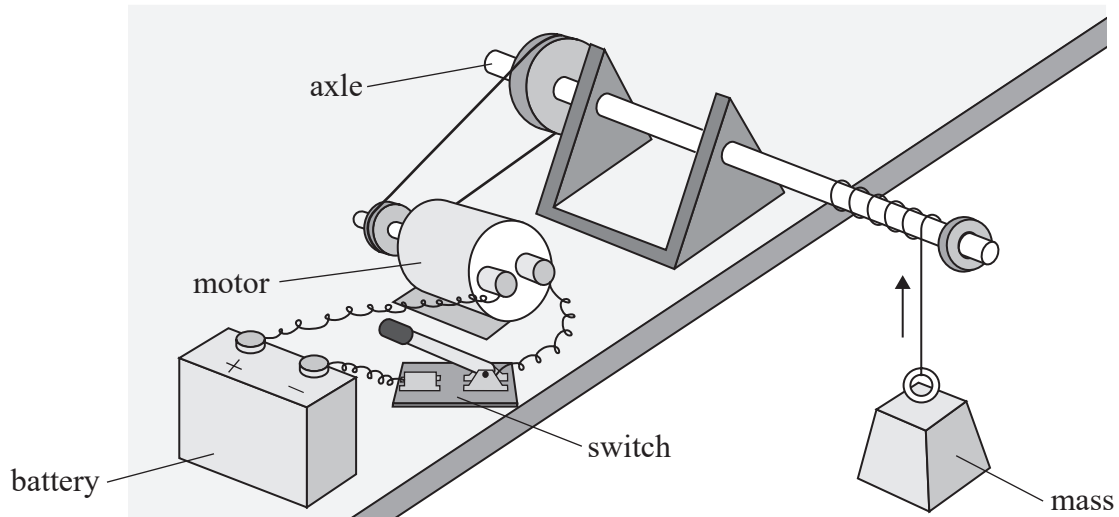
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- 2 A student investigated the efficiency of an electric motor, using the apparatus shown.

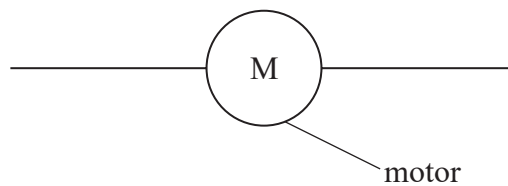


- (a) The motor was connected in a circuit including a battery and a switch.

The student connected additional components to determine the power of the motor.

Complete the circuit diagram for the circuit the student should use.

(2)



- (b) The student closed the switch in the circuit, and the motor lifted the mass from the floor.

She used a metre rule to measure the height gained by the 1 kg mass in 10 s.

- (i) Describe how she should measure a single value of the height gained as accurately as possible.

You should include the use of any additional apparatus needed.

(4)

- (ii) Explain why repeat measurements are appropriate for this measurement.

(2)

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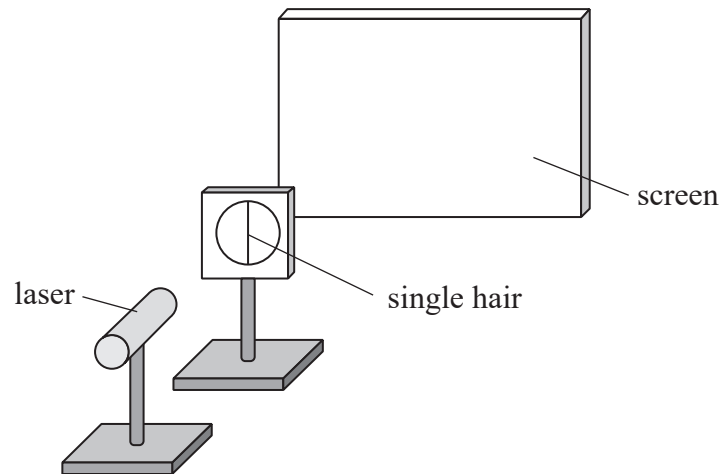
- (c) Explain how the measurements made by the student should be used to determine the efficiency of the motor as it lifts the mass.

(3)

(Total for Question 2 = 11 marks)



- 3 A student used a laser and screen to determine the diameter of a hair. The apparatus was arranged as shown.



- (a) Identify a health and safety issue caused by using a laser and how this issue may be dealt with.

(2)

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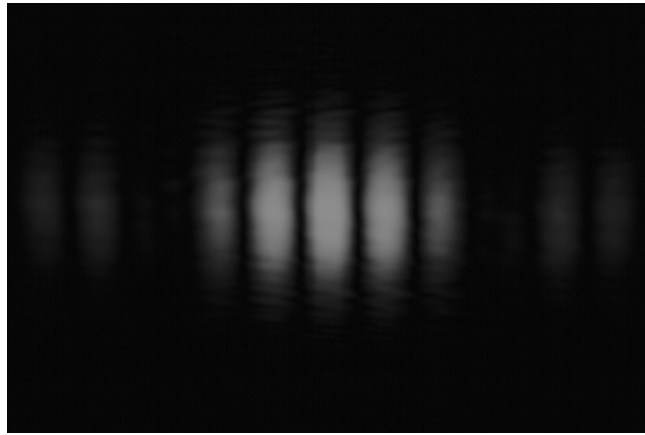
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- (b) The student placed the screen 2 m from the hair.

He switched on the laser. A diffraction pattern was produced on the screen, as shown.



(Source: © GIPHOTOSTOCK/SCIENCE PHOTO LIBRARY)

- (i) The student used a metre rule to measure the distance between adjacent minima.

Describe how the student should determine an accurate value for the distance between adjacent minima.

(2)

- (ii) Explain how the student could modify the arrangement of the apparatus to reduce the percentage uncertainty in this value.

(2)



- (c) The student repeated the procedure using three different lasers. Each laser produced a different wavelength of light.

The student calculated the diameter d of the hair using each laser. He recorded the values as shown.

	$d / \mu\text{m}$
Laser 1	76.0
Laser 2	84.4
Laser 3	77.1

- (i) Determine the mean value of d .

(2)

Mean value of $d =$

- (ii) Determine the percentage uncertainty in the mean value of d .

(2)

Percentage uncertainty =



- (d) In a different experiment, the student applied force to stretch the hair. He determined the average breaking stress for hair as 181 MPa with a percentage uncertainty of 6%.

The student suggested that the breaking stress for hair is the same as the breaking stress for copper wire.

Deduce whether the suggestion is correct.

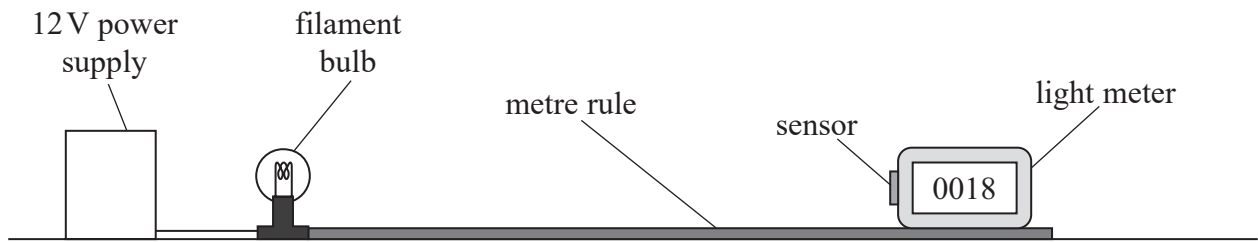
breaking stress for copper wire = 210 MPa

(2)

(Total for Question 3 = 12 marks)



- 4 A student investigated the inverse square law for light, using the apparatus shown.



The student used a metre rule to measure the distance d between the filament of the bulb and the sensor on the light meter.

The reading on the light meter is the intensity I of the light.

- (a) Explain how **two** sources of error can be reduced in this investigation.

(4)

- (b) The relationship between I and d is given by

$$I = \frac{k}{d^2}$$

where k is a constant.

- (i) Explain why a graph of I against $\frac{1}{d^2}$ should be a straight line through the origin.

(2)



- (ii) The student varied d and recorded corresponding values of I . She recorded the results in the table as shown.

d / m	$I / \text{W m}^{-2}$	
0.125	996	
0.175	510	
0.250	276	
0.375	109	
0.500	48	
0.750	18	

Complete the table with corresponding values of $\frac{1}{d^2}$

Use the additional column to record your processed data.

(2)

- (iii) Plot a graph of I on the y -axis against $\frac{1}{d^2}$ on the x -axis on the grid opposite.

(5)

- (iv) Determine the value of k from the graph.

(3)

$k =$

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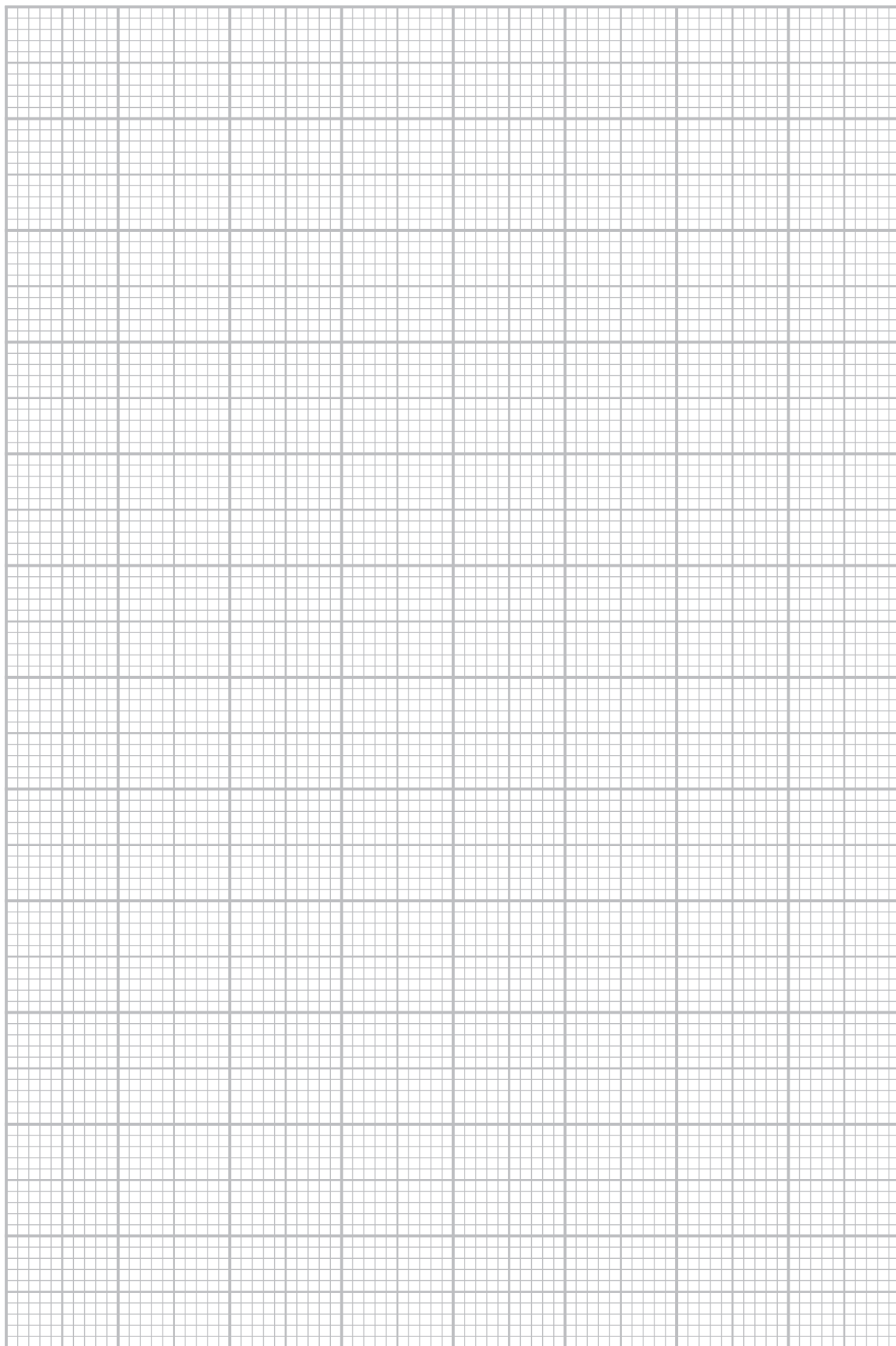
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- (v) The student switched off the filament bulb. She recorded the intensity of the background light as 4 W m^{-2} .

The student then switched on the filament bulb. She moved the light meter to change d , until the reading on the light meter was 8 W m^{-2} .

Determine the distance between the light meter and the filament bulb.

(2)

Distance =

(Total for Question 4 = 18 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

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

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

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

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

$$P = VI$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

$$W = VIt$$

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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