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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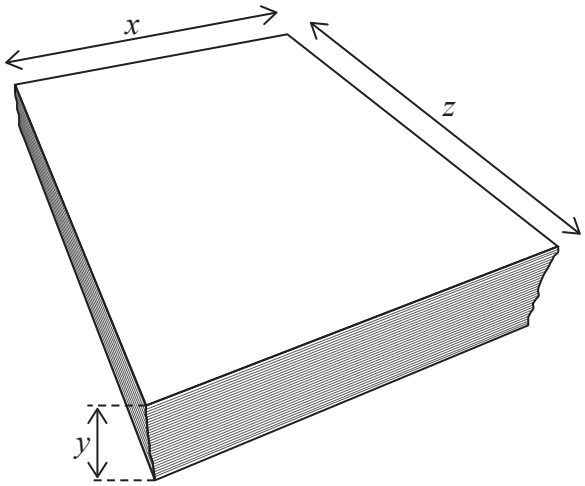
Pearson

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.

(i) State the resolution of the balance.

(1)

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.....

(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 $g\,cm^{-3}$

$x = 210\,mm$
$y = 42.7\,mm$
$z = 297\,mm$

(2)

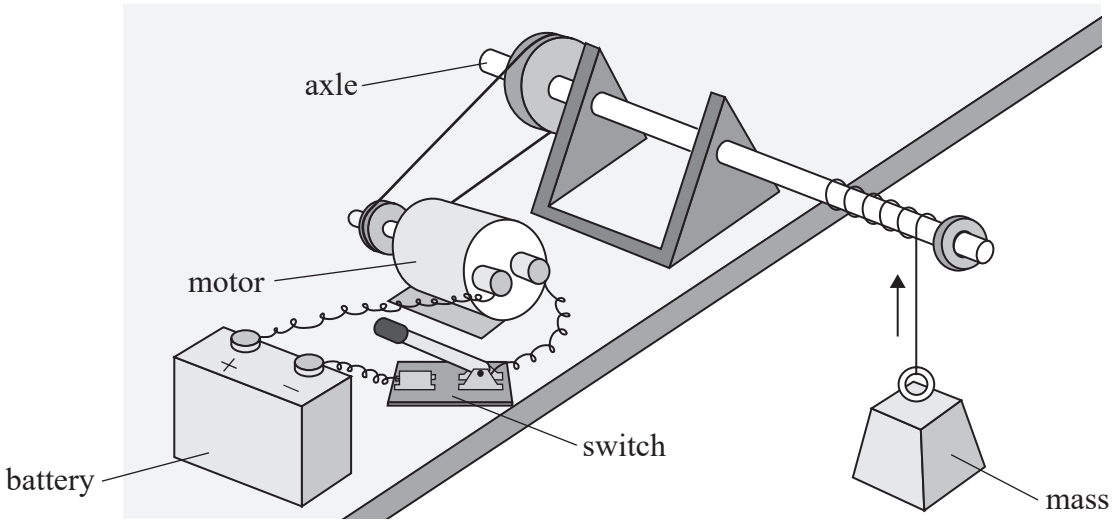
Density = ... $g\,cm^{-3}$

(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)

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

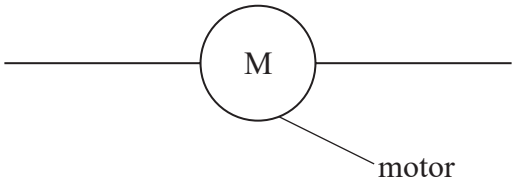


(a) The motor was connected in a circuit including a battery and a switch.

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)

(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)

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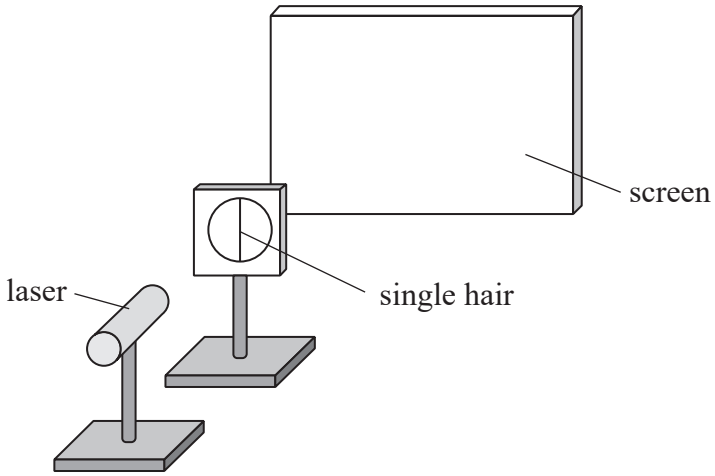
(Total for Question 2 = 11 marks)

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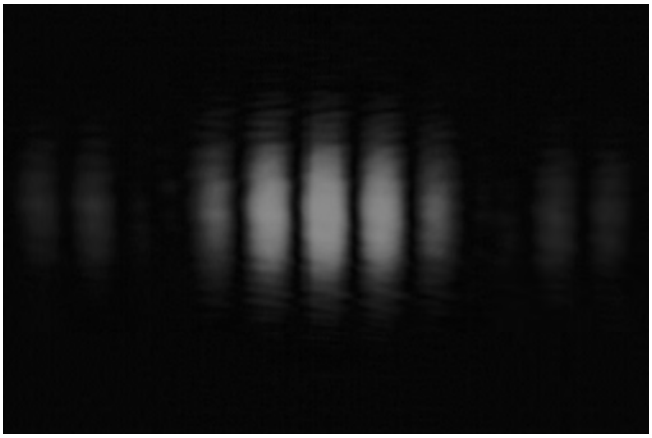
(b) The student placed the screen 2 m from the hair.

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)

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

(2)

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(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 / µm
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)

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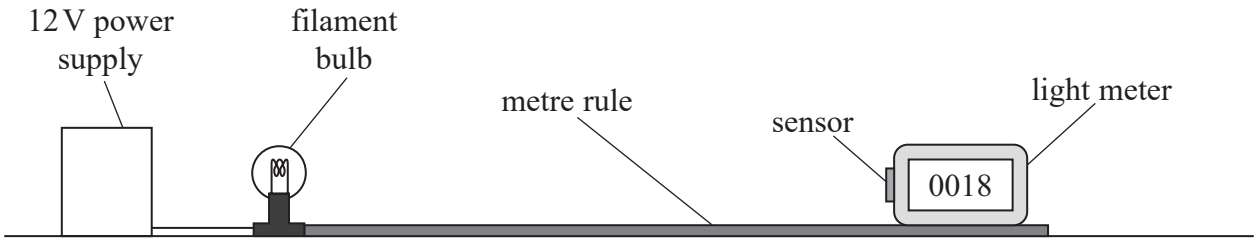
(Total for Question 3 = 12 marks)

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 / 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)

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$k =$ .....

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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)

.....

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.....

Distance = ...

(Total for Question 4 = 18 marks)

TOTAL FOR PAPER = 50 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81$ m s^{-2}	(close to Earth's surface)
Electron charge	$e = -1.60 \times 10^{-19}$ C	
Electron mass	$m_e = 9.11 \times 10^{-31}$ kg	
Electronvolt	$1\,\text{eV} = 1.60 \times 10^{-19}$ J	
Gravitational field strength	$g = 9.81$ N kg^{-1}	(close to Earth's surface)
Planck constant	$h = 6.63 \times 10^{-34}$ J s	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}$ 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 $\rho = \frac{m}{V}$

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

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

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

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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