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 18 October 2023

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

P75623A

©2023 Pearson Education Ltd.

Z:1/1/1/

P 7 5 6 2 3 A 0 1 2 0

Answer ALL questions.

1 A student investigated the metal cube shown.

She measured the length, width and height of the cube.

She repeated these measurements in different places on the cube. Her measurements are shown in the table below.

	Length / mm	Width / mm	Height / mm
Measurement 1	20.3	20.4	20.1
Measurement 2	20.2	20.5	20.1
Measurement 3	20.1	20.0	20.1
Mean	20.2	20.3	20.1

(a) Identify a suitable measuring instrument for these measurements.

(1)

....

(b) The student noticed that the uncertainty in the mean width is larger than the uncertainties in the mean length and the mean height.

Suggest why the uncertainty in the mean width is larger.

(1)

....

....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(c) Determine the percentage uncertainty in the mean length.

(2)

Percentage uncertainty = ...

(d) The student measured the mass of the metal cube as 72.8 g, using a top pan balance.

(i) Show that the density of the metal is about 8800 kg m^{-3}.

(4)

(ii) The student is told the cube is made from copper, bronze or brass.

The table shows the densities of these metals.

Metal	**Density / kg m^{-3}**
copper	8940
bronze	8620
brass	8520

She estimates the percentage uncertainty in the value of the density of the cube to be 2%.

Deduce which metal the cube is made from.

(3)

....

....

....

....

....

....

(Total for Question 1 = 11 marks)

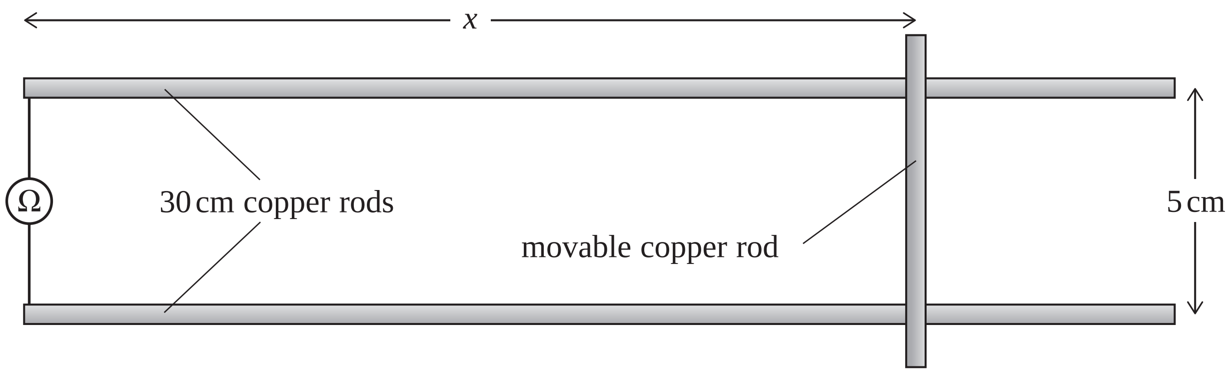
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

2 A student models a safety system used on a railway.

Two parallel 30 cm copper rods model the rails. These rods are fixed 5 cm apart and are connected to an ohmmeter.

A movable copper rod models the train. This rod completes the circuit with the ohmmeter, as shown.



As the distance x varies, the resistance R of the circuit varies.

(a) Describe how the student could determine accurate values of x and R.

(4)

....

....

....

....

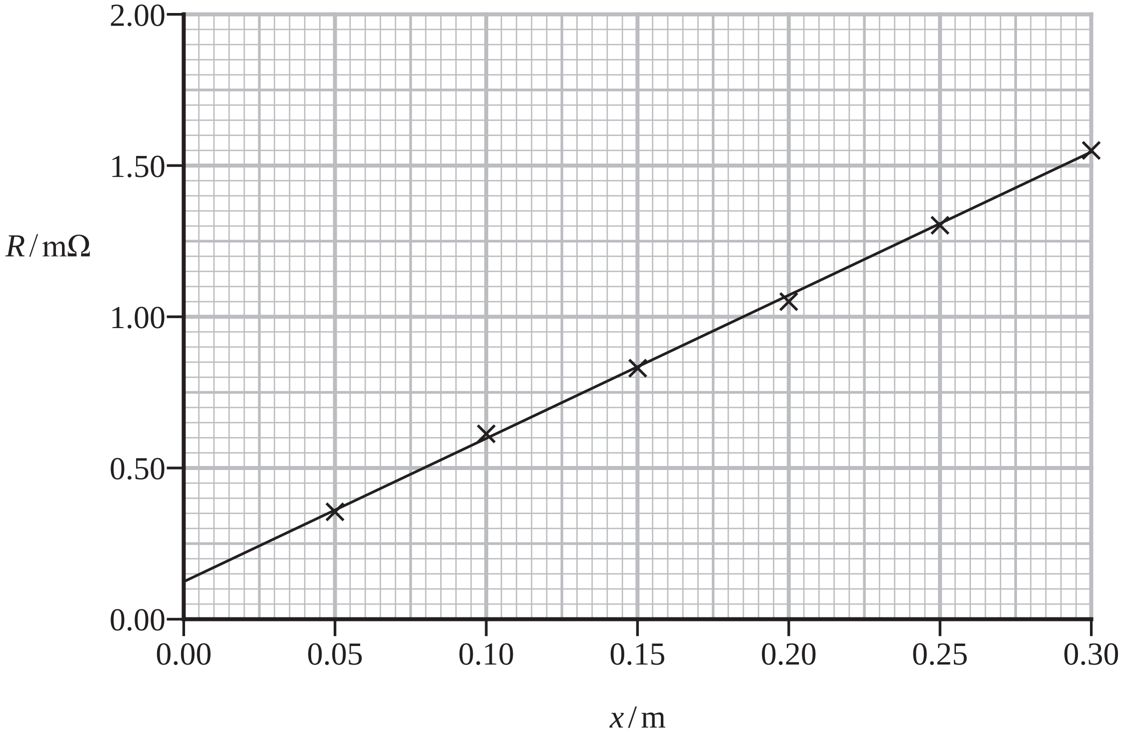
....

....

....

....

(b) The student measured values of x and corresponding values of R and plotted a graph of his measurements.



State why the line of best fit does not pass through the origin.

(1)

....

....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c) The total length l of copper in the circuit is given by

$$l = 2x + 0.050\,\text{m}$$

The copper rods have a diameter of 3.0 mm.

Determine the resistivity of the copper.

(4)

....

....

....

....

....

....

....

Resistivity = ...

(d) The safety system of the railway estimates the position of a train on the track using a resistance measurement.

The rails become worn with continual use, so their cross-sectional area decreases.

Explain how the decrease in cross-sectional area affects the estimate of the position of a train.

(2)

....

....

....

....

....

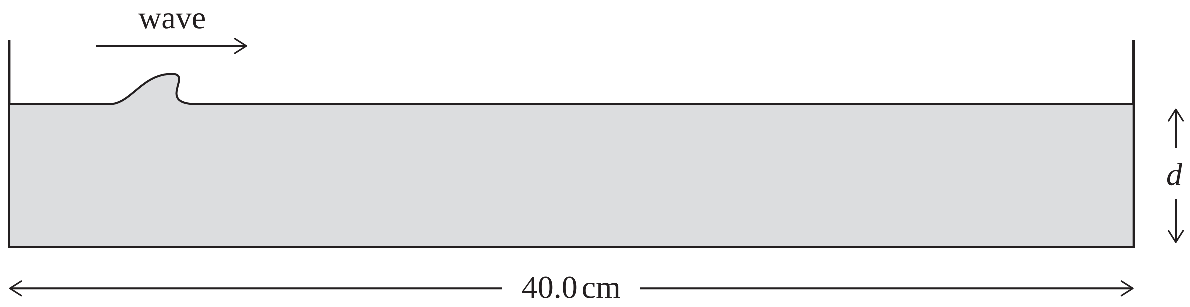
....

(Total for Question 2 = 11 marks)

3 A student investigated how the speed *v* of waves in water is affected by the depth of the water.

She filled a 40.0 cm long plastic tray with water to a depth *d*.

She raised and released one end of the tray, creating a wave which travelled along the surface of the water, as shown.



The wave travelled to the far end of the tray and was reflected.

(a) The student had a metre rule and a stopwatch.

Describe how the student could determine accurate values for *d* and *v*.

(4)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The student was given a formula for the speed of water waves

$$v^2 = kd$$

where k is a constant.

(i) Describe how the student could use a graph to determine a value of k.

(2)

....

....

....

....

(ii) She determined the speed v of the wave for three depths d of water.

She calculated the value of k for each depth.

d/mm	v/m s^{-1}	k/m s^{-2}
7.5	0.265	9.36
11	0.331	9.9
15	0.385	9.88

Criticise the recording of these results.

(1)

....

....

(iii) The student suggested that the value of k should be equal to the gravitational field strength.

Discuss whether it is likely that k is the gravitational field strength. Your answer should include calculations.

(3)

....

....

....

....

....

....

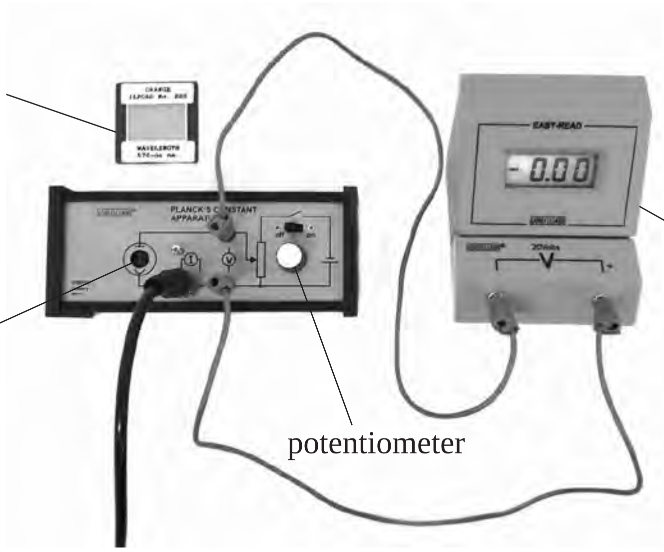
(Total for Question 3 = 10 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

BLANK PAGE

4 A student investigated the photoelectric effect using the apparatus shown.



He used a source of white light and colour filters to shine different wavelengths λ of light onto the photocell.

Photoelectrons were emitted with a range of kinetic energies, creating a small current in the photocell.

Using the potentiometer, the student varied the potential difference across the photocell. As the potential difference across the photocell increased, the current in the photocell decreased.

He measured the potential difference V_s when the current in the photocell was zero.

He calculated the maximum kinetic energy E_{max} of the photoelectrons for each wavelength of light.

(a) The table shows the student's data.

V_s / V	E_{max} / 10^{-20} J	λ / nm	
0.35	5.6	620	
0.43	6.9	577	
0.51	8.2	546	
0.75	12.0	470	
0.87	13.9	436	

(i) Plot a graph of E_{max} on the y-axis against $1/\lambda$ on the x-axis on the grid opposite.

Use the additional column of the table for your processed data.

(6)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

PMT

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(ii) The relationship between the maximum kinetic energy E_{max} of the emitted electrons and the wavelength λ of the incident photons is given by the equation

$$\frac{hc}{\lambda} = \phi + E_{max}$$

Show that the Planck constant h is equal to $\dfrac{\text{gradient of graph}}{c}$

(2)

....

....

....

....

(iii) Determine a value of h.

(4)

....

....

....

....

....

h = ...

(iv) Calculate the percentage difference between h and the accepted value for the Planck constant.

(2)

....

....

....

Percentage difference = ...

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The student's investigation involves a small random error and a large systematic error.

For each of these, suggest a source of the error and a realistic modification to the procedure which would reduce it.

(4)

Random error:

....

....

....

....

Systematic error:

....

....

....

....

(Total for Question 4 = 18 marks)

TOTAL FOR PAPER = 50 MARKS

P 7 5 6 2 3 A 0 1 5 2 0

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

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

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

P75623A01620

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

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 $\Delta E_{\text{el}} = \dfrac{1}{2}F\Delta x$

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

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

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

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

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

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

BLANK PAGE

BLANK PAGE

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA