Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Friday 18 October 2024

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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Pearson

Answer ALL questions.

1 A student used a steel sphere in an experiment to determine the viscosity of a liquid.

(a) The student used vernier calipers to determine the diameter d of the steel sphere.

(i) The student recorded a single measurement of d as 12.7 mm.

Determine the percentage uncertainty in this measurement.

(2)

Percentage uncertainty = ...

(ii) The student repeated the measurements of d at different orientations and calculated the mean.

Explain another technique she should use to determine an accurate value for d.

(2)

(iii) Describe how the student should determine a value for the density of steel.

(3)

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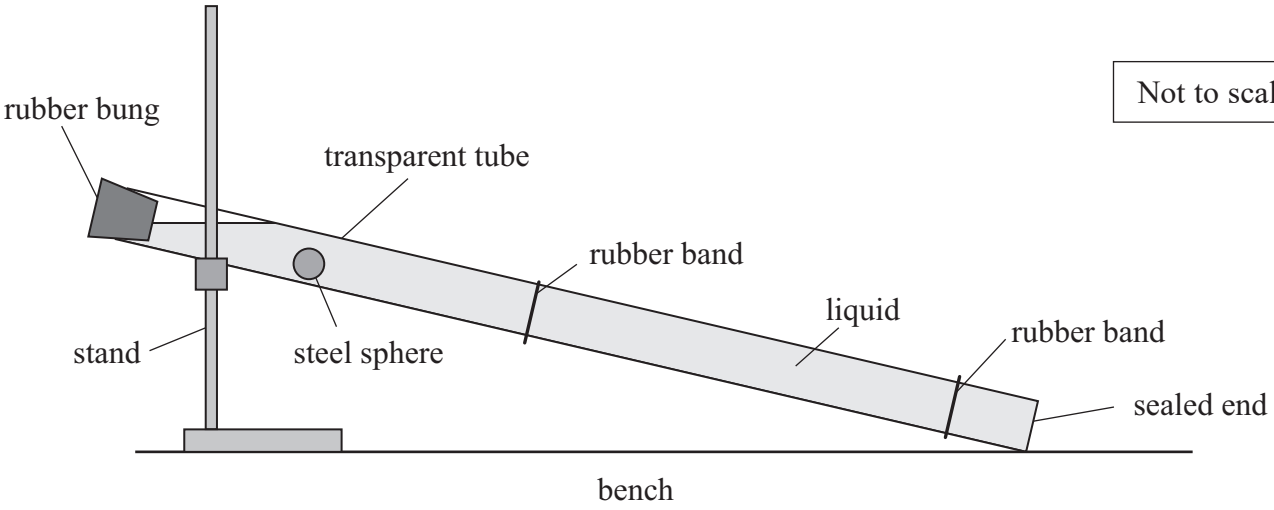
(b) The student placed the steel sphere in a transparent tube filled with the liquid. She arranged the transparent tube as shown.



The student used a stopwatch to measure the time for the steel sphere to travel between the rubber bands.

Describe how she should ensure that the steel sphere is travelling at terminal velocity between the rubber bands.

You should include any additional apparatus required.

(4)

(c) The student determined the viscosity of the liquid as 0.72 Pa s with a percentage uncertainty of 6%.

The viscosity of castor oil is 0.65 Pa s.

Deduce whether the liquid could be castor oil.

(2)

(Total for Question 1 = 13 marks)

2 A student was given a sealed box that contained some electrical components.

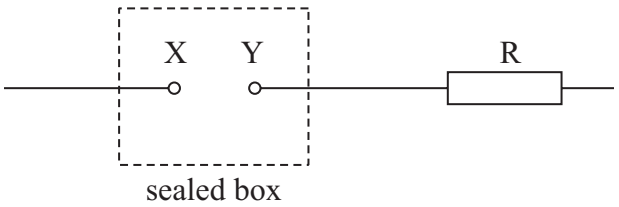
The sealed box could contain a diode, resistor, filament bulb, or a combination of any of these components. The student could not see the components inside the sealed box.

Two terminals, X and Y, on the sealed box enabled the student to connect the components to a 6.0 V power supply and fixed resistor R.

The student investigated the current-potential difference characteristics of the sealed box.

(a) (i) Complete the diagram to show the circuit the student should use for this investigation.

(2)



(ii) The student was told that the sealed box contained a diode.

Explain why the resistor R is needed in the circuit.

(3)

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(iii) The student had a choice of resistors to use for the resistor R, as shown in the table.

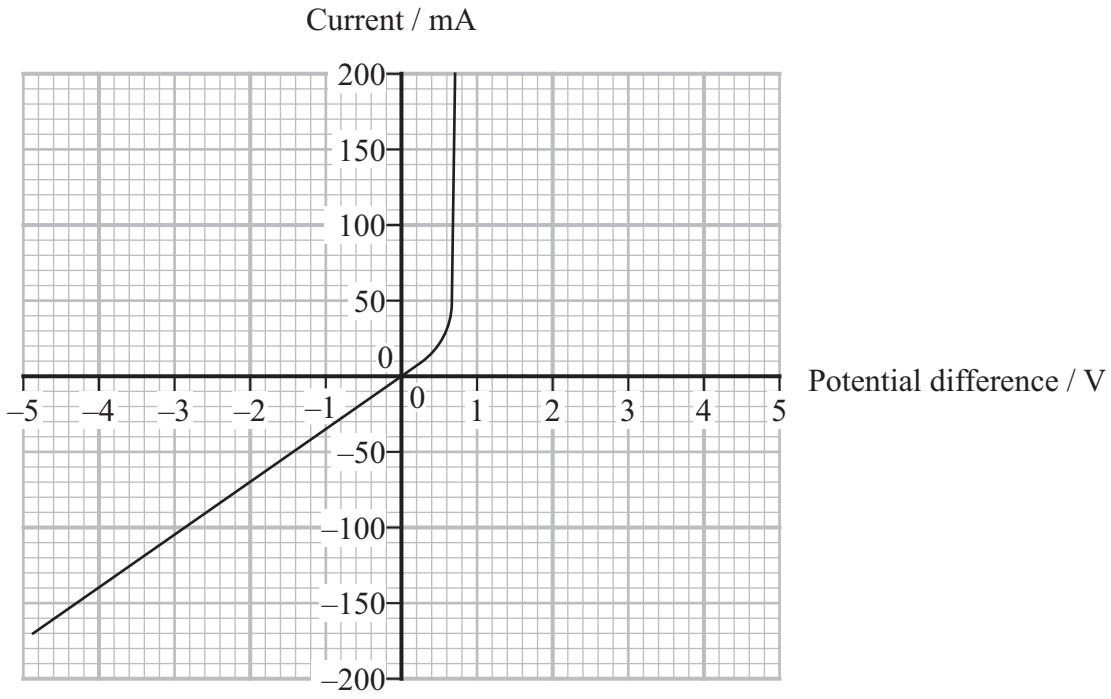
Resistor	**A**	**B**	**C**	**D**
Resistance / Ω	18	18	33	33
Maximum power / W	0.5	2.0	0.5	2.0

The student was told that, when the potential difference across the sealed box is 0.7 V, the current must not exceed 200 mA.

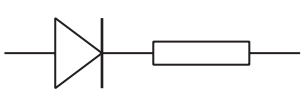
Deduce which of the resistors he should choose.

(4)

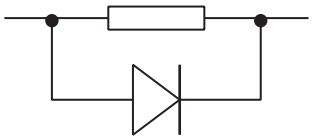
(b) The student plotted the graph below.



The sealed box contained a diode and a resistor. The diode and resistor were either connected in series or connected in parallel, as shown below.



Series



Parallel

Explain whether the diode and resistor were connected in series or in parallel.

(2)

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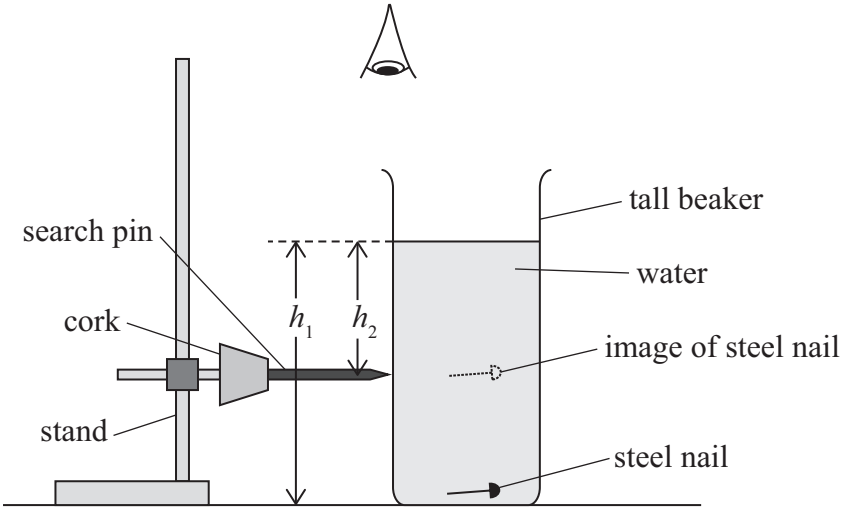
(Total for Question 2 = 11 marks)

3 A student determined the refractive index of a liquid using the apparatus shown.

Not to scale



(a) The student filled the tall beaker with water.

He used a metre rule to measure the depth h_1 of the water.

Describe an accurate method to determine a single value of h_1.

(3)

(b) The student placed a steel nail at the bottom of the beaker.

He viewed the search pin and the image of the steel nail from above while adjusting the height of the search pin.

When the search pin appeared to be in line with the image of the steel nail from all angles, he measured the value of h_2.

The student varied h_1 by adding more water and repeated the process.

He recorded the following data.

h_1 / cm	h_2 / cm
20.7	15
40	28.5
49.6	37.3
58	451

Criticise the recording of the data.

(3)

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(c) The student used values of h_1 and h_2 to calculate values for the refractive index n of the liquid.

His values of n are given in the table below.

n	1.38	1.41	1.33	1.29

(i) Determine the mean value of n.

(2)

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Mean value of n = ...

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

(2)

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Percentage uncertainty = ...

(Total for Question 3 = 10 marks)

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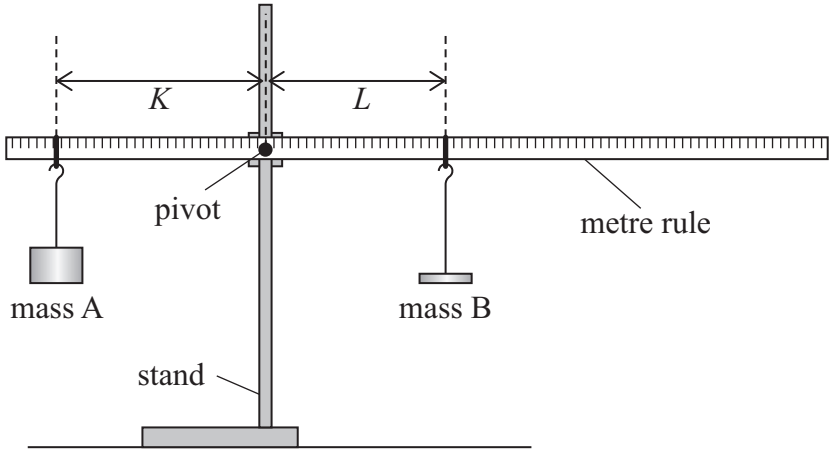
4 A student determined the mass of a metre rule using the apparatus shown.

Not to scale



When the metre rule is in equilibrium, the relationship between the distance K and the distance L is given by the formula

$$K = \left(\frac{M_B}{M_A}\right)L + \frac{0.2M_R}{M_A}$$

where
M_A is the mass of mass A
M_B is the mass of mass B
M_R is the mass of the metre rule.

(a) Explain how a graph of K against L can be used to determine the value of M_R.

(2)

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(b) The student placed mass A at a distance K from the pivot.

She moved mass B until the metre rule was in equilibrium.
She then measured the distance L.

The student repeated this procedure for different values of K.

She recorded the following data.

K / m	L / m
0.080	0.075
0.110	0.203
0.140	0.308
0.170	0.451
0.200	0.554
0.230	0.698

(i) Plot a graph of K on the y-axis against L on the x-axis on the grid opposite.

(5)

(ii) Determine the gradient of the graph.

(3)

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Gradient = ...

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(iii) Determine a value for M_B.

$M_A = 0.400\,\text{kg}$

(2)

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$M_B =$ .....

(iv) Determine a value for M_R.

(4)

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$M_R =$ .....

(Total for Question 4 = 16 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

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

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

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

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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