Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Thursday 24 October 2019

Morning (Time: 1 hour 20 minutes) | Paper Reference **WPH13/01**

Physics

Advanced Subsidiary
Unit 3: Practical Skills in Physics I

You must have:
Scientific Calculator, ruler

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **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 in calculations** with **your answer clearly identified** at the **end of your solution**.

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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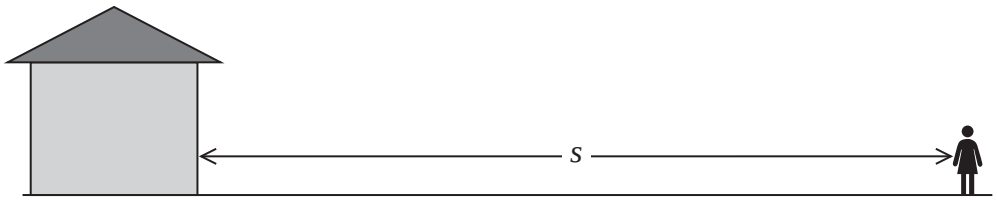
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Pearson

Answer ALL questions.

1 A teacher demonstrated echolocation to her students. The teacher made a loud sound and an echo returned from a distant building as shown in the diagram.



The teacher and five students stood a distance *s* from the building. Each student measured the time *t* between hearing the sound and hearing the echo.

(a) State one source of uncertainty in the values of *t* measured by the students.

(1)

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(b) The table shows the values recorded by the five students.

Student	1	2	3	4	5
t/s	0.88	0.87	0.91	0.75	0.88

The students suggested that they should include in their calculations all the values of *t*. The teacher suggested the value recorded by student 4 should be discarded.

(i) Explain why both of these suggestions are reasonable.

(4)

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(ii) Calculate the mean value for t.

(2)

Mean t = ...

(iii) Calculate the percentage uncertainty in t.

(2)

Percentage uncertainty in t = ...

(iv) The speed of sound in air is $330\,m\,s^{-1}$.

Calculate the maximum value of s from the students' values.

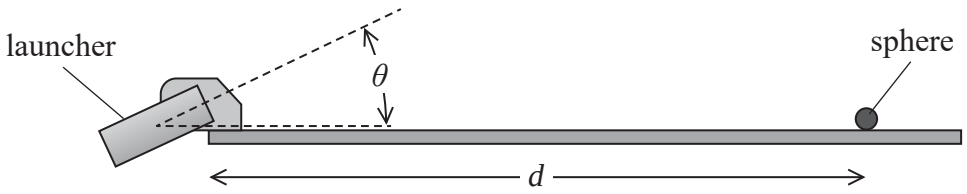
(4)

Maximum s = ...

(Total for Question 1 = 13 marks)

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2 A student launched a small solid plastic sphere from one end of a long table to the other end using the apparatus shown.



The student measured the horizontal distance d travelled by the sphere for different launch angles θ.

d is given by the equation

$$d = \frac{v^2}{g} \sin 2\theta$$

where v is the launch velocity, which is constant.

(a) Describe an experimental method to determine the value of θ at which d is a maximum.

(4)

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(b) The equation predicts that when θ is 45°, d is a maximum.

From the student's measurements, d was a maximum when θ was less than 45°.

Suggest two reasons why.

(2)

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(Total for Question 2 = 6 marks)

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3 A student was given a thin aluminium rod of length 30 cm.

(a) The rod appeared to have a uniform diameter.

Explain how the student could confirm that the rod had a uniform diameter, by suspending it from a thread.

(2)

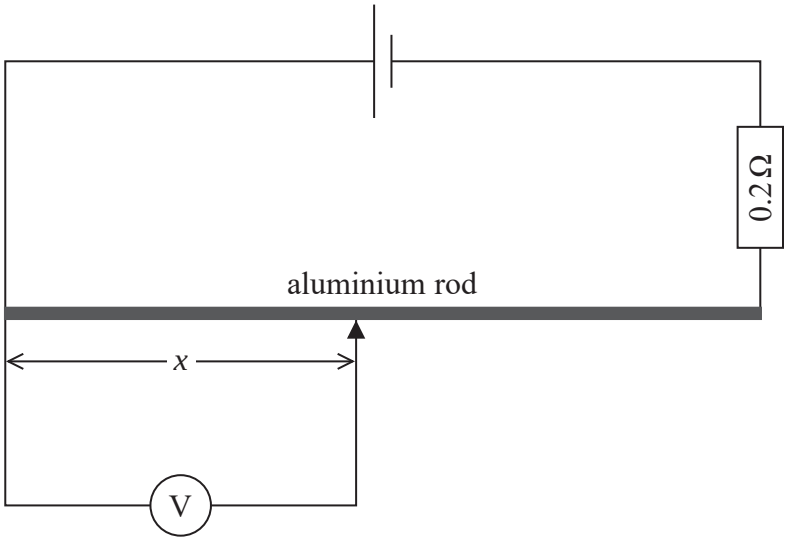
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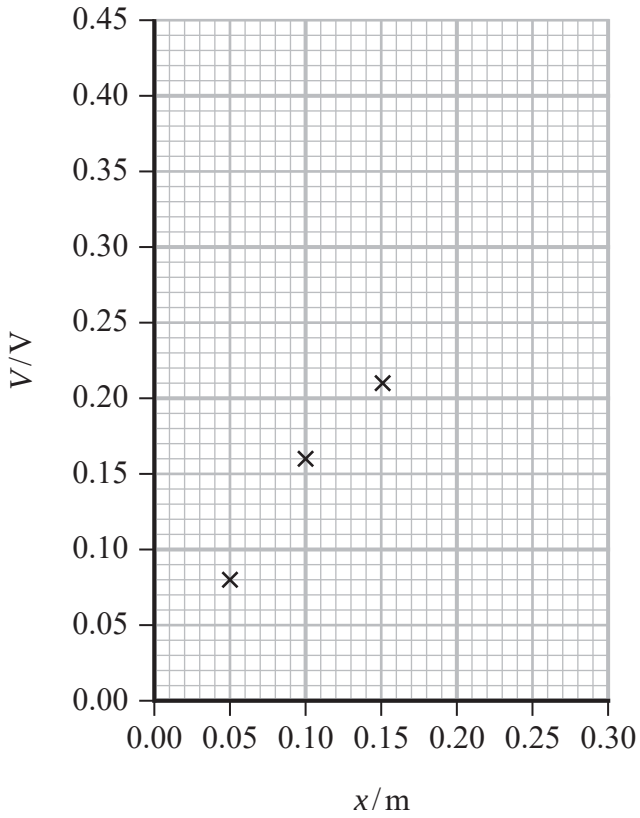
(b) The student connected the rod to an electrical circuit to make a potential divider, as shown.



The voltmeter was connected to the aluminium rod to give three different values of x. The values of x and potential difference (p.d.) V were recorded.

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The student plotted the values on a graph.



(i) Determine the value of V when x is 30 cm.

(1)

$V =$ .....

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(ii) The student measured the resistance of the full length of the rod using an ohmmeter.

The resistance was 70 mΩ.

Determine the terminal p.d. of the cell.

(2)

Terminal p.d. = ...

(c) The student measured only three values of V and x.

Explain why taking further readings could improve the accuracy of his value for the terminal p.d. of the cell.

(2)

(Total for Question 3 = 7 marks)

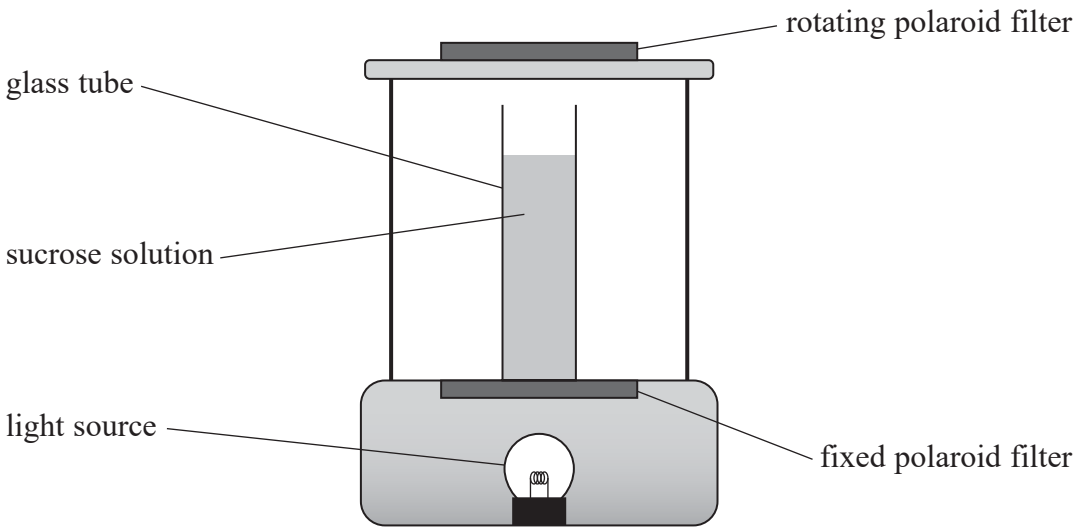
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4 As polarised light passes through a sucrose solution the plane of polarisation is rotated.

The angle of rotation can be measured using the polarimeter shown.



The angle of rotation depends on the concentration of the sucrose solution

$$\text{angle of rotation} = k \times \text{concentration of solution} \times \text{depth of solution}$$

where k is a constant.

A student used the polarimeter to investigate this relationship. She recorded her results in the table below.

Concentration of sucrose solution / kg m^{-3}	Angle of rotation / °
125	8
170	11
215	14
250	16
290	19

The depth of the sucrose solution in the glass tube was 10 cm each time.

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(a) Determine whether these results support the statement that k is a constant.

(3)

(b) Explain why the polarimeter light source should have a low power.

(3)

(c) Describe a graphical method the student could have used to determine k.

(3)

(Total for Question 4 = 9 marks)

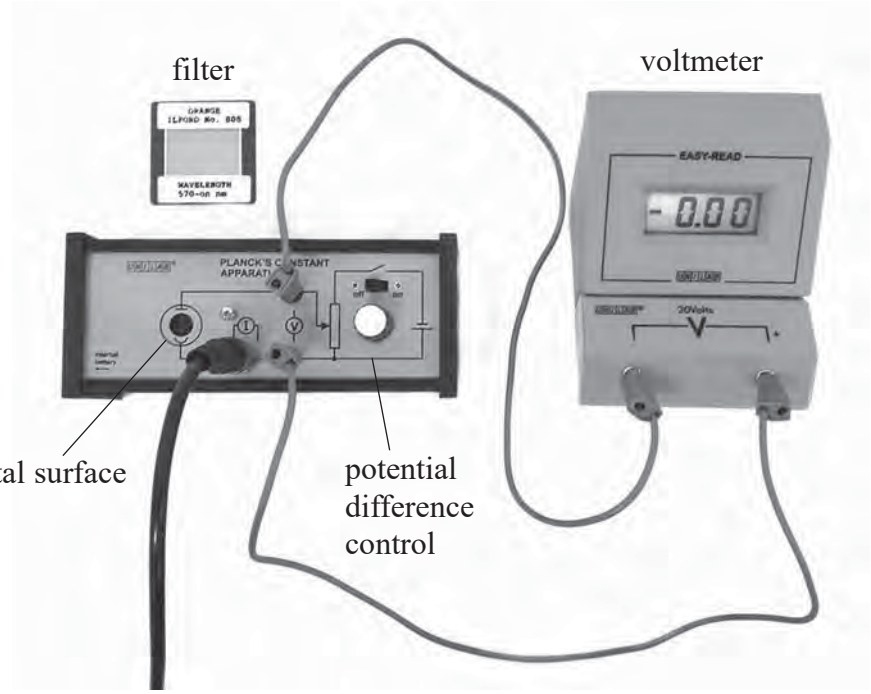
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5 The photoelectric effect occurs when photons of sufficient energy are absorbed by electrons, which are then emitted from the surface of a metal.

The photograph shows apparatus used to determine the Planck constant using the photoelectric effect.



(a) The metal surface in this apparatus can be used to determine the Planck constant with visible light. Other metals require higher photon energies.

Explain an advantage of using this apparatus.

(2)

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(b) The potential difference applied to the circuit does work on the electrons emitted from the metal surface.

Calculate the work done on an emitted electron by a potential difference of 1.58 V.

(2)

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Work done = ...

(c) A teacher used different filters to vary the wavelength λ of the light hitting the metal surface. For each value of λ he slowly increased the potential difference V until the reading on the ammeter fell to zero. He repeated this for each value of λ and calculated mean values of V.

The table shows his results.

λ / nm		Mean V / V
380		1.58
440		1.10
470		0.94
530		0.66
570		0.46
620		0.34

(i) Plot a graph of V on the y-axis against $\frac{1}{\lambda}$ on the x-axis, on the grid provided.

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

(6)

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(ii) Determine the Planck constant using your graph and the equation

$$h = \frac{\text{gradient} \times e}{c}$$

(3)

Planck constant = ...

(d) Suggest two modifications that would improve the accuracy of the value of the Planck constant determined from this experiment.

(2)

(Total for Question 5 = 15 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

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

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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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