Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel International Advanced Level

Centre Number | Candidate Number

Wednesday 8 May 2019

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

Physics

Advanced Subsidiary
Unit 3: Practical Skills in Physics I

You must have:
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.*

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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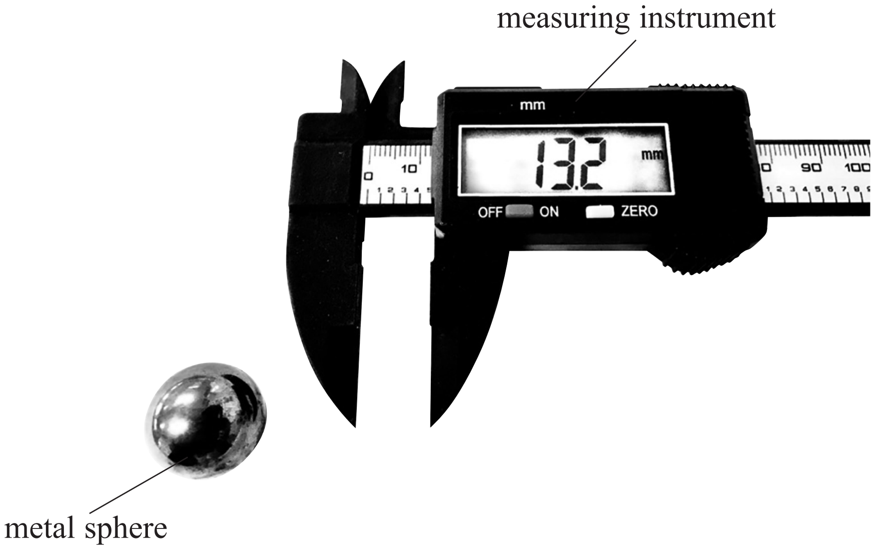
Pearson

Answer ALL questions.

1 During an experiment a student used the measuring instrument shown in the photograph to measure the diameter of a small metal sphere.



(a) (i) State the resolution of the measuring instrument shown in the photograph.

(1)

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(ii) Explain why this device is suitable to measure the diameter of the metal sphere.

(2)

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(b) The student measured the diameter. The reading obtained was 20.5 ± 0.05 mm.

Calculate the percentage uncertainty in the measurement of the diameter.

(1)

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Percentage uncertainty in the diameter = ...

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(c) The student took further measurements of the diameter and calculated a mean.

Describe how the student should use this measuring device to make the measurements as accurate as possible.

(2)

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(d) The student measured the diameter of a second metal sphere and recorded the following readings.

19.0 mm   19.1 mm   18.9 mm   18.3 mm   19.1 mm

(i) Calculate the mean diameter of the second metal sphere.

(2)

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Mean diameter of the second metal sphere = ...

(ii) Calculate the percentage uncertainty in the mean diameter of the second metal sphere.

(2)

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Percentage uncertainty in the mean diameter = ...

(e) The student measured the mass of the first metal sphere using a top pan balance.

The mass reading obtained was 35.6 g.

Calculate the density of the first metal sphere.

(4)

Density of the first metal sphere = ...

(f) The student calculated the density of the second metal sphere to be $7.75 \times 10^3\,\text{kg}\,\text{m}^{-3}$ with an uncertainty of 2%.

Determine whether the two spheres could be made from the same metal.

(2)

(Total for Question 1 = 16 marks)

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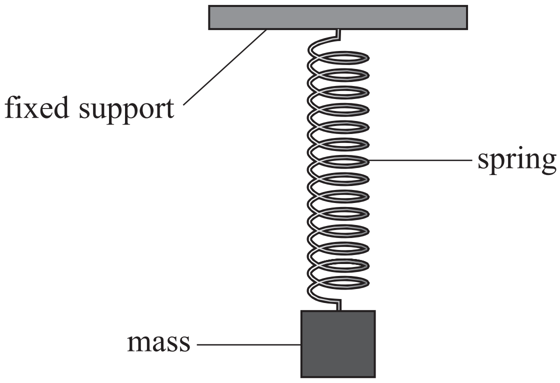
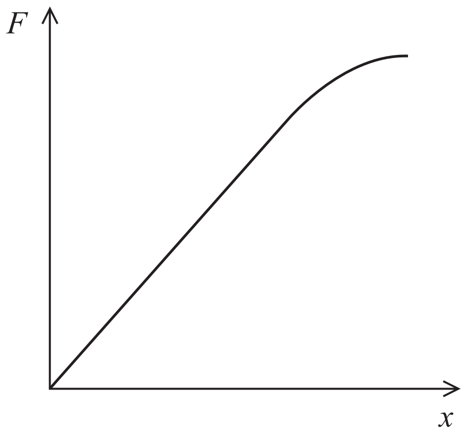
2 A student investigated the extension of a spring to determine its stiffness.

The student suspended the spring from a fixed support and added masses to the lower end of the spring as shown.



The student used a metre rule to make measurements of the spring as the mass was increased.

The student plotted a graph of applied force F against the extension of the spring x.



(a) Describe what the student should do to obtain the data to plot the force-extension graph.

(4)

(b) Explain how you would use the graph to determine the stiffness of the spring.

(2)

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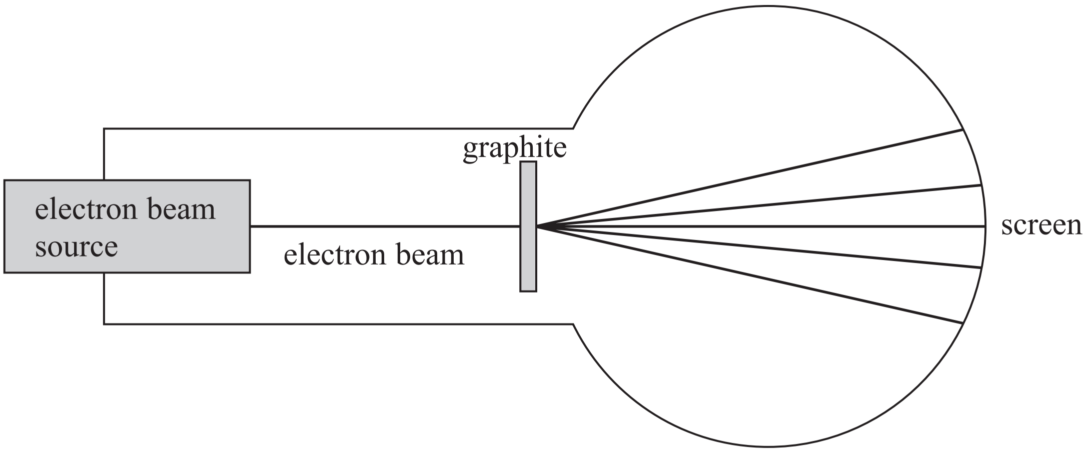
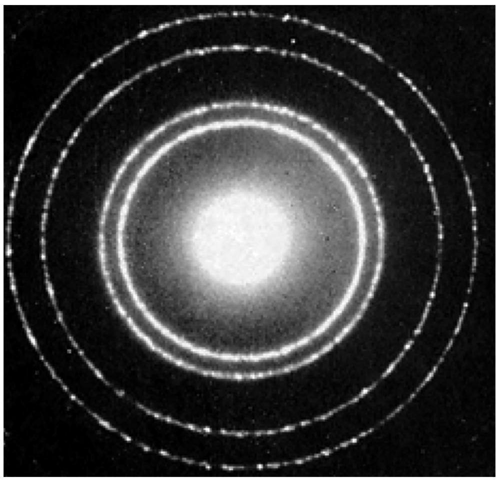
(Total for Question 2 = 6 marks)

3 A student used an electron beam tube to accelerate electrons towards a thin slice of graphite as shown. The electrons passing through the graphite produced a diffraction pattern on the screen. This is similar to the effect seen when light passes through a diffraction grating.



The diffraction pattern seen on the curved screen is shown below.



(a) Describe how the student can accurately determine the radius of the first bright ring of the diffraction pattern.

(4)

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(b) Explain how the diffraction pattern provides evidence for the wave nature of electrons.

(2)

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(c) The student determined the radius of the first bright ring of the diffraction pattern for a range of electron energies. The student then calculated the de Broglie wavelength λ of the electrons and the angle of diffraction θ. The results are shown in the table.

$\lambda / 10^{-11}$ m	$\theta / °$	$\sin\theta$
3.47	19.2	
3.2	17.7	
2.93	16.1	
2.44	13.7	
1.9	10.9	

(i) Criticise these results.

(2)

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(ii) Use the results in the table to plot a graph of λ on the y-axis against $\sin\theta$ on the x-axis on the grid provided. Use the right-hand column of the table for your processed data.

(6)

(iii) Determine the gradient of the graph.

(3)

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Gradient = ...

(iv) The diffraction occurs as the electrons pass through the thin slice of graphite. The atoms in the graphite are arranged in layers.

The position of the rings in the diffraction pattern can be approximated by the equation

$$n\lambda = d \sin\theta$$

where d is the spacing between the layers.

Explain why the spacing between the layers is given by the gradient of the graph.

(2)

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(Total for Question 3 = 19 marks)

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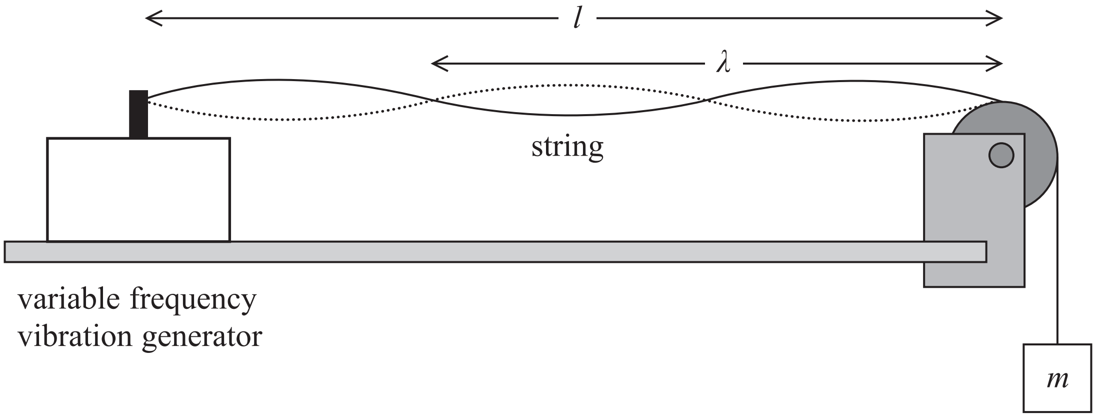
4 A student carried out an experiment to determine the mass per unit length μ of a string, using a standing wave. The standing wave produced is shown in the diagram.



The student recorded the following data.

Length of string l	1.25 m
Frequency f	105 Hz
Mass m	0.25 kg

(a) Calculate μ given the equation below.

$$\sqrt{\frac{mg}{\mu}} = f\lambda$$

(3)

μ = ...

(b) (i) Identify two significant sources of uncertainty in the student's measurements.

(2)

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(ii) For each of these sources of uncertainty, describe an experimental technique the student could have used to obtain an accurate measurement.

(4)

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(Total for Question 4 = 9 marks)

TOTAL FOR PAPER = 50 MARKS

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

$$= Fx$$

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 $\rho = \dfrac{m}{V}$

Stokes' law $F = 6\pi\eta r v$

Hooke's law $\Delta F = k\Delta x$

Elastic strain energy $\Delta E_{el} = \dfrac{1}{2}F\Delta x$

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

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

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

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	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

Quantum physics

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2}mv^2_{max}$
de Broglie wavelength	$\lambda = \dfrac{h}{p}$

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