Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 20 January 2025

Afternoon (Time: 1 hour 20 minutes)

Paper reference **WPH16/01**

Physics

International Advanced Level
UNIT 6: Practical Skills in Physics II

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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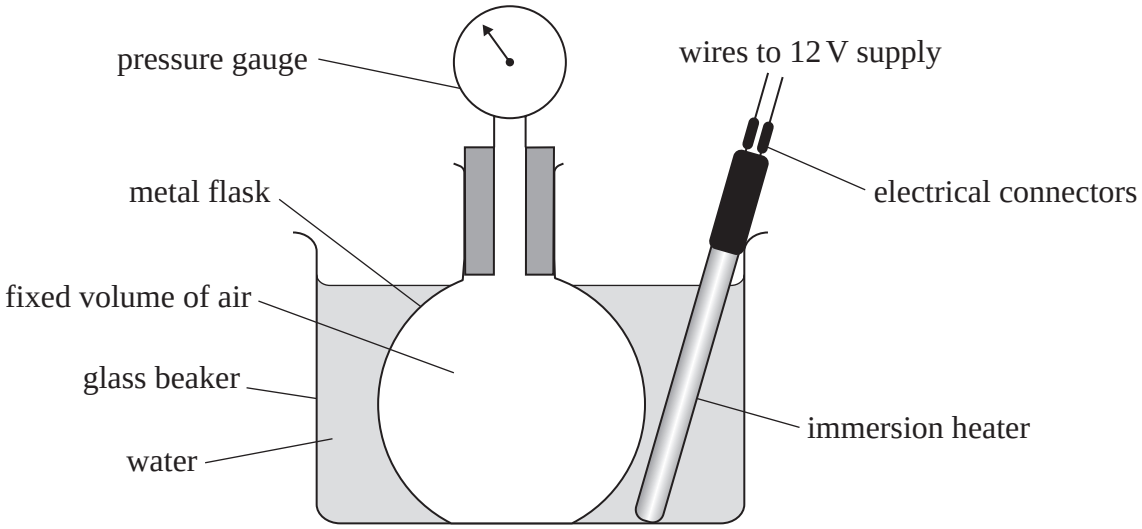
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Pearson

Answer ALL questions.

1 A student investigated the pressure of a fixed volume of air using the apparatus shown.



(a) The student used the immersion heater to heat the water in the beaker.

Identify **one** health and safety issue and how it should be dealt with.

(2)

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(b) The student determined the temperature θ of the fixed volume of air.

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

(3)

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(c) The student recorded θ at a pressure of 110 kPa. He repeated the measurement several times as the flask was cooled and reheated.

He recorded the following measurements.

θ / °C	42.5	41.0	42.0	43.5

(i) Determine the mean value of θ.

(1)

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Mean θ = ...

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

(2)

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Percentage uncertainty = ...

(iii) The diameter of the flask was 15 cm.

Determine the number of air molecules in the flask.

You may assume the volume of air is spherical.

(4)

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Number of air molecules = ...

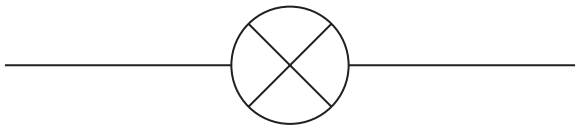
(Total for Question 1 = 12 marks)

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2 A student investigated how varying the power input P to a 12 V filament bulb affected the brightness of the filament bulb.

(a) Complete the circuit diagram for the circuit the student could use in this investigation.

(2)



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(b) The student placed a light sensor a distance from the filament bulb. The light sensor measured X, the light received, in lux, from the filament bulb.

She predicted that the relationship between P and X is given by

$$P = kX^4$$

where k is a constant.

Devise a method to test this prediction.

You should include the use of a suitable graph.

(6)

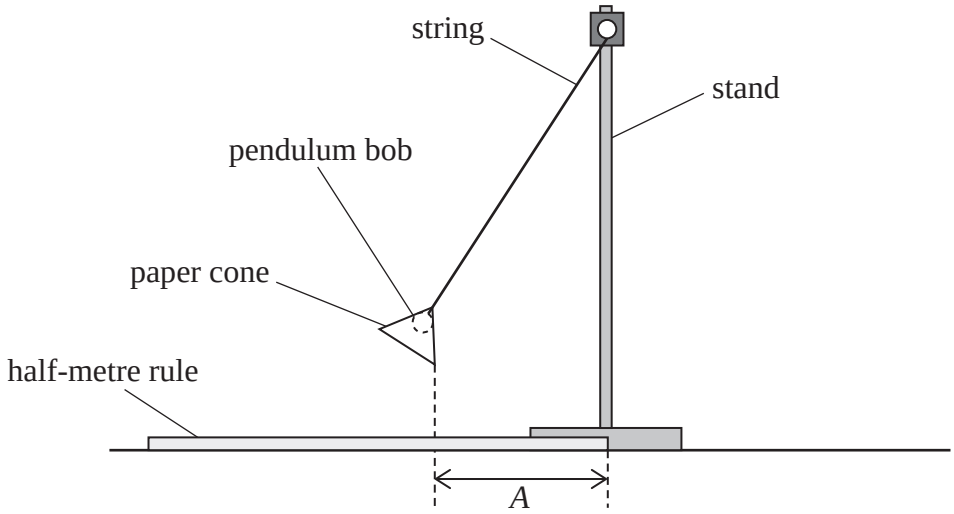
(Total for Question 2 = 8 marks)

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3 A student investigated the damped oscillations of a pendulum using the apparatus shown.



The paper cone acted as a damper.

The student displaced the cone and allowed the pendulum to oscillate.

He measured the amplitude A every 5 oscillations and recorded the value to the nearest 5 mm.

(a) Give **two** reasons why it would **not** be appropriate to record A to the nearest mm.

(2)

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(b) The relationship between A and the number of oscillations n is

$$A = A_0 e^{-\lambda n}$$

where A_0 is the initial amplitude and λ is a constant.

(i) Explain how a graph of ln A against n can be used to determine the value of λ.

(2)

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(ii) The student recorded the following results.

n	***A* / cm**	
5	8.5	
10	7.0	
15	5.5	
20	5.0	
25	4.0	
30	3.5	

Plot a graph of ln A against n on the grid opposite.

Use the additional column for your processed data.

(5)

(iii) Determine the value of λ from the graph.

(3)

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λ = ...

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(iv) Determine the value of A_0 from the graph.

(3)

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A_0 = ...

(v) Explain why the value of A_0 determined from the graph may not be the true value of A_0.

(2)

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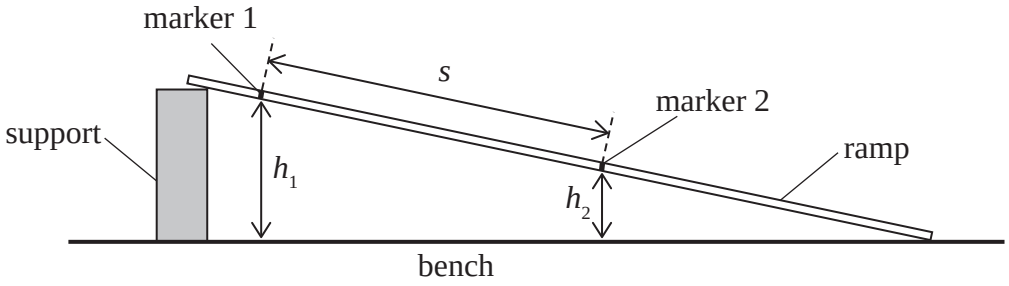
(Total for Question 3 = 17 marks)

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4 A student set up a ramp, as shown.

The student placed two markers, a distance *s* apart, on the ramp.

Not to scale



(a) The student used a metre rule to measure the heights h_1 and h_2.

She calculated the difference in height Δh as 21 mm ± 1 mm.

Explain why it was appropriate to record the uncertainty in Δh as 1 mm.

(3)

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(b) The student placed a small glass sphere at marker 1.

She released the sphere and used a stopwatch to measure the time *t* taken for the sphere to reach marker 2. She repeated this several times.

The student moved marker 2 to the lower end of the ramp and repeated the procedure.

Discuss how moving marker 2 to the lower end of the ramp could affect the percentage uncertainty in *t*.

(3)

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(c) The time t is related to the acceleration due to gravity g by the formula

$$t^2 = \frac{14s^2}{5g\Delta h}$$

The student recorded the following data

$s = 90.0\,\text{cm} \pm 0.1\,\text{cm}$
$\Delta h = 21\,\text{mm} \pm 1\,\text{mm}$
$t = 3.36\,\text{s} \pm 0.03\,\text{s}$

(i) Determine the student's value of g.

(2)

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$g =$ .....

(ii) Show that the percentage uncertainty in the student's value of g is about 7%.

(3)

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(iii) Deduce whether the student's value of g is accurate.

(2)

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(Total for Question 4 = 13 marks)

TOTAL FOR PAPER = 50 MARKS

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List of data, formulae and relationships

Acceleration of free fall	$g = 9.81$ m s^{-2}	(close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23}$ J K^{-1}	
Coulomb's law constant	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^{9}$ N m^2 C^{-2}	
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 constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}	
Gravitational field strength	$g = 9.81$ N kg^{-1}	(close to Earth's surface)
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ F m^{-1}	
Planck constant	$h = 6.63 \times 10^{-34}$ J s	
Proton mass	$m_p = 1.67 \times 10^{-27}$ kg	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}$ m s^{-1}	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}	
Unified atomic mass unit	$u = 1.66 \times 10^{-27}$ kg	

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

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

Unit 4

Further mechanics

Impulse	$F\Delta t = \Delta p$
Kinetic energy of a non-relativistic particle	$E_k = \frac{p^2}{2m}$
Motion in a circle	$v = \omega r$
	$T = \frac{2\pi}{\omega}$
	$a = \frac{v^2}{r}$
	$a = r\omega^2$
Centripetal force	$F = ma = \frac{mv^2}{r}$
	$F = mr\omega^2$

Electric and magnetic fields

Electric field	$E = \frac{F}{Q}$
Coulomb's law	$F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$
	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$
	$E = \frac{V}{d}$
Electrical potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
Capacitance	$C = \frac{Q}{V}$
Energy stored in capacitor	$W = \frac{1}{2}QV$
	$W = \frac{1}{2}CV^2$
	$W = \frac{1}{2}\frac{Q^2}{C}$
Capacitor discharge	$Q = Q_0 e^{-t/RC}$

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Resistor-capacitor discharge $I = I_0 e^{-t/RC}$

$V = V_0 e^{-t/RC}$

$\ln Q = \ln Q_0 - \frac{t}{RC}$

$\ln I = \ln I_0 - \frac{t}{RC}$

$\ln V = \ln V_0 - \frac{t}{RC}$

In a magnetic field $F = Bqv \sin \theta$

$F = BIl \sin \theta$

Faraday's and Lenz's laws $\mathscr{E} = \frac{-\mathrm{d}(N\phi)}{\mathrm{d}t}$

Nuclear and particle physics

In a magnetic field $r = \frac{p}{BQ}$

Mass-energy $\Delta E = c^2 \Delta m$

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Unit 5

Thermodynamics

Heating

$$\Delta E = mc\Delta\theta$$

$$\Delta E = L\Delta m$$

Ideal gas equation

$$pV = NkT$$

Molecular kinetic theory

$$\tfrac{1}{2}m\langle c^2\rangle = \tfrac{3}{2}kT$$

Nuclear decay

Mass-energy

$$\Delta E = c^2\Delta m$$

Radioactive decay

$$A = \lambda N$$

$$\frac{\mathrm{d}N}{\mathrm{d}t} = -\lambda N$$

$$\lambda = \frac{\ln 2}{t_{1/2}}$$

$$N = N_0 \mathrm{e}^{-\lambda t}$$

$$A = A_0 \mathrm{e}^{-\lambda t}$$

Oscillations

Simple harmonic motion

$$F = -kx$$

$$a = -\omega^2 x$$

$$x = A\cos\omega t$$

$$v = -A\omega\sin\omega t$$

$$a = -A\omega^2\cos\omega t$$

$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

$$\omega = 2\pi f$$

Simple harmonic oscillator

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$T = 2\pi\sqrt{\frac{l}{g}}$$

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Astrophysics and cosmology

Gravitational field strength	$g = \frac{F}{m}$
Gravitational force	$F = \frac{Gm_1m_2}{r^2}$
Gravitational field	$g = \frac{Gm}{r^2}$
Gravitational potential	$V_{grav} = \frac{-Gm}{r}$
Stefan-Boltzmann law	$L = \sigma AT^4$
Wien's law	$\lambda_{max}T = 2.898 \times 10^{-3}\,\text{m K}$
Intensity of radiation	$I = \frac{L}{4\pi d^2}$
Redshift of electromagnetic radiation	$z = \frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$
Cosmological expansion	$v = H_0 d$

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