Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

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

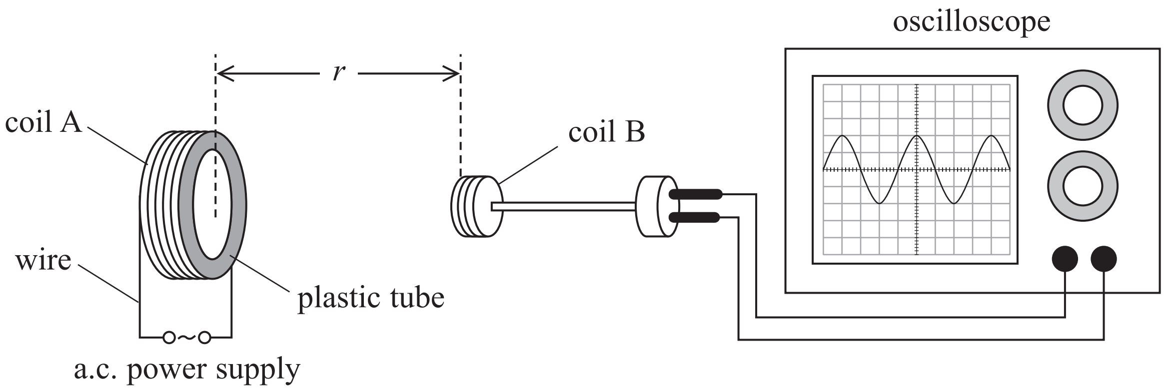
B:1/1/1/1/

Answer ALL questions.

1 A student investigated the magnetic field produced by a current-carrying coil, coil A.

She made coil A by wrapping a wire around a plastic tube. Coil A was connected to an alternating current (a.c.) power supply.

A second coil, coil B, was placed in the magnetic field and connected to an oscilloscope as shown.



(a) Describe one safety issue and how it should be dealt with.

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(b) The distance r between the two coils varied between 2 cm and 10 cm.

Explain why using Vernier calipers would be better than a metre rule to measure r.

You should include calculations in your answer.

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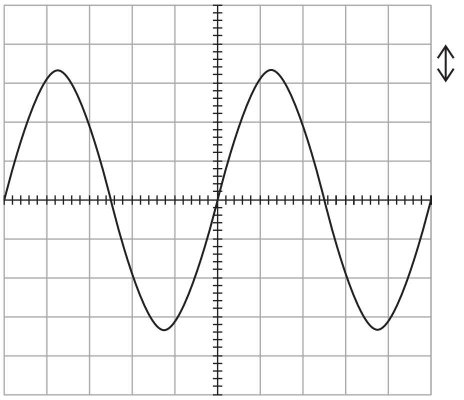
(c) When the a.c. power supply was switched on, an e.m.f. *E* was induced across coil B. The variation in *E* is shown on the oscilloscope screen below.



The *y*-scale was set to 100 mV per division.

Describe how an accurate maximum value for *E* can be determined from the oscilloscope screen.

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(d) The student measured values of r with Vernier calipers and determined corresponding maximum values of E.

The student's values are shown in the table.

***r* / cm**	2	4	6	8
***E* / V**	320	40	11.9	5

Criticise the recording of this data.

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(Total for Question 1 = 10 marks)

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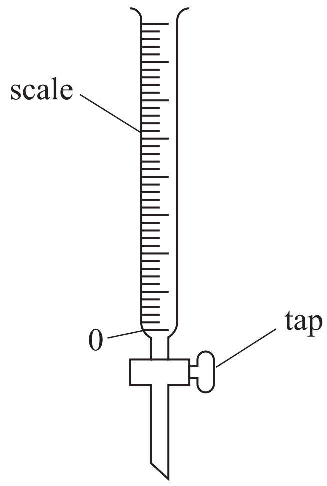
2 A student used a transparent tube to measure a volume of liquid, as shown. Opening the tap allows liquid to flow out of the tube at a controlled rate.



When the tap is open, the volume V of liquid inside the tube decreases with time t according to the relationship

$$V = V_0 \, e^{-bt}$$

where V_0 is the initial volume of liquid in the tube and b is a constant.

(a) Explain why a graph of $\ln V$ against t should be used to test this relationship.

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(b) A student investigates the relationship between V and t.

Describe how the student could obtain an accurate set of values for V and t to test this relationship.

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(c) Explain a source of uncertainty in this investigation.

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(Total for Question 2 = 8 marks)

3 A liquid is placed inside a closed container. Some of the liquid evaporates.

The pressure of the vapour above the surface of the liquid increases to a maximum value. This maximum pressure is called the saturated vapour pressure.

(a) The table shows data for the saturated vapour pressure P at different absolute temperatures T.

P / kPa	T / K		
7.8	308		
17.0	323		
34.6	338		
66.1	353		
120.1	368		
208.1	383		

(i) Plot a graph of $\log P$ against $\frac{1}{T}$ on the grid opposite. Use the additional columns for your processed data.

(6)

(ii) Determine the gradient of the graph.

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Gradient = ...

(iii) The gradient of the graph of log P against $\frac{1}{T}$ is given by

$$\text{gradient} = -\frac{X}{2.30k}$$

where X is a constant with unit joules, and k is the Boltzmann constant.

Determine the value of X in joules.

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X = ... J

(b) Liquids boil when the saturated vapour pressure is equal to atmospheric pressure.

Determine the boiling point of the liquid in °C when the atmospheric pressure is 100 kPa.

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Boiling point = ... °C

(Total for Question 3 = 15 marks)

4 A student had two pieces of constantan wire, X and Y.

Wires X and Y had different diameters.

(a) The student measured the diameter d_X of wire X several times using a micrometer screw gauge.

(i) Explain one measuring technique he should use.

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(ii) The student recorded the following measurements.

d_X / mm	0.31	0.32	0.31	0.33	0.30

Determine the mean value of d_X and its uncertainty in mm.

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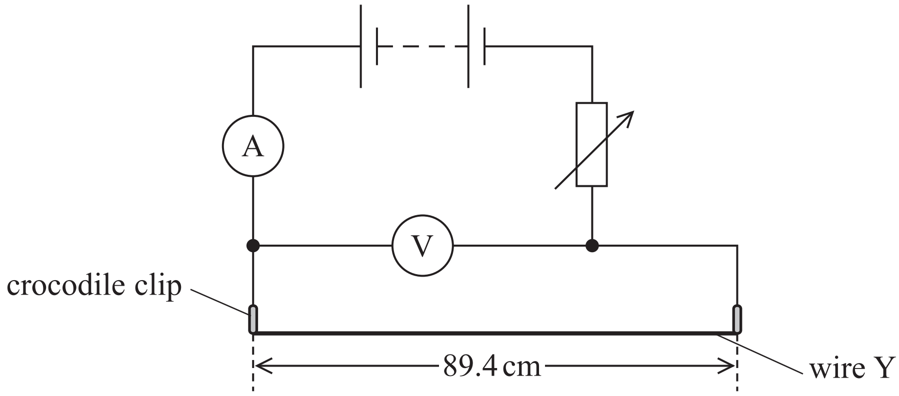
Mean value of d_X = ... mm ± .... mm

(b) The student measured the diameter d_Y of wire Y as 0.22 mm ± 0.01 mm.

He connected part of wire Y in a circuit as shown.



The student measured the potential difference V across the wire in the circuit and the current I in the wire.

He recorded the following values

$V = 4.990\,\text{V} \pm 0.005\,\text{V}$
$I = 0.4570\,\text{A} \pm 0.0005\,\text{A}$

The length of wire Y in the circuit was 89.4 cm ± 0.1 cm.

(i) Show that the resistivity ρ of the metal is about $5 \times 10^{-7}\,\Omega\,\text{m}$.

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(ii) Show that the percentage uncertainty in ρ is about 9%.

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(c) The student measured the resistances R_1 and R_2 of different lengths of wire Y using an ohmmeter. Each resistance was measured once.

The student's values are given in the table.

	Length / cm	Resistance / Ω
R_1	40.0	4.5
R_2	90.0	10.2

He calculated the resistance R_L for one metre of wire using the formula

$$R_L = 2 \times (R_2 - R_1)$$

Show that the percentage uncertainty in R_L is about 2%.

$R_L = 11.4\,\Omega$

(3)

(d) The student wanted to confirm that the metal of the wire is constantan.

The student compared his calculated values of ρ and R_L to published values for constantan.

The values are shown in the table below.

	ρ / $10^{-7}\,\Omega$ m	R_L / Ω
Calculated	4.6 ± 9%	11.4 ± 2%
Published	4.9	11.2

Comment on how well the student's calculated values confirm that the metal of the wire is constant.

You must include calculations in your answer.

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(Total for Question 4 = 17 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)
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$	
Coulomb's law constant	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^{9} \text{ N m}^2 \text{ C}^{-2}$	
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 constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to Earth's surface)
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$	
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	
Proton mass	$m_p = 1.67 \times 10^{-27} \text{ kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8} \text{ m s}^{-1}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27} \text{ kg}$	

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

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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 $F = 6\pi\eta rv$

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	$v = \sqrt{\dfrac{T}{\mu}}$
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	$\lambda = \dfrac{h}{p}$

Unit 4

Further mechanics

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

Electric and magnetic fields

Electric field	$E = \dfrac{F}{Q}$
Coulomb's law	$F = \dfrac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$
	$E = \dfrac{Q}{4\pi\varepsilon_0 r^2}$
	$E = \dfrac{V}{d}$
Electrical potential	$V = \dfrac{Q}{4\pi\varepsilon_0 r}$
Capacitance	$C = \dfrac{Q}{V}$
Energy stored in capacitor	$W = \frac{1}{2}QV$
	$W = \frac{1}{2}CV^2$
	$W = \frac{1}{2}\dfrac{Q^2}{C}$
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 $\Delta E = c^2 \Delta m$

Unit 5

Thermodynamics

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

$\Delta E = L\Delta m$

Ideal gas equation $pV = NkT$

Molecular kinetic theory $\frac{1}{2}m < c^2 > = \frac{3}{2}kT$

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	$V_{\text{grav}} = \frac{-Gm}{r}$
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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