Pleasecheckthe examinationdetailsbelowbeforeenteringyourcandidateinformation

Candidatesurname | Othernames

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

TotalMarks

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 ▶

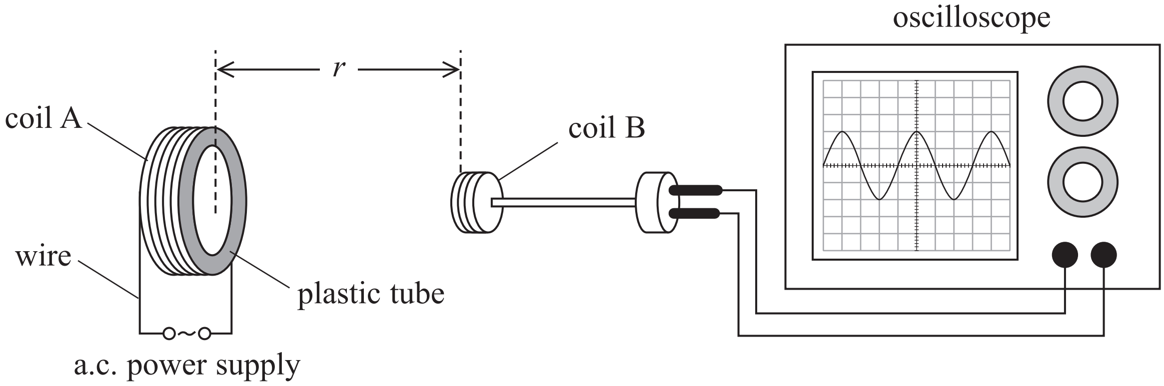
Pearson

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.

(2)

....

....

....

....

(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.

(3)

....

....

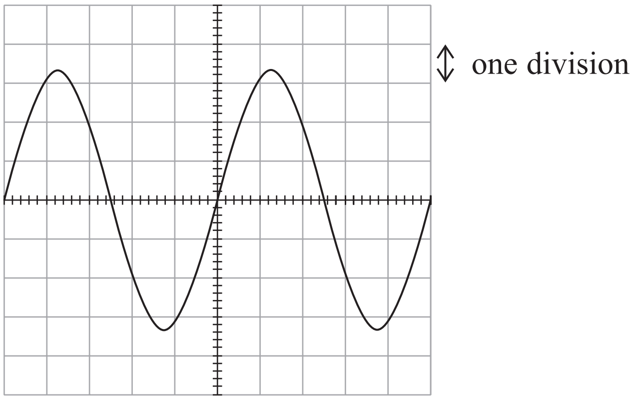
....

....

....

....

(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.

(3)

....

....

....

....

....

....

(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.

(2)

....

....

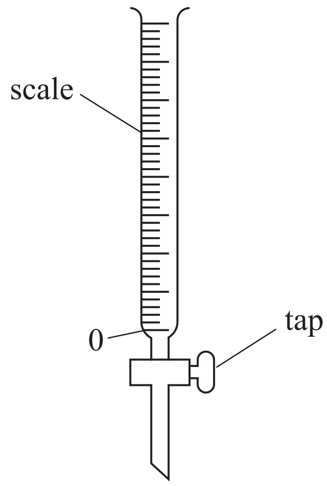
....

....

(Total for Question 1 = 10 marks)

BLANK PAGE

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.

(2)

....

....

....

....

(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.

(4)

....

....

....

....

....

....

....

....

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

(2)

....

....

....

....

(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.

(3)

....

....

....

....

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.

(3)

....

....

....

....

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.

(3)

....

....

....

....

....

....

Boiling point = ... °C

(Total for Question 3 = 15 marks)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

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.

(2)

....

....

....

....

(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.

(3)

....

....

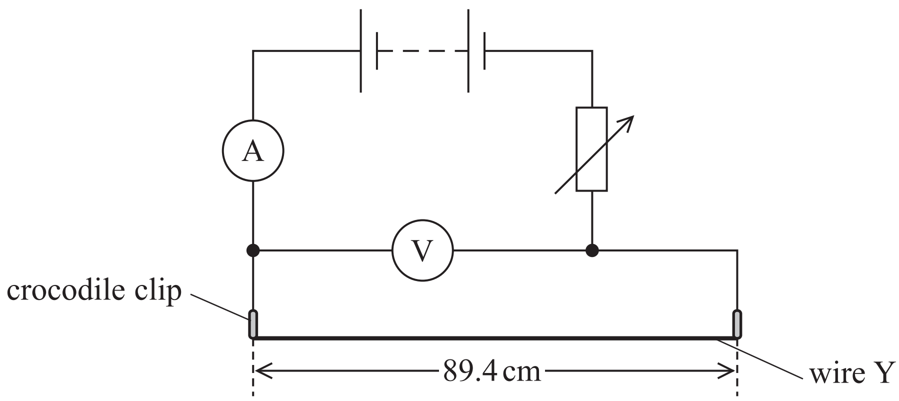
....

....

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

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

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 $5 \times 10^{-7}\,\Omega\,m$.

(3)

....

....

....

....

....

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

(3)

....

....

....

....

....

....

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(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} Ω 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.

(3)

....

....

....

....

....

....

(Total for Question 4 = 17 marks)

TOTAL FOR PAPER = 50 MARKS

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

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

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

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

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

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	$Q = Q_0 e^{-t/RC}$

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 $\mathscr{E} = \frac{-d(N\phi)}{dt}$

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

Nuclear decay

Mass-energy	$\Delta E = c^2\Delta m$
Radioactive decay	$A = \lambda N$
	$\frac{dN}{dt} = -\lambda N$
	$\lambda = \frac{\ln 2}{t_{1/2}}$
	$N = N_0 e^{-\lambda t}$
	$A = A_0 e^{-\lambda t}$

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

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

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	$L = \sigma A T^4$
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	$v = H_0 d$

P 7 1 8 8 2 A 0 2 1 2 4

BLANK PAGE

BLANK PAGE

BLANK PAGE