Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number	Candidate Number

Monday 12 November 2018

Morning (Time: 1 hour 20 minutes)	Paper Reference **WPH06/01**

Physics

Advanced
Unit 6: Experimental Physics

You must have: Ruler	Total Marks

Instructions

- Use **black** ink or 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.*

Information

- The total mark for this paper is 40.
- 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.
- Candidates may use a scientific calculator.

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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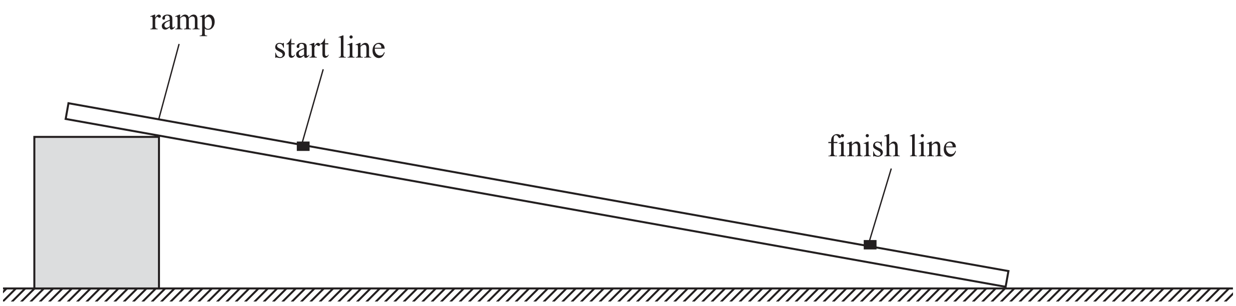
Pearson

Answer ALL questions in the spaces provided.

1 A student determined a value for the acceleration of free fall *g*, using the apparatus shown.

He placed a marble on the start line and used a stopwatch to measure the time *t* the marble took to roll to the finish line.



He obtained the following data.

t / s	2.37	2.33	2.36	2.29	2.32

(a) (i) Calculate the mean value for *t*.

(1)

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t = ...

(ii) Calculate the percentage uncertainty in *t*.

(2)

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Percentage uncertainty in t = ...

(b) (i) The student measured the vertical heights of the start line and finish line from the bench. He used a metre rule and a set square each time.

He recorded the change in height Δh as 3.4 cm ± 0.2 cm.

Explain why the uncertainty is stated as ± 0.2 cm.

(2)

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(ii) t is given by the equation

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

where s is the distance travelled by the marble.

Calculate a value for g.

$s = 0.800\,\text{m} \pm 0.001\,\text{m}$

(1)

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g = ...

(iii) Calculate the percentage uncertainty in the value for g.

(3)

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....

Percentage uncertainty in g = ...

(iv) Comment on the value of g determined in this experiment.

(2)

(c) The student suggested modifying the experiment to use a set of light gates to measure the time the marble took to roll to the finish line.

Discuss whether this modification would improve the accuracy of the value of g.

(2)

(Total for Question 1 = 13 marks)

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2 A student is investigating the absorption of gamma radiation by lead.

She has been provided with the following apparatus:

- laboratory source of gamma radiation,
- Geiger-Müller tube and counter,
- 16 lead sheets each of approximately 1 mm thickness,
- stopwatch.

(a) Explain the measuring instrument the student should use to measure the thickness of each lead sheet.

(2)

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(b) State any variables the student should control.

(1)

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(c) Describe how the student should make sure that the recorded count rate is accurate.

(2)

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(d) State one safety precaution the student should take when using a radioactive source.

(1)

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(Total for Question 2 = 6 marks)

3 A student measured the energy *W* stored in a capacitor of unknown capacitance *C*.

He charged the capacitor using a power supply of potential difference *V*, then discharged the capacitor through a joulemeter.

He repeated the experiment twice more and recorded the following results.

V / V	*W* / mJ
6.0	8.47
4.5	4.76
3.0	2.11

(a) Show that these results are consistent with the equation

$$W = \tfrac{1}{2}CV^2$$

(3)

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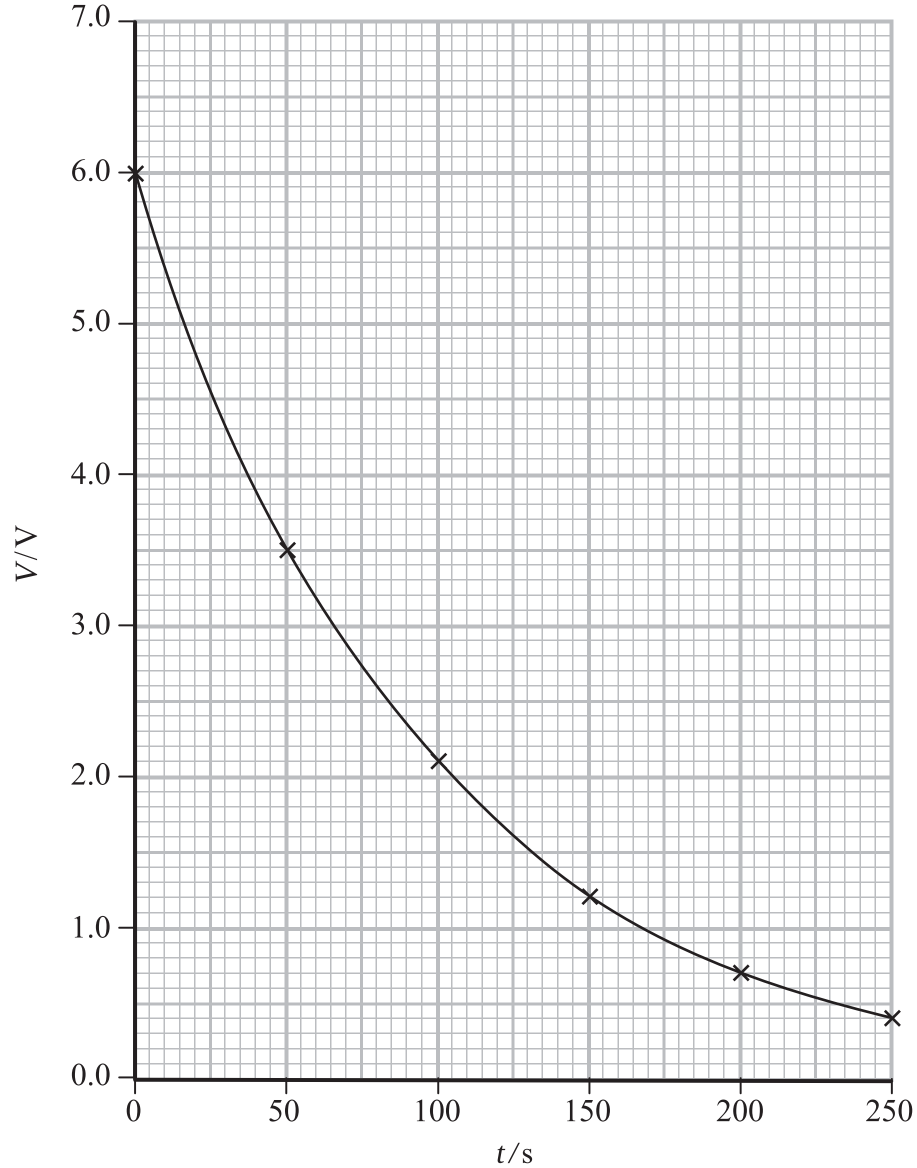
(b) The same capacitor was charged to a potential difference of 6.0 V and then discharged through an analogue voltmeter. The student recorded the potential difference V every 50 s and plotted the graph shown.



(i) State the significance of the time constant for the discharge of a capacitor.

(1)

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....

(ii) Determine a value for the resistance R of the voltmeter.

(2)

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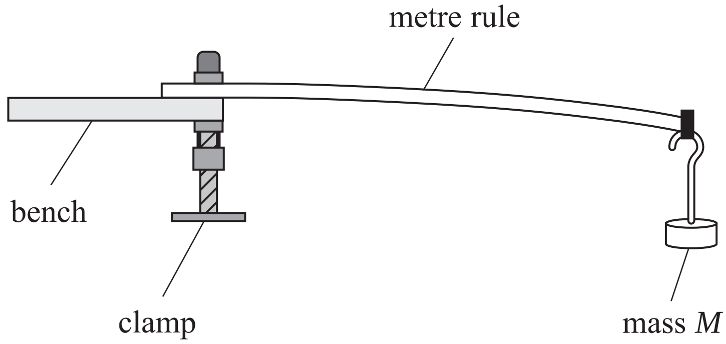
R = ...

(Total for Question 3 = 6 marks)

4 A student investigated the vertical oscillations of a mass *M* attached to the end of a wooden metre rule, using the arrangement shown.



(a) The student wrote the following plan.

> To measure the oscillations:
>
> - Place a marker at the equilibrium position.
> - Time at least 10 oscillations and divide by the number of oscillations.
> - Repeat the measurement and calculate a mean.

Explain how this method would ensure that the time period *T* is as accurate as possible.

(3)

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(b) The time period T is related to the mass M by the equation

$$T = qM^r$$

where q and r are constants.

Explain why plotting log T against log M should produce a straight line graph.

(2)

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(c) The student recorded the following data.

***M* / kg**	***T* / s**		
0.300	0.416		
0.400	0.475		
0.500	0.526		
0.600	0.570		
0.700	0.618		
0.800	0.664		

(i) Plot a graph of log T against log M on the grid opposite. Use the additional columns to record your processed data.

(6)

(ii) Determine the constants q and r and hence state the mathematical relationship between T and M.

(4)

(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 40 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	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
Forces	$\Sigma F = ma$ $g = F/m$ $W = mg$
Work and energy	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{grav} = mg\Delta h$

Materials

Stokes' law	$F = 6\pi\eta rv$
Hooke's law	$F = k\Delta x$
Density	$\rho = m/V$
Pressure	$p = F/A$
Young modulus	$E = \sigma/\varepsilon$ where Stress $\sigma = F/A$ Strain $\varepsilon = \Delta x/x$
Elastic strain energy	$E_{el} = \frac{1}{2}F\Delta x$

Unit 2

Waves

Wave speed $v = f\lambda$

Refractive index ${}_1\mu_2 = \sin i/\sin r = v_1/v_2$

Electricity

Potential difference $V = W/Q$

Resistance $R = V/I$

Electrical power, energy and efficiency

$P = VI$
$P = I^2R$
$P = V^2/R$
$W = VIt$

$$\%\ \text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$$

$$\%\ \text{efficiency} = \frac{\text{useful power output}}{\text{total power input}} \times 100$$

Resistivity $R = \rho l/A$

Current

$I = \Delta Q/\Delta t$
$I = nqvA$

Resistors in series $R = R_1 + R_2 + R_3$

Resistors in parallel $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Quantum physics

Photon model $E = hf$

Einstein's photoelectric equation $hf = \phi + \frac{1}{2}mv^2_{max}$

Unit 4

Mechanics

Momentum	$p = mv$
Kinetic energy of a non-relativistic particle	$E_k = p^2/2m$
Motion in a circle	$v = \omega r$ $T = 2\pi/\omega$ $F = ma = mv^2/r$ $a = v^2/r$ $a = r\omega^2$

Fields

Coulomb's law	$F = kQ_1Q_2/r^2$ where $k = 1/4\pi\varepsilon_0$
Electric field	$E = F/Q$ $E = kQ/r^2$ $E = V/d$
Capacitance	$C = Q/V$
Energy stored in capacitor	$W = \frac{1}{2}QV$
Capacitor discharge	$Q = Q_0 e^{-t/RC}$
In a magnetic field	$F = BIl \sin\theta$ $F = Bqv \sin\theta$ $r = p/BQ$
Faraday's and Lenz's laws	$\varepsilon = -d(N\phi)/dt$

Particle physics

Mass-energy	$\Delta E = c^2 \Delta m$
de Broglie wavelength	$\lambda = h/p$

Unit 5

Energy and matter

Heating	$\Delta E = mc\Delta\theta$
Molecular kinetic theory	$\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$
Ideal gas equation	$pV = NkT$

Nuclear Physics

Radioactive decay	$\mathrm{d}N/\mathrm{d}t = -\lambda N$
	$\lambda = \ln 2/t_{\frac{1}{2}}$
	$N = N_0 e^{-\lambda t}$

Mechanics

Simple harmonic motion	$a = -\omega^2 x$ $a = -A\omega^2 \cos \omega t$ $v = -A\omega \sin \omega t$ $x = A \cos \omega t$ $T = 1/f = 2\pi/\omega$
Gravitational force	$F = Gm_1m_2/r^2$

Observing the universe

Radiant energy flux	$F = L/4\pi d^2$
Stefan-Boltzmann law	$L = \sigma T^4 A$ $L = 4\pi r^2 \sigma T^4$
Wien's law	$\lambda_{max} T = 2.898 \times 10^{-3}$ m K
Redshift of electromagnetic radiation	$z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$
Cosmological expansion	$v = H_0 d$

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