

Please check the examination details below before entering your candidate information

Candidate surname		Other names	
Pearson Edexcel		Centre Number	Candidate Number
International		<input type="text"/>	<input type="text"/>
Advanced Level		<input type="text"/>	<input type="text"/>
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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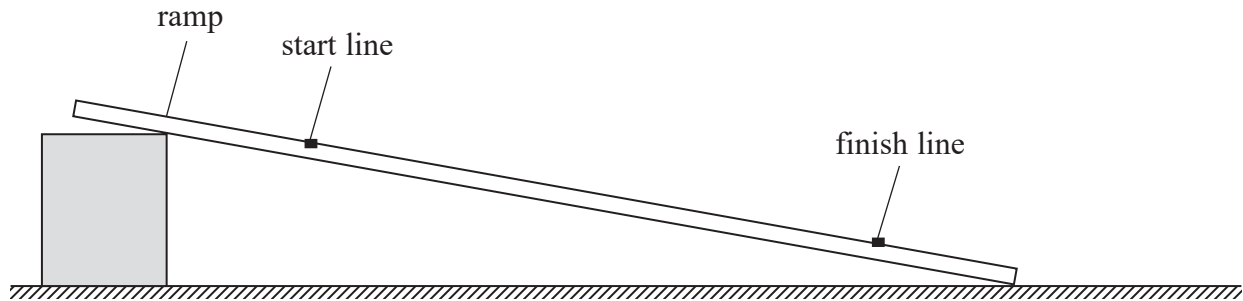



Pearson

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

(1)

$t =$

- (ii) Calculate the percentage uncertainty in t .

(2)

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 $3.4 \text{ cm} \pm 0.2 \text{ cm}$.

Explain why the uncertainty is stated as $\pm 0.2 \text{ cm}$.

(2)

- (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)

$$g = \dots\dots\dots$$

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

(3)

Percentage uncertainty in $g = \dots\dots\dots$



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

(2)

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(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)

(Total for Question 2 = 6 marks)

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- 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

$$W = \frac{1}{2}CV^2 \quad (3)$$

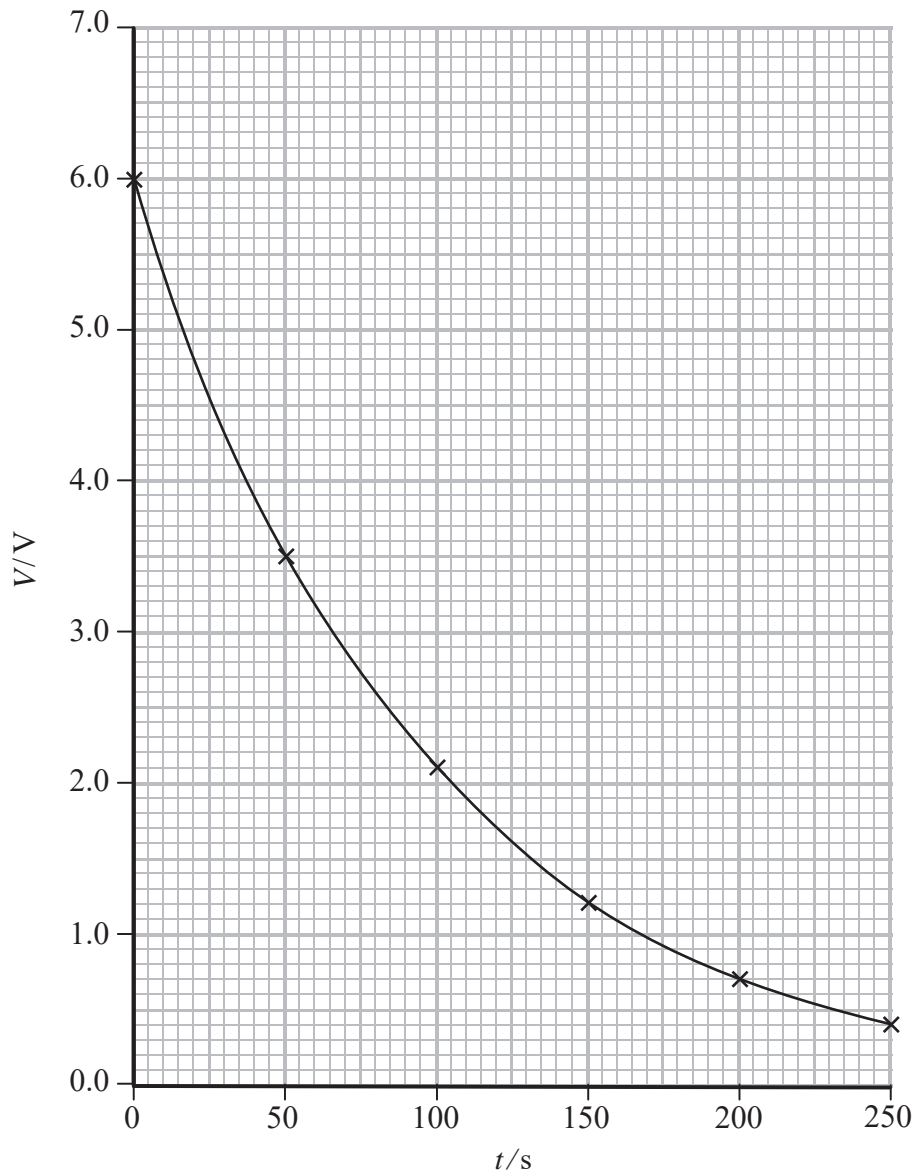
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- (b) The same capacitor was charged to a potential difference of 6.0 V and then discharged through an analogue voltmeter. The student recorded the potential difference V every 50 s and plotted the graph shown.



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

(1)



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

(2)

$R =$

(Total for Question 3 = 6 marks)

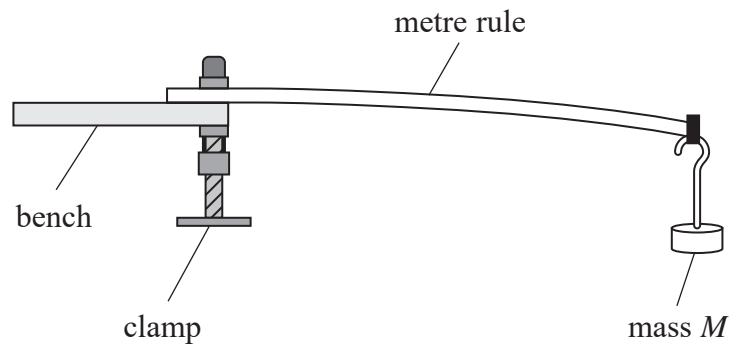
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- 4 A student investigated the vertical oscillations of a mass M attached to the end of a wooden metre rule, using the arrangement shown.



- (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.

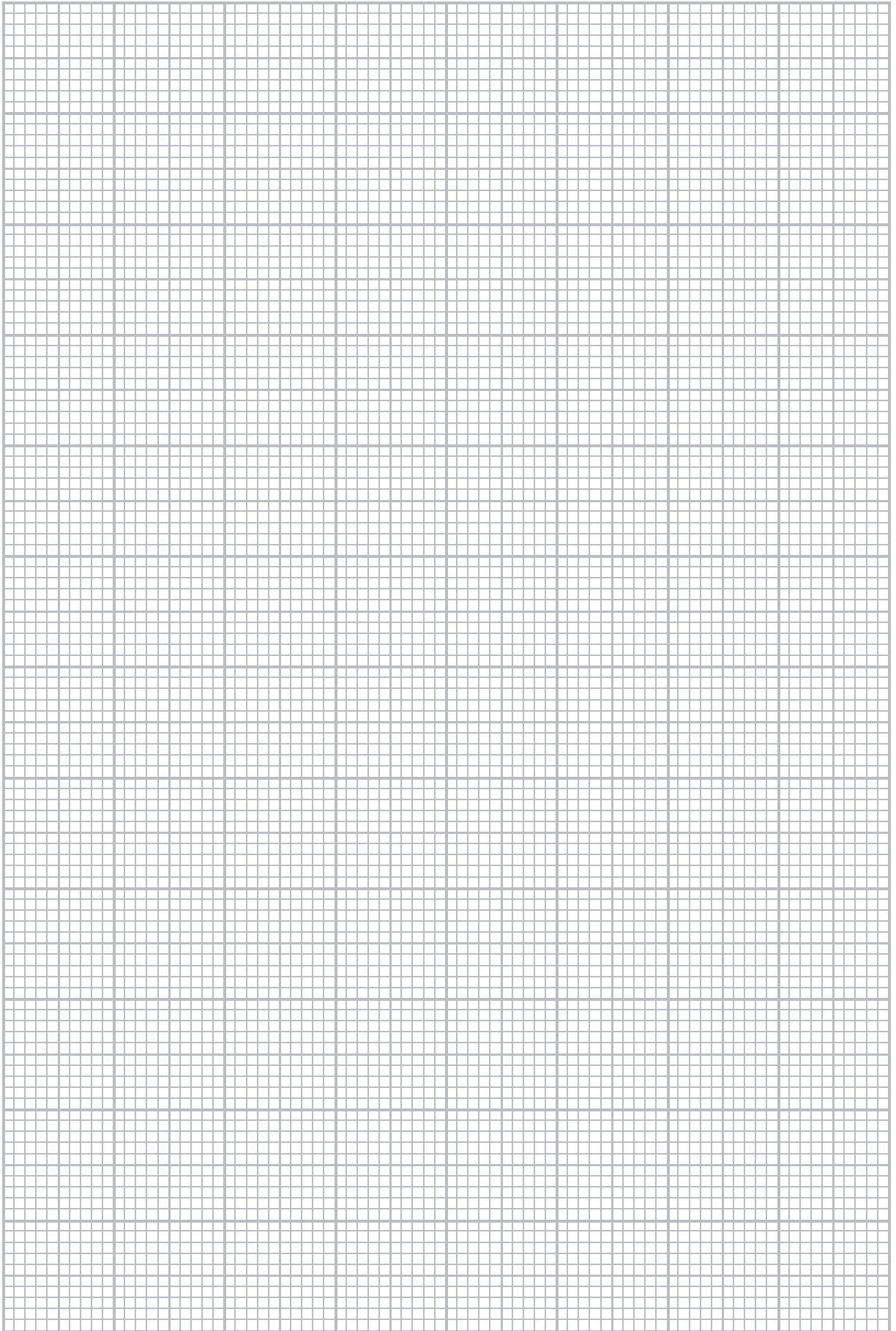
(6)



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- (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	$k = 1/4\pi\epsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
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	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$	
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	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{\text{grav}} = mg\Delta h$

Materials

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



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

$$hf = \phi + \frac{1}{2}mv_{\max}^2$$

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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

$$F = kQ_1Q_2/r^2 \text{ where } k = 1/4\pi\epsilon_0$$

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

$$\epsilon = -d(N\phi)/dt$$

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	$dN/dt = -\lambda N$
	$\lambda = \ln 2/t_{1/2}$
	$N = N_0 e^{-\lambda t}$

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	$\lambda_{\max} T = 2.898 \times 10^{-3} \text{ m K}$
Redshift of electromagnetic radiation	$z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$
Cosmological expansion	$v = H_0 d$

