

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 10 June 2024

Morning (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 ►

P75812A

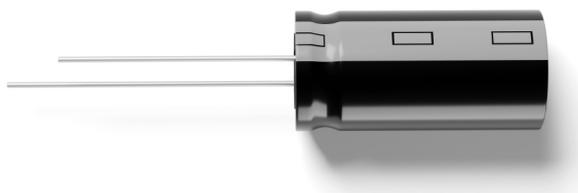
©2024 Pearson Education Ltd.
F:1/1/




Pearson

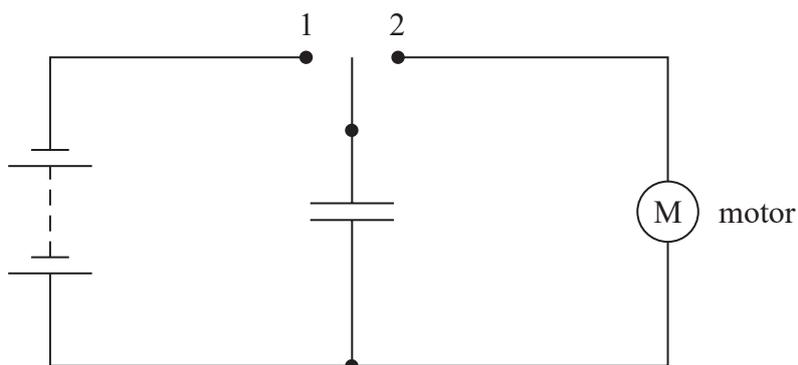
Answer ALL questions.

- 1 The electrolytic capacitor shown can be used to store energy.



(Source: © Andrei Kuzmik/Shutterstock)

A student connected the electrolytic capacitor into the circuit below.



- (a) State **two** safety precautions the student should take when connecting and using the circuit.

(2)

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

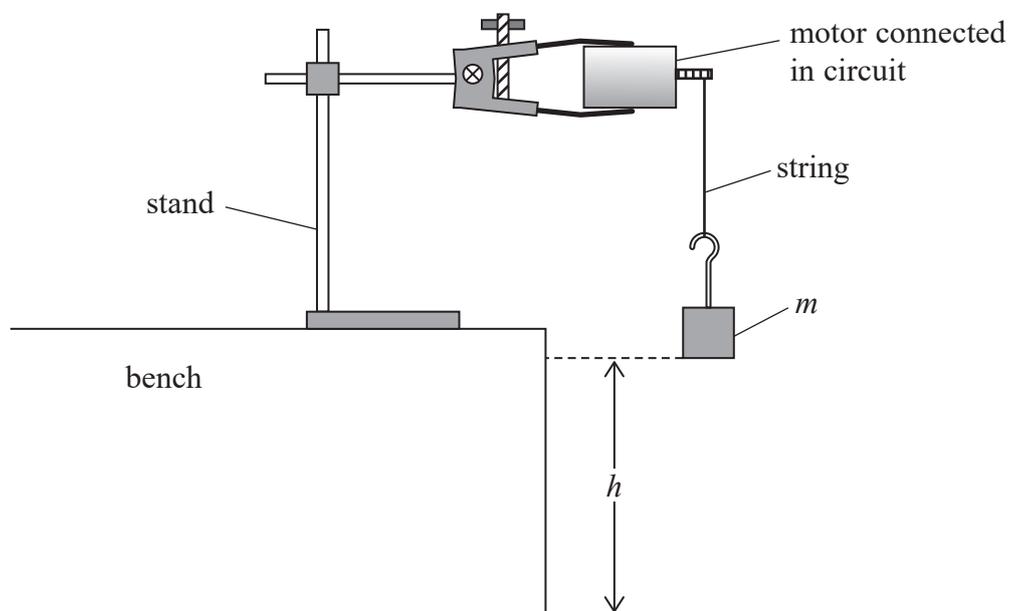
DO NOT WRITE IN THIS AREA



(b) The student used the switch in position 1 to charge the capacitor.

The student changed the switch to position 2 to discharge the capacitor through the motor.

As the capacitor discharged, the motor raised a small mass m through a height h , as shown.



The student used a metre rule to measure h .

Describe an accurate method to determine a single value of h using a metre rule.

You may include additional apparatus.

(3)

.....

.....

.....

.....

.....

.....



(c) The student repeated the procedure in (b) several times. She recorded the following measurements.

h/m	0.246	0.239	0.243	0.241
-------	-------	-------	-------	-------

(i) Calculate the mean value of h .

(1)

Mean value of $h =$

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

(2)

Percentage uncertainty =

(iii) Determine the efficiency of the electric motor.

maximum potential difference across capacitor = 6 V

capacitance of capacitor = 4700 μF

$m = 20 \text{ g}$

(3)

Efficiency =

(Total for Question 1 = 11 marks)



DO NOT WRITE IN THIS AREA

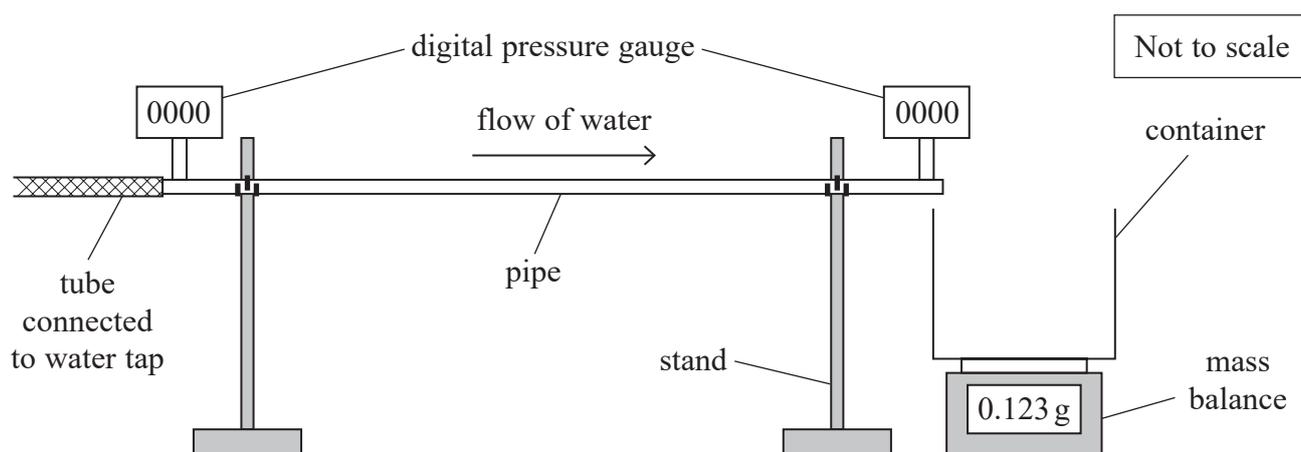
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE



- 2 A student investigated the flow of water through a horizontal pipe using the apparatus shown.



The mass M of water leaving the pipe in a time t is given by the formula

$$M = \frac{\pi \rho P r^4 t}{8 \eta L}$$

where

ρ = density of water

P = pressure difference between the ends of the pipe

r = internal radius of the pipe

η = viscosity of water

L = distance between digital pressure gauges

- (a) Show that the formula gives the unit for η as N s m^{-2} .

(2)

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



DO NOT WRITE IN THIS AREA

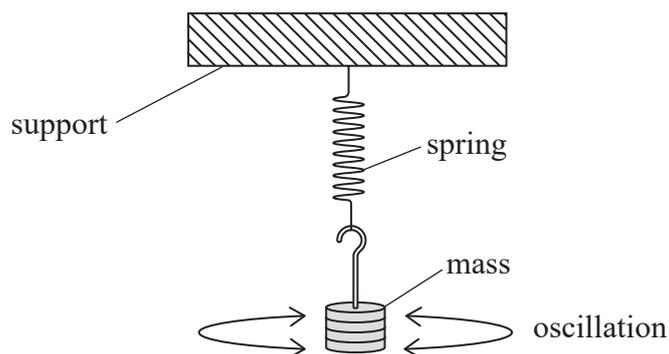
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE



- 3 A student investigated the rotational oscillations of a mass on a spring, using the apparatus shown.



When the mass is displaced through a small angle, the mass performs rotational oscillations about a vertical axis through the spring.

- (a) The student used a stopwatch to determine the time period T of the rotational oscillations.

Describe how the student should determine an accurate value for T .

(3)

.....

.....

.....

.....

.....

.....

- (b) The student predicted that the relationship between T and the mass M was of the form

$$T = aM^b$$

where a and b are constants.

- (i) Explain how a graph of $\log T$ against $\log M$ can be used to determine the value of b .

(2)

.....

.....

.....

.....



- (ii) The student varied M and determined the corresponding values of T . She recorded the following data.

M/kg	T/s		
0.200	1.46		
0.300	1.86		
0.400	2.14		
0.500	2.36		
0.600	2.63		
0.700	2.88		

Plot a graph of $\log T$ against $\log M$ on the grid opposite.

Use the additional columns for your processed data.

(6)

- (iii) Determine the gradient of the graph.

(3)

Gradient =

- (iv) Determine the value of a .

(3)

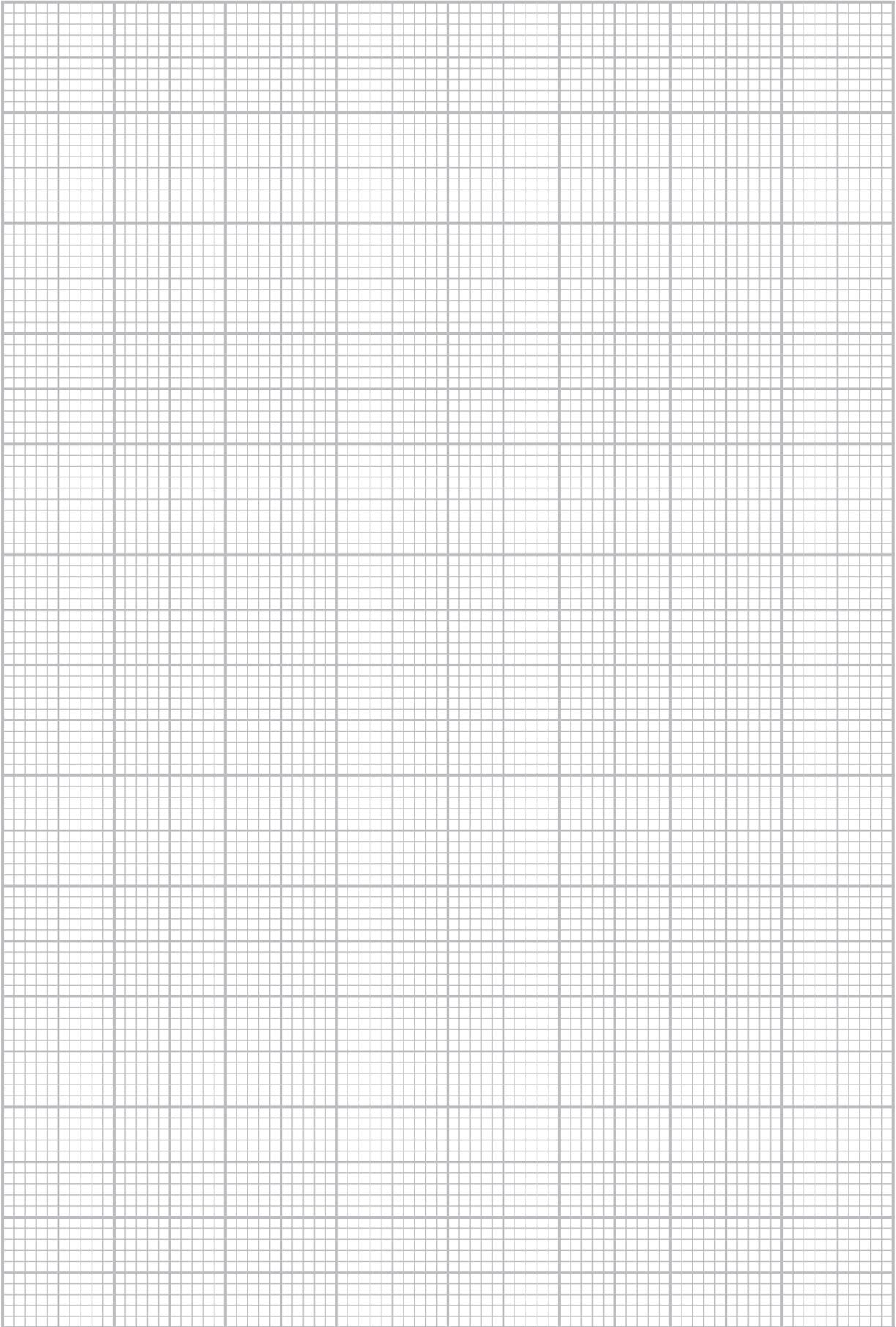
$a = \dots\dots\dots$



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

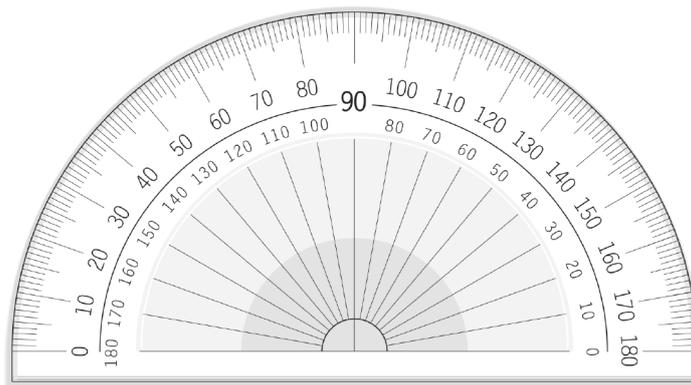


(Total for Question 3 = 17 marks)



P 7 5 8 1 2 A 0 1 1 2 4

4 A student made measurements of the plastic protractor shown.



(Source: © Natsmith1/Shutterstock)

- (a) (i) The student used a micrometer screw gauge to measure the thickness t of the plastic protractor.

Explain **one** technique she should use when measuring t .

(2)

.....

.....

.....

.....

- (ii) The student determined a value of t as 1.41 mm.

Explain why a micrometer screw gauge is an appropriate instrument for this measurement.

Your answer should include a calculation.

(2)

.....

.....

.....

.....

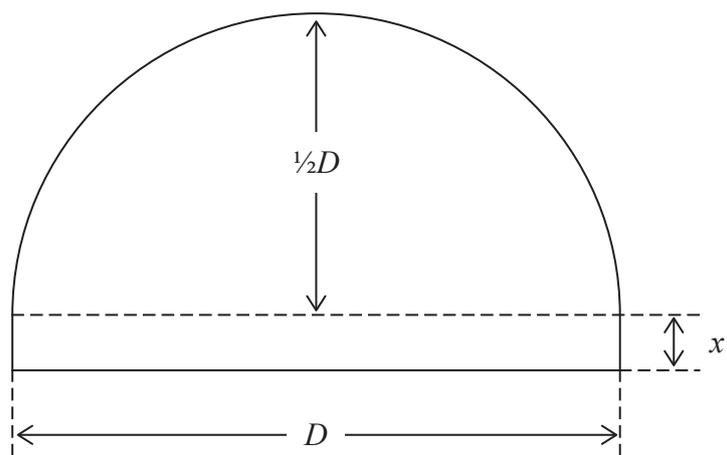


DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b) The student determined the volume V of the plastic protractor from the measurements shown.



The student recorded the following measurements.

$$D = 10.10 \text{ cm} \pm 0.05 \text{ cm}$$

$$x = 4.5 \text{ mm} \pm 0.1 \text{ mm}$$

$$t = 1.40 \text{ mm} \pm 0.02 \text{ mm}$$

(i) Show that V is about 6.2 cm^3 .

(2)

.....

.....

.....

(ii) Show that the uncertainty in V is about 0.2 cm^3 .

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c) The student determined the density of the plastic as 1.04 g cm^{-3} with a percentage uncertainty of 3%.

The accepted value of the density of Perspex is 1.18 g cm^{-3} .

Explain whether the student's measurements suggest that the protractor could be made of Perspex.

Your answer should include a calculation.

(2)

.....

.....

.....

.....

(Total for Question 4 = 12 marks)

TOTAL FOR PAPER = 50 MARKS



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	$s = \frac{(u + v)t}{2}$
	$v = u + at$
	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$

Forces	$\Sigma F = ma$
	$g = \frac{F}{m}$
	$W = mg$

Momentum	$p = mv$
----------	----------

Moment of force	moment = Fx
-----------------	---------------

Work and energy	$\Delta W = F\Delta s$
	$E_k = \frac{1}{2}mv^2$

Power	$\Delta E_{\text{grav}} = mg\Delta h$
	$P = \frac{E}{t}$
	$P = \frac{W}{t}$



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

$$\Delta E_{\text{el}} = \frac{1}{2}F\Delta x$$

Young modulus

$$E = \frac{\sigma}{\varepsilon} \text{ where}$$

$$\text{Stress } \sigma = \frac{F}{A}$$

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

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



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

$$F = \frac{Q_1 Q_2}{4\pi\epsilon_0 r^2}$$

$$E = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$E = \frac{V}{d}$$

Electrical potential

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

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

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

Nuclear and particle physics

In a magnetic field

$$r = \frac{p}{BQ}$$

Mass-energy

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

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



P 7 5 8 1 2 A 0 1 9 2 4

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

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

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



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 $\lambda_{\text{max}}T = 2.898 \times 10^{-3} \text{ mK}$

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 $v = H_0d$

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

BLANK PAGE



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE

