

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 9 June 2025

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 ►

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Answer ALL questions.

1 A student investigated the charging and discharging of a capacitor.

(a) The student connected a $680\ \mu\text{F}$ electrolytic capacitor in a circuit with a power supply and a switch.

(i) Describe two safety precautions the student should take when using electrolytic capacitors in a circuit.

(2)

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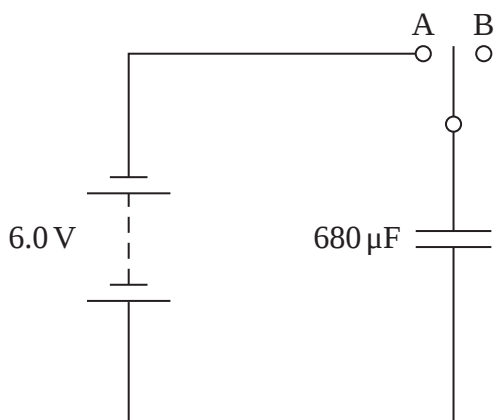
(ii) The student moved the switch to position A to charge the $680\ \mu\text{F}$ electrolytic capacitor.

She moved the switch to position B to connect the capacitor to another capacitor X.

She measured the potential difference across the $680\ \mu\text{F}$ electrolytic capacitor when the switch was in position A and in position B.

Complete the diagram to show the circuit the student used.

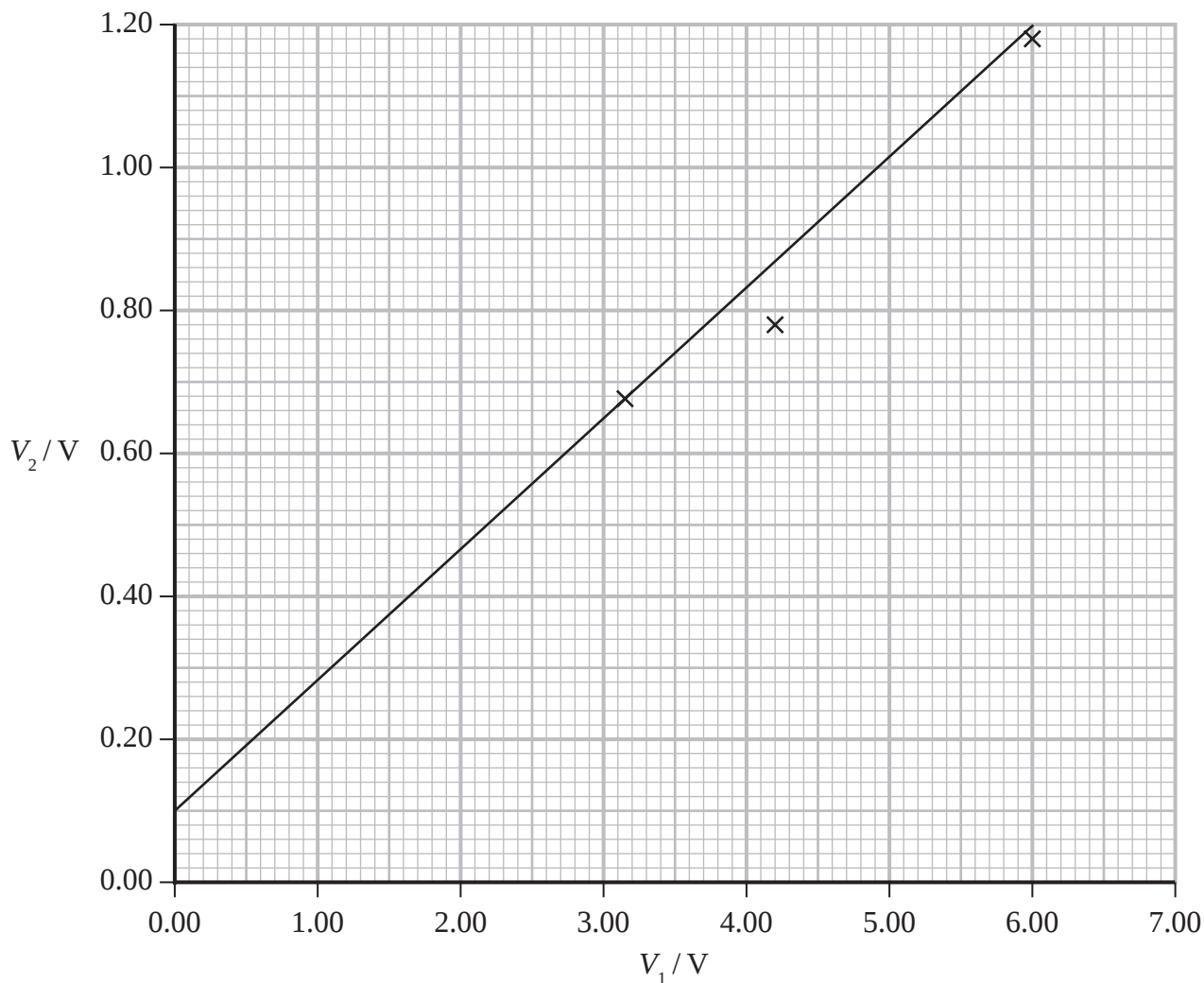
(2)



(b) The student charged the $680\ \mu\text{F}$ capacitor to different potential differences, V_1 .

For each value of potential difference V_1 , she connected the $680\ \mu\text{F}$ capacitor to capacitor X. The final value of the potential difference across the $680\ \mu\text{F}$ capacitor was V_2 .

She recorded the corresponding values of V_1 and V_2 and plotted the graph below.



Criticise the student's graph.

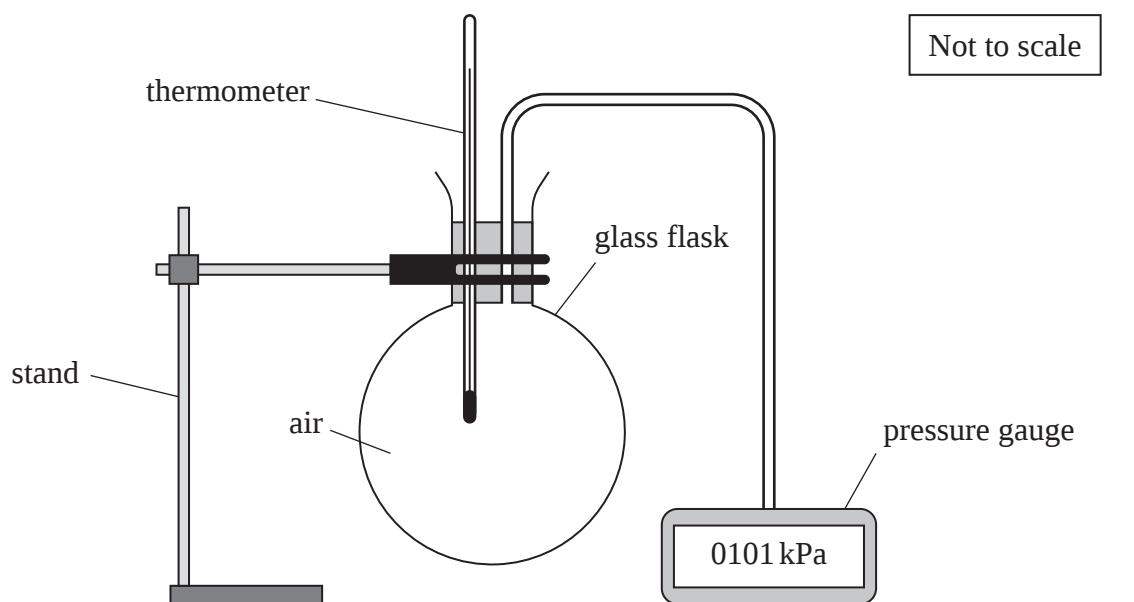
(3)

(Total for Question 1 = 7 marks)



P 7 8 8 3 6 A 0 3 2 0

- 2 A student investigated how the pressure of a fixed volume of air varied with temperature using the apparatus shown.



- (a) The student used temperatures ranging from 0°C to 100°C .

Devise a method the student could use to estimate a value for absolute zero.

Your method should include any additional apparatus and the use of a suitable graph.

(6)



- (b) The student suggested that using a data logger with a temperature probe and a pressure sensor would improve the investigation.

Explain how using a data logger could improve the accuracy of the measurements.

(3)

(Total for Question 2 = 9 marks)

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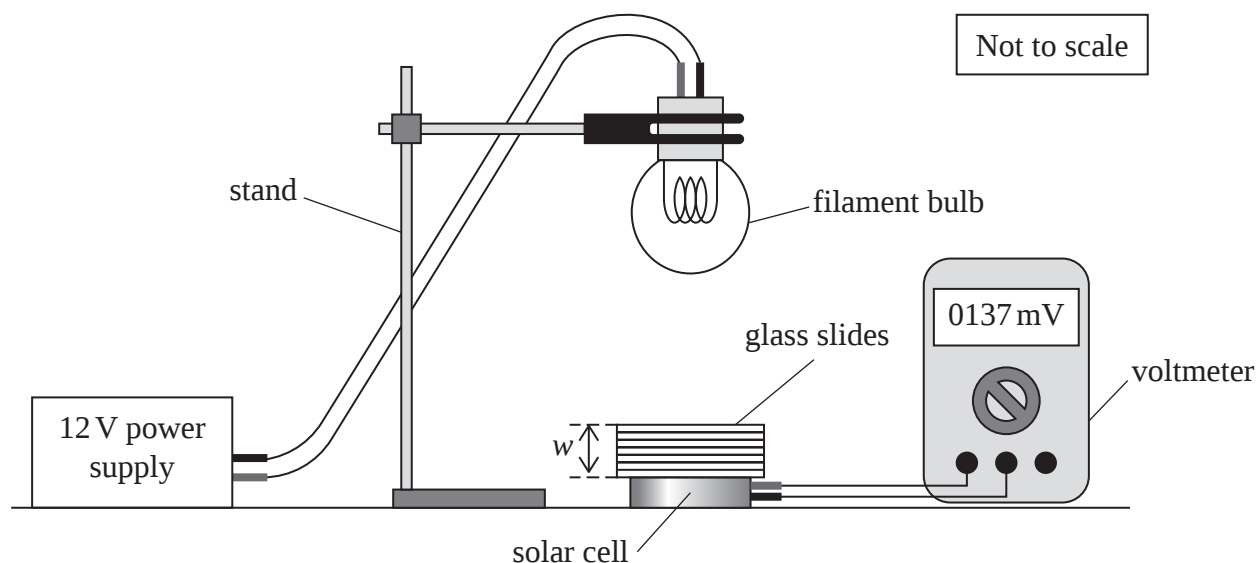
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- 3 A student investigated the absorption of light by glass using the apparatus shown.



The student varied the thickness w of glass by placing glass slides on the solar cell.

- (a) The student used a micrometer screw gauge to measure the thickness of one glass slide. She recorded a single measurement as 1.21 mm.

Explain why a micrometer screw gauge was an appropriate instrument to use for this measurement.

Your answer should include a calculation.

(2)

- (b) For each value of w the student recorded the potential difference V across the solar cell.

Explain one variable she should control in this investigation.

(2)



(c) The relationship between V and w is given by

$$V = Ae^{-Bw}$$

where A and B are constants.

(i) Explain how a graph of $\ln V$ against w could be used to determine a value for B .

(2)

(ii) The student recorded the following results.

w/mm	V/mV	
1.21	381	
2.46	375	
4.88	366	
6.10	361	
8.55	352	
10.97	344	

Plot a graph of $\ln V$ against w on the grid opposite.

Use the additional column to record your processed data. You should keep the values of V in mV.

(5)

(iii) Determine the gradient of the graph.

(3)

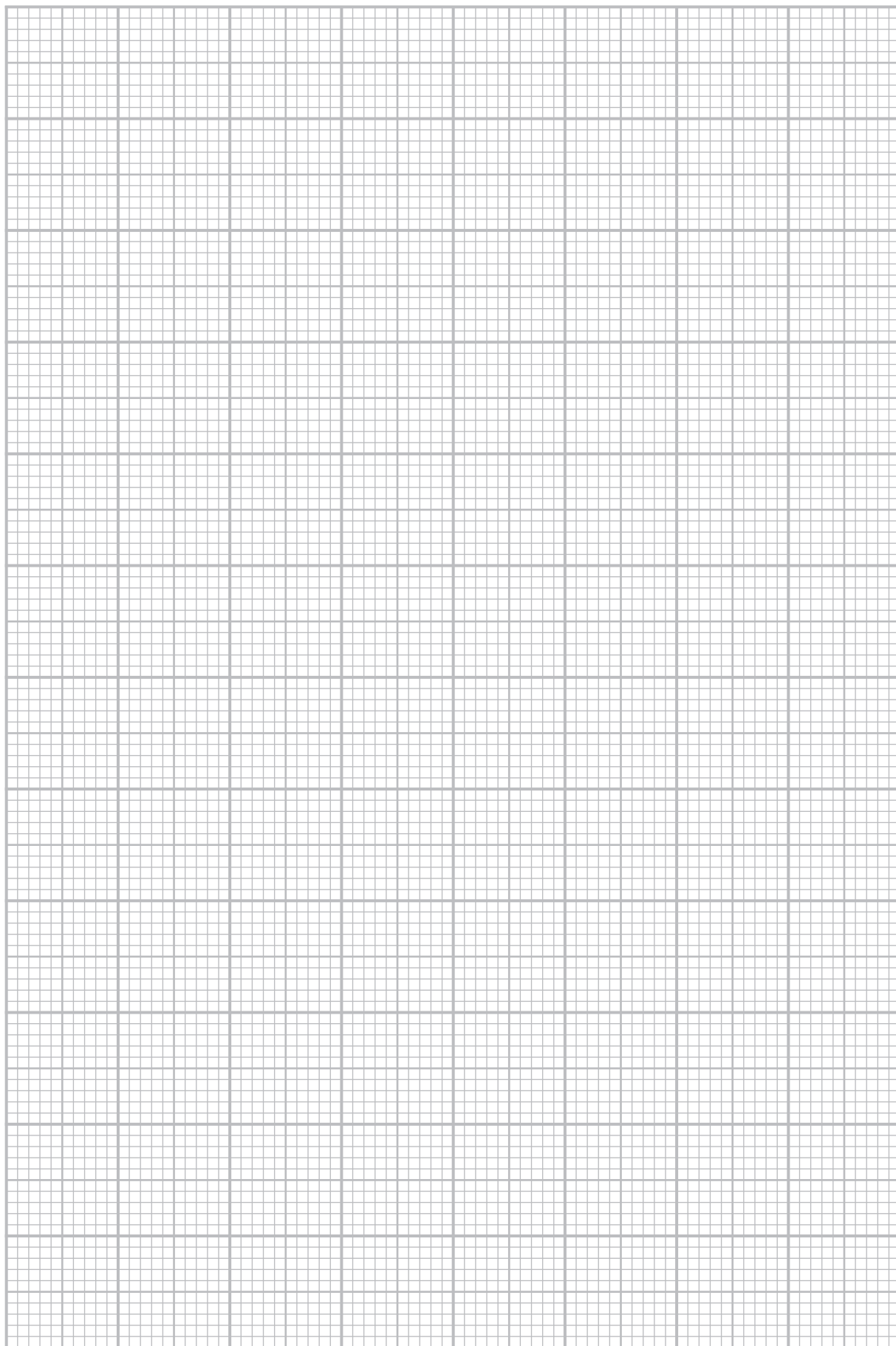
Gradient =



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(iv) The mean thickness of each glass slide was 1.22 mm.

Determine the minimum number of glass slides needed to reduce V to 75% of the initial value.

(4)

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Minimum number of glass slides =

(Total for Question 3 = 18 marks)

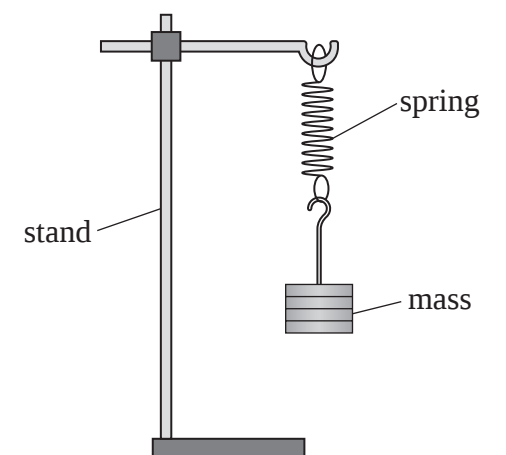
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- 4 A student investigated the properties of a spring using the apparatus shown.



- (a) The student determined the time period T of the oscillations of the mass-spring system.

The student displaced the mass downwards. He released the mass so that the mass oscillated vertically. He used a stopwatch to measure the time for multiple oscillations.

- (i) Explain why timing multiple oscillations improves the measurement of T .

(3)

- (ii) Describe two techniques the student should use when timing oscillations.

(2)



(iii) The student recorded the following results.

$10T/s$	6.88	6.93	6.84	6.96
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Calculate the mean value of T .

(2)

Mean value of $T =$

(iv) Determine the percentage uncertainty in the mean value of T .

(2)

Percentage uncertainty =

(b) The Poisson Ratio is a property of the material the spring is made from.

For oscillations on a spring, the Poisson Ratio ν can be calculated using

$$\nu = N^2 \frac{D^2}{2d^2} - 1$$

where N is a constant related to the time period of oscillations

D is the diameter of the mass

d is the internal diameter of the coiled part of the spring.

(i) The student used vernier calipers to measure d .

Explain one technique he should use to determine an accurate value for d .

(2)

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- (ii) Show that the percentage uncertainty in the term $\frac{D^2}{2d^2}$ is about 2%.

$$D = 59.4 \text{ mm} \pm 0.2 \text{ mm}$$

$$d = 13.9 \text{ mm} \pm 0.1 \text{ mm}$$

(3)

- (iii) The student determined the value of the constant N experimentally and estimated its percentage uncertainty.

He determined the value of v as 0.276 with a percentage uncertainty of 6%.

The value of v for steel is 0.265

Deduce whether this spring was made from steel.

(2)

(Total for Question 4 = 16 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	$s = \frac{(u + v)t}{2}$ $v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
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Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_{\text{grav}} = mg\Delta h$$

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

$$F = 6\pi\eta r v$$

Hooke's law

$$\Delta F = k\Delta x$$

Elastic strain energy

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

Young modulus

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

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

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

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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

$$P = VI$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

$$W = VIt$$

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

$$\lambda = \frac{h}{p}$$

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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

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

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

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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