

Write your name here

Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Physics

Advanced

Unit 6: Experimental Physics

Thursday 18 May 2017 – Afternoon

Time: 1 hour 20 minutes

Paper Reference

WPH06/01

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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Answer ALL questions in the spaces provided.

- 1** A student determines the viscosity η of oil by measuring its volume flow rate $\frac{V}{t}$ through a horizontal pipe.

The student uses the formula

$$\frac{V}{t} = \frac{Pr^4}{8L}$$

P = the pressure difference between the ends of the pipe

r = the internal radius of the pipe

L = the length of the pipe

The pipe is approximately 1cm in diameter.

- (a) The student measures the internal diameter of the pipe.

(i) State a suitable instrument for this measurement.

(1)

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(ii) Explain your choice of instrument.

(2)

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(iii) State the measuring technique you would use with this instrument to obtain an accurate value for the internal diameter of the pipe.

(1)

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- (b) The mean value for the internal diameter of the pipe is $0.995 \text{ cm} \pm 0.003 \text{ cm}$.

Calculate the percentage uncertainty in this measurement.

(1)

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Percentage uncertainty =

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(c) The student recorded the following values omitting the SI units.

Quantity	Value	Percentage uncertainty
V/t	8.5×10^{-6}	3.5
P	695	0.7
L	2.00	0.5

(i) Show that the unit for η is N s m^{-2} .

(2)

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(ii) Calculate a value for η .

(2)

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$\eta =$

(iii) Calculate the percentage uncertainty in η .

(2)

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Percentage uncertainty =

(Total for Question 1 = 11 marks)

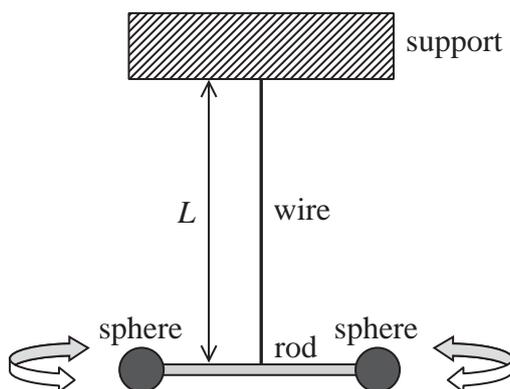
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- 2 The diagram shows a rotational pendulum. The identical steel spheres perform angular oscillations about a vertical axis through the centre of the rod.



A student investigates how the period of the oscillations T varies with the length of the wire L .

The student also has a metre rule, a stopwatch with a precision of 0.01 s and an optical pin.

- (a) Describe how the student can use this apparatus to obtain values for T that are as accurate as possible. (3)

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- (b) The student is given the formula $T = 2 \sqrt{\frac{IL}{K}}$ where I and K are constants.
- (i) Describe the graph she should plot to obtain a straight line. (2)

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(ii) The value K is a constant for the wire.

State how the graph described in (i) can be used to calculate K if I is known.

(1)

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(c) A light gate, attached to a data logger, can be placed so that one of the spheres breaks the light beam as it passes.

Describe how this would improve the accuracy in the measurement of T .

(2)

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(Total for Question 2 = 8 marks)

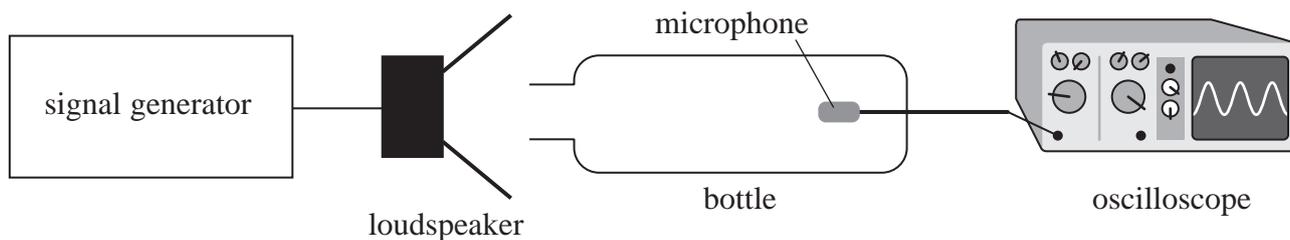
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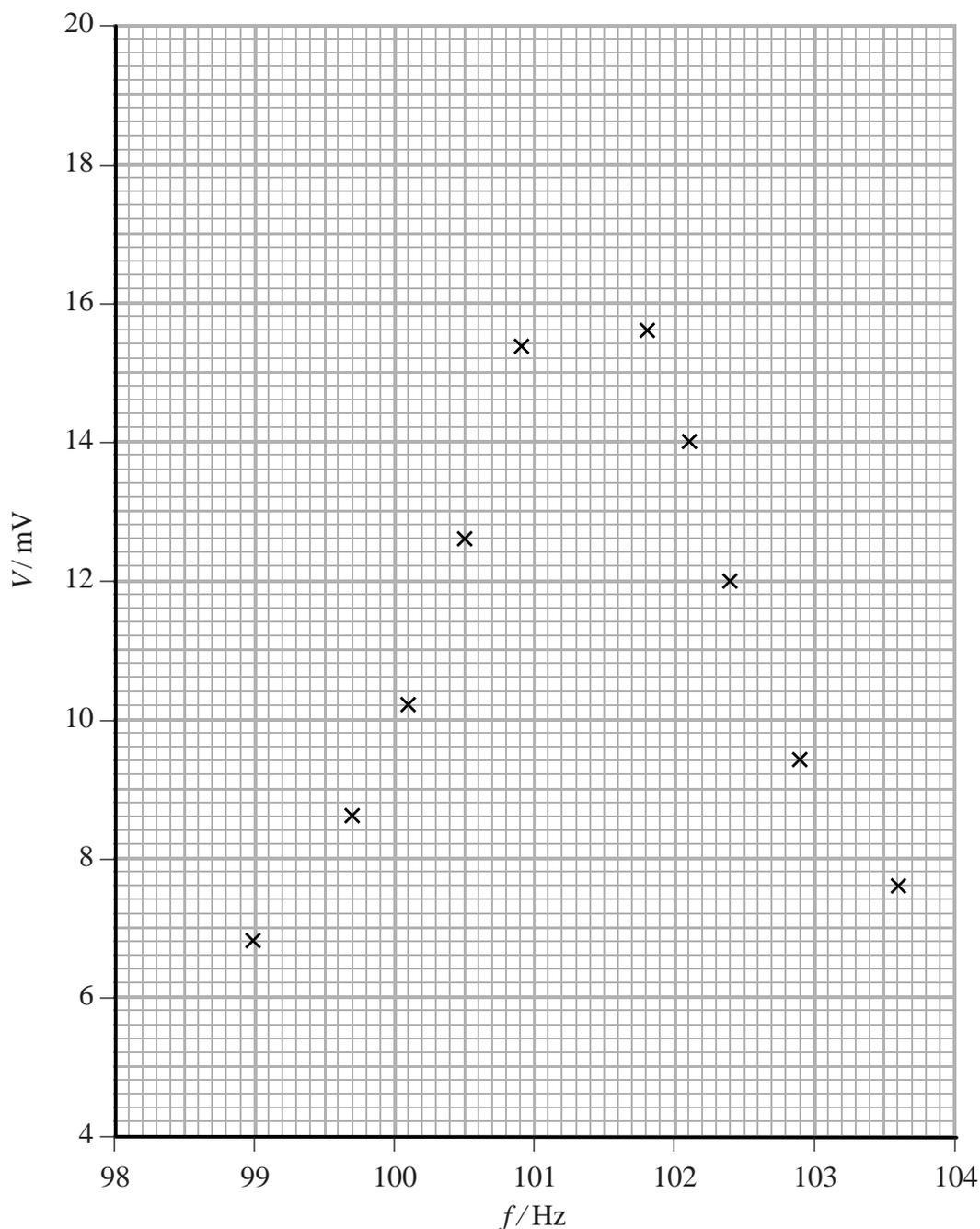


3 A student uses the apparatus shown to determine the resonant frequency of the air in a bottle.



The frequency f of the sound produced by the loudspeaker is varied using the signal generator. The sound detected by the microphone is displayed as a potential difference V on the oscilloscope.

The student plots a graph of the maximum value of V for a range of values of f .



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(a) (i) Draw a best fit line on the graph. (2)

(ii) Estimate the maximum value of V . (1)

(iii) State the resonant frequency f_0 of the bottle. (1)

(b) The student takes more readings in the range 100 Hz to 102 Hz.
Suggest how this would increase the accuracy of the value of f_0 obtained. (1)

(Total for Question 3 = 5 marks)



- 4 A student investigated the decay of a sample of protactinium-234 using a Geiger-Müller tube connected to a ratemeter.

The student first measured the background count rate. She recorded the count rate from the sample every 20 s and corrected each value by subtracting the background count rate. The corrected count rates are shown.

Time / s	Count rate / s ⁻¹	
0	150	
20	126	
40	98	
60	88	
80	70	
100	61	
120	46	
140	39	
160	28	

- (a) State the type of error that the student avoided by subtracting the background count rate. (1)

- (b) Identify a variable that must be kept constant in this investigation. (1)

- (c) The activity of the sample of protactinium is given by the formula

$$A = A_0 e^{-\lambda t}$$

where A is taken as the measured count rate at a time t .

A_0 is the count rate at $t = 0$

λ is the decay constant of protactinium-234

Show that a graph of $\ln A$ against t should be a straight line. (2)

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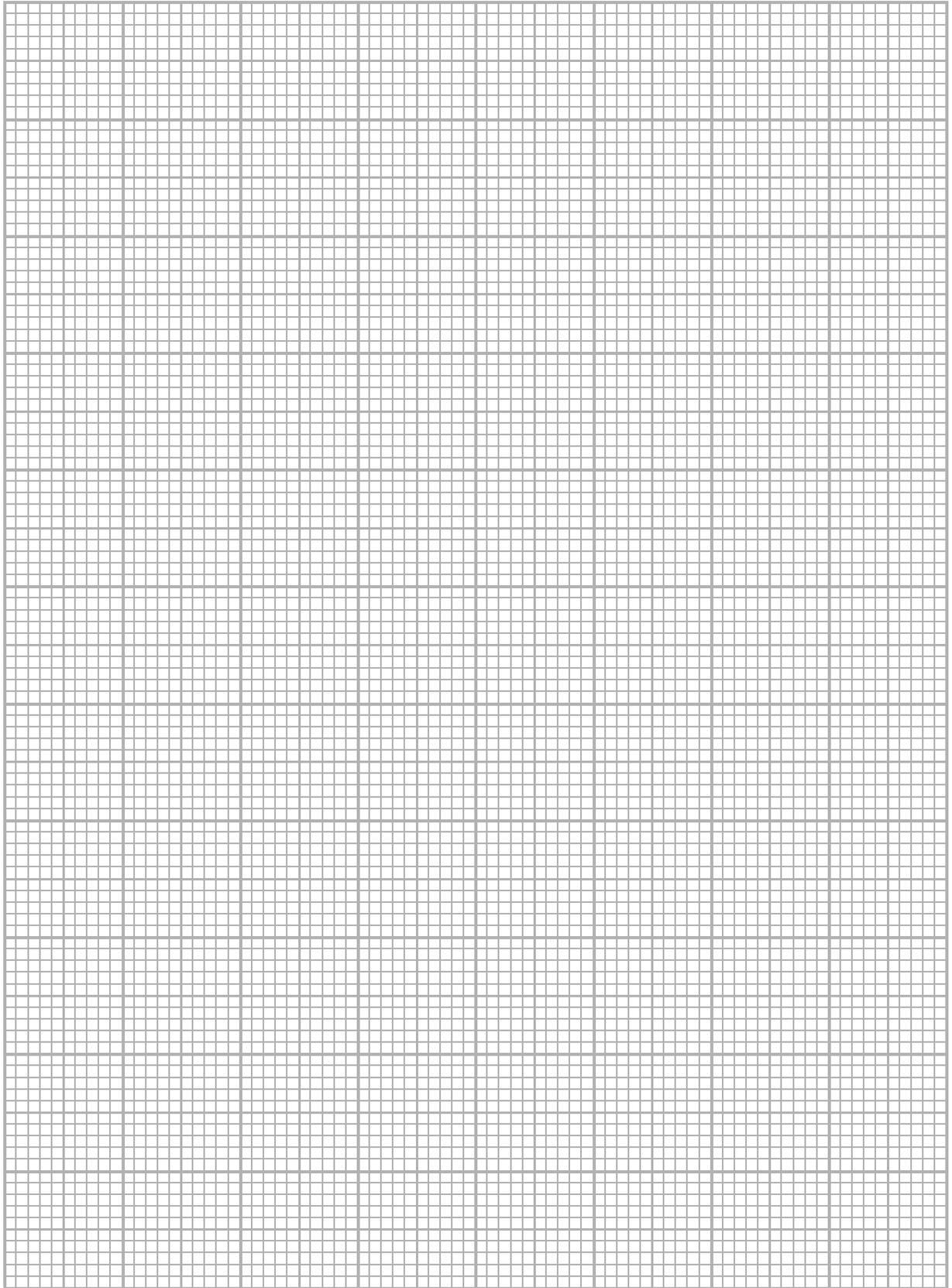
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(d) Draw a graph of $\ln A$ against t on the grid below. Use the extra column in the table for your processed data.

(5)



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(e) Use the graph to determine a value for λ .

(4)

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$\lambda =$

(f) The half-life of a radioactive isotope is given as $t_{1/2} = \frac{0.69}{\lambda}$.

(i) Calculate a value for the half-life of protactinium-234.

(1)

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Half-life =

(ii) The half-life for this isotope is quoted as 1.2 minutes.

Comment on the accuracy of your answer.

(2)

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(Total for Question 4 = 16 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	$F = 6\pi\eta rv$
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	$E_{\text{el}} = \frac{1}{2}F\Delta x$

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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

$$P = VI$$

$$P = I^2R$$

$$P = V^2/R$$

$$W = VI t$$

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

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

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

$$\lambda = h/p$$

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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 $F = Gm_1 m_2 / r^2$

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 $v = H_0 d$

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