Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	7	3	4	/	0	1	Signature	

Paper Reference(s)

6734/01

Edexcel GCE

Physics

Advanced Level

Unit Test PHY 4

Wednesday 11 June 2008 – Morning

Time: 1 hour 20 minutes

Examiner's use only		

Team Leader's use only		

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
Total	

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Materials required for examination
Nil

Items included with question papers
Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Answer **ALL** questions in the spaces provided in this question paper.
In calculations you should show all the steps in your working, giving your answer at each stage.
Calculators may be used.
Include diagrams in your answers where these are helpful.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets.
There are seven questions in this paper. The total mark for this paper is 60.
The list of data, formulae and relationships is printed at the end of this booklet.

Advice to Candidates

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

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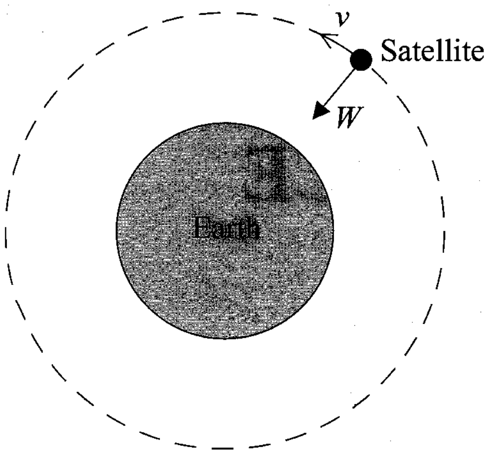
1. (a) A satellite is moving at a constant speed v in a circular orbit around the Earth. The only force acting on the satellite is its weight W.



(i) Although an unbalanced force is acting on the satellite, its speed does not change.

Explain why.

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(ii) According to Newton's second law, the unbalanced force causes an acceleration.

Explain how the satellite can accelerate while its speed remains constant.

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(4)

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(b) A satellite used in the global positioning system travels in an orbit of radius 2.7×10^4 km. At this distance from the Earth, the acceleration of the satellite is 0.56 m s^{-2}.

Calculate its speed.

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Speed = ...

(2)

Q1

(Total 6 marks)

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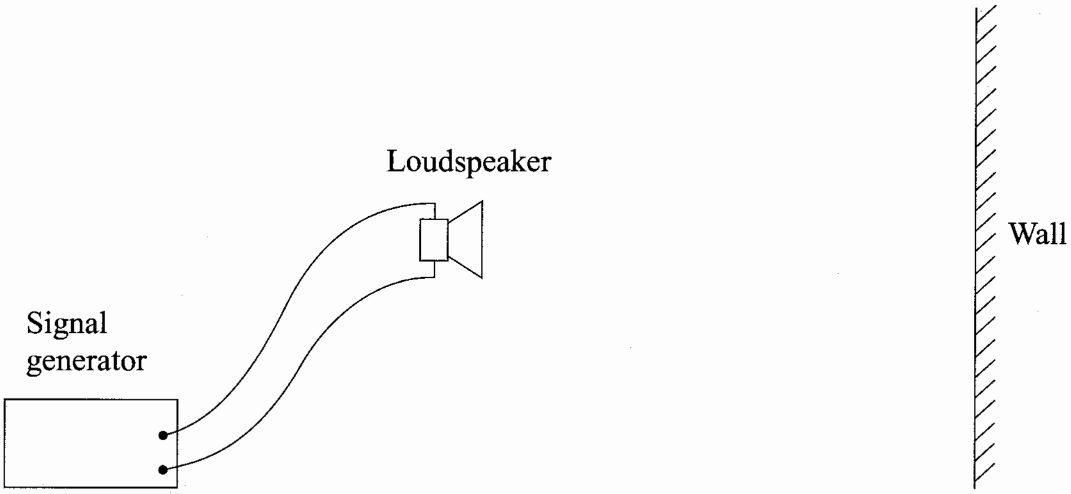
2. A loudspeaker connected to a signal generator is set up facing a wall.



Sound waves from the loudspeaker are reflected from the wall and a stationary wave is produced in the region between the loudspeaker and the wall.

(a) (i) Describe how you would use a small microphone, connected to a cathode ray oscilloscope, to demonstrate the presence of the stationary wave.

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(2)

(ii) Explain how the nodes and antinodes are produced.

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(iii) Outline how you would use this apparatus to obtain a value for the speed of sound waves in air.

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(4)

(b) (i) In principle, stationary waves produced in this way could cause problems for listeners in a concert hall. Explain why.

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(ii) In practice, the problem is not serious. Suggest a reason why.

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(2)

Q2

(Total 11 marks)

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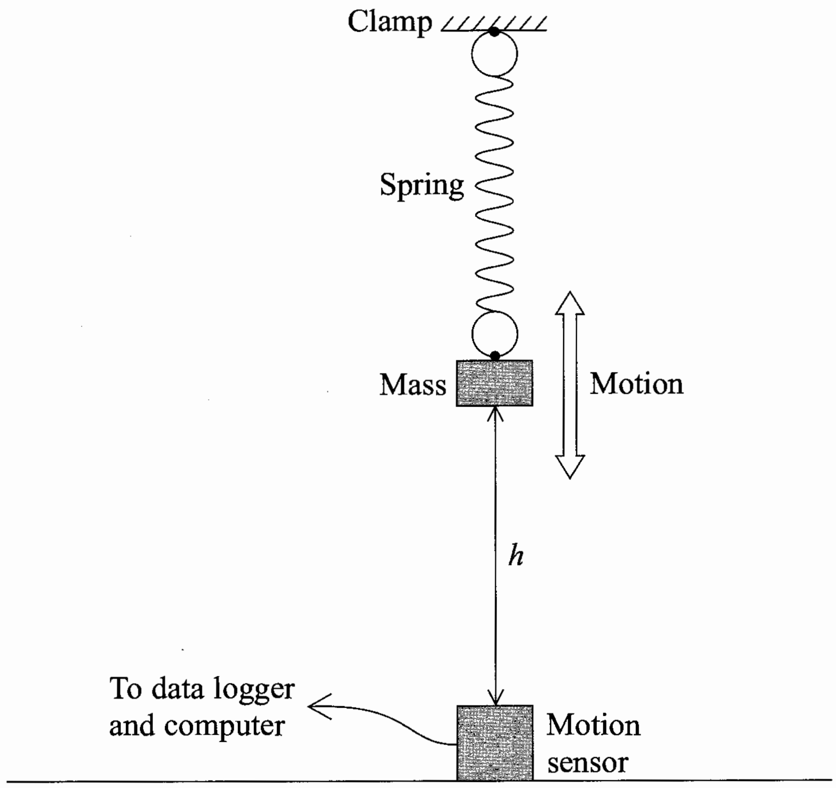
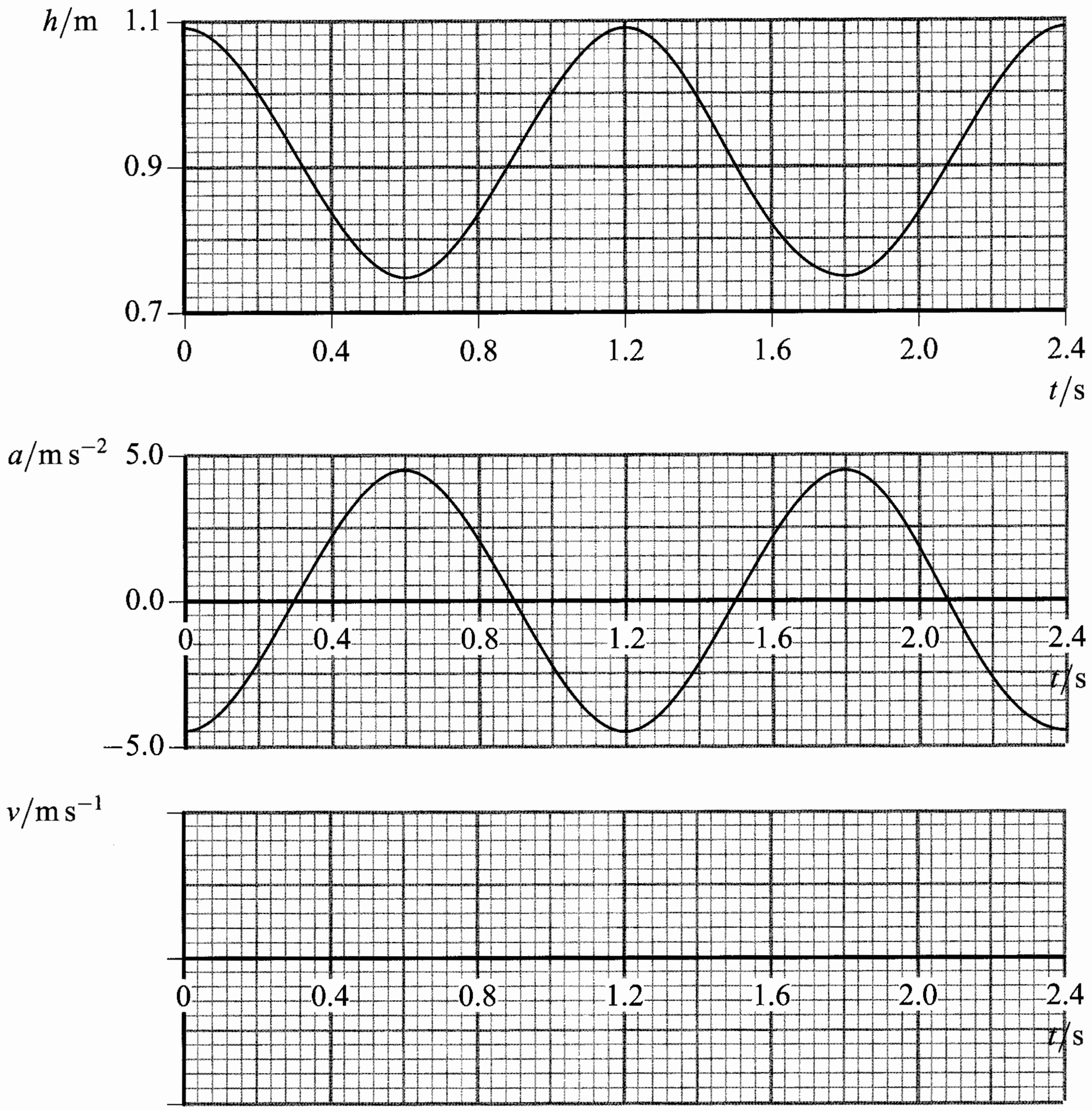
3. A motion sensor, connected through a data logger to a computer, is used to study the simple harmonic motion of a mass on a spring.



The data logger records how the height h of the mass above the sensor varies with the time t. The computer calculates the velocity v and acceleration a and displays graphs of h, v and a against t. Idealised graphs of h and a for two cycles are shown opposite.



(a) (i) Determine the amplitude and frequency of the motion.

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Amplitude = ... Frequency = ... **(2)**

(ii) Show that the maximum velocity of the mass is approximately $0.9\ \mathrm{m\ s^{-1}}$.

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(2)

(iii) Complete the above set of graphs by sketching the velocity-time graph for the same interval.

(2)

Leave blank

(b) (i) Define simple harmonic motion.

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(2)

(ii) Describe how you would use data from the graphs of h and a against t to check that the motion of the mass was simple harmonic. (Note that you are not required to actually carry out the check.)

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(4)

Q3

(Total 12 marks)

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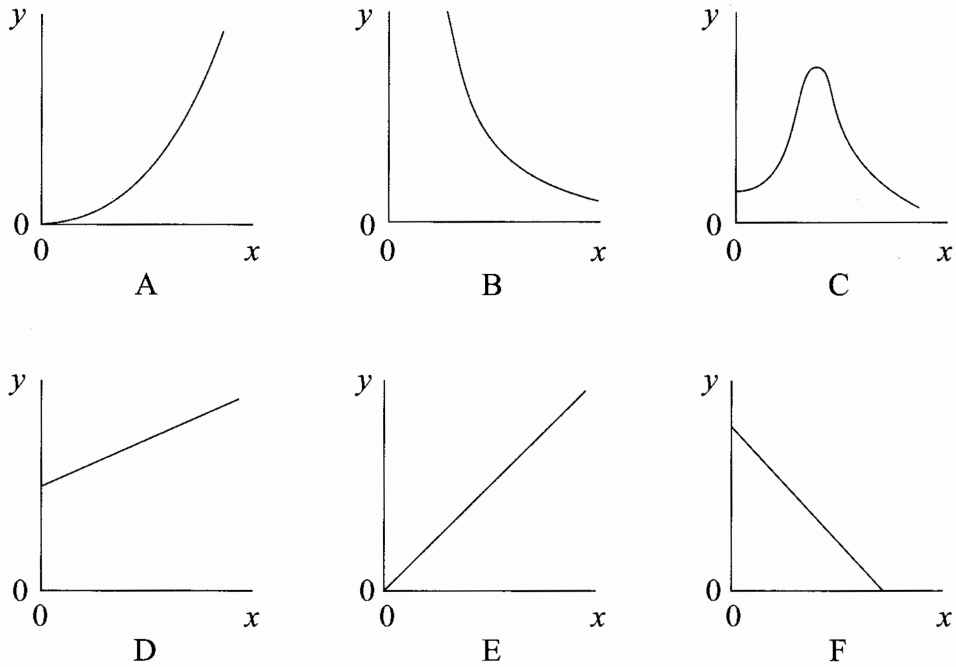
4. Six graphs, A to F, are shown below.



Tick the appropriate box in each row of the table below to show which graph is obtained when the variables given in the table are plotted. Each graph may be used once, more than once or not at all.

Variable on y-axis	Variable on x-axis	Graph					
		A	B	C	D	E	F
Amplitude of a forced oscillation	Frequency of the driving force						
Intensity of radiation from a point source in a vacuum	Distance from the source						
Spacing of fringes in a double slit experiment	Wavelength of the radiation						
Observed wavelength of a spectral line	Recession speed of the galaxy emitting the light						

Q4

(Total 4 marks)

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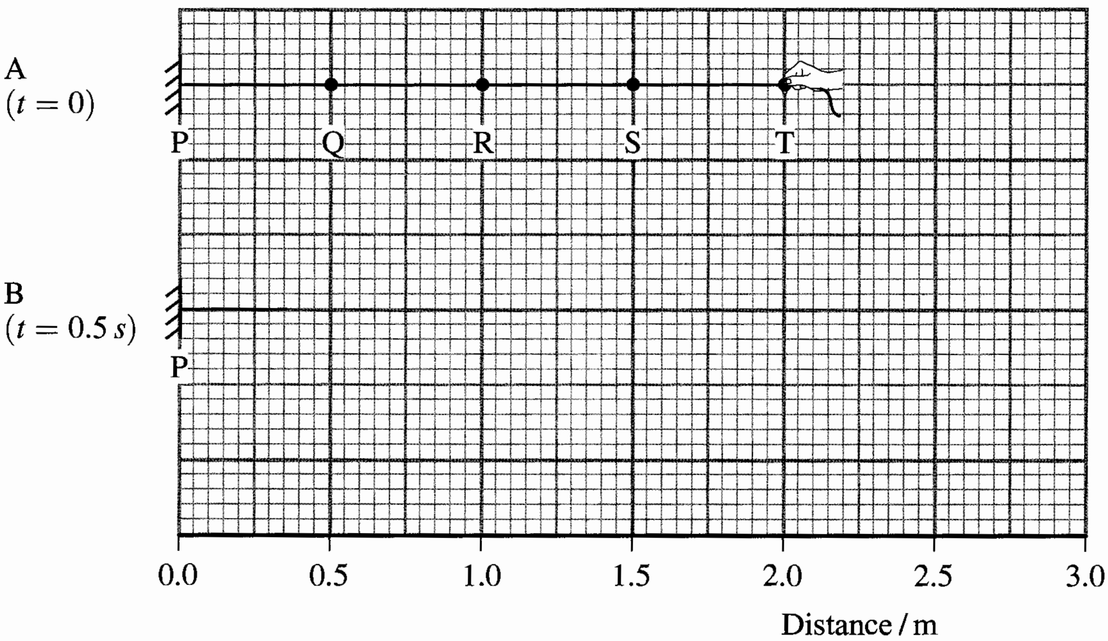
5. A physics teacher uses a simple model to illustrate the behaviour of the Universe. A long elastic cord, clamped at one end P, has knots Q, R, S and T tied in it at equal intervals. Initially the cord is straight but unstretched with the knots 0.50 m apart, as shown in part A of the diagram.



The teacher grasps knot T and pulls it away from P at a steady speed of 0.80 m s^{-1}. The cord stretches uniformly.

(a) (i) On part B of the diagram, mark the position of knot T after 0.50 s.

(ii) Hence complete part B by marking the positions of knots Q, R and S after 0.50 s.

(2)

(b) Explain how this model represents the Universe and its behaviour.

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(2)

Leave blank

(c) Using values taken from the diagram, show how the model illustrates Hubble's law.

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(3)

(d) State **two** ways in which this demonstration is not a good model of the Universe.

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2 ....

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(2)

Q5

(Total 9 marks)

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6. (a) Magnesium has a work function of 5.89×10^{-19} J. Explain the meaning of this statement.

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(2)

(b) Ultraviolet radiation from an extremely faint source is incident normally on a magnesium plate. The intensity of the radiation is 0.035 W m^{-2}. A single magnesium atom occupies an area of about 8×10^{-20} m^2 on the surface of the plate.

(i) Show that, if the radiation is regarded as a wave motion, it should take at least 200 s for a magnesium atom to absorb 5.89×10^{-19} J of energy.

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(3)

(ii) In practice, it is found that photoemission from the plate begins as soon as the radiation source is switched on. Explain how the photon model of electromagnetic radiation accounts for this. You may be awarded a mark for the clarity of your answer.

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(4)

Q6

(Total 9 marks)

Leave blank

7. (a) In a pendulum clock the timing is regulated by oscillations of a simple pendulum. The pendulum consists of a heavy mass attached to a thin metal rod. It swings through a fixed small amplitude.

(i) In one such clock, the period of the pendulum is 2.00 s. Calculate its length.

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Length = ...

(2)

(ii) Pendulum clocks are inaccurate because the period of swing varies slightly under different conditions. Suggest one reason for such a variation.

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(1)

(iii) Instead of a simple pendulum, a mass-spring system could be used to regulate the timing of a clock. Suggest, with a reason, whether the period of the mass-spring system would also vary under different conditions.

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(1)

(b) In the most accurate modern clock (the 'atomic' clock), timing is regulated by the vibrations of a particular electromagnetic wave. To set the frequency of this wave precisely, it is adjusted until the wave is strongly absorbed by caesium atoms. The frequency at which this occurs is known exactly, and is 9.19×10^9 Hz to three significant figures.

(i) Show that the wavelength of the wave is approximately 33 mm.

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(1)

(ii) To which part of the electromagnetic spectrum does this wave belong?

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(1)

(iii) The absorption of the wave results in a particular transition between energy levels in the caesium atom. Calculate the energy difference, in eV, between these levels.

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Energy difference = ... eV

(3)

Q7

(Total 9 marks)

TOTAL FOR PAPER: 60 MARKS

END

List of data, formulae and relationships

Data

Speed of light in vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$	
Gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	
Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to the Earth)
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to the Earth)
Elementary (proton) charge	$e = 1.60 \times 10^{-19} \text{ C}$	
Electronic mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$	
Electronvolt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	
Unified atomic mass unit	$\text{u} = 1.66 \times 10^{-27} \text{ kg}$	
Molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$	
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$	
Coulomb Law constant	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ N A}^{-2}$	
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	

Rectilinear motion

For uniformly accelerated motion:

$$v = u + at$$

$$x = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2ax$$

Forces and moments

Moment of F about O = $F \times$ (Perpendicular distance from F to O)

Sum of clockwise moments about any point in a plane = Sum of anticlockwise moments about that point

Dynamics

Force $\quad F = m\dfrac{\Delta v}{\Delta t} = \dfrac{\Delta p}{\Delta t}$

Impulse $\quad F\Delta t = \Delta p$

Mechanical energy

Power $\quad P = Fv$

Radioactive decay and the nuclear atom

Activity $\quad A = \lambda N \quad$ (Decay constant λ)

Half-life $\quad \lambda t_{\frac{1}{2}} = 0.69$

M 3 1 1 7 1 A 0 1 6 2 0

Electrical current and potential difference

Electric current	$I = nAQv$	
Electric power	$P = I^2R$	

Electrical circuits

Terminal potential difference	$V = \mathcal{E} - Ir$	(E.m.f. $\mathcal{E}$; Internal resistance r)
Circuit e.m.f.	$\Sigma\mathcal{E} = \Sigma IR$	
Resistors in series	$R = R_1 + R_2 + R_3$	
Resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	

Heating matter

Change of state:	energy transfer $= l\Delta m$	(Specific latent heat or specific enthalpy change l)
Heating and cooling:	energy transfer $= mc\Delta T$	(Specific heat capacity c; Temperature change ΔT)
Celsius temperature	$\theta/°\mathrm{C} = T/\mathrm{K} - 273$	

Kinetic theory of matter

Temperature and energy	$T \propto$ Average kinetic energy of molecules	
Kinetic theory	$p = \frac{1}{3}\rho\langle c^2\rangle$	

Conservation of energy

Change of internal energy	$\Delta U = \Delta Q + \Delta W$	(Energy transferred thermally ΔQ; Work done on body ΔW)
Efficiency of energy transfer	$= \frac{\text{Useful output}}{\text{Input}}$	
Heat engine: maximum efficiency	$= \frac{T_1 - T_2}{T_1}$	

Circular motion and oscillations

Angular speed	$\omega = \frac{\Delta\theta}{\Delta t} = \frac{v}{r}$	(Radius of circular path r)
Centripetal acceleration	$a = \frac{v^2}{r}$	
Period	$T = \frac{1}{f} = \frac{2\pi}{\omega}$	(Frequency f)

Simple harmonic motion:

displacement $x = x_0 \cos 2\pi ft$

maximum speed $= 2\pi f x_0$

acceleration $a = -(2\pi f)^2 x$

For a simple pendulum	$T = 2\pi\sqrt{\frac{l}{g}}$	(Pendulum length l)
For a mass on a spring	$T = 2\pi\sqrt{\frac{m}{k}}$	(Spring constant k)

M 3 1 1 7 1 A 0 1 7 2 0

Waves

Intensity	$I = \dfrac{P}{4\pi r^2}$	(Distance from point source r; Power of source P)

Superposition of waves

Two slit interference	$\lambda = \dfrac{xs}{D}$	(Wavelength λ; Slit separation s; Fringe width x; Slits to screen distance D)

Quantum phenomena

Photon model	$E = hf$	(Planck constant h)
Maximum energy of photoelectrons	$= hf - \varphi$	(Work function φ)
Energy levels	$hf = E_1 - E_2$	
de Broglie wavelength	$\lambda = \dfrac{h}{p}$	

Observing the Universe

Doppler shift	$\dfrac{\Delta f}{f} = \dfrac{\Delta\lambda}{\lambda} \approx \dfrac{v}{c}$	
Hubble law	$v = Hd$	(Hubble constant H)

Gravitational fields

Gravitational field strength	$g = F/m$	
for radial field	$g = Gm/r^2$, numerically	(Gravitational constant G)

Electric fields

Electrical field strength	$E = F/Q$	
for radial field	$E = kQ/r^2$	(Coulomb law constant k)
for uniform field	$E = V/d$	
For an electron in a vacuum tube	$e\Delta V = \Delta(\frac{1}{2}m_e v^2)$	

Capacitance

Energy stored	$W = \frac{1}{2}CV^2$	
Capacitors in parallel	$C = C_1 + C_2 + C_3$	
Capacitors in series	$\dfrac{1}{C} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3}$	
Time constant for capacitor discharge	$= RC$	

18

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Magnetic fields

Force on a wire $F = BIl$

Magnetic flux density (Magnetic field strength)

in a long solenoid $B = \mu_0 nI$ (Permeability of free space μ_0)

near a long wire $B = \mu_0 I / 2\pi r$

Magnetic flux $\Phi = BA$

E.m.f. induced in a coil $\mathcal{E} = -\dfrac{N\Delta\Phi}{\Delta t}$ (Number of turns N)

Accelerators

Mass-energy $\Delta E = c^2 \Delta m$

Force on a moving charge $F = BQv$

Analogies in physics

Capacitor discharge $Q = Q_0 e^{-t/RC}$

$$\frac{t_{\frac{1}{2}}}{RC} = \ln 2$$

Radioactive decay $N = N_0 e^{-\lambda t}$

$$\lambda t_{\frac{1}{2}} = \ln 2$$

Experimental physics

$$\text{Percentage uncertainty} = \frac{\text{Estimated uncertainty} \times 100\%}{\text{Average value}}$$

Mathematics

$$\sin(90° - \theta) = \cos\theta$$

$$\ln(x^n) = n \ln x$$

$$\ln(e^{kx}) = kx$$

Equation of a straight line $y = mx + c$

Surface area cylinder $= 2\pi rh + 2\pi r^2$

sphere $= 4\pi r^2$

Volume cylinder $= \pi r^2 h$

sphere $= \frac{4}{3}\pi r^3$

For small angles: $\sin\theta \approx \tan\theta \approx \theta$ (in radians)

$\cos\theta \approx 1$

M 3 1 1 7 1 A 0 1 9 2 0

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