Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	7	3	5	/	0	1	Signature	

Paper Reference(s)

6735/01

Edexcel GCE

Physics

Advanced Level

Unit Test PHY5

Wednesday 11 June 2008 – Morning

Time: 1 hour

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
Total	

Materials required for examination	Items included with question papers
Nil	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: e.g. **(2)**.
There are five questions in this question paper. The total mark for this paper is 40.
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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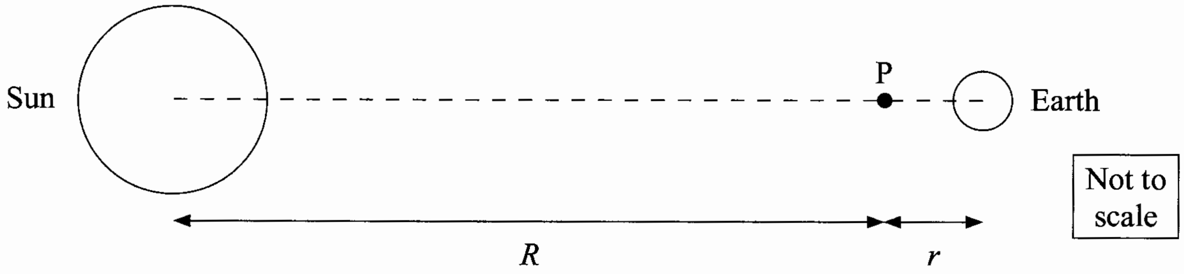
1. On a line between the Earth and the Sun is a point P where the gravitational field strength of the Sun is equal and opposite to that of the Earth. Point P is a distance R from the centre of the Sun and a distance r from the centre of the Earth.



The mass of the Sun is M_S. The mass of the Earth is M_E. The gravitational constant is G.

(a) Using the symbols given, write down an expression for

(i) the gravitational field strength of the Sun at point P

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....

(ii) the gravitational field strength of the Earth at point P.

....

....

(1)

(b) The mass of the Sun is 2.0×10^{30} kg. The mass of the Earth is 6.0×10^{24} kg.

(i) Show that the ratio of R to r is about 600 : 1.

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(2)

Leave blank

(ii) Hence find the value of r, given that the distance from the centre of the Earth to the centre of the Sun is 1.5×10^8 km.

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$r =$ ....

(2)

(c) SOHO, a satellite that monitors the Sun, is positioned at a point on the line between the Earth and the Sun. The gravitational forces acting on it keep it in the same relative position, orbiting the Sun at the same rate as the Earth.

On the diagram opposite, mark with a letter L a possible position for SOHO.

With reference to the circular motion of SOHO, explain how you decided on the position of L. You are **not** expected to perform any calculations.

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(3)

Q1

(Total 8 marks)

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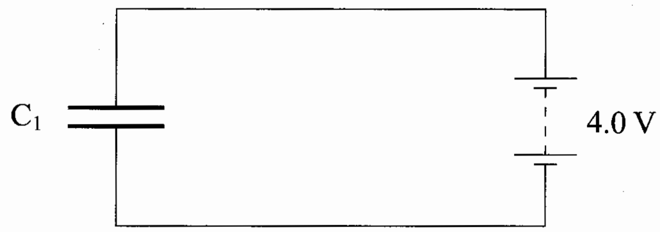
2. A capacitor C_1 is connected to a supply. When a potential difference of 4.0 V is applied across the capacitor, it stores a charge of 0.80 nC.



(a) (i) Calculate the electrical work done by the supply as it transfers this charge.

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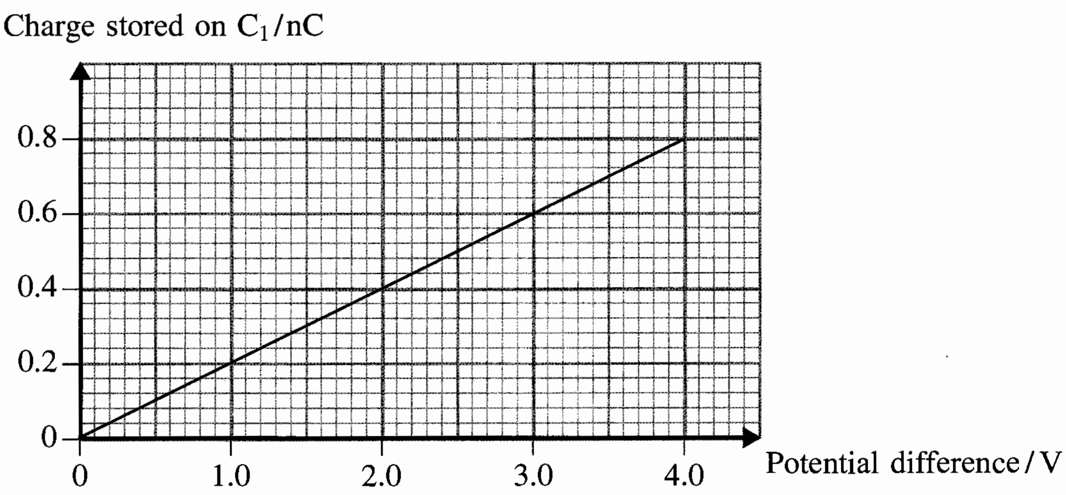
Work done = ...

(2)

(ii) Mark on the diagram above the magnitudes and polarities of the charges stored on the plates of the capacitor.

(1)

(b) A graph of charge stored against potential difference across the capacitor is shown.



Explain how this graph supports the fact that the charged capacitor is storing 1.6 nJ of energy.

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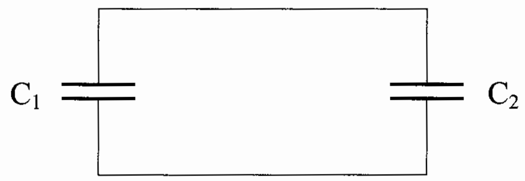
(2)

(c) With capacitor C_1 charged to 4.0 V, the supply is removed and a second, uncharged capacitor C_2 is connected in its place as shown.



Capacitor C_1 transfers some of its charge to the plates of capacitor C_2. As a result the potential difference across C_1 falls to 3.0 V.

(i) By referring to the graph for capacitor C_1, deduce how much charge transfers to capacitor C_2.

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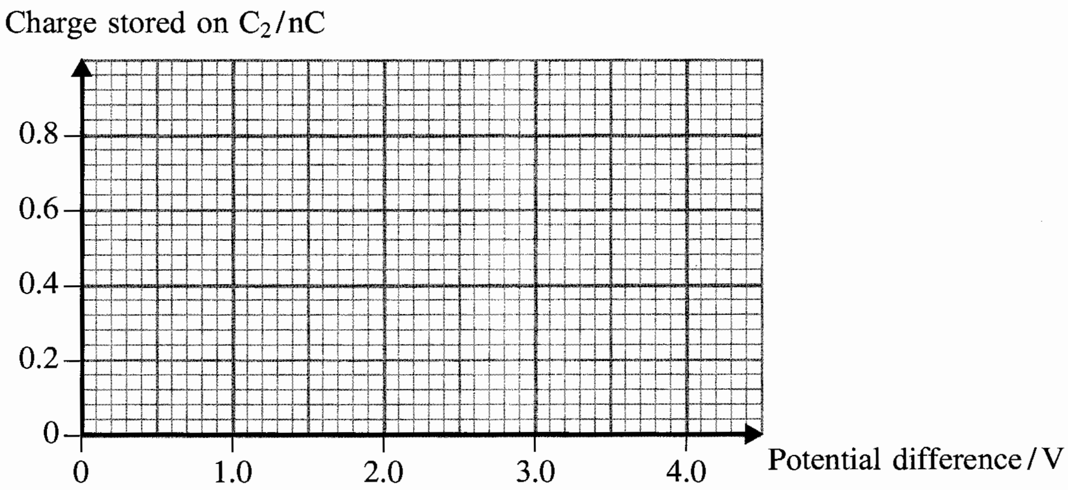
Charge transferred to C_2 = ...

(1)

(ii) On the grid below, show how the charge stored on capacitor C_2 varies with potential difference during this charge transfer process.



(2)

(iii) Use the values you have plotted to find the capacitance of capacitor C_2.

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Capacitance of C_2 = ...

(2)

(Total 10 marks)

Leave blank

Q2

Turn over

M 2 9 3 7 8 A 0 5 1 6

Leave blank

3. Inside a long solenoid, the magnetic field strength (flux density) along the axis is $B = \mu_0 nI$.

(a) Show that this equation is homogeneous with respect to units.

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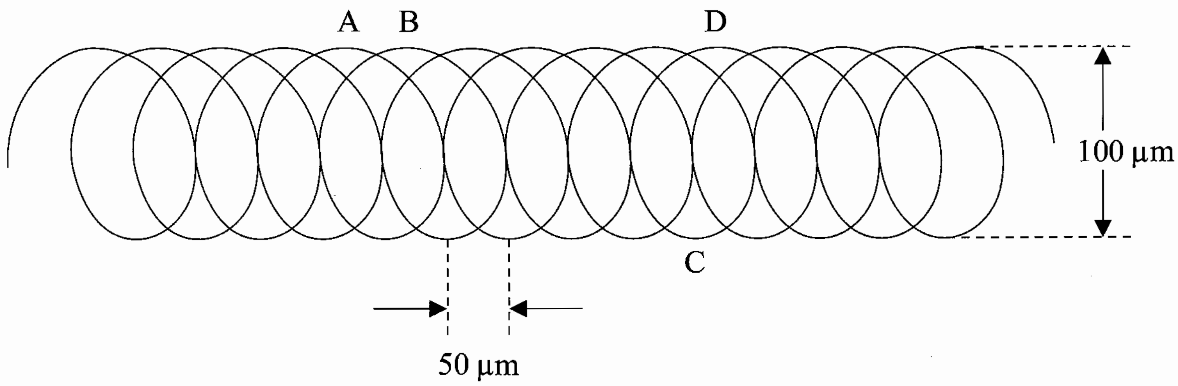
(3)

(b) The filament of a conventional light bulb is an extended coil of thin tungsten wire, with adjacent turns 50 μm apart.



By treating this coil as a long solenoid, determine the magnetic field strength along the axis of the filament when there is a current of 0.40 A.

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B = ...

(2)

M 2 9 3 7 8 A 0 6 1 6

Leave blank

(c) When there is a steady direct current in the filament, the sections of wire in adjacent turns at A and B experience a constant mutually attractive force, acting along the length of the coil, while the sections at C and D experience a constant repulsive force, acting across the width of the coil.

(i) Explain **briefly** why one force would be attractive and the other repulsive.

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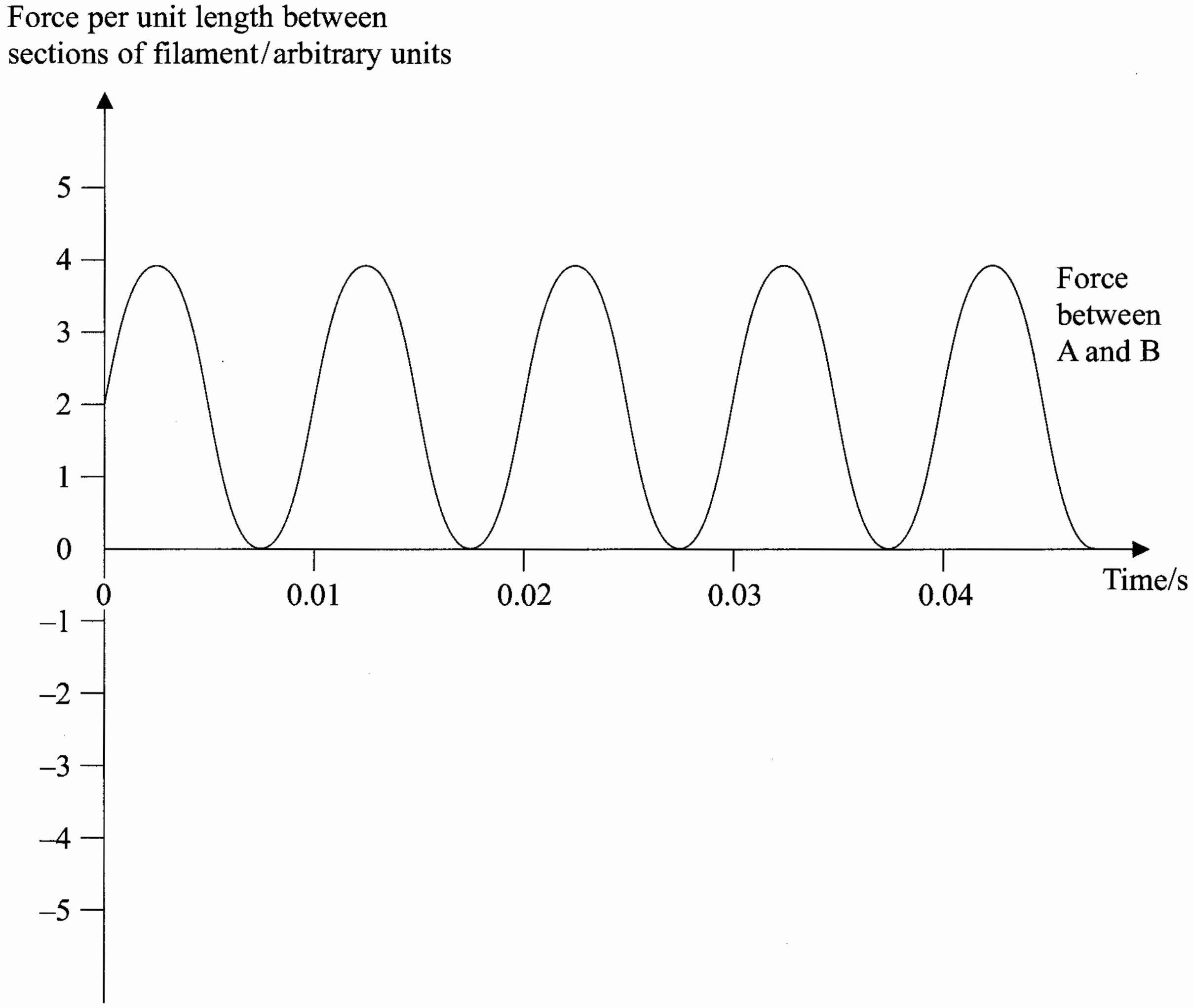
(1)

(ii) In practice the current through the filament will be alternating. The graph shows how the force per unit length between sections A and B will vary over time. Attractive forces are taken to be positive.



Add to the above graph to show how the force experienced per unit length between wire sections C and D varies during the same time interval. The diameter of the coil is 100 μm.

(2)

Q3

(Total 8 marks)

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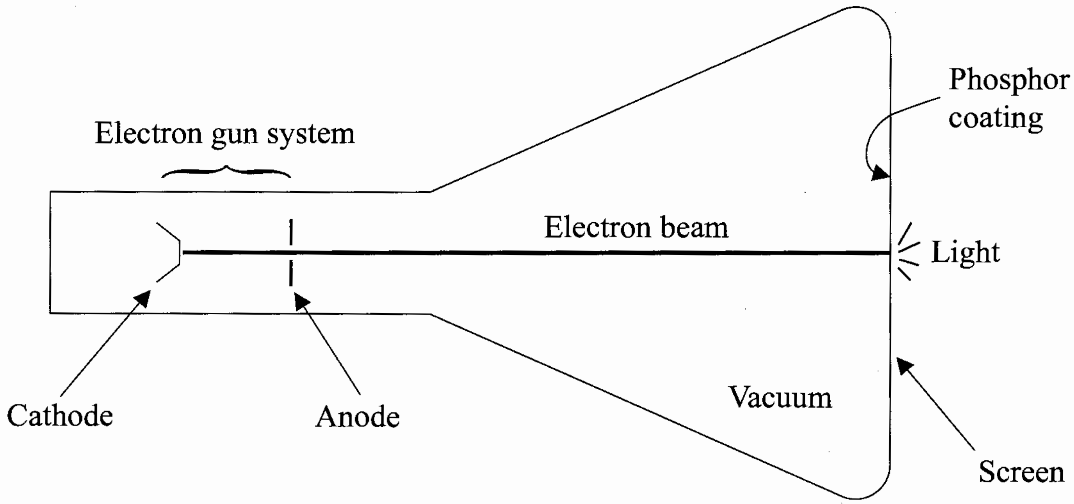
4. A simplified diagram of a cathode ray oscilloscope is shown.



(a) Electrons liberated from the cathode are accelerated to the anode through a large potential difference, giving each electron in the beam an energy of 1.2 keV.

(i) Calculate the velocity of electrons in the beam.

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Velocity = ...

(3)

(ii) The phosphor coating produces green light, each photon of which has an energy of 2.4 eV. The efficiency of the conversion of electron kinetic energy to light in the phosphor is 8.0%. Calculate the number of photons that will be liberated from the phosphor coating by the arrival of one electron in the beam.

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Number of photons = ...

(2)

(b) In a badly-designed cathode ray tube, electrons arriving at the screen are not conducted away but build up in the area where the beam hits it. Explain how this will have an adverse effect on the amount of light emitted by the phosphor. You may be awarded a mark for the clarity of your answer.

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(4)

(Total 9 marks)

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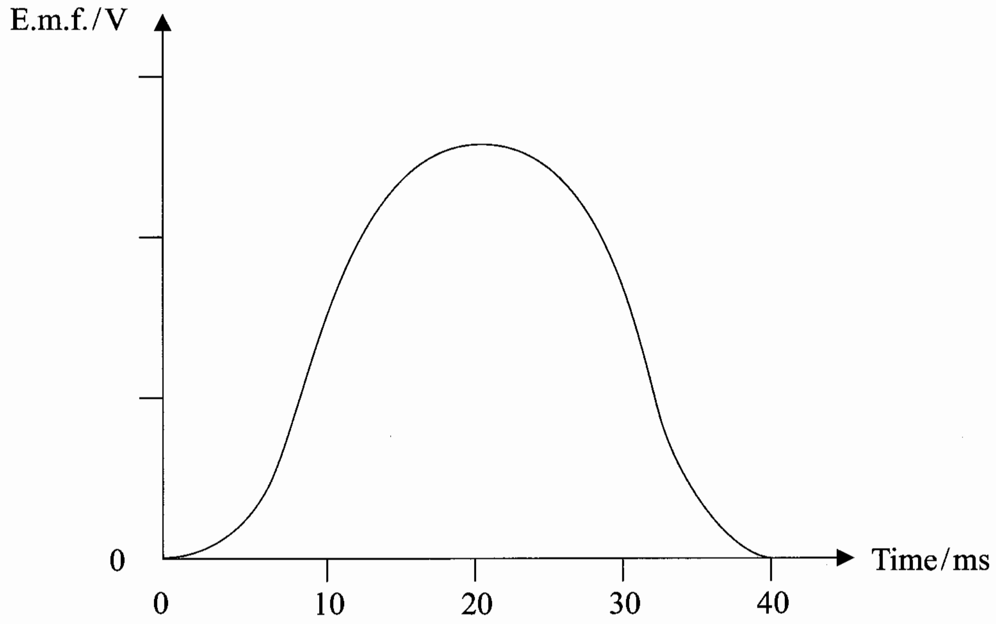
Q4

Leave blank

5. A small 'search coil', connected to a data-logger, is used to investigate a steady magnetic field. The coil is placed so that the field is perpendicular to the plane of the coil. The coil is then turned through 90° in 40 ms, finishing with its plane parallel to the field. This induces an e.m.f. across the ends of the coil.

The data-logger indicates that the **mean** value of the e.m.f. during the process is 0.12 V.

It also displays the following trace.



(a) Add an appropriate scale to the vertical axis on the graph above.

(1)

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(b) The search coil has 5000 turns.

(i) The mean e.m.f. induced during the rotation is 0.12 V. Show that the magnetic flux through the coil before rotation was approximately 1 μWb.

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(2)

(ii) The coil has a diameter of 1.0 cm. Calculate the magnetic flux density of the magnetic field in which the coil is rotated.

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Magnetic flux density = ...

(2)

Q5

(Total 5 marks)

TOTAL FOR PAPER: 40 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	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$	
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	
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	$\mu_0 = 4\pi \times 10^{-7}\ \text{N A}^{-2}$	

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 × (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 $\quad \lambda t_{\frac{1}{2}} = 0.69$

Electrical current and potential difference

Electric current $I = nAQv$

Electric power $P = I^2 R$

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

For a mass on a spring $T = 2\pi\sqrt{\frac{m}{k}}$ (Spring constant k)

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 to charge or discharge	$= RC$	

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 $\varepsilon = -\dfrac{N\Delta\Phi}{\Delta t}$ (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)

$\cos\theta \approx 1$

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