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 21 January 2009 – Morning

Time: 1 hour

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
Total	

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: e.g. **(2)**.
There are six 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. (a) State Newton's law for the gravitational force between point masses.

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(2)

(b) An asteroid of mass 1.0×10^{10} kg, which one day might collide with the Earth, is to be deflected from its path using a spacecraft as a 'gravity tractor'. The tractor, of mass 2.0×10^{4} kg, will take up position beside the asteroid with its centre of gravity 150 m from that of the asteroid.

(i) Show that the force of gravitational attraction between the asteroid and the tractor will be about 0.6 N.

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(2)

(ii) Determine the acceleration of the asteroid as a result of this gravitational force.

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Acceleration = ...

(2)

(iii) If the asteroid had only half the stated mass, what mass of tractor would be needed to produce the same acceleration?

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....

Mass = ...

(1)

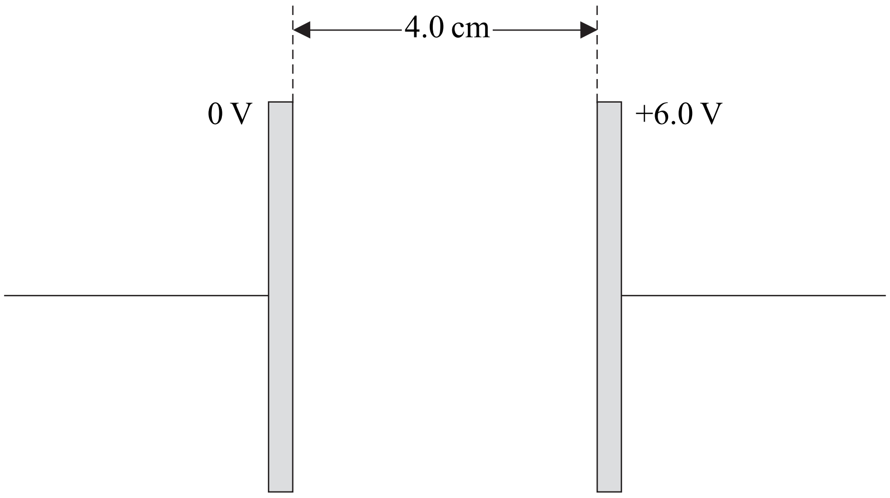
Q1

(Total 7 marks)

Leave blank

2. A student intends to investigate the electrical conduction properties of a Bunsen burner flame using a pair of metal plates. A potential difference of 6.0 V is applied across the plates while they are held a fixed distance of 4.0 cm apart.

The arrangement is shown in the diagram.



(a) (i) The electric field strength between the plates can be measured either in $V\,m^{-1}$ or in $N\,C^{-1}$. Show that these two sets of units are equivalent.

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(2)

(ii) On the diagram above, sketch the 3.0 V and 4.0 V equipotential lines in the region between the plates. Label each line with its value.

(2)

Leave blank

(b) The Bunsen flame is now positioned between the plates. Positive ions and electrons in the flame are acted on by the electric field.

(i) Assuming the electric field between the plates remains uniform, calculate the magnitude of the force exerted on a single electron in the flame.

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Force = ...

(3)

(ii) A sensitive meter in the circuit records a current of 8.0 nA. How many electrons arrive per second on the positive plate?

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Number = ... s^{-1}

(1)

Q2

(Total 8 marks)

N 2 9 3 7 5 R A 0 5 1 6

Turn over

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3. (a) A ‘super capacitor’ of capacitance 10 F is charged to a potential difference of 2.5 V.

(i) Show that the energy stored is approximately 30 J.

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(1)

(ii) The capacitor is a cylinder 2.0 cm long, with a diameter of 1.0 cm. Calculate the energy stored per unit volume in J m^{-3}.

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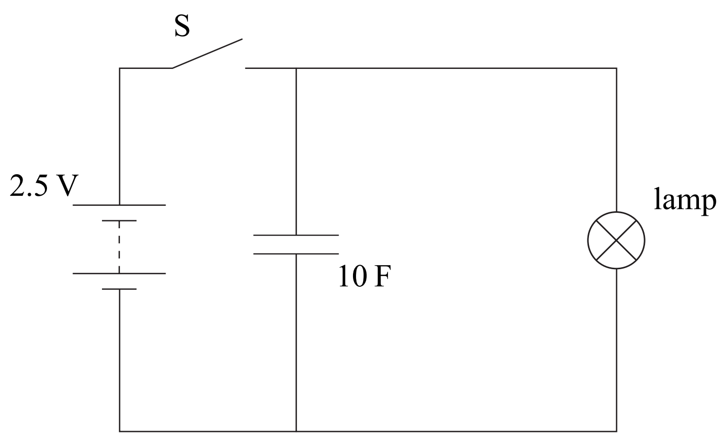
Energy per unit volume = ... J m^{-3}

(2)

(b) A student uses the capacitor to supply current to a lamp rated 2.5 V, 0.2 A. The capacitor is first charged to 2.5 V using the circuit shown.

The switch S is then opened so that the capacitor discharges through the lamp. The student uses a stop-clock to time how long the lamp stays lit from the moment the switch is opened.



(i) By considering the amount of charge initially stored, calculate the time it would take for the capacitor to fully discharge if it delivered a steady current of 0.2 A throughout the process.

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Discharge time = ...

(2)

(ii) Explain why, in practice, the current will not remain at 0.2 A as the capacitor discharges.

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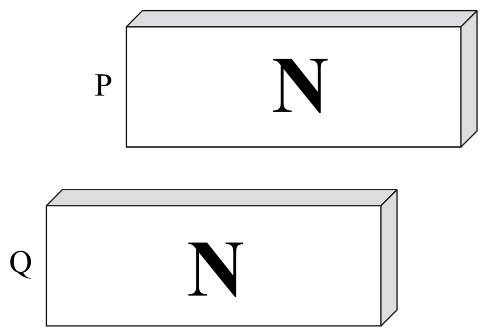
(1)

Q3

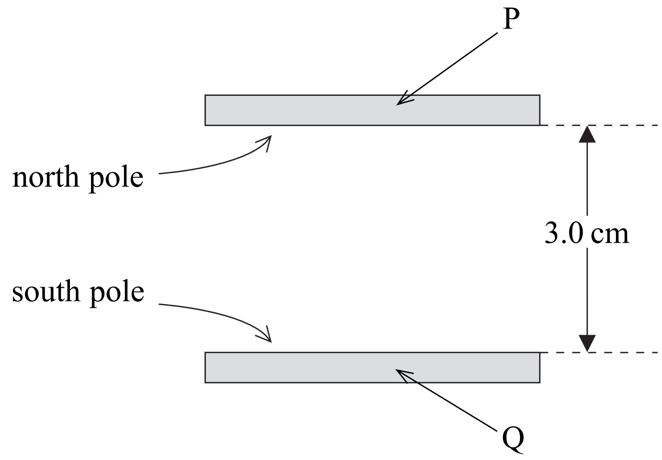
(Total 6 marks)

4. Two identical magnets, P and Q, are rectangular in shape and have their north and south poles on their largest faces. They are stood on edge, 3.0 cm apart and parallel to each other, with opposite poles facing, as shown.

Side view:

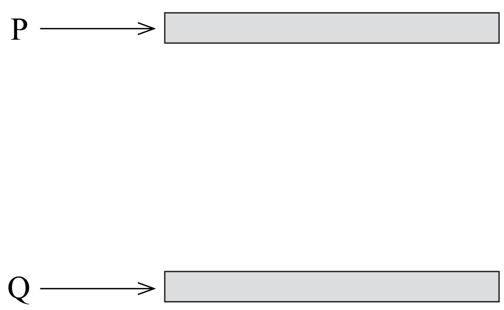


View from above:



(a) This arrangement is intended to produce a uniform magnetic field.

(i) Show, on the diagram below, the magnetic field pattern you would get in the gap between the magnets if there were a uniform field between them.



(2)

(ii) A pre-calibrated Hall probe is moved across the gap without changing its orientation. It goes directly from the centre of the north pole of P to the centre of the south pole of Q. The reading from the probe remains at a constant value of 4.0 units while this is done.

To what extent does this confirm that a uniform field has been produced in the gap?

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(2)

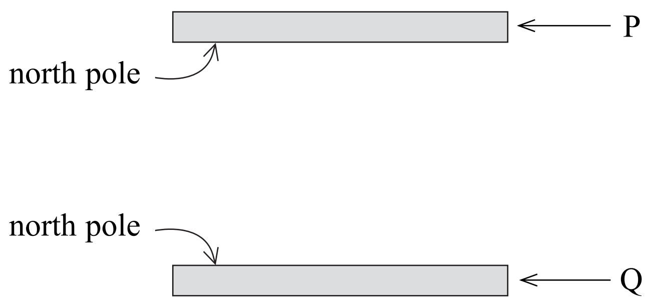
Leave blank

N 2 9 3 7 5 R A 0 8 1 6

Leave blank

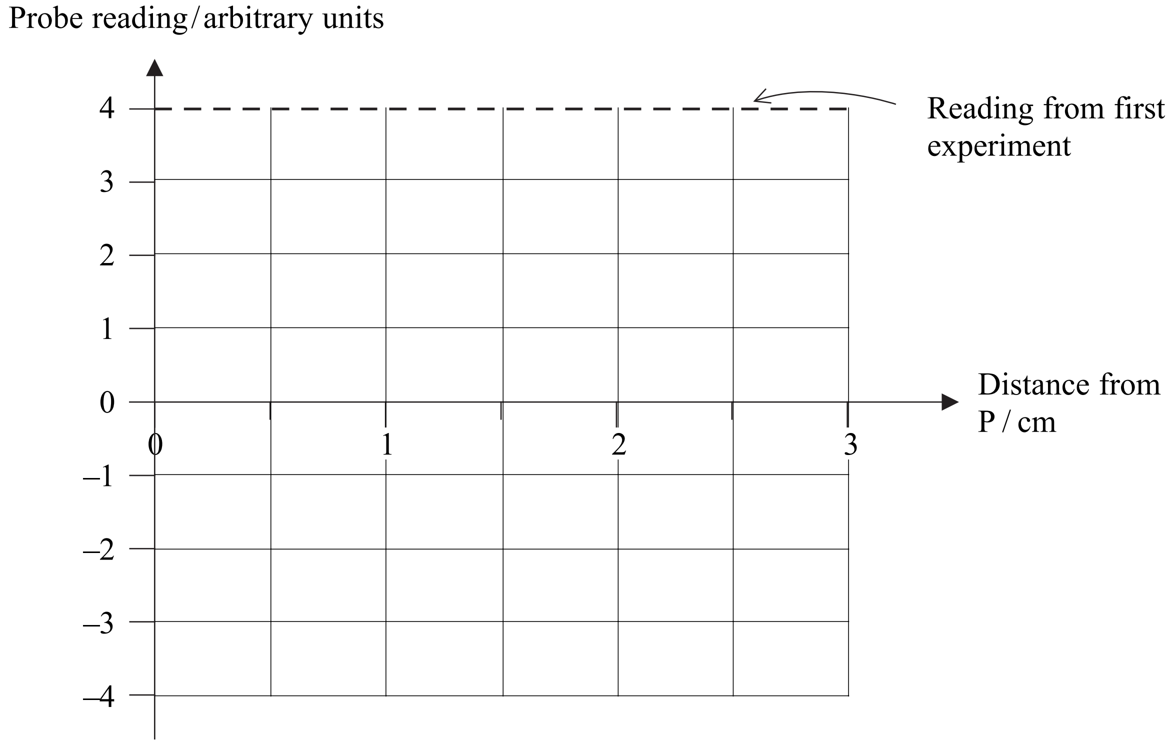
(b) Magnet Q is turned round so that both north poles are facing. The magnets remain 3.0 cm apart.

(i) Show, on the diagram below, the magnetic field pattern that will now be produced in the gap between the magnets. Label any significant feature.



(3)

(ii) With this new arrangement, the Hall probe is moved from P to Q in the same way as before. On the graph below show how you would expect the reading from the probe to vary over the 3.0 cm distance from P to Q. The result of the previous experiment, as described in part (a), is shown for reference. Assume that the effect of the Earth's magnetic field is negligible and the calibration of the Hall probe is unchanged.



(2) **Q4**

(Total 9 marks)

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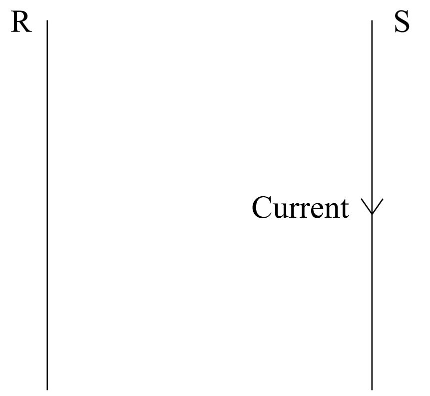
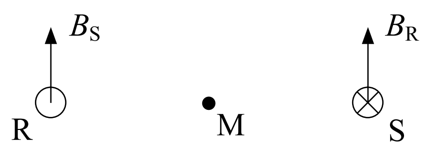
5. Figure 1 shows two vertical current-carrying wires R and S. The current direction in wire S is downwards, as shown.

Figure 2 illustrates the same arrangement as seen from above. The arrow B_R gives the magnitude and direction of the field at S due to the current in wire R. Similarly, B_S shows the magnetic field at R due to the current in wire S.



Side view

Figure 1



Plan (top) view

Figure 2

The wires experience forces due to the interaction of the magnetic fields with the currents.

(a) Name the rule used to determine the direction of the force acting on wire S.

....

(1)

(b) Use this rule to determine the direction of the force that acts on wire S. Show this force on Figure 2, using an arrow labelled *F*.

(1)

(c) Deduce the direction of the current in wire R. Indicate this with an arrow on Figure 1.

(1)

(d) The magnetic field at point M, mid-way between the wires, is caused by the currents in both R and S.

On Figure 2, draw an arrow labelled *B* that shows the magnitude and direction of the resultant magnetic field at M.

(2)

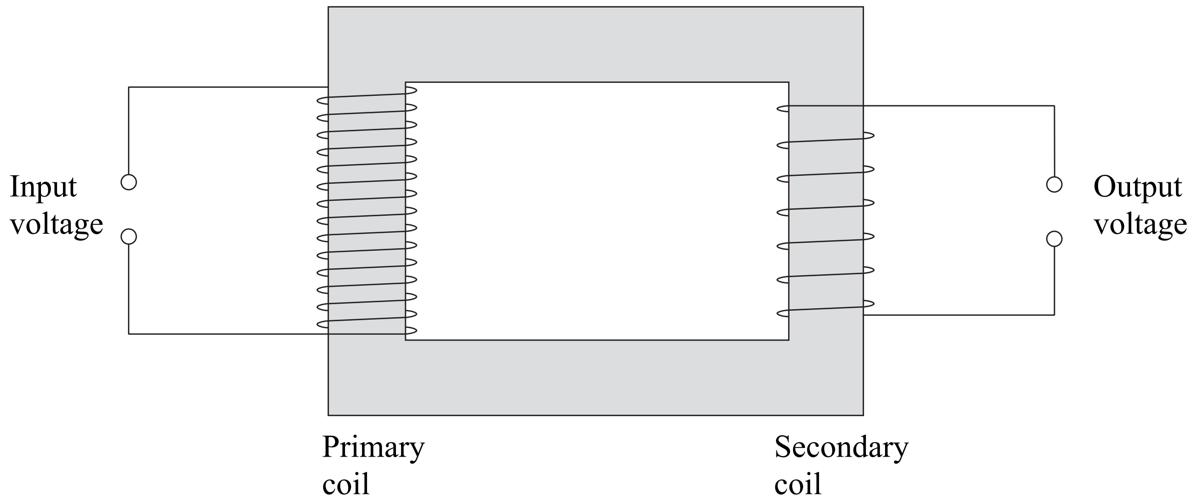
(Total 5 marks)

Leave blank

Q5

Leave blank

6. The diagram shows a step-down transformer.



Explain the action of this transformer. You may be awarded a mark for the clarity of your answer.

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Q6

(Total 5 marks)

TOTAL FOR PAPER: 40 MARKS

END

N 2 9 3 7 5 R A 0 1 1 1 6

List of data, formulae and relationships

Data

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

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

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 $\theta/°\text{C} = T/\text{K} - 273$

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

Superposition of waves

Two slit interference $\lambda = \frac{xs}{D}$ (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 $\lambda = \frac{h}{p}$

Observing the Universe

Doppler shift $\frac{\Delta f}{f} = \frac{\Delta\lambda}{\lambda} \approx \frac{v}{c}$

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 $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

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