Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	7	5	4	/	0	1	Signature	

Paper Reference(s)

6754/01

Edexcel GCE

Salters Horners Physics

Advanced Level

Unit Test PSA4

Wednesday 11 June 2008 – Morning

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
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** of the questions, writing your answers in this question booklet.
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 mark 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. In 2002 the Jefferson Laboratory released the results of an experiment involving collisions of high speed electrons with protons. The results suggested that protons are not spherical, but have a bulging shape. In a subsequent paper some of these results were explained by modelling a nucleon as 'a relativistic system of three bound quarks surrounded by a cloud of pions.'

Protons and neutrons are the two types of nucleon and both consist of up and down quarks.

Nucleon	**Quark composition**
proton	uud
neutron	udd

Quark	Charge
up quark	+2/3 *e*
down quark	–1/3 *e*

(a) Use the information in the tables to show how the charge of the proton and the charge of the neutron are arrived at.

proton ....

neutron ....

(2)

(b) Protons, neutrons and pions are all hadrons. There are two types of hadron, with different quark combinations.

(i) Complete the table below to name the two types of hadron.

Particles	**Hadron type**
proton, neutron	
pion	

(ii) State the differences in quark composition between these two types of hadron.

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(4)

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(c) Explain why high speed particles are used to examine the internal structure of other particles.

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(4)

(d) The model mentions a 'relativistic system'. State the condition needed for relativistic effects to be significant.

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(1)

Q1

(Total 11 marks)

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2. A student is researching information about CERN, the particle research centre near Geneva.
He finds the following statement on a web site:

"The circular tunnel is eight kilometres in diameter … fully accelerated particles circle the tube twenty thousand times in one second …"

Calculate the speed of the particles, and comment on the likely accuracy of the statement.

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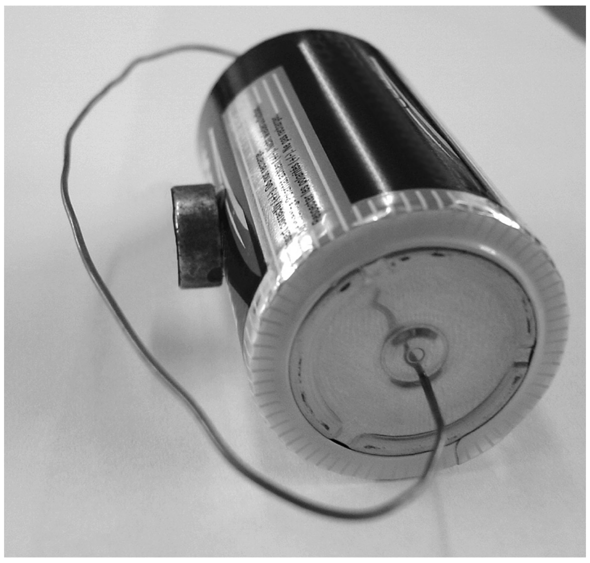
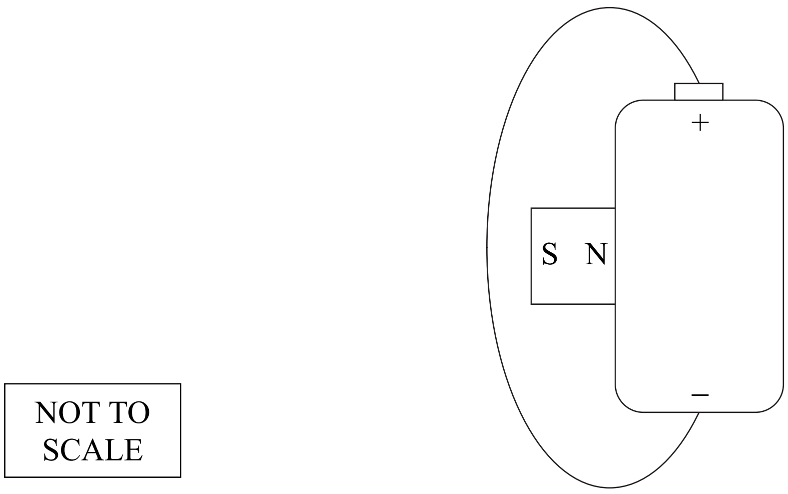
Q2

(Total 4 marks)

3. The photograph shows a flexible copper wire attached to the terminals of a dry cell. A strong circular magnet, 12 mm in diameter, is attached to the side of the cell. The interaction between the current in the wire and the magnetic field of the magnet causes the wire to levitate.



The diagram shows the arrangement viewed from above.



(a) Draw on the diagram the magnetic field produced by the magnet.

(2)

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Turn over

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(b) The following measurements were made:

upward force on wire = 8.0×10^{-3} N

current in wire = 5.8 A

length of wire in magnetic field = 12 mm

(i) Show that the magnetic flux density is about 0.1 T.

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(2)

(ii) State one assumption you made in your calculation.

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(1)

(c) The manufacturer's data sheet supplied with the magnets gives a value of 0.3 T for the magnetic flux density. Suggest a reason why this is different from the value given in (b)(i).

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(1)

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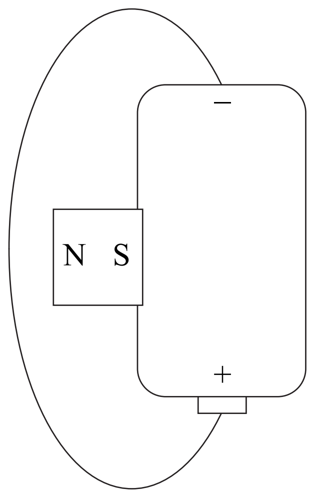
(d) Explain what would happen to the wire in the following arrangement.



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(2) **Q3**

(Total 8 marks)

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4. Devices which contain electrically charged grids are sometimes used to control the numbers of flying insects. The grids are connected to capacitors that store charge at a high voltage.

(a) Explain why a capacitor cannot be charged directly from the mains supply.

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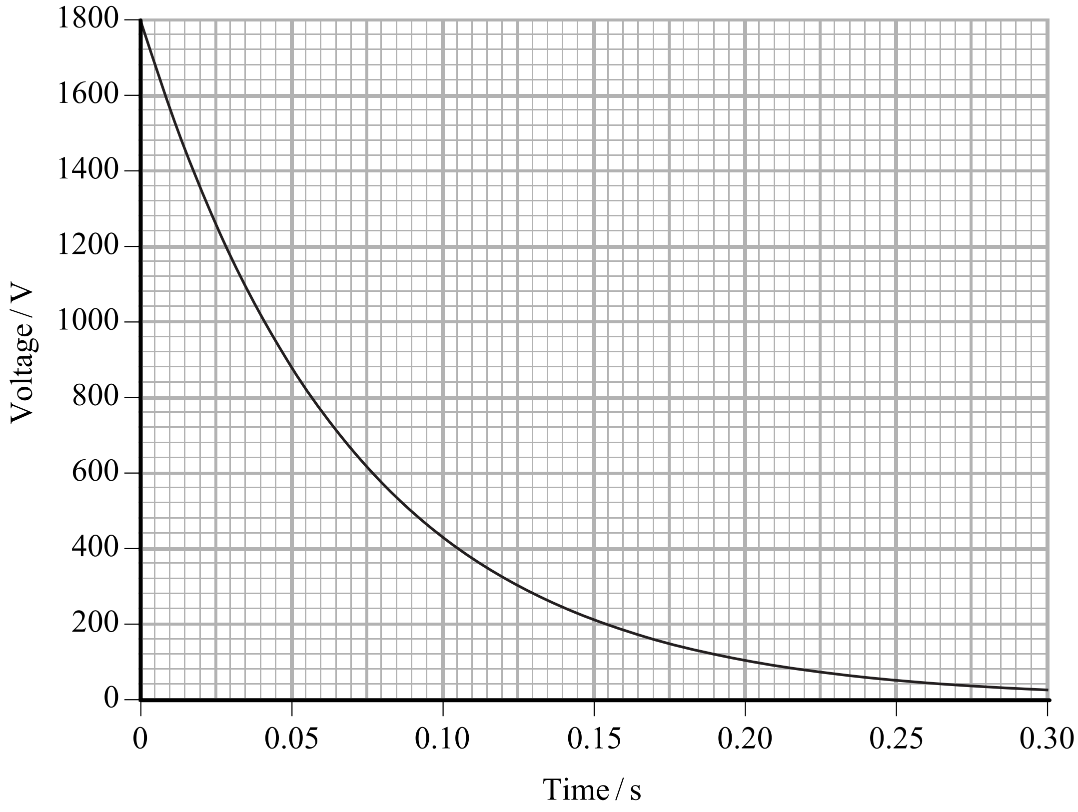
(2)

(b) A user reports on his device in a magazine: "The grids in my device didn't work very well, so I opened it up to have a look. I found that it only produced a voltage of 600 V, which was too low. I replaced it with a circuit that charged a 100 nF capacitor to 1800 V. This worked better."

The graph shows how the voltage across the 100 nF capacitor varies with time as it discharges through an insect.



N 3 1 1 9 0 A 0 8 2 0

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(i) Use the graph to estimate the time constant for the circuit containing the capacitor and the insect.

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Time constant = ...
(2)

(ii) Calculate a value for the resistance of the insect.

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Resistance = ...
(2)

(c) The user continues: "The manufacturers have recently introduced a new device incorporating a capacitor of 100 μF charged to 300 V."

(i) Calculate the charge stored on this capacitor when fully charged.

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Charge = ...
(2)

(ii) Calculate the energy stored in this capacitor when fully charged.

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Energy stored = ...
(2)

Q4

(Total 10 marks)

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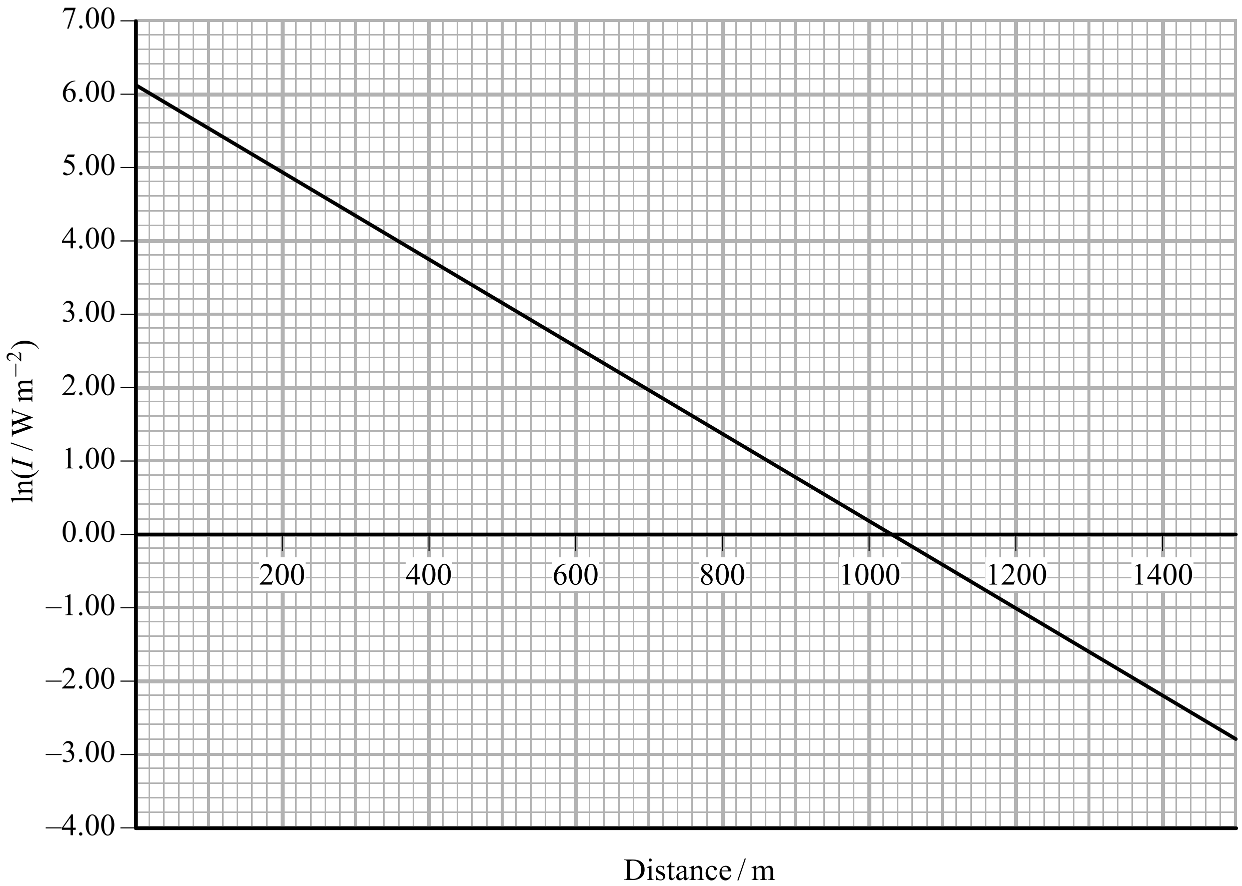
5. The water droplets in fog attenuate light and reduce visibility significantly.

The graph shows the attenuation of a laser beam of initial intensity 450 W m^{-2} as it passes through fog.

The natural logarithm of intensity has been plotted against distance from the laser.



(a) Use the graph to show that the attenuation coefficient is about 0.006 m^{-1}.

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(2)

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(b) The visibility of the light from lighthouses is affected by fog.

A particular lighthouse uses a 1000 W lamp and a system of lenses and mirrors to produce a beam of light. The lamp converts energy to visible light with an efficiency of 12% and the optical system transmits 83% of this light.

Assume that the beam is parallel, with a constant cross-sectional area 17.5 m^2.

(i) Show that the initial intensity of the emitted beam is about 6 W m^{-2}.

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(3)

(ii) 'Invisible' may be defined as a light intensity of 1×10^{-7} W m^{-2} or lower.

Calculate the distance from the lighthouse at which the light would become invisible.

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Distance = ...

(3)

Leave blank

(iii) The measured visibility range for this fog is actually 500 m. Comment on this measurement in comparison to your calculated answer.

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(2)

(c) In foggy weather, lights may be supplemented by foghorns, which emit loud sounds to give warnings. In fog, the attenuation coefficient for sound varies with frequency:

Attenuation coefficient at 512 Hz is 0.0018 m^{-1}
Attenuation coefficient at 8000 Hz is 0.0032 m^{-1}

Explain whether high or low frequencies would be more suitable for a foghorn.

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(1)

Q5

(Total 11 marks)

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6. A student wanted to choose which memory card to buy for a new digital camera.

The shop offered a choice of four different memory cards, all of comparable design. Their capacities were 128 MB, 256 MB, 512 MB and 1 GB.

To help customers to choose, the manufacturer of the cards supplied the following table. The numbers in the body of the table are the number of individual photos which each card can store, related to the number of pixels in the photos taken by the customer's camera.

Pixels per photo	**Card capacity**			
	128 MB	**256 MB**	**512 MB**	**1 GB**
2 M	127	254	508	1016
3 M	85	171	341	683
4 M	64	128	256	512
5 M	51	102	205	410
6 M	43	86	172	344
8 M	32	64	128	256

(a) Describe any patterns that occur in the data supplied. You must use numbers from the table to support your statements.

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(b) Make an estimate of the number of bits required to store the information from one pixel.

1 B (byte) is eight bits of data.

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(3)

Q6

(Total 8 marks)

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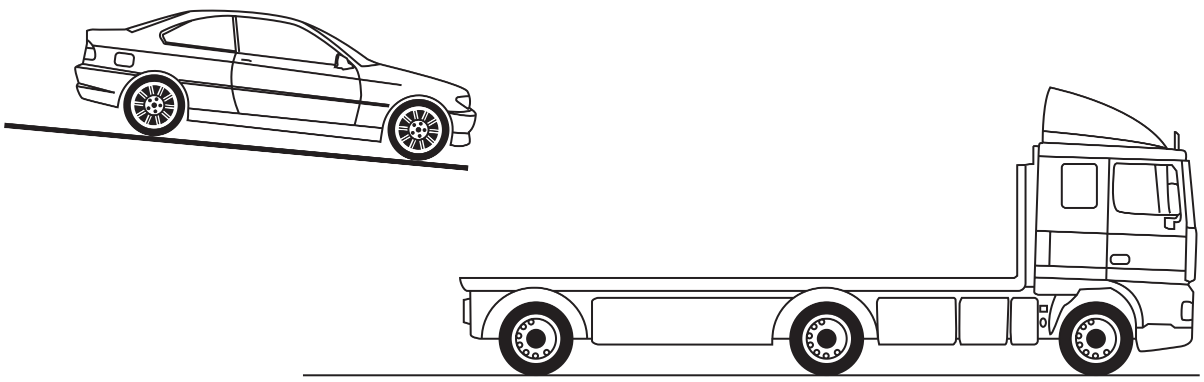

Two students are watching an action film in which a car drives down a ramp onto the back of a moving lorry. Both are moving at high speed, the car slightly faster than the lorry.

One student complains that this is impossible because the car would not be able to stop before hitting the cab of the lorry.

The car has mass 1250 kg and is moving at a speed of 28.0 m s^{-1}. The lorry has mass 3500 kg and a speed of 25.5 m s^{-1}. The length of the flat back of the lorry allows a braking distance of 5.0 m.

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By considering both momentum and energy show that the stunt is possible, provided a minimum force of about 600 N slows the car down. You should support your explanations with calculations.

Treat the situation as one in which two objects join together.

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(Total 8 marks)

TOTAL FOR PAPER: 60 MARKS

END

List of data, formulae and relationships

Data

Gravitational constant	$G = 6.67\times10^{-11}\,\mathrm{N\,m^2\,kg^{-2}}$	
Acceleration of free fall	$g = 9.81\,\mathrm{m\,s^{-2}}$	(close to Earth's surface)
Gravitational field strength	$g = 9.81\,\mathrm{N\,kg^{-1}}$	(close to Earth's surface)
Electronic charge	$e = -1.60\times10^{-19}\,\mathrm{C}$	
Electronic mass	$m_e = 9.11\times10^{-31}\,\mathrm{kg}$	
Electronvolt	$1\,\mathrm{eV} = 1.60\times10^{-19}\,\mathrm{J}$	
Proton mass	$m_p = 1.67\times10^{-27}\,\mathrm{kg}$	
Planck constant	$h = 6.63\times10^{-34}\,\mathrm{J\,s}$	
Speed of light in a vacuum	$c = 3.00\times10^{8}\,\mathrm{m\,s^{-1}}$	
Molar gas constant	$R = 8.31\,\mathrm{J\,K^{-1}\,mol^{-1}}$	
Boltzmann constant	$k = 1.38\times10^{-23}\,\mathrm{J\,K^{-1}}$	
Permittivity of free space	$\varepsilon_0 = 8.85\times10^{-12}\,\mathrm{F\,m^{-1}}$	
Permeability of free space	$\mu_0 = 4\pi\times10^{-7}\,\mathrm{N\,A^{-2}}$	

Unit 1

Physics at work, rest and play

Mechanics

Kinematic equations of motion $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

Energy

% *efficiency* = [*useful energy* (or power) *output/total energy* (or power) *input*] × 100%

Heating $\Delta E = mc\Delta\theta$

Quantum Phenomena

Photon model $E = hf$

Waves and Oscillations

For waves on a wire or string $v = \sqrt{(T/\mu)}$

For a lens $P = 1/f$

Unit 2

Physics for life

Quantum Phenomena

Photoelectric effect $hf = \phi + \frac{1}{2}mv^2_{max}$

Materials

Elastic strain energy $\Delta E_{el} = F\Delta x/2$

Stress $\sigma = F/A$

Strain $\varepsilon = \Delta x/x$

Young modulus $E = \sigma/\varepsilon$

Stokes' law $F = 6\pi\eta rv$

Waves and Oscillations

Refraction $\mu = \sin i/\sin r = v_1/v_2$

For lenses $P = P_1 + P_2$

$1/u + 1/v = 1/f$

Mathematics

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

Unit 4

Moving with physics

Mechanics

Motion in a circle $v = \omega r$

$T = 2\pi/\omega$

Energy

Attenuation $I = I_0 e^{-\mu x}$

Nuclear Physics

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

Quantum Phenomena

de Broglie wavelength $\lambda = h/p$

Fields

Electric field $E = F/Q$

$E = V/d$

In a magnetic field $F = BIl\sin\theta$

$F = Bqv\sin\theta$

$r = p/BQ$

Energy stored in capacitor $W = \frac{1}{2}QV$

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

Magnetic Effects of Currents

Faraday's and Lenz's Laws $E = -\mathrm{d}(N\Phi)/\mathrm{d}t$

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