OCR RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

PHYSICS A

2826/01

Unifying Concepts in Physics

Friday **20 JUNE 2003** Afternoon 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**11**	
2	**14**	
3	**23**	
4	**12**	
TOTAL	**60**	

This question paper consists of 11 printed pages and 1 blank page.

[Turn over

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
refractive index,	$n = \dfrac{1}{\sin C}$
capacitors in series,	$\dfrac{1}{C} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
capacitor discharge,	$x = x_0 e^{-t/CR}$
pressure of an ideal gas,	$p = \frac{1}{3}\dfrac{Nm}{V}<c^2>$
radioactive decay,	$x = x_0\, e^{-\lambda t}$ $t_{\frac{1}{2}} = \dfrac{0.693}{\lambda}$
critical density of matter in the Universe,	$\rho_0 = \dfrac{3H_0^{\,2}}{8\pi G}$
relativity factor,	$= \sqrt{(1 - \dfrac{v^2}{c^2})}$
current,	$I = nAve$
nuclear radius,	$r = r_0 A^{1/3}$
sound intensity level,	$= 10\lg\left(\dfrac{I}{I_0}\right)$

[Turn over

For Examiner's Use

Answer **all** the questions.

1 The following statements have been seen or heard in the media. The physics in each statement is incorrect. Explain why.

(a) 'The heat of the oven should be 180 °C.'

....

....[1]

(b) 'Global warming could cause a rise in sea temperature of 5 °C (278 K) in the next 100 years.'

....

....

....[2]

(c) 'Items of weight greater than 0.75 kg cannot be posted second class.'

....

....[1]

(d) 'The power output of the power station is 500 mW.'

....

....[1]

(e) 'The pressure on the floor was 5 tonnes.'

....

....

....[2]

(f) 'Once out of the Earth's atmosphere the astronaut was weightless.'

....

....

....[2]

(g) 'The cricketer transferred his weight from his right foot to his left foot.'

....

....

....[2]

[Total: 11]

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For Examiner's Use

2 Vectors are used in many branches of physics.

(a) **(i)** Explain what is meant by a *vector*.

....

....[1]

(ii) Underline the vector quantities in the following list.

mass
displacement
magnetic flux density
density
weight
time
distance
kinetic energy

[4]

(b) A car of mass 600 kg changes its velocity in **three** different ways, as shown in Fig. 2.1.

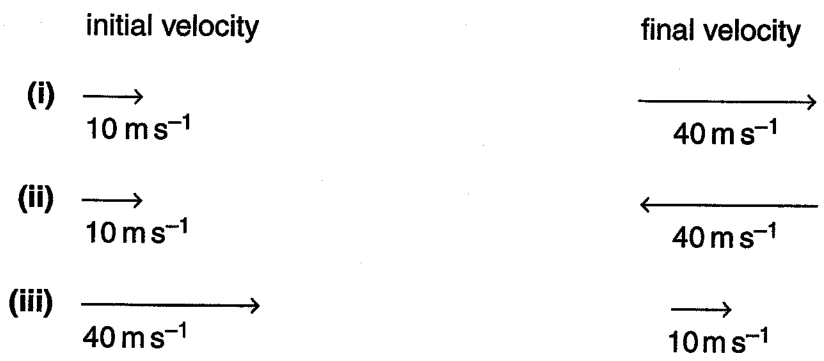

Fig. 2.1

Calculate the magnitude and direction of the *momentum change* in each case. Give the unit for momentum.

(i) change in momentum .... unit ...... in a direction ....

(ii) change in momentum .... unit ...... in a direction ....

(iii) change in momentum .... unit ...... in a direction ....

[5]

For Examiner's Use

(c) **(i)** Give an example of a situation where two vectors, other than velocity or momentum, are added.

....

....

....[2]

(ii) Give an equation, expressed in words, in which a scalar quantity is obtained by multiplying two vectors together.

....

....

....[2]

[Total: 14]

[Turn over

3 An electric motor is shown in Fig. 3.1.

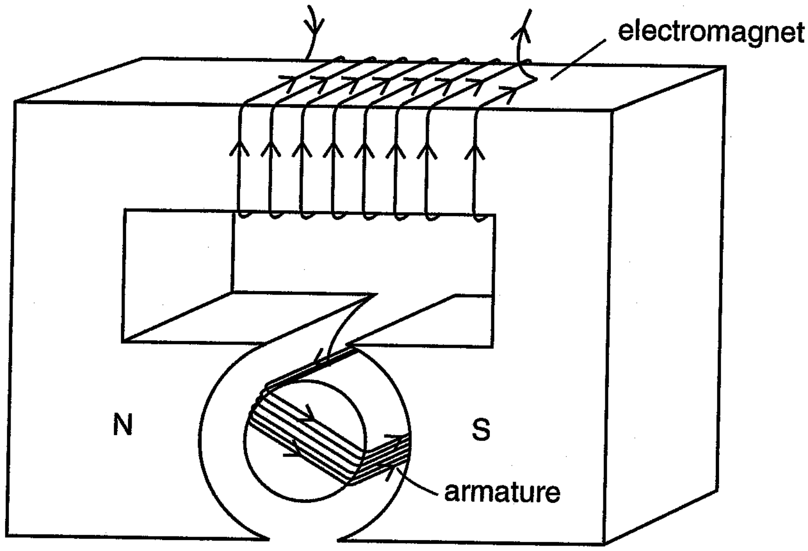

Fig. 3.1

In a motor called a shunt-wound motor, the rotating coil, the armature, is in parallel with the electromagnet which provides the magnetic field. The circuit for a particular shunt-wound motor connected to a 12.0 V supply is shown in Fig. 3.2. In the figure, the resistance of the armature is shown separately, as is often done with the internal resistance of a battery.

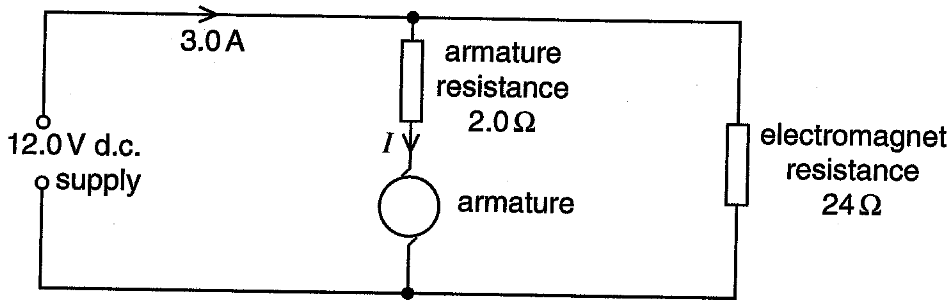

Fig. 3.2

(a) Draw arrows on Fig. 3.1 to show the direction of the turning forces on the armature, given the indicated directions of field and current. Explain how you found these directions.

....

....

....

....[4]

For Examiner's Use

(b) When the armature of the motor is turning but is not driving anything, it is said to be off-load. When off-load, it is found that the current from the supply is 3.0 A.

(i) Show that the current in the electromagnet is 0.50 A. [1]

(ii) Hence deduce the current I in the armature.

current = ... A [1]

(iii) Calculate the power supplied by the 12.0 V power supply. Give the unit of power.

power = ... unit ...... [3]

(iv) Calculate the power wasted as heat in

1. the electromagnet

power wasted = ... [1]

2. the armature resistance.

power wasted = ... [2]

(v) Calculate the power used driving the armature.

power = ... [1]

For Examiner's Use

(c) For the off-load condition in **(b)**, explain in terms of conservation of energy why

(i) after the first few seconds of operation the electromagnet is not using power to produce magnetic field

....

....

....[2]

(ii) the armature current is **not** 6.0 A

....

....

....[2]

(iii) power is required by the armature to drive it.

....

....[1]

(d) If too much load is put on the armature it may cease to rotate and the current increases.

(i) Calculate the total current supplied to the motor when the armature is stationary.

current = ... A [2]

(ii) Explain why the motor may burn out when the armature is stationary. Justify your answer with a calculation.

....

....

....

....[3]

[Total: 23]

For Examiner's Use

4 *Equilbrium* is a word frequently used in mechanics and structural engineering.

(a) What **two** conditions are necesssary for a body to be in mechanical equilibrium?

....

....

....

..........[2]

(b) Discuss why is it important that a bridge designer considers the mechanical equilibrium of a bridge both during and after construction.

....

....

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....

....

..........[2]

(c) The term *dynamic equilibrium* does not appear in your physics specification but can be applied to a moving object, such as an aircraft. Suggest a condition which applies if an aircraft is in dynamic equilibrium.

....

..........[1]

(d) *Thermal equilibrium* is another use of the idea of equilibrium. Give examples from everyday life of

(i) an object in thermal equilibrium with its surroundings

....

....

....

(ii) an object not in thermal equilibrium with its surroundings.

....

....

..........[2]

(e) Much discussion is taking place concerning global warming of the Earth. Use your knowledge of the electromagnetic spectrum, of wave theory in relation to the transfer of energy, and your general knowledge, to outline how the mean temperature of the Earth's surface is related to energy gains and losses.

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[Total: 12]