OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

PHYSICS A

2826/01

Unifying Concepts in Physics

Thursday **16 JUNE 2005** Morning 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 provided 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	**9**	
2	**16**	
3	**19**	
4	**16**	
TOTAL	**60**	

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

SPA (KN) S72731/3

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

[Turn over

For Examiner's Use

Answer **all** the questions.

1 **(a)** The mathematical term **proportion** is used a great deal in physics to describe in certain situations how one quantity varies with another. Answer the questions in the table and explain under what circumstances the relationships correctly do show direct proportion. The first one is done for you to show you the way answers should be presented.

terms used	in equation	question	answer
s distance moved u initial velocity t time taken a acceleration	$s = ut + \frac{1}{2}at^2$	Is $s \propto t$?	No, but when the acceleration is zero then s is directly proportional to t since u is constant.
v final velocity u initial velocity a acceleration t time taken	$v = u + at$	Is $v \propto t$?	[2]
p pressure V volume n amount of gas R gas constant T temperature	$pV = nRT$	Is $p \propto T$?	[2]
P power F force v velocity	$P = Fv$	Is $P \propto F$?	[2]
A area of circle r radius of circle	$A = \pi r^2$	Is $A \propto r^2$?	[1]

(b) What features of a graph plotting one variable against another would determine whether the two variables were directly proportional?

....

....[2]

[Total: 9]

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For Examiner's Use

2 In the following situations, explain the physics of

(a) why there is always a strong wind near any forest fire

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....[3]

(b) how it is possible to have a shoe which is both shiny and black

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....[3]

(c) why the tension in the string of an oscillating simple pendulum is **not** equal to the weight of the pendulum bob when the string is vertical

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....[3]

For Examiner's Use

(d) why X-rays do **not** seem to be diffracted by a narrow slit of width about 0.1 mm

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....[3]

(e) why it is **not** possible to polarise sound waves in air

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....[2]

(f) why keeping a refrigerator door open does **not** cool a kitchen.

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....[2]

[Total: 16]

3 The electrical supply in most cars uses a 12.0 V battery and a 16.0 V generator connected in parallel with it. Fig. 3.1 shows part of the arrangement in a particular car. The battery has a very low internal resistance, which may be neglected, and the generator has an internal resistance of 0.50 Ω. The part of the car circuit shown is that for two bright headlamps and two side lamps, together with their switch. Sidelights and headlights cannot both be on at the same time.

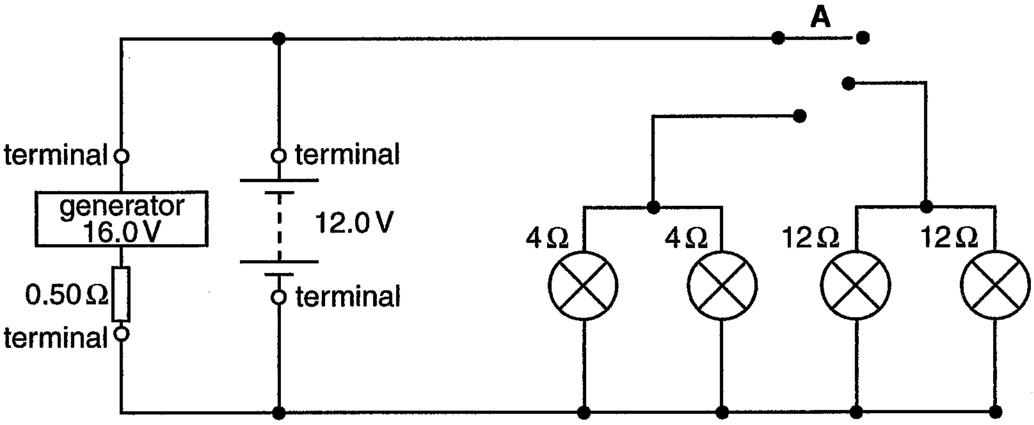

Fig. 3.1

(a) Explain why headlamps have a lower resistance than side lamps.

....

....[2]

(b) Explain the function of the three-way switch **A**.

....

....

....

....

....[3]

(c) The p.d. across the terminals of the generator must be 12.0 V, the same as the terminal p.d. of the battery. Calculate the current through the generator.

current = ... A [2]

(d) When the headlamps are switched on, calculate

(i) the current to each headlamp

current = ... A [2]

(ii) the total power supplied to the two headlamps. Give the correct unit.

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

(e) For the situation in **(d)(i)** and assuming that no other current is being required by other car components, deduce the current through the battery.
State what is happening to the battery.

current = ... A

....[3]

(f) What advantage is gained by

(i) using a battery with a very low internal resistance

....

....

....[2]

(ii) having the e.m.f. of the generator higher than the e.m.f. of the battery?

....

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....[2]

[Total: 19]

For Examiner's Use

4 A radioactive material is known to contain a mixture of two nuclides **X** and **Y** of different half-lives. Readings of activity, taken as the material decays, are given in the table, together with the activity of nuclide **X** over the first 12 hours.

time / hour	activity of material / Bq	activity of nuclide **X** / Bq	activity of nuclide **Y** / Bq
0	4600	4200	400
6	3713	3334	
12	3002	2646	
18	2436		
24	1984		
30	1619	1323	296
36	1333		

(a) State the meaning of the terms

(i) *radioactive*

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....[1]

(ii) *nuclide*

....

....[1]

(iii) *half-life.*

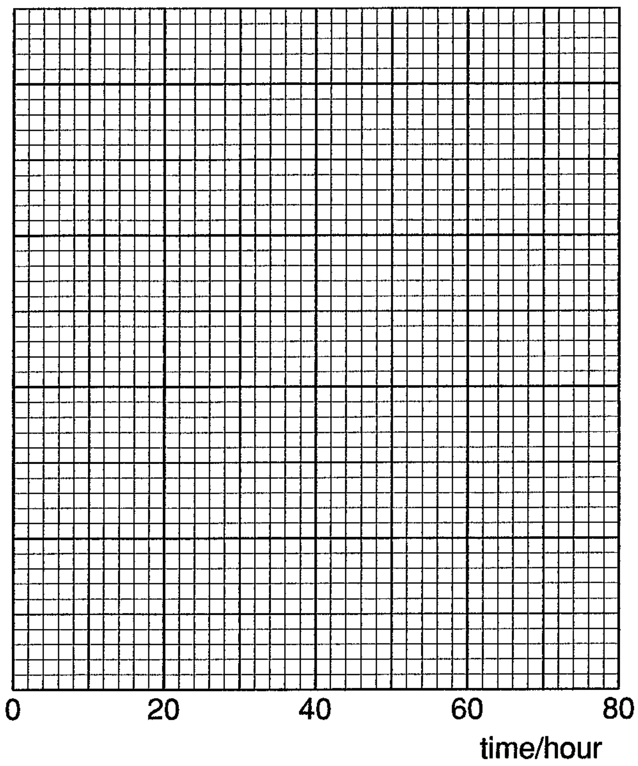
....

....[1]

(b) **(i)** The half-life of nuclide **X** is 18 hours. Complete the *activity of nuclide* **X** column. [3]

(ii) Using your answer to **(i)** complete the *activity of nuclide* **Y** column. [2]

(c) Calculate, or use a graph to determine, the half-life of nuclide **Y**.



half-life of **Y** = ... hours [3]

(d) Indicate briefly how it would be possible **experimentally** to obtain the initial activity (4200 Bq in this case) of nuclide **X** by itself.

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....[2]

(e) Explain why it is **not** possible to give a half-life for a **mixture** of two nuclides.

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....[3]

[Total: 16]

END OF QUESTION PAPER