THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

PHYSICS A

Unifying Concepts in Physics

2826/01

Candidates answer on the Question Paper

OCR Supplied Materials:
None

Other Materials Required:
- Electronic calculator

Friday 18 June 2010
Morning

Duration: 1 hour 15 minutes

OCE/22851

2826 01

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **12** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**15**	
2	**13**	
3	**11**	
4	**16**	
5	**5**	
TOTAL	**60**	

OCR is an exempt Charity

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,	$\mathrm{u} = 1.66 \times 10^{-27}\ \mathrm{kg}$
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, $p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$

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, $= 10 \lg\left(\frac{I}{I_0}\right)$

Answer **all** the questions.

1 At a theme park there is a roundabout which consists of a central post supporting a bar, 4.0 m long, which rotates freely in a horizontal plane. At the ends of the bar, chains are attached. The other end of each chain has a flat seat on which a child can sit. The arrangement is shown in Fig. 1.1. Throughout the question air resistance should be neglected.

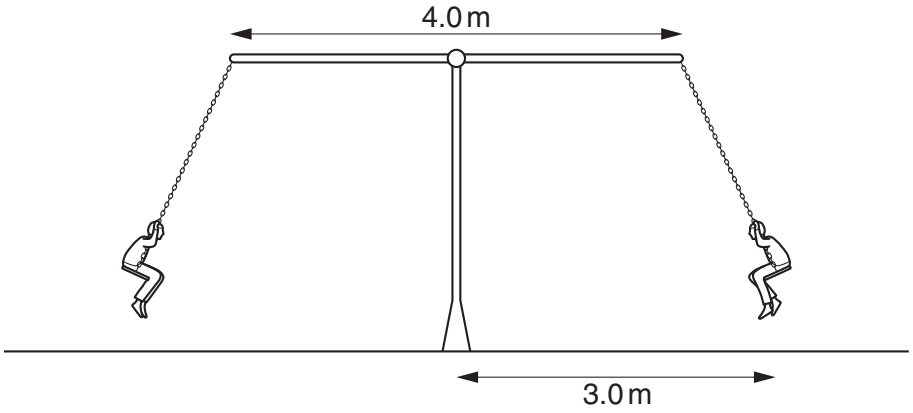

Fig. 1.1

The figure shows two children, each of weight 220 N, rotating in a horizontal circle of radius 3.0 m. Each revolution takes 4.7 s.

(a) On Fig. 1.1, draw arrows to represent the **two** forces acting on one of the children. On each arrow name the object that provides the force. **[3]**

(b) Calculate

(i) the mass of each child

mass = ... kg **[1]**

(ii) the speed of each child

speed = ... $m\,s^{-1}$ **[1]**

(iii) the kinetic energy of each child

kinetic energy = ... J **[2]**

(iv) the magnitude and direction of the resultant force on each child

force = ... N **[2]**

direction..... **[1]**

(v) the angle of the chain to the vertical.

angle = ... ° **[2]**

(c) For a child on this roundabout a force diagram that is sometimes drawn is shown in Fig. 1.2(a). A triangle of forces for these three forces is given in Fig. 1.2(b).

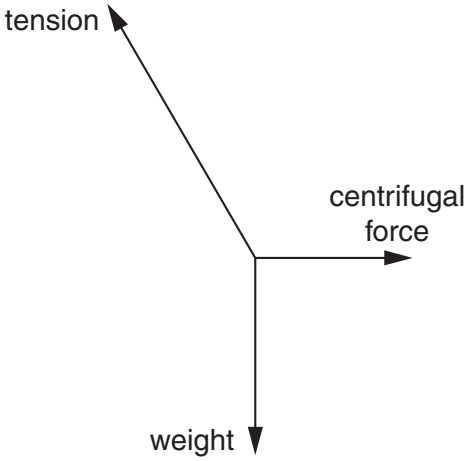

Fig. 1.2(a)

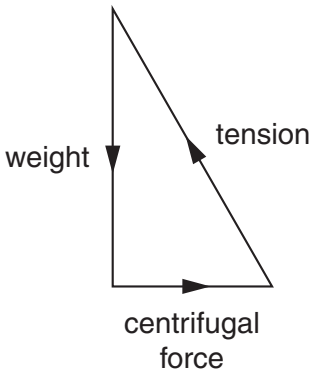

Fig. 1.2(b)

Explain why these diagrams are **incorrect** even though they can be used to obtain the correct value for the magnitude of the resultant force on the child.

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..... **[3]**

[Total: 15]

2 **(a)** Apart from forces in the nucleus, the A-level physics course deals with three force fields. Name each of these three fields and for each state the definition of the field strength.

field 1 .....

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field 2 .....

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field 3 .....

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..... **[6]**

(b) Discuss the similarities and the differences between the directions of the forces associated with each of the fields. Diagrams may help your answer.

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..... **[5]**

(c) Explain how it is known that there must be a different type of field within the nucleus of an atom.

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

[Total: 13]

3 Kirchhoff's laws in electricity are conservation laws.

(a) (i) State Kirchhoff's first law.

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

(ii) Illustrate this law by drawing part of a circuit diagram that is labelled with some possible numerical values.

[1]

(iii) State the quantity that is conserved in the first law.

quantity conserved is ..... **[1]**

(b) Kirchhoff's second law states that the total electromotive force (e.m.f.) in any closed loop in a circuit is equal to the sum of the potential differences around the loop.

(i) State what law of conservation this is equivalent to.

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

(ii) A cell with an e.m.f. of 3.0V and internal resistance 2.0Ω is connected to resistors of resistance 10Ω and 40Ω connected in parallel as shown in Fig. 3.1.

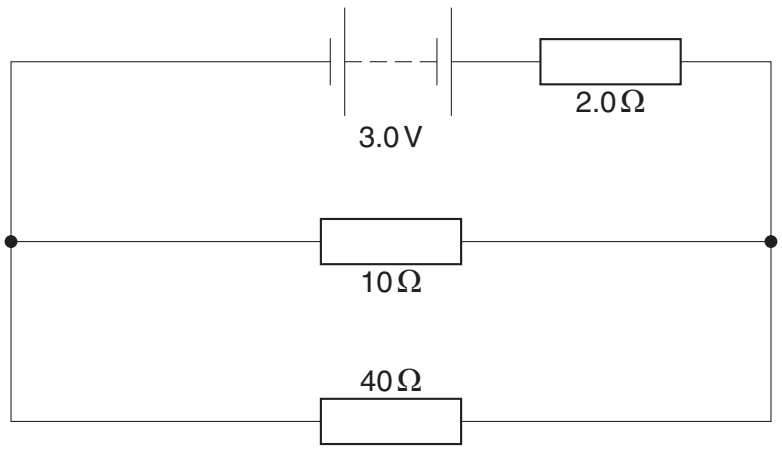

Fig. 3.1

1 Calculate the potential difference across each of the three resistors in the circuit.

p.d. across 2 Ω resistor = ... V

p.d. across 10 Ω resistor = ... V

p.d. across 40 Ω resistor = ... V

[4]

2 Explain how Kirchhoff's second law applies to this circuit.

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

[Total: 11]

4 The following table is a list of various particles, giving their usual notation and the mass of each in unified mass units u. 1 u = 1.66×10^{-27} kg.

particle	mass/u	particle	mass/u
$^{1}_{1}p$	1.00783	$^{90}_{38}Sr$	89.9073
$^{1}_{0}n$	1.00867	$^{142}_{54}Xe$	141.9070
$^{2}_{1}H$	2.01410	$^{235}_{92}U$	235.0439
$^{4}_{2}He$	4.00260		

(a) State the meaning of the numbers 38 and 90 for strontium (Sr) in the table.

38 is the number of .....

90 is the number of ..... **[2]**

(b) Give reasons why the mass given for each nuclide is near to a whole number but is not exactly a whole number.

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..... **[3]**

(c) **(i)** Write down the nuclear equation showing the fusion reaction between two deuterium nuclides that result in a nuclide given in the list. **[1]**

(ii) Show that the energy released in this fusion reaction is about 24 MeV.

[3]

(d) (i) Write down the nuclear equation for the fission reaction using only particles and nuclides given in the list.

[3]

(ii) Calculate the amount of energy released for this fission reaction. Give your answer in both joules and in electron-volts.

energy = ... J

energy = ... eV

[4]

[Total: 16]

TURN OVER FOR QUESTION 5

5 Describe a feature of your A-level physics course that you consider will be most useful to you in the future. Give reasons for your answer.

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..... **[5]**

[Total: 5]

END OF QUESTION PAPER