



# OXFORD CAMBRIDGE AND RSA EXAMINATIONS Advanced Subsidiary GCE

## **PHYSICS A**

Forces and Motion

Monday

14 JUNE 2004

Afternoon

1 hour

Candidates answer on the question paper. Additional materials:

Electronic calculator Protractor

Ruler

Hule

Candidate Name			
Centre Number		Candidate Number	

TIME 1 hour

## **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.

**DO NOT** ANSWER IN PENCIL. **DO NOT** WRITE IN THE BARCODE. **DO NOT** WRITE IN THE GREY AREAS BETWEEN THE PAGES.

 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 will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE			
Qu.	Mark		
1	15		
2	13		
3	12		
4	10		
5	10		
TOTAL	60		

This question paper consists of 14 printed pages and 2 blank pages.



#### Data

speed of light in free space,
permeability of free space,
permittivity of free space,
elementary charge,
the Planck constant,
unified atomic mass constant,
rest mass of electron,
rest mass of proton,

gravitational constant, acceleration of free fall,

the Avogadro constant,

molar gas constant,

$$c = 3.00 \times 10^8 \,\mathrm{m\,s^{-1}}$$

$$\mu_0 = 4\pi \times 10^{-7} \,\mathrm{H\,m^{-1}}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \, \mathrm{F} \, \mathrm{m}^{-1}$$

$$e = 1.60 \times 10^{-19} \,\mathrm{C}$$

$$h = 6.63 \times 10^{-34} \,\mathrm{Js}$$

$$u = 1.66 \times 10^{-27} \text{ kg}$$

$$m_{\rm e} = 9.11 \times 10^{-31} \text{ kg}$$

$$m_{\rm p} = 1.67 \times 10^{-27} \, \rm kg$$

$$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$N_{\rm A} = 6.02 \times 10^{23} \, \rm mol^{-1}$$

$$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$$

$$g = 9.81 \text{ m s}^{-2}$$



### **Formulae**

uniformly accelerated motion,

$$s = ut + \frac{1}{2}at^2$$

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

$$n = \frac{1}{\sin C}$$

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

$$C = C_1 + C_2 + \dots$$

$$x = x_0 \mathrm{e}^{-t/CR}$$

$$p = \frac{1}{3} \frac{Nm}{V} < c^2 >$$

$$x = x_0 e^{-\lambda t}$$

$$t_{\frac{1}{2}} = \frac{0.693}{\lambda}$$

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.

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(a) Explain the difference between a *scalar* and *vector* quantity, including one example of each in your explanation.(i) a scalar

(i)	a scalar	
/ii\	a vector	
(,	a vector	
		[4]

(b) Fig. 1.1 shows the path of a car as it travels around a right-angled bend.

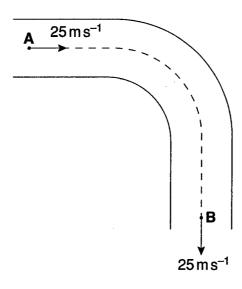


Fig. 1.1

The car travels from point  $\bf A$  to point  $\bf B$  in 7.6 s at a constant speed of 25 m s<sup>-1</sup>.

(i) Calculate the distance the car travels in 7.6 s.

distance = ..... m [2]

(ii) Draw a line on Fig. 1.1 to show the displacement of the car having travelled from A to B. [1]



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(iii)	Explain why the velocity of the car changes as it travels from <b>A</b> to <b>B</b> although the speed remains constant.
	[2]
(iv)	Using a labelled vector triangle, calculate the magnitude of the change in velocity of the car (velocity at ${\bf B}$ – velocity at ${\bf A}$ ).
	magnitude of velocity change = $m s^{-1}$ [4]
(v)	State and explain whether the car is accelerating as it travels around the bend from A to B.

[Total: 15]



(a) Explain the quantities 2 (i) gravitational potential energy ......[2] (ii) kinetic energy ......[2] (iii) power. ......[1] (b) Water leaves a reservoir and falls through a vertical height of 130 m and causes a water wheel to rotate. The rotating wheel is then used to produce 110 kW of electrical power. (i) Calculate the velocity of the water as it reaches the wheel, assuming that all the gravitational potential energy is converted to kinetic energy.

velocity = .....  $m s^{-1}$  [3]

(ii) Calculate the mass of water flowing through the wheel per second, assuming that the production of electrical energy is 100% efficient.

mass of water per second = ..... unit ...... [3]

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(iii) State and explain two reasons why the mass of water flowing per second needs to be greater than the value in (ii) in order to produce this amount of electrical power.

[2]

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3 Fig. 3.1 shows a helicopter that has a cable hanging from it to the sea below.

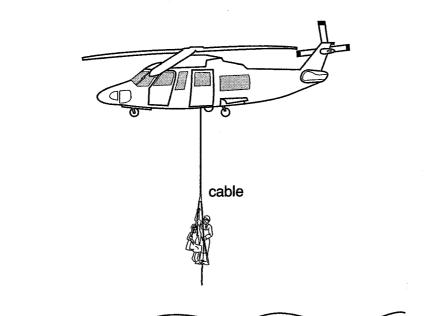


Fig. 3.1

sea

A girl of mass 55 kg is rescued by a man of mass 75 kg. The two are attached to the cable and are lifted from the sea to the helicopter. The lifting process consists of an initial acceleration followed by a period of constant velocity and completed by a final deceleration.

(a)	Name the <b>two</b> main forces acting on the two people being lifted.				

(b) Calculate the combined weight of the man and girl.

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(c) Calculate the tension in the cable during

(i) the initial acceleration of  $0.55 \,\mathrm{m}\,\mathrm{s}^{-2}$ 

tension = ...... N [2]

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ROCR OCRO CROC ROCR (ii) the period of constant velocity.

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(d) Calculate the final deceleration if the tension in the cable is 1240 N.

deceleration = ..... 
$$m s^{-2}$$
 [2]

(e) Sketch on Fig. 3.2 a graph of velocity v against time t for the complete lifting process. Numerical values are not required.

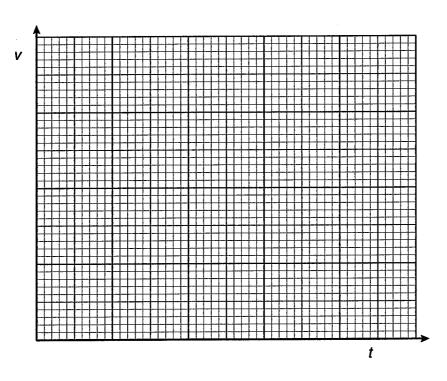


Fig. 3.2

[3]

[Total: 12]



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(a)	Def	ine the <i>Young modulus</i> .
		[1]
(b)	was	e wire used in a piano string is made from steel. The original length of wire used s 0.75 m. Fixing one end and applying a force to the other stretches the wire. The ension produced is 4.2 mm.
	(i)	Calculate the strain produced in the wire.
	(ii)	strain =
		wife Calculated in (i).
		force = N [3]
(c)	leng	ifferent material is used for one of the other strings in the piano. It has the same ith, cross-sectional area and force applied. Calculate the extension produced in this if the Young modulus of this material is half that of steel.

extension = ..... mm [2]

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(d) (i) Define density.

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	[1]
(ii)	State and explain what happens to the density of the material of a wire when it is stretched. Assume that when the wire stretches the cross-sectional area remains constant.
	[1]

[Total: 10]



ın ti	nis question, two marks are available for the quality of written communication.
a)	Describe how the driving wheels of a car can generate a motive force.
•	
	[
<b>o)</b>	Explain why friction is important in accelerating and decelerating a car.
•	In your answer
	discuss factors affecting the magnitude of the acceleration
	• state the direction in which friction acts for both acceleration and deceleration.



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[4]

Quality of Written Communication [2]

[Total: 10]

**END OF QUESTION PAPER** 



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Q1	(a)(i)	scalar named	B1
		has (only) magnitude / size / value (not quantity)	B1
	(ii)	vector named	B1
		has magnitude and direction	<b>B</b> 1
		allow one out of two for a vector has direction and a scalar does r	not
	(b)(i)	speed = distance / time or distance = speed x time	C1
		distance = 25 x 7.6	
		= 190 (m)	A1
	· (ii)	displacement shown as a straight line from A and B	B1
	(iii)	velocity is a vector or has a direction / speed is a scalar or does r	ot
		have a direction	B1
		direction of (the velocity) changes / car changes direction	B1
	(iv)	triangle showing correct orientation of the vectors	B1

 $v_B - v_A = [(25)^2 + (25)^2]^{1/2}$  / scale given for triangle C1 = 35.4 (m s<sup>-1</sup>) / 34 to 37 (m s<sup>-1</sup>) if clearly a scale diagram A2 penalise (-1) for any further subtraction of this value (e.g. 35 – 25)

(v) acceleration is a change in velocity / car has a change of velocity / car has a change in direction
 car is accelerating
 B1
 TOTAL [15]

Final Mark Scheme		eme 2821/01	June 2004
depend or mgh		energy due to position / height / above the ground ds on gravitational field strength / weight n / wh B1 and symbols defined as mass, gravitational field strength and height / weight and height B1	B1 B1
	(ii)	energy due to movement / motion	B1
	• •	depends on mass and speed  or ½mv² B1 and symbols defined B1	<b>B</b> 1
	(iii)	work is the rate of doing work or rate of using energy (work done/time taken)	B1
ı	(b)(i)	pe = ke / mgh = $\frac{1}{2}$ mv <sup>2</sup>	C1
. '	(~/\./	$9.81 \times 130 = 0.5 \times v^2$	C1
		$v = 50.5 \text{ m s}^{-1}$ (allow 50 or 51) allow the use of $v^2 = u^2 + 2as$	<b>A1</b>
	(ii)	mgh / t = 110000 m/t = 110000 / (9.81 x 130)	C1
		$= 86.3 \text{ (kg s}^{-1})$ allow 86	A1
		unit kg s <sup>-1</sup> or kg	B1

(iii) not all the pe of water will be converted to ke friction of water with ground or air resistance not all the ke of water will be converted to ke of the wheel, the water retains some ke friction in the rotation of the wheel not all ke converted to electrical energy friction in the generator not all ke converted to electrical any two

B2
TOTAL [13]

Q3	(a)	weight / gravitational force B tension B	
	(b)	W = (55 + 75) x 9.81 = 1275 (N) (allow 1280)	.1
	(c)(i)	F = ma T - 1275 = (130) x 0.55	:1
	(ii)	T = 1346.5 (N) (allow 1350) A T-W=0 C T=W=1275 (N)	1
	(d)	T - W = ma $1240 - 1275 = 130 \times a$ $a = (-) 0.27 \text{ m s}^{-2}$	
	(e)	line with constant positive gradient from origin horizontal line (above zero) line of constant negative gradient at end taking more time than the first section (allow ecf from acceleration value in part (d)	31

**TOTAL [12]** 

Final Mark Scheme		ieme 282	2821/01		June 200	
Q4	(a)	(E) = stress/strain			B1	
	(b)(i)	strain = extension/length = 4.2 x 10 <sup>-3</sup> / 0.75			<b>C1</b>	
		$= 5.6 \times 10^{-3}$			A1	
	(b)(ii)	E = force / (area x strain) F = E x A x strain			C1	
		$= 2 \times 10^{11} \times 4.5 \times 10^{11}$	<sup>-7</sup> x 5.6 x 10 <sup>-3</sup>	3	<b>C1</b>	
		= 504 (N)			<b>A1</b>	
	(c)	larger extension in words score (twice the extension) 8.4	es 1 scores 2		B2	
	(d)(i)	density = mass / volume	,00100 <u>2</u>		B1	
	(ii)	volume larger hence density le	ess		B1	
	("'/	Volume larger memor denoty 1999			Total [10]	
Q5	(a)	engine provides turning effect Tyre pushes <b>back on</b> the ground Ground pushes on the tyre Friction between tyre and ground Force on tyre is (unbalanced) Example of Newton's third law	ind ind in the forward	d direction		
				Max 4	В4	
,	(b)	acceleration needs forward force on car friction enables forward push from road on the tyres effect greatly reduced if the road surface is e.g. wet (suitable comment on effect due to road surface) comment on tyre surface tread and its effect faster car is travelling greater air resistance and less acceleration				
	deceleration needs force to oppose / backwards to mot friction between brakes and wheel friction due to road and tyres friction in bearings friction from air resistance					
		max 3 from each part	and	Max 4 in tota	I B4	
		Spelling, punctuation and grammar			<b>B</b> 1	
		Use of technical language			B1 TOTAL [10]	