

ADVANCED SUBSIDIARY GCE UNIT **PHYSICS A**

Forces and Motion

FRIDAY 12 JANUARY 2007

2821

Afternoon

Time: 1 hour

Additional materials: Electronic Calculator

> Ruler (cm/mm) Protractor

		HBI	
		HEI	
		HBI	

Candidate Name		
Centre Number	Candidate Number	

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre Number and Candidate Number in the boxes above.
- Answer all the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do not write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is 60.
- 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.	Max	Mark
1	8	
2	9	
3	10	
4	12	
5	10	
6	11	
TOTAL	60	-

This document consists of 14 printed pages and 2 blank pages.

SP (SM/CGW) T15143/7

© OCR 2007 [M/100/3700]

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,

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

permittivity of free space,

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

elementary charge,

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

the Planck constant,

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

unified atomic mass constant,

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

rest mass of electron,

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

rest mass of proton,

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

molar gas constant,

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

the Avogadro constant,

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

gravitational constant,

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

acceleration of free fall,

 $g = 9.81 \text{ ms}^{-2}$





201942402

Downloaded from http://www.thepaperbank.co.uk

Formulae

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

refractive index,
$$n = \frac{1}{\sin C}$$

capacitors in series,
$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \dots$$

capacitors in parallel,
$$C = C_1 + C_2 + \dots$$

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



4

Answer all the questions.

1 Fig. 1.1 shows the path of a ball thrown from A and passing through positions B, C and D.

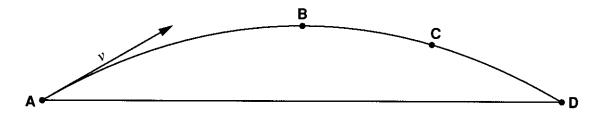


Fig. 1.1

The ball is thrown from ${\bf A}$ with a velocity ${\bf v}$. A vector arrow on Fig. 1.1 represents the magnitude and direction of the velocity of the ball at ${\bf A}$.

- (a) On Fig. 1.1 draw arrows to represent the horizontal and vertical components of the velocity of the ball at A. [1]
- (b) State how the components of the velocity of the ball at B, C and D compare with the components at A. Assume air resistance is negligible.

(i)	The vertical component at B
	The horizontal component at B[1]
(ii)	The vertical component at C
	The horizontal component at C[1]
(iii)	The vertical component at D
	The horizontal component at D [1]
Ехр	lain the answers you have given for the components of the velocity of the ball at positions

in the second of
Explain the answers you have given for the components of the velocity of the ball at positions B , C and D .
······
[4]
[Total: 8]

© OCR 200

(c)

	r		Downloaded from http://www.thepaperbank.co.uk
			5
2	(a)	Ехр	lain, with reference to a car, the quantities
		(i)	braking force
			[1]
			[1]
		(ii)	braking distance.
			[1]
	(b)	A c	ar of mass 1380 kg, travelling at 31.1 m s ⁻¹ , is brought to rest by the brakes in 48.2 m.
		Cal	culate
		(i)	the initial kinetic energy of the car
		()	
			kinetic energy = J [3]
		(ii)	the average deceleration of the car
			deceleration = ms ⁻² [2]
		/:::\	
		(iii)	the average braking force.
			braking force = N [2]
			[Total: 9]
1			IT. was asset



	3	(a)	Define	the	quantities
--	---	-----	--------	-----	------------

'')	WORK
	[1]

(ii) power.

.....[1]

(b) Define the watt.

(c) Fig. 3.1 shows a crane that is used to move heavy objects.

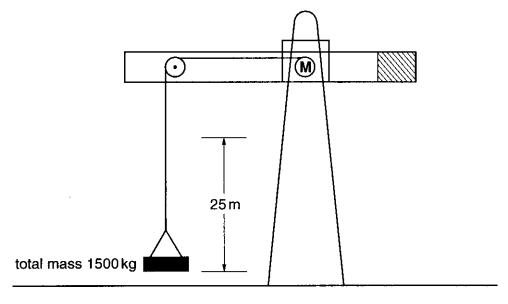


Fig. 3.1

The motor $\bf M$ in the crane lifts a total mass of 1500 kg through a height of 25 m at a constant velocity of 1.6 m s⁻¹.

Calculate

(i) the tension in the lifting cable

tension = N [2]



	Downloaded from http://www.thepaperbank.co.uk
(ii)	7 the time taken for the mass to be raised through the height of 25 m
(iii)	time =s [1] the rate of gain of potential energy of the mass
(iv)	. $ \mbox{rate of gain of potential energy} = \mbox{Js$^{-1}$} \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ $
	power = W [1] [Total: 10]

201942407

8

4 ((a)	De	efine

(i)

(ii)

•	
	the moment of a force
	[2]
	the torque of a couple.

(b) Fig. 4.1 shows a uniform rectangular beam supported by two straps. The beam is in equilibrium.

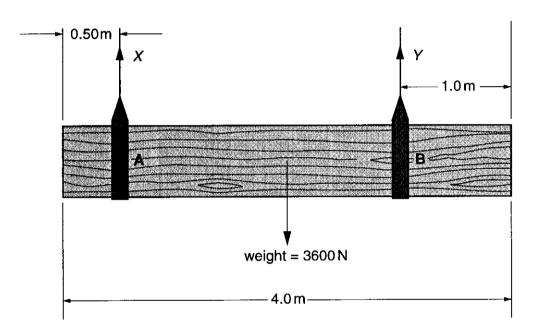


Fig. 4.1

The weight of the beam is 3600N and its length is 4.0m. The strap **A** is positioned 0.50m from one end of the beam and the strap **B** is positioned 1.0m from the other end.

(i) 1 Use the principle of moments to show that the upward force X at strap A is 1440 N.

[2]

	Downloaded from http://www.thepaperbank.co.uk	_
	9	
	2 Hence determine the force Y at the strap B.	
	force = N [2	1
ii)	Discuss whether the forces X and Y provide a couple.	•
',	biscuss whether the forces A and 7 provide a couple.	
		•
	[2]
ii)	The area of strap A in contact with the underside of the beam is $2.3 \times 10^{-2} \text{m}^2$.	
	Calculate the average pressure exerted on the beam by strap A.	
	pressure = unit [3]
	[Total: 12]	1
	[rotali 12]	J

■© OCR 2007



4	4	-
1	ı	

			10]
5 (a)	Define	e the quantities			
	(i) s	stress			
					[1]
	(ii) s	strain.			
					[1]
(b)		esults given in Table 5.1 netal in the form of a w ded.	are obtained in an expe	eriment to determine th	e Young modulus
			loading	unloading	
		load/N	extension/mm	extension/mm	
		0.0	0.00	0.00	
		5.0	0.24	0.24	
		10.0	0.47	0.48	
		15.0	0.71	0.71	
		20.0	0.96	0.95	
		25.0	1.20	1.20	
			Table 5.1		
	(Using the results in Table deformation of the wire is plastic or elastic		g a graph, state and ex	plain whether the
	:	2 obeys Hooke's law	√.		[1]
					[2]



	DOWINGAGED HOTH HILLD://WWW.thepaperpark.co.uk = =	
	·	
	11	
(ii)	Explain how the extension and length of the wire may be determined experimentally.	
		••
	[2	2]
(iii)	The wire tested is 1.72m long and has a cross-sectional area of 1.80x 10^{-7}m^2 . Use the extension value given in Table 5.1 for a load of 25.0 N to calculate the Young modulus of the metal of the wire.	e of
	Young modulus = Pa [3	3]
	[Total: 10)]

© OCR 2007

12

6 In this question, two marks are available for the quality of written communication.

Fig. 6.1 shows a graph of the displacement against time for the motion of a radio-controlled model car.

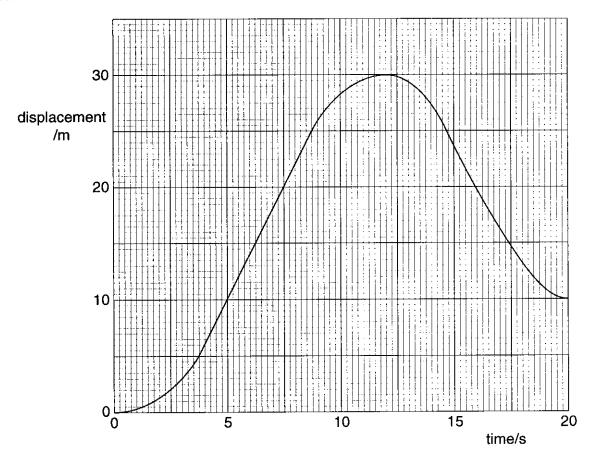


Fig. 6.1

Use Fig. 6.1 to describe and explain, without calculation

How the velocity changes from time r = 0 to time r = 200

OCR 2007

	Downloaded from http://www.thepenorbenk.co.uk
	Downloaded from http://www.thepaperbank.co.uk
	[5]
(b)	how the acceleration changes from time $t = 0$ to time $t = 20$ s.
	·····
	[4]
	Quality of Written Communication [2]
	[Total: 11]

END OF QUESTION PAPER



Downloaded from http://www.thepaperbank.co.uk 14 **BLANK PAGE** PLEASE DO NOT WRITE ON THIS PAGE



Downloaded from http://www.thepaperbank.co.uk	
15	
BLANK PAGE	
PLEASE DO NOT WRITE ON THIS PAGE	
© OCR 2007	_
201942415	
201942415	

 Downloaded from http://www.thepaperbank.co.uk
16
PLEASE DO NOT WRITE ON THIS PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (OCR) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

OCR is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

