OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics

Advanced GCE

Unit **4729:** Mechanics 2

Mark Scheme for January 2011

Oxford Cambridge and RSA Examinations

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

Question			Expected Answer	Mark	Rationale/Additional Guidance
1	**(i)**		$3x_G = 2x0.3 + 1x0.6$ OR $3x_G = 2x0.3 + 0$ OR $3x_G = 4x0.3$ OR $3y_G = 1x0.3 + 1x0.6 + 0$ OR $3y_G = 4x0.3 - 1x0.3$ $x_G = 0.4$ (from AD) OR $x_G = 0.2$ (from BC) $y_G = 0.3$m from AB or CD $AG^2 = 0.4^2 + 0.3^2$ AG = 0.5 m	M1 A1 A1 M1 A1 **[5]**	Table of moments idea. M0 for reducing to 1D problem. Masses/weights may be included. Pythagoras with 2 appropriate distances. This may only be seen in (ii), allow M1A1 in this case.
	(ii)		$v = 0.5x3$ $v = 1.5\ ms^{-1}$	M1 A1 **[2]**	Allow use of candidate's 0.2, 0.4, 0.3, 0.5
2	**(i)**		$(k25^{3/2}) \times 25 = 15000$ k = 4.8 **AG**	M1 A1 A1 **[3]**	Tractive force x speed = power
	(ii)		$R = 4.8 \times 16^{3/2}$ $T - 4.8x16^{3/2} + 700gx1/15 = 700x0.3$ P = 59.9 x 16 P = 958 W	B1 M1 A1 M1 A1 **[5]**	307.2 N2L, 4 terms to find tractive force (T) Allow cv(R), R not 600; (T = 59.866..) 16xTractive force

3	**(i)**		$T_A\cos30 + T_B\cos60 = 0.4g$ $2T\cos30 + T\cos60 = 0.4g$ $T_B = 1.76$ N $T_A = 3.51$ N	M1 A1 A1 A1 **[4]**	Resolves vertically, 3 terms T = 1.756. Watch for MR of Tcos30 + 2Tcos60 = 0.4g Accept 3.52
	(ii)		r = 0.5sin30 (= 0.25) $3.51\sin30 + 1.76\sin60 = 0.4\omega^2 0.5\sin30$ $\omega = 5.72$ rad s^{-1}	B1 M1 A1ft A1 **[4]**	 N2L radial, 3 terms cv(1.76, 3.51, 0.25) Accept 5.73
4	**(i)**		WD = 100cos20 x 30 WD = 2820 J	M1 A1 **[2]**	Product of 3 relevant elements. Angle could be 5, 25 or complements 2819.1...
	(ii)		PE = 25g x 30sin5 PE = 641	M1 A1 **[2]**	Product of weight and vertical height. Allow without g 640.6
	(iii)	 **OR**	 2819.1 = 640.6 $+ 30x70 + 25v^2/2$ v = 2.51 ms^{-1} $25a = 100\cos20 - 70 - 25g\sin5$ a = 0.105 $v^2 = 2 \times 30 \times$ 'a' v = 2.51	M1 A1ft A1 A1 **[4]** *M1 A1 dep*M1 A1 **[4]**	4 term energy equation ft(cv 2820 and cv 641) cao 4 term equation Allow 0.1 here Or equivalent complete method cao

5	**(i)**		$x_H = 3x0.6/8$ $\pi(0.6^2x0.6)(0.6/2) - (0.6^3x2\pi/3)0.225$ $= \pi x0.6^3(1+2/3)x_G$ $x_G = 0.09$ m **AG**	B1 M1 A1 A1 A1 **[5]**	CoM hemisphere ($x_H = 0.225$), may be implied Use of table of moments idea SC Volume of sphere used, max B1M1A1, moment equation fully correct for A1 (3/5) Accept -0.09
	(ii)	**(a)**	 $mg(0.09\cos45) =$ $2(0.6+0.6\cos45+0.6\sin45)$ $m = 4.65$kg	M1 A1 A1 A1 **[4]**	Attempt at moments (must resolve), allow without g $2(0.6+\sqrt{[0.6^2+0.6^2]})$ (4.6451...)
	(ii)	**(b)**	 $2/4.6451g$ $\mu \geq 0.0439$	M1 A1 A1 **[3]**	Ratio force/weight cv(4.65) Correct inequality sign, accept 0.044
6	**(i)**		$0 = (14\sin30)^2 - 2gh$ $h = 2.5$ m	M1 A1 **[2]**	$h = (14\sin30)x1/1.4 - g(1/1.4)^2/2$ or use $(u^2\sin^2\theta)/2g$
	(ii)		 $0.4x15 = 0.4(14\cos30) + I$ $I = 1.15$	M1 A1 A1 **[3]**	Impulse = change in momentum Not 14 or 0 for horizontal speed before impulse aef
	(iii)		$v^2 = (14\sin30)^2 + 15^2$ $v = 16.6$ ms^{-1} $\tan\theta = 14\sin30/15$ OR $\tan\psi = 15/14\sin30$ $\theta = 25(.0)°$ OR $\psi = 65(.0)°$	M1 A1 M1 A1 **[4]**	Not $(14\sin30)^2 + (14\cos30)^2$ Allow $\sqrt{274}$ Correct trig to find an appropriate angle; not 14cos 30 for 15
	(iv)		$t = 14\sin30/g$ (= 1/1.4 = 0.7142..) $T = 1.43$ s $R = 14\cos30/1.4 + 15/1.4$ $R = 19.4$ m	M1 A1 M1A1 A1 **[5]**	Rise or fall time (not to be given in (i)) Accept 10/7 $(14^2\sin(2x30) + 16.6^2\sin(2x25))/2g$. 14 resolved, 15 not

7	(i)		b + a =1.8e	M1 A1	Uses restitution b - a =1.8e
			0.7b - 0.2a=0.2x1.8	M1 A1	Uses momentum 0.7b + 0.2a=0.2x1.8, signs consistent with first eqn
			b =0.4(1+e) a = 1.4e - 0.4 1.4e - 0.4 > 0.4 + 0.4e e > 0.8	M1 A1 A1 M1 A1 **[9]**	Solves 2 simultaneous equations (eliminate a or b) a = 0.4 - 1.4e Using a>b, correct signs in a essential
	OR	**Last 5 marks**	Using a > b a > 0.72 b > 0.72 1.8e > 0.72 + 0.72 e > 0.8	M1 A1 A1 M1 A1	correct signs in a essential
	OR	**Last 5 marks**	Using a = b to find a or b a (or b) = 0.9e and a (or b) = 0.72 e = 0.8 Convincing argument for correct inequality e > 0.8	M1 A1 A1 M1 A1	
	OR	**Last 5 marks**	a = 1.4e - 0.4 or b =0.4(1+e) Using a > b a > 0.9e or b < 0.9e e > 0.8	M1 A1 M1 A1 A1	Solves 2 simultaneous equations (eliminate a or b) aef or multiples thereof correct signs in a essential aef or multiples thereof

	(ii)		c – (±0.25) = 1x0.75 c = 0.5, 1 0.75x0.7 = 0.25x0.7 + m (x1) *OR* 0.75x0.7 = -0.25x0.7 + 0.5m m = 0.35 (from first equation) m=1.4 (from second equation)	M1 A1A1 M1 A1 A1 **[6]**	Uses restitution with e = 1, either Or 0.75 ± 0.25 Uses momentum conservation with correct combination of sign and c value *OR* mx(0.75 ± 0.25) ± 0.7x0.25 = 0.75x0.7
	OR		½ x0.7x0.75^2 = ½ x0.7X0.25^2 + ½mc^2 0.7x 0.75 = 0.7x(+/-0.25) + mc Solving simultaneous equations m = 0.35 m = 1.4	B1 M1 A1 M1 A1 A1	½ may not be seen At least one momentum equation mc = 0.35 and 0.7
			Total	**[72]**	

[END]

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553