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RECOGNISING ACHIEVEMENT

GCE

Mathematics

Advanced GCE **4729**

Mechanics 2

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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1	$v^2 = 2 \times 9.8 \times 10$ $v = 14$ m s^{-1} speed = $\sqrt{(7^2 + 14^2)}$ 15.7 or $7\sqrt{5}$ m s^{-1} $\tan^{-1}(14/7)$ or $\tan^{-1}(7/14)$ 63.4° to the horizontal	M1 A1 M1 A1 M1 A1 **6**	Using $v^2 = u^2 + 2as$ with $u = 0$ Method to find speed using their "v" Method to find angle using their "v" 26.6° to vertical **6**

2 **(i)**	$(6\sin \Pi/2) \div (\Pi/2)$ 3.82	M1 A1 **2**	Use of correct formula **AG**
(ii)	$8đ = 3(6-3.82) + 5x9.82$ or $8x = \pm\{3(-3.82) + 5x3.82\}$ $đ = 6.95$ or 6.96 or $x = +/-0.955$ $\tan\theta = 0.96/6$ $\theta = 9°$	M1 A1 A1 M1 A1 **5**	Method to find centre of mass Attempt to find the required angle **7**

3 **(i)**	D = 128 000/80 (= 1600) $k(80)^2 = 128\,000/80$ k = ¼ R = 900 N FT	B1 M1 A1 A1 B1 **5**	 Driving force = resistance FT on their k (R = 3600k)
(ii)	D = 128 000 / 60 (= 2133⅓) 2000 x 9.8 x sin2° 6400/3-900-2000 x 9.8 x sin2° = 2000a a = 0.275 m s^{-2}	B1 B1 M1 A1 **4**	 4 terms required **9**

4 **(i)**	$4T\cos20° = 5 \times g \times 2.5$ T = 32.6 N	M1 A1 A1 **3**	Using moments; allow sin/cos mix Allow with omission of g
(ii)	X = Tsin20° X = 11.1 FT Y + Tcos20° = 5 x g or 2.5Y = 1.5 x Tcos20 or 4Y = 1.5 x 5g Y = 18.4 FT R = $\sqrt{(X^2 + Y^2)}$ or $\tan^{-1}(Y/X)$ or $\tan^{-1}(X/Y)$ R = 21.5 N θ = 58.8° above the horizontal	M1 A1 M1 A1 M1 A1 A1 **7**	allow sin/cos mix FT their T FT their T, but not from omission of g $X \neq 0$, $Y \neq 0$ or 31.2° to left of vertical **10**

5	(i)	Tcos45° + Rsin45° = mg	*M1 A1	3 terms
		Tsin45° - Rcos45° = mlsin45°ω^2	*M1 A1	3 terms; a = r ω^2
		2T = $\sqrt{2}$mg + mlω^2 T = m/2($\sqrt{2}$g + lω^2)	Dep*M1 A1 **6**	Method to eliminate R **AG** www
	(ii)	R = 0 2R = $\sqrt{2}$mg - mlω^2 or Tcos45° = mg or T = mlω^2 Solve to find ω	B1 B1 M1	may be implied
		ω = 4.16 rad s^{-1}	A1 **4**	**10**

6	(i)	$2mu = 2mv + 3mv$ $v = 2/5\ u$	M1 A1 A1 **3**	Conservation of momentum Must be v =
	(ii)	e = $(3v - v) / u$ e = 4/5	M1 A1 **2**	Using restitution **AG**
	(iii)	Initial K.E. = $9mv^2 / 2 = 18mu^2/25$ Final K.E. = $9mv^2 / 8 = 9mu^2/50$ ½ $m (V)^2$ = Final K.E. $V = 3\ u\ /5$	B1 FT B1 FT M1 A1 **4**	FT on their v from (i) FT on their v from (i) **AG**
	(iv)	$4mu / 5 - 3mu /5 = 2mx + my$ $u / 5 = 2x + y$ e = 4/5 = $(y - x) / u$ $4u = 5y - 5x$ solving 2 relevant equations $x = -u/5\ y = 3u/5$ $y = 3u/5$ away from wall (x) + towards wall (y)	M1 A1 FT M1 FT A1 M1 A1 A1 A1 **8**	Conservation of momentum FT on their v from (i); aef Using restitution FT on their v from (i); aef both **17**

7 (i)	R = 0.2 x 9.8 x cos30° (= 1.70) F = 0.1 x 9.8 x cos30° (= 0.849) FT ½ x 0.2 x 11^2 - ½ x 0.2 v^2 = 0.2 x 9.8 x 5sin30 + 5 x 0.849 v = 5.44 m s^{-1}	B1 B1 M1 A1 A1 A1 6	 FT on their R, but not R =0.2g Use of conservation of energy **AG**
Or last 4 marks of (i)	F + 0.2gsin30 = ±0.2a a = ±9.1 $v^2 = 11^2 + 2$ x a x 5 v = 5.44 m s^{-1}	M1 A1 M1 A1	Use of N2L, 3 terms Complete method to find v
(ii)	t = 5cos30°/5.44cos30° t = 0.919 s u = 5.44sin30° (= 2.72) s = 2.72 x 0.919 – 4.9 x 0.919^2 s = -1.6 (or better) Ht drop to *C* = 5sin30° = 2.5 m Ball does not hit the roof	M1 A1 B1 M1 A1 B1 A1 7	time to lateral position over *C* Ht dropped **13**
Or first 5 marks of (ii)	$y = x\tan\theta - gx^2 \sec^2\theta/2V^2$ substitute values V = 5.44 θ = 30° x = 5cos30° y = 2.5 – 9.8x25x3/4x4/3 / (2x5.44^2) y = -1.6 (or better)	B1 M1 A1 A1 A1	 all 3 correct
OR (ii)	u = 5.44sin30° (= 2.72) $-2.5 = 5.44\sin30t - 4.9t^2$ t = 1.04 x = 5.44cos30 x 1.04 = 4.9 (or better) Horizontal distance from B to C = 5cos30 = 4.3(or better) Ball does not hit the roof	B1 M1 A1 A1 A1 B1 A1 7	 aef time to position level with *AC*
OR (ii)	$y = x\tan\theta - gx^2 \sec^2\theta/2V^2$ substitute values $-2.5 = 0.577x - 0.221x^2$ Attempt to solve quadratic for x x = 4.9 (or better) Horizontal distance from B to C = 5cos30 = 4.3 (or better) Ball does not hit the roof	B1 M1 A1 M1 A1 B1 A1 7	 aef
OR (ii)	u = 5.44sin30° = 2.72 $-2.5 = 5.44\sin30t - 4.9t^2$ t = 1.0 (or better) T = 5cos30°/5.44cos30° T = 0.92 (or better) Ball does not hit the roof	B1 M1 A1 A1 M1 A1 A1 7	 aef time to position level with *AC* time to lateral position over *C*

OR (ii)	Attempt at equation of trajectory $y = 0.577x - 0.221x^2$ $y = -0.577x$ Solving their quadratic and linear equations to get at least x or y x = 5.2 (or better) or y = -3.0 (or better) Horizontal distance from B to C = 5cos30 = 4.3 (or better) Or Ht drop to *C* = 5sin30° = 2.5 Ball does not hit the roof	M1 A1 B1 M1 A1 B1 A1	**7**	 Equation of BC Must be the one needed for comparison
OR (ii)	Attempt at equation of trajectory $y = 0.577x - 0.221x^2$ $y = -0.577x$ Solving their quadratic and linear equations x = 5.2 (or better) and y = -3.0 (or better) Distance = 6.0 (or better) Ball does not hit the roof	M1 A1 B1 M1 A1 B1 A1	**7**	 Distance from B to point of intersection

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