RECOGNISING ACHIEVEMENT

GCE

Mathematics

Advanced Subsidiary GCE

Unit **4728:** Mechanics 1

Mark Scheme for June 2011

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Question			Expected Answer	Mark	Rationale/Additional Guidance
1			$R^2 = 8^2 + 15^2$ R = 17 N cosθ = 15/17 θ = 28.1°	M1 A1 M1 A1 [4]	Uses Pythagoras 3 squared terms, addition Uses trig appropriately and targets either angle Accept 28°, 0.49 rad
2	**i**	**Also if in ii**	T – 0.45g = 0.45x0.98 T = 4.85(1) N	M1 A1 [2]	N2L on 0.45 kg, weight - tension and +/-0.98m Not 4.9, 4.8 (4.851 is exact, but 4.85 acceptable) {g=9.81→ T=4.85 or 4.86 or better}
	ii	**Also If in i**	mg – 4.85(1) = 0.98m m = 4.85(1)/(9.8-0.98) or m(g – 0.98) = 4.85(1) m = 0.55 *OR* 0.98 = g (m-0.45)/(m+0.45) m = (g+0.98)/(g-0.98) x 0.45 m = 0.55	M1 A1ft A1 [3] M1 A1 A1	N2L on Q, weight – tension, tension=T(i), and 0.98m Simplified to a single term in m, ft cv(T(i)) art 0.550 {g=9.81→ m=0.55(0) or better} a = g x Δ(masses)/Σ(masses)
	iii		$v^2 = (0 +) 2x0.98x0.36$ v = 0.84 ms^{-1}	M1 A1 [2]	Uses $v^2 = u^2 + 2as$, a not 9.8, 2as>0, u = 0 or omitted
	iv		$0 = 0.84^2 – 2x9.8s$ (s = 0.036) S = 0.036 + 2x0.36 = 0.756 m	M1 A1 A1 [3]	0 =(cv(iii))^2 – 2gs, or t=cv(iii)/g <u>and</u> s = ut+/-gt^2/2 May be implied by final answer (eg 0.396) Must be 3 sf (exact) {g=9.81→ s=0.756 or better}

			Frequent mis-read “horizontal/vertical” MR version in {}		Allow all A1 marks in (i) and (ii) *except final A1 in (ii).*
3	**i**		R = 0.8g – 6cos60 {R = 0.8g – 6sin60} R = 4.84 {R = 2.64}	M1 A1 [2]	Resolves vertically, (R=) difference of 2 forces inc. component of 6 Accept 4.8 {2.6} {g=9.81→ R=4.848 {2.65}; accept 4.8 {2.6 or 2.7} }
	ii		Fr = 0.2x4.84 (=0.968) { Fr = 0.2x2.64..(=0.5287..)} 6sin60 - 0.968 = 0.8a {6cos60 – 0.5287.. = 0.8a} a = 5.29 ms^{-2} {a = 3.09 ms^{-2} A0}	M1 M1 A1 A1 [4]	Uses F=0.2(cv(i)) or F=0.2x(R found in (ii) by a method which would be given M1 in (i)) Uses N2L, 3 terms inc. component of 6 Fr need not be evaluated Accept 5.3 {g=9.81→ a=5.28 {3.09 A0} Accept 5.3 {3.1 A0}
	iii		Fr = 0.2x0.8x9.8 (= 1.568) 0.8a = -0.2x0.8x9.8 0 = 4.9 – 1.96t t = 2.5 s	B1 M1* D*M1 A1 [4]	Uses Fr = 0.2x0.8g N2L, Fr only, accept use of Fr from (ii) Accept 0.8a = 0.2x0.8x9.8, (a = (-)1.96) Accept 4.9/1.96, not 0 = 4.9 + 1.96t Accept art 2.50 {g=9.81→ t=2.50 Accept art 2.50}
4	**i**		a = 15/6 or d = 15/2 a = 2.5 ms^{-2} d = 7.5 ms^{-2}	M1 A1 A1 [3]	Uses a = speed change/time Accept -7.5
	ii		T = 6+11+2 (=19) x = 15(11+19)/2 or 15x6/2+15x11+15x2/2 x = 225 m	M1 M1 A1 [3]	Accounts for totality of car journey (may be implied) Idea area = distance **SR** Accept 15x(13+17)/2 M1M1
	iii		Walks = 20x(-)2 = (-)40 m Jogs = 40/5 = 8 s T_s = 60 – ({6+11+2} + 20 + 8) T_s = 13 s	M1 A1 M1 A1 [4]	Finds distance walked T_s + ({6+11+2} + 20 + 8) = 60, needs all time elements

5	**i**		$V_P = 3 – 2.5x0.4$ (= 2) $V_Q = 2.5x0.4$ (= 1) +/-(0.5x2 - 0.2x1) (=+/-0.8) 0.5x2 - 0.2x1 = 0.5v + 0.2x3.2 (v = 0.32) 0.32 ms^{-1} up	M1 A1 B1 M1 A1 [5]	Calculation of either speed, either directions, |a|=2.5 Both magnitudes correct (disregard signs) Momentum before Uses conservation of momentum in collision (not both $v_P = 3$ and $v_Q = 0$) Accept "same", value positive
	ii		$V_Q = 3.2 – 2.5x0.6$ (=1.7) $V_R = 2.5x(0.4+0.6)$ (= 2.5) 0.2x1.7 – 0.3x2.5 = (0.2+0.3)v (v = -0.82) 0.82 ms^{-1} down	M1 A1 M1 A1ft A1 [5]	Calculation of either speed with its correct time, |a|=2.5 Both magnitudes correct (disregard signs) Uses momentum conservation in collision (not both $v_Q = 3.2$ and $v_R = 0$) LHS different signs, RHS same signs, ft cv(speeds Q, R) Value positive
6	**i**		"...smooth ring...", "..no friction at ring.."	B1 [1]	If a variety of reasons is offered, "smooth ring" must be the last
	ii		Tcosθ +5 = Tcos(90-θ) Tcosθ +5 = Tsinθ ……..(a) Tsinθ + Tsin(90-θ) = 7 Tsinθ + Tcosθ = 7 ……. (b)	M1 A1 M1 A1 [4]	"Resolves horiz" equation, needs TCorSθ, 3 terms, 2 of which are T resolved "Resolves vert" equation, needs TCorSθ, 3 terms, 2 of which are T resolved {Allow candidates solving for (iii) to begin in (ii)}
	iii		uses (b)+(a) and (b)-(a) for example Tsinθ = 6 or 2Tsinθ = 12, Tcosθ = 1 or 2Tcosθ = 2 $T^2 = 6^2 + 1^{(2)}$ T = 6.08 N Tanθ = 6(/1) θ = 80.5° *OR* (b) gives T=7/(sinθ+cosθ), subs in (a) for example 12cosθ = 2sinθ then mark as 6(iii) below for D*M1 A1 D*M1 A1	M1* A1 D*M1 A1 D*M1 A1 [6] M1* A1	Attempts to solve 2 equations in 2 unknowns Both terms have values correct Accept √37, 6.1 Uses a correct trig identity Accept 81°, 1.4 rad, 1.41 rad Attempts to solve 2 equations in 2 unknowns Correct two term equation in one variable

7	**i**		v = dx/dt $v = 0.3t^2 - 0.6t + 0.2$ a = dv/dt a = 0.6t – 0.6	M1 A1 M1 A1ft [4]	Uses differentiation of x Uses differentiation of v Correct differentiation of candidate's v(t)
	ii		0.6t - 0.6 = 0 (t = 1) $x(1) = 0.1x1^3 - 0.3x1^2 + 0.2x1$ x(1) = 0 AG *OR* $0.1t^3 – 0.3t^2 + 0.2t = 0$ (t=1, and disregard others) a(1) = 0.6x1 -0.6 a(1) = 0	M1* D*M1 A1 [3]	Attempts to solve a=0 Puts solution in x formula Attempts to solve x=0 Puts solution in a formula
	iii		$0.3t^2 - 0.6t + 0.2 = 0$ t = 0.423 s t = 1.58 s	M1 A1 A1 [3]	Attempts to solve 3 term QE v = 0, accept imperfect attempt at formula, completing square or factorisation Accept $1 - 1/\sqrt{3}$, 0.42, 0.422, or better Accept $1 + 1/\sqrt{3}$, 1.6, 1.57, or better
	iv		$x = \int 0.2t^2 - 0.4dt$ $x = 0.2t^3/3 – 0.4t$ (+k) $0.1t^3 – 0.3t^2 + 0.2t = 0.2t^3/3 - 0.4t$ (+k) $t^3 - 9t^2 + 18t = 0$ $t^2 – 9t + 18 = 0$ AG (t-3)(t-6)=0 T = 3 s	M1* A1 D*M1 D*M1 A1 M1 A1 [7]	Uses integration, ignore omission of k $x = 2t^3/30 – 4/10\ t$ (+k), or coeff t^3 0.067 or better Equates expressions for distance 3 terms with different powers of t, no constant Explains T is non-zero, or explains division by t Tries to solve given quadratic, accept imperfect attempt at completing square, formula or factorisation, and chooses smaller positive root A1
			Total	**[72]**	

Continued

Question 6 specifies the method students are likely to find most helpful. A more sophisticated approach, resolving parallel and perpendicular to the string, is mathematically valid, and leads to correct solutions. If seen it should be marked according to the following scheme, and no penalty levied.

The final 4 marks, in 6(iii), use the same mathematics as may be encountered when choosing an unorthodox method for solving the two simultaneous equations generated in 6(ii) of the specified method (see 6(iii) above).

			OR		
6	**i**		"...smooth ring...", "..no friction at ring.."	B1 [1]	If a variety of reasons is offered, "smooth ring" must be the last
	ii		T = 7cosθ + 5sinθ …….(a) T = 7sinθ – 5cosθ ……..(b)	M1 A1 M1 A1 [4]	Resolves //AR (Need not create Tcos/sinθ) Resolves //BR (Need not create Tcos/sinθ)
	iii		Equating expressions for T from (a) and (b) 2sinθ = 12cosθ tanθ = 6(/1) θ = 80.5° T = 7cos80.5 + 5sin80.5 or 7sin80.5 – 5cos80.5 T = 6.08	M1* A1 D*M1 A1 D*M1 A1 [6]	Attempts to solve 2 equations in 2 unknowns Correct two term equation in one variable Uses a correct trig identity Accept 81°, 1.4 rad, 1.41 rad Accept √37, 6.1

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