Mark Scheme 4728
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1	(i)	R is smooth	B1	1	
	(ii)		M1		For resolving forces horizontally to obtain an equation in T (requires 3 relevant terms and at least one force resolved)
		$T + T\cos60^o = 1.6\cos45^o$	A1		
		Tension is 0.754 N **AG**	A1	3	
	(iii)		M1		For resolving forces vertically to obtain an equation for m (requires 3 relevant terms with both T and the 1.6 N force resolved)
			A1 ft		
		$mg = T\sin60^o +1.6\sin 45^o$			ft sin/cos mix from (ii)
		$m = 0.182$	A1	3	
					SR $m = T\sin60^o +1.6\sin 45^o$ M1
					$m = 1.78$ B1

2	(i)		M1		For applying $F = ma$ (requires at least ma, T and air resistance in linear combination in at least one equation). At least one equation with not more than one error.
			A1		
		$0.2g + T – 0.4 = 0.2a$	A1		SR $0.2g - T – 0.4 = 0.2a$
		$0.3g – T – 0.25 = 0.3a$	A1	4	**and** $0.3g + T – 0.25 = 0.3a$ B1
	(ii)		M1		For obtaining an equation in T or a only, either by eliminating a or T from the equations in (i) or by applying $F = ma$ to the complete system
		$0.5g – 0.65 = 0.5a$ or $5T – 0.7 = 0$	A1 ft		For a correct equation in a only or T only ft opposite direction of T only
		$a = 8.5$ **and** $T = 0.14$ (positive only)	A1	3	

3	(i)	Momentum before = $0.1 \times 4 - 0.2 \times 3$	B1		or Loss by $P = 0.1 \times 4 + 0.1u$
		Momentum after = $-0.1u + 0.2(3.5 - u)$	B1		or Gain by $Q = 0.2(3.5 - u) + 0.2 \times 3$
		$0.1 \times 4 - 0.2 \times 3 = -0.1u + 0.2(3.5 - u)$	M1		For using the principle of conservation of momentum
		$u = 3$ (positive value only)	A1	4	
					SR If mgv used for momentum instead of mv, then $u = 3$ B1
	(ii)		M1		For using $v^2 = u^2 + 2as$ with $v = 0$ (either case) or equivalent equations
		$0 = 3^2 - 10s_1$ and $0 = 0.5^2 - 10s_2$	A1 ft		ft value of u from (i)
		$0.9 + 0.025$	M1		For using $PQ = s_1 + s_2$
		Distance is 0.925 m cao	A1	4	

4	(i) α		M1		For using $s = ut + \frac{1}{2}at^2$ for the first stage
		$2 = 0.8u + \frac{1}{2}a(0.8)^2$	A1		
			M1		For obtaining another equation in u and a with relevant values of velocity, displacement and time
		$8 = 2u + \frac{1}{2}a2^2$ or $6 = 1.2(u + 0.8a) + \frac{1}{2}a(1.2)^2$ or $6 = 1.2(2 \times 2 \div 0.8 - u) + \frac{1}{2}a(1.2)^2$	A1		
			M1		For eliminating a or u
		$u = 1.5$	A1		
		Acceleration is 2.5 ms^{-2}	A1	7	
	(i) β		M1		For using $s = vt - \frac{1}{2}at^2$ for the first stage
		$2 = 0.8v - \frac{1}{2}a(0.8)^2$	A1		
			M1		For using $s = ut + \frac{1}{2}at^2$ for the second stage
		$6 = 1.2v + \frac{1}{2}a(1.2)^2$	A1		
			M1		For obtaining values of a and v and using $v = u + at$ for first stage to find u
		Acceleration is 2.5 ms^{-2} ($v = 3.5$)	A1		
		$u = 1.5$	A1	7	
	(i) γ	$2 \div 0.8$ ms^{-1} and $6 \div 1.2$ ms^{-1}	M1		For finding average speeds in both intervals
		$= 2.5$ ms^{-1} and 5ms^{-1}	A1		
		$t_1 = 0.4$ and $t_2 = (0.8 +) 0.6$	B1		For finding mid-interval times
		$5 = 2.5 + a(1.4 - 0.4)$	M1		For using $v = u + at$ between the mid-interval times
		Acceleration is 2.5 ms^{-2}	A1		

		$2.5 = u + 2.5 \times 0.4$ or $\quad 5 = u + 2.5 \times 1.4$	M1		For using $v = u + at$ between $t = 0$ and one of the mid-interval times
		$u = 1.5$	A1	7	
	(ii)	$2.5 = 9.8\sin\alpha$ $\alpha = 14.8^{\circ}$	M1 A1ft	2	For using $(m)a = (m)g\sin\alpha$ ft value of acceleration

5	(i)		M1		For resolving forces on A vertically (3 terms)
		$F = 2 + 7\cos\alpha$ $F = 3.96$ (may be implied)	A1 A1		
		$N = 7\sin\alpha$	M1		For resolving forces on A horizontally (2 terms)
		$N = 6.72$ (may be implied)	A1		
		$3.96 = \mu\, 6.72$	M1		For using $F = \mu N$
		Coefficient is 0.589 or 33/56 cao	A1	7	
	(ii)	$T\cos\beta = 7\cos\alpha$	M1		For resolving forces at P vertically (2 terms)
		$T\cos\beta = 7 \times 0.28\ (\ = 1.96\ \textbf{AG})$	A1	2	
	(iii)		M1		For resolving forces on B vertically (2 terms)
		$T\cos\beta - mg = 0$	A1		
		Mass is 0.2 kg	A1	3	

6	(i)(a)	$V = P\cos20^{\circ} - 0.04g$	B1 M1		For setting $V = 0$
		$P = 0.417$	A1	3	
	(i)(b)	$R = P\sin20^{\circ}$	M1		For using R = horizontal component of P
		Magnitude is 0.143 N	A1ft	2	ft value of P
	(i)(c)	$0.143 = 0.04a$	M1		For using Newton's second law
		Acceleration is 3.57 ms^{-2}	A1ft	2	ft magnitude of the resultant
	(ii)	$R^2 = 0.08^2 + (0.04g)^2$	M1		For using $R^2 = P^2 + W^2$
		Magnitude is 0.400 N (or 0.40 or 0.4)	A1		
		$\tan\theta = +/-0.04g/0.08$ or $\tan(90^{\circ} - \theta) = +/-0.08/0.04g$	M1		For using $\tan\theta = Y/X$ or $\tan(90^{\circ} - \theta) = X/Y$
		Angle made with horizontal is 78.5° or 1.37 radians, or angle made with vertical is 11.5° or 0.201 radians	A1		
		Downwards or below horizontal	B1	5	Direction may alternatively be shown clearly on a diagram or given as a bearing

7	(i)		M1	For using the idea that the area of the quadrilateral represents distance
		½ 200×16 + 300× ½ (16 + 25) + ½ 100×25 (=1600 + 6150 + 1250) Distance is 9000m	A1 A1 3	
	(ii)	$a = (0 - 25)/(600 - 500)$ Deceleration is 0.25 ms^{-2}	M1 A1 2	For using the idea that gradient (= vel ÷ time) represents acceleration Or for using v = u + at Allow acceleration = - 0.25 ms^{-2}
	(iii)	Acceleration is $(1200t - 3t^2)\times 10^{-6}$	M1 A1 2	For using $a(t) = \dot{v}(t)$
	(iv)	0.25 – 0.2475 Amount is +/- 0.0025 ms^{-2}	M1 A1ft 2	For using 'ans(ii) – $|a_Q(550)|$' ft ans(ii) only
	(v)	$1200t - 3t^2 = 0$ $t = (0 \text{ or) } 400$ **AG**	M1 A1 2	For solving $a_Q(t) = 0$ or for finding $a_Q(400)$ Or for obtaining $a_Q(400) = 0$
	(vi)	½ 200×16 + 200× ½ (16 + 22) $s_Q(t) = (200t^3 - t^4/4) \times 10^{-6}$ (+C) 6400 – 5400 Distance is 1000 m	M1 A1 M1 A1 M1 A1 6	For correct method for $s_P(400)$ For using $s_Q(t) = \int v_Q dt$ For using correct limits and finding $\left\| s_Q(400) - s_P(400) \right\|$

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