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

2	(i)	$0.2g + T - 0.4 = 0.2a$ $0.3g - T - 0.25 = 0.3a$	M1 A1 A1 A1 4	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. SR $0.2g - T - 0.4 = 0.2a$ **and** $0.3g + T - 0.25 = 0.3a$ B1
	(ii)	$0.5g - 0.65 = 0.5a$ or $5T - 0.7 = 0$ $a = 8.5$ **and** $T = 0.14$ (positive only)	M1 A1 ft A1 3	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 For a correct equation in *a* only or *T* only ft opposite direction of *T* only

3	(i)	Momentum before= $0.1\times4 - 0.2\times3$ Momentum after = $-0.1u + 0.2(3.5 - u)$ $0.1\times4 - 0.2\times3 = -0.1u + 0.2(3.5 - u)$ $u = 3$ (positive value only)	B1 B1 M1 A1 4	or Loss by $P = 0.1\times4 + 0.1u$ or Gain by $Q = 0.2(3.5 - u) + 0.2\times3$ For using the principle of conservation of momentum
				SR If mgv used for momentum instead of mv, then $u = 3$ B1
	(ii)	$0 = 3^2 - 10s_1$ and $0 = 0.5^2 - 10s_2$ $0.9 + 0.025$ Distance is 0.925 m cao	M1 A1 ft M1 A1 4	For using $v^2 = u^2 + 2as$ with $v = 0$ (either case) or equivalent equations ft value of u from (i) For using $PQ = s_1 + s_2$

4	(i) α	$2 = 0.8u + ½ a(0.8)^2$ $8 = 2u + ½ a2^2$ or $6 = 1.2(u + 0.8a) + ½ a(1.2)^2$ or $6 = 1.2(2\times2\div0.8 - u) + ½ a(1.2)^2$ $u = 1.5$ Acceleration is 2.5 ms^{-2}	M1 A1 M1 A1 M1 A1 A1 7	For using $s = ut + ½ at^2$ for the first stage For obtaining another equation in u and a with relevant values of velocity, displacement and time For eliminating a or u
	(i) β	$2 = 0.8v - ½ a(0.8)^2$ $6 = 1.2v + ½ a(1.2)^2$ Acceleration is 2.5 ms^{-2} ($v = 3.5$) $u = 1.5$	M1 A1 M1 A1 M1 A1 A1 7	For using $s = vt - ½ at^2$ for the first stage For using $s = ut + ½ at^2$ for the second stage For obtaining values of a and v and using $v = u + at$ for first stage to find u
	(i) γ	$2\div0.8$ ms^{-1} and $6\div1.2$ ms^{-1} = 2.5 ms^{-1} and 5ms^{-1} $t_1 = 0.4$ and $t_2 = (0.8 +)\ 0.6$ $5 = 2.5 + a(1.4 - 0.4)$ Acceleration is 2.5 ms^{-2}	M1 A1 B1 M1 A1	For finding average speeds in both intervals For finding mid-interval times For using $v = u + at$ between the mid-interval times

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

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

6	(i)(a)	$V = P\cos 20° - 0.04g$ P = 0.417	B1 M1 A1 3	 For setting V = 0
	(i)(b)	$R = P\sin 20°$ Magnitude is 0.143 N	M1 A1ft 2	For using R = horizontal component of P ft value of P
	(i)(c)	0.143 = 0.04a Acceleration is 3.57 ms^{-2}	M1 A1ft 2	For using Newton's second law ft magnitude of the resultant
	(ii)	$R^2 = 0.08^2 + (0.04g)^2$ Magnitude is 0.400 N (or 0.40 or 0.4) $\tan\theta$ = +/-0.04g/0.08 or tan(90° - θ) = +/-0.08/0.04g Angle made with horizontal is 78.5° or 1.37 radians, or angle made with vertical is 11.5° or 0.201 radians Downwards or below horizontal	M1 A1 M1 A1 B1 5	For using $R^2 = P^2 + W^2$ For using $\tan\theta = Y/X$ or tan(90° - θ) = X/Y Direction may alternatively be shown clearly on a diagram or given as a bearing

7	(i)	½ 200 × 16 + 300 × ½ (16 + 25) + ½ 100 × 25 (=1600 + 6150 + 1250) Distance is 9000m	M1 A1 A1 3	For using the idea that the area of the quadrilateral represents distance
	(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) – $\lvert a_Q(550)\rvert$' ft ans(ii) only
	(v)	$1200t - 3t^2 = 0$ t = (0 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 $\lvert s_Q(400) - s_P(400) \rvert$