

**Mark Scheme 4728
June 2007**

1(i)	X = 5 Y = 12	B1 B1 [2]	X=-5 B0. Both may be seen/implied in (ii) No evidence for which value is X or Y available from (ii) award B1 for the pair of values 5 and 12 irrespective of order
(ii)	$R^2 = 5^2 + 12^2$ Magnitude is 13 N $\tan \theta = 12/5$ Angle is 67.4°	M1 A1 M1 A1 [4]	For using $R^2 = X^2 + Y^2$ Allow 13 from X=-5 For using correct angle in a trig expression SR: p=14.9 and Q=11.4 giving R=13+/-0.1 B2, Angle = 67.5+/-0.5 B2
2(i)	250 + ½ (290 – 250) t = 270	M1 A1 [2]	Use of the ratio 12:12 (may be implied), or v = u+at
(ii)	½ x 40x12+210x12+½x20x12– ½x20x12 or ½ x40x12+210x12 or ½ x(210+250)x12etc Displacement is 2760m	M1 M1 A1 [3]	The idea that area represents displacement Correct <u>structure</u> , ie triangle1 + rectangle2 + triangle3 - triangle4 with triangle3 = triangle4 , triangle1 + rectangle2, trapezium1&2, etc
(iii)	appropriate <u>structure</u> , ie triangle + rectangle + triangle + triangle , triangle + rectangle + 2triangle, etc Distance is 3000m	M1 A1 [2]	All terms positive Treat candidate doing (ii) in (iii) and (iii) in (ii) as a mis-read.
3(i)	R + Tsin72° = 50g	M1 A1 [2]	An equation with R, T and 50 in linear combination. R + 0.951T = 50g
(ii)	T = 50g/sin72° T = 515 (AG) T = mg m = 52.6	M1 A1 B1 B1 [4]	Using R = 0 (may be implied) and Tsin72° = 50(g) Or better Accept 52.5
(iii)	X = Tcos72° X = 159	B1 B1 [2]	Implied by correct answer Or better
4(i)	<i>In Q4 right to left may be used as the positive sense throughout.</i> 0.18 x 2 – 3m = 0 m = 0.12	M1 A1 A1 [3]	For using Momentum ‘before’ is zero 3 marks possible if g included consistently
(iia)	Momentum after = -0.18 x 1.5 + 1.5m 0.18 x 2 – 3m = -0.18 x 1.5 + 1.5m m = 0.14	B1 M1 A1 [3]	For using conservation of momentum 3 marks possible if g included consistently
(iib)	0.18 x 2 – 3m = (0.18 + m)1.5 m = 0.02 0.18 x 2 – 3m = - (0.18 + m)1.5 m = 0.42	B1ft B1 B1ft B1 [4]	ft wrong momentum ‘before’ 0 marks if g included

5(i)	$8.4^2 - 2gs_{\max} = 0$ Height is 3.6m (AG)	M1 A1 A1 [3]	Using $v^2 = u^2 \pm 2gs$ with $v = 0$ or $u = 0$
(ii)	$u = 5.6$	M1 A1 [2]	Using $u^2 = \pm 2g(\text{ans(i)} - 2)$
(iii)	EITHER (time when at same height)	M1	Using $s = ut + \frac{1}{2}at^2$ for P and for Q, $a = \pm g$, expressions for s terms must differ
	$s \pm 2 = 8.4t - \frac{1}{2}gt^2$ and $(s \pm 2) = 5.6t - \frac{1}{2}gt^2$ $t = 5/7$ (0.714)	A1 A1	Or $8.4t - \frac{1}{2}gt^2 = 5.6t - \frac{1}{2}gt^2 \pm 2$ Correct sign for g , cv(5.6), ± 2 in only one equation cao
	$v_P = 8.4 - 0.714g$ and $v_Q = 5.6 - 0.714g$	M1 A1	Using $v = u + at$ for P and for Q, $a = \pm g$, cv(t) Correct sign for g , cv(5.6), candidates answer for t (including sign)
	$v_P = 1.4$ and $v_Q = -1.4$	A1 [6]	cao
	OR (time when at same speed in opposite directions)	M1	Using $v = u + at$ for P and for Q, $a = \pm g$
	$v = 8.4 - gt$ and $-v = 5.6 - gt$ $v = 1.4$ {or $t = 5/7$ (0.714)}	A1 A1	Correct sign for g , cv(5.6) Only one correct answer is needed
	(with $v = 1.4$) $1.4^2 = 8.4^2 - 2gs_P$ and $(-1.4)^2 = 5.6^2 - 2gs_Q$	M1 A1	Using $v^2 = u^2 + 2as$ for P and for Q, $a = \pm g$, cv(v) Correct sign for g , cv(5.6), candidate's answer for v (including - for Q)
	$s_P = 3.5$ and $s_Q = 1.5$ {(with $t = 5/7$)}	A1	cao
	$s = 8.4 \times 0.714 - \frac{1}{2}g \times 0.714^2$ and $s = 5.6 \times 0.714 - \frac{1}{2}g \times 0.714^2$	M1 A1	Using $s = ut + \frac{1}{2}at^2$ for P and for Q, $a = \pm g$, cv(t) Correct sign for g , cv(5.6), candidate's answer for t (including sign of t if negative)
	$s_P = 3.5$ and $s_Q = 1.5$	A1	cao}
	OR (motion related to greatest height and verification)	M1	Using $v = u + at$ for P and for Q, $a = \pm g$
	$0 = 8.4 - gt$ and $0 = 5.6 - gt$ $t = 6/7$ and $t = 4/7$	A1	Both values correct mid-interval $t = (6/7 + 4/7)/2 = 0.714$ {Or semi-interval = $(6/7 - 4/7)/2 = 1/7$ }
	$v_P = 8.4 - 0.714g$ and $v_Q = 5.6 - 0.714g$ $\{0 = v_P - g/7 \text{ and } v_Q = 0 + g/7\}$	A1	cao
	$v_P = 1.4$ and $v_Q = -1.4$ $s_P = 8.4 \times 0.714 - \frac{1}{2}g \times 0.714^2$ and $s_Q = 5.6 \times 0.714 - \frac{1}{2}g \times 0.714^2$	M1	$s = ut + \frac{1}{2}at^2$ for P and for Q, correct sign for g , cv(5.6) and cv(t)
	$\{s_P = 0/7 - \frac{1}{2}(-g) \times (1/7)^2 \text{ and}$ $s_Q = 0/7 + \frac{1}{2}g \times (1/7)^2\}$	A1	$\{s = vt - \frac{1}{2}at^2 \text{ for P and } s = ut + \frac{1}{2}at^2 \text{ for Q}\}$
	$s_P = 3.5$ $s_Q = 1.5$	A1	cao
	$\{s_P = 0.1$ $s_Q = 0.1\}$	A1	cao

continued

5(iii)	OR (without finding exactly where or when)	M1	Using $v^2 = u^2 + 2as$ for P <i>and</i> for Q, $a = +/-g$, cv(5.6), different expressions for s.
cont	$v_p^2 = 8.4^2 - 2g(s+/-2)$ and		Correct sign for g, cv(5.6), (s+/-2) used only once cao. Verbal explanation essential
	$v_Q^2 = 5.6^2 - 2g[(s+/-2)]$	A1	Using $v = u+at$ for P <i>and</i> for Q, $a = +/-g$
	$v_p^2 = v_Q^2$ for all values of s so that the speeds are always the same at the same heights.	A1	Correct sign for g, correct choice for velocity of zero, cv(5.6)
	$0 = 8.4 -gt$ and $0 = 5.6-gt$	M1	
		A1	
	$t_p = 6/7$ and $t_Q = 4/7$ means there is a time interval when Q has started to descend but P is still rising, and there will be a position where they have the same height but are moving in opposite directions.		cao. Verbal explanation essential
		A1	

6(i)	$v = 0.004t^3 - 0.12t^2 + 1.2t$	M1	For differentiating s
	$v(10) = 4 - 12 + 12 = 4ms^{-1}$ (AG)	A1	Condone the inclusion of +c
		A1	Correct formula for v (no +c) and t=10
		[3]	stated sufficient
(ii)	$v = 0.8t - 0.04t^2$ (+ C)	M1	For integrating a
	$8 - 4 + C = 4$	A1	
	$v = 0.8 \times 20 - 0.04 \times 20^2$ (+ C)	M1*	Only for using $v(10) = 4$ to find C
	$v(20) = 16 - 16 = 0$ (AG)	M1	
		DA1	Dependant on M1*
		[5]	
(iii)	$S = 0.4t^2 - 0.04t^3/3$ (+K)	M1	For integrating v
	$s(10) = 10 - 40 + 60 = 30$	A1	Accept $0.4t^2 - 0.013t^3$ (+ ct +K, must be linear)
	$40 - 40/3 + K = 30 \rightarrow K = 10/3$	B1	
	$S(20) = 160 - 320/3 + 10/3 = 56.7m$	M1	For using $S(10) = 30$ to find K
	OR	A1	Not if S includes ct term
	$s(10) = 10 - 40 + 60 = 30$	[6]	Accept 56.6 to 56.7, Adding 30 subsequently is not isw, hence B0
	$S = 0.4t^2 - 0.04t^3/3$	B1	
	$S(20) - S(10) = 26.6, 26.7$	M1	For integrating v
		A1	Accept $0.4t^2 - 0.013t^3$ (+ ct +K, must be linear)
		M1	Using limits of 10 and 20 (limits 0, 10 M0A0B0)
		A1	For 53.3 - 26.7 or better (Note $S(10) = 26.7$ is fortuitously correct M0A0B0)
	displacement is 56.7m	B1	Accept 56.6 to 56.7

7(i)	$R = 1.5g\cos 21^\circ$ Frictional force is 10.98N (AG)	B1 M1 A1 [3]	For using $F = \mu R$ Note $1.2g\cos 21^\circ = 10.98$ fortuitously, B0M0A0
(ii)	$T + 1.5g\sin 21^\circ - 10.98 = 1.5a$ $1.2g - T = 1.2a$	M1 A2 A2 [5]	For obtaining an N2L equation relating to the block in which F, T, m and a are in linear combination or For obtaining an N2L equation relating to the object in which T, m and a are in linear combination -A1 for each error to zero -A1 for each error to zero Error is a wrong/omitted term, failure to substitute a numerical value for a letter (excluding g), excess terms. Minimise error count.
(iii)	$T - 1.5a = 5.71$ and $1.2a + T = 11.76$ $a = 2.24$ (AG)	M1 A1 [2]	For solving the simultaneous equations in T and a for a. Evidence of solving needed
(iva)	$v^2 = 2 \times 2.24 \times 2$ Speed of the block is 2.99ms^{-1}	M1 A1 [2]	For using $v^2 = 2as$ with cv (a) or 2.24 Accept 3
(ivb)	$a = -3.81$ $v^2 = 2.99^2 + 2 \times (-3.81) \times 0.8$ Speed of the block is 1.69ms^{-1}	M1 A1 M1 A1 [4]	For using $T = 0$ to find a For using $v^2 = u^2 + 2as$ with cv(2.99) and $s = 2.8 - 2$ and any value for a Accept art 1.7 from correct work