Mark Scheme 4728
June 2007

1(i)	X = 5	B1	X=-5 B0. Both may be seen/implied in (ii)
	Y = 12	B1	No evidence for which value is X or Y available from (ii)
			award B1 for the pair of values 5 and 12 irrespective of
		[2]	order
(ii)	$R^2 = 5^2 + 12^2$	M1	For using $R^2 = X^2 + Y^2$
	Magnitude is 13 N	A1	Allow 13 from X=-5
	$\tan\theta$ = 12/5	M1	For using correct angle in a trig expression
	Angle is 67.4^o	A1	**SR:** p=14.9 and Q=11.4 giving R=13+/-0.1 B2,
		[4]	Angle = 67.5+/-0.5 B2

2(i)	250 + ½ (290 – 250)	M1	Use of the ratio 12:12 (may be implied), or v = u+at
	t = 270	A1	
		[2]	
(ii)		M1	The idea that area represents displacement
	½ x40x12+210x12+½x20x12–	M1	Correct <u>structure</u>, ie triangle1 + rectangle2 + triangle3 -
	½x20x12 or ½ x40x12+210x12		|triangle4| with triangle3 = |triangle4|, triangle1 +
	or ½ x(210+250)x12etc		rectangle2, trapezium1&2, etc
	Displacement is 2760m	A1	
		[3]	
(iii)	appropriate <u>structure</u>, ie triangle +	M1	All terms positive
	rectangle + triangle + |triangle|,		
	triangle + rectangle + 2triangle, etc		
	Distance is 3000m	A1	Treat candidate doing (ii) in (iii) and (iii) in (ii)
		[2]	as a mis-read.

3(i)		M1	An equation with R, T and 50 in linear combination.
	R + Tsin72^o = 50g	A1	R + 0.951T = 50g
		[2]	
(ii)	T = 50g/sin72^o	M1	Using R = 0 (may be implied) and Tsin72^o = 50(g)
	T = 515 (AG)	A1	Or better
	T = mg	B1	
	m = 52.6	B1	Accept 52.5
		[4]	
(iii)	X = Tcos72^o	B1	Implied by correct
			answer
	X = 159	B1	Or better
		[2]	

4(i)	*In Q4 right to left may be used as the*	M1	For using Momentum 'before' is zero
	positive sense throughout.		
	0.18 x 2 – 3m = 0	A1	
	m = 0.12	A1	
		[3]	3 marks possible if g included consistently
(iia)	Momentum after	B1	
	= -0.18 x 1.5 + 1.5m		
	0.18 x 2 – 3m = -0.18 x 1.5 + 1.5m	M1	For using conservation of momentum
	m = 0.14	A1	
		[3]	3 marks possible if g included consistently
(iib)	0.18 x 2 – 3m	B1ft	ft wrong momentum 'before'
	= (0.18 + m)1.5		
	m = 0.02	B1	
	0.18 x 2 – 3m= - (0.18 + m)1.5	B1ft	
	m = 0.42	B1	
		[4]	0 marks if g included

5(i)		M1	Using $v^2 = u^2 +/- 2gs$ with $v = 0$ or $u = 0$
	$8.4^2 - 2gs_{max} = 0$	A1	
	Height is 3.6m (AG)	A1	
		[3]	
(ii)		M1	Using $u^2 =+/- 2g(ans(i) - 2)$
	$u = 5.6$	A1	
		[2]	
(iii)	EITHER (time when at same height)	M1	Using $s = ut + \frac{1}{2} at^2$ for P *and* for Q, $a = +/-g$, expressions for s terms must differ
			Or $8.4t (- \frac{1}{2} gt^2)=5.6t (- \frac{1}{2} gt^2)+/- 2$
	$s+/-2 = 8.4t - \frac{1}{2} gt^2$ and		
	$(s+/-2) = 5.6t - \frac{1}{2} gt^2$	A1	Correct sign for g, cv(5.6), +/-2 in only one equation
	$t = 5/7$ (0.714)	A1	cao
		M1	Using $v = u +at$ for P *and* for Q, $a = +/-g$, cv(t)
	$v_P =8.4 -0.714g$ and $v_Q =5.6-0.714g$	A1	Correct sign for g, cv(5.6), candidates answer for t (including sign)
	$v_P = 1.4$ and $v_Q = -1.4$	A1	cao
		[6]	
	OR (time when at same speed in opposite directions)	M1	Using $v = u+at$ for P *and* for Q, $a = +/-g$
	$v = 8.4 -gt$ and $-v =5.6-gt$	A1	Correct sign for g, cv(5.6)
	$v = 1.4$ {or $t = 5/7$ (0.714)}	A1	Only one correct answer is needed
	(with $v = 1.4$)	M1	Using $v^2 = u^2 + 2as$ for P *and* for Q, $a = +/-g$, cv(v)
	$1.4^2 = 8.4^2 - 2gs_P$ and		
	$(-1.4)^2 = 5.6^2 - 2gs_Q$	A1	Correct sign for g, cv(5.6), candidate's answer for v (including - for Q)
	$s_P = 3.5$ and $s_Q = 1.5$	A1	cao
	{(with $t=5/7$)	M1	Using $s = ut + \frac{1}{2} at^2$ for P *and* for Q, $a = +/-g$, cv(t)
	$s = 8.4x0.714 - \frac{1}{2} gx0.714^2$ and		
	$s = 5.6x0.714 - \frac{1}{2} gx0.714^2$	A1	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 $v = u+at$ t for P *and* for Q, $a = +/-g$
	$0 = 8.4 -gt$ and $0 =5.6-gt$		
	$t = 6/7$ and $t = 4/7$	A1	Both values correct
	$v_P =8.4 -0.714g$ and $v_Q =5.6-0.714g$		mid-interval t $(6/7+4/7)/2 = 0.714$
	$\{0 = v_P - g/7$ and $v_Q = 0 +g/7\}$		{Or semi-interval = $6/7-4/7)/2=1/7$}
	$v_P = 1.4$ and $v_Q = -1.4$	A1	cao
	$s_P = 8.4x0.714 - \frac{1}{2} gx0.714^2$ and	M1	$s = ut + \frac{1}{2} at^2$ for P *and* for Q, correct sign for g,
	$s_Q = 5.6x0.714 - \frac{1}{2} gx0.714^2$		cv(5.6) and cv(t)
	$\{ s_P = 0/7 - \frac{1}{2}(- g)x(1/7)^2$ and		{$s = vt - \frac{1}{2} at^2$ for P *and* $s = ut + \frac{1}{2} at^2$ for Q}
	$s_Q = 0/7 + \frac{1}{2} gx(1/7)^2\}$	A1	
	$s_P = 3.5$ $s_Q = 1.5$		
	{ $s_P = 0.1$ $s_Q = 0.1$}	A1	cao
			continued

5(iii)	OR (without finding exactly where or when)	M1	Using $v^2 = u^2 + 2as$ for P *and* for Q, a = +/-g, cv(5.6), different expressions for s.
co*nt*	$v_P^2 = 8.4^2 -2g(s+/-2)$ and		Correct sign for g, cv(5.6), (s+/-2) used only once cao. Verbal explanation essential
	$\qquad v_Q^2 = 5.6^2 -2g[(s+/-2)]$	A1	Using $v = u+at$ t for P *and* 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 M1	Correct sign for g, correct choice for velocity of zero, cv(5.6)
	$0 = 8.4 -gt$ and $0 = 5.6-gt$	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.	A1	cao. Verbal explanation essential

6(i)		M1	For differentiating s
	$v = 0.004t^3 – 0.12t^2 + 1.2t$	A1	Condone the inclusion of +c
	$v(10) = 4 – 12 + 12 = 4 \text{ms}^{-1}$ (AG)	A1 [3]	Correct formula for v (no +c) and t=10 stated sufficient
(ii)		M1	For integrating a
	$v = 0.8t – 0.04t^2$ (+ C)	A1	
	$8 - 4 + C = 4$	M1*	Only for using v(10) = 4 to find C
	$v = 0.8 \times 20 – 0.04 \times 20^2$ (+ C)	M1	
	$v(20) = 16 – 16 = 0$ (AG)	DA1 [5]	Dependant on M1*
(iii)		M1	For integrating v
	$S = 0.4t^2 – 0.04t^3/3$ (+K)	A1	Accept $0.4t^2 – 0.013t^3$ (+ ct +K, must be linear)
	$s(10) = 10 – 40 + 60 = 30$	B1 M1	For using S(10) = 30 to find K
	$40 – 40/3 + K = 30$ ➜ $K = 10/3$	A1	Not if S includes ct term
	$S(20) = 160 – 320/3 + 10/3 = 56.7 \text{m}$ OR	B1 [6]	Accept 56.6 to 56.7, Adding 30 subsequently is not isw, hence B0
	$s(10) = 10 – 40 + 60 = 30$	B1	
	$S = 0.4t^2 – 0.04t^3/3$	M1 A1	For integrating v Accept $0.4t^2 – 0.013t^3$ (+ ct +K, must be linear)
	$S(20) - S(10) = 26.6, 26.7$	M1 A1	Using limits of 10 and 20 (limits 0, 10 M0A0B0) 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)	$R = 1.5g\cos21^{\circ}$	B1	
		M1	For using $F = \mu R$
	Frictional force is 10.98N (AG)	A1 [3]	Note $1.2g\cos21 = 10.98$ fortuitously, B0M0A0
(ii)		M1	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
	$T + 1.5g\sin21^{\circ} - 10.98 = 1.5a$	A2	-A1 for each error to zero
	$1.2g - T = 1.2a$	A2 [5]	-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 $1.2a + T = 11.76$	M1	For solving the simultaneous equations in T and a for a.
	$a = 2.24$ (AG)	A1 [2]	Evidence of solving needed
(iva)	$v^2 = 2 \times 2.24 \times 2$	M1	For using $v^2 = 2as$ with cv (a) or 2.24
	Speed of the block is 2.99ms^{-1}	A1 [2]	Accept 3
(ivb)		M1	For using $T = 0$ to find a
	$a = -3.81$	A1	
	$v^2 = 2.99^2 + 2 \times (-3.81) \times 0.8$	M1	For using $v^2 = u^2 + 2as$ with cv(2.99) and $s = 2.8 - 2$ and any value for a
	Speed of the block is 1.69ms^{-1}	A1 [4]	Accept art 1.7 from correct work