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^o	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 x40x12+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)	$R + T\sin 72^o = 50g$	M1 A1 [2]	An equation with R, T and 50 in linear combination. R + 0.951T = 50g
(ii)	$T = 50g/\sin 72^o$ T = 515 (AG) T = mg m = 52.6	M1 A1 B1 B1 [4]	Using R = 0 (may be implied) and $T\sin 72^o = 50(g)$ Or better Accept 52.5
(iii)	$X = T\cos 72^o$ X = 159	B1 B1 [2]	Implied by correct answer Or better

4(i)	*In Q4 right to left may be used as the positive sense throughout.* 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)		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 $u^2 = +/- 2g(\text{ans(i)} - 2)$
	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
	$s+/-2 = 8.4t - \frac{1}{2}gt^2$ and		Or $8.4t (-\frac{1}{2}gt^2) = 5.6t (-\frac{1}{2}gt^2) +/- 2$
	$(s+/-2) = 5.6t - \frac{1}{2}gt^2$	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 $s_Q = 5.6x0.714 - \frac{1}{2}gx0.714^2$	M1	$s = ut + \frac{1}{2}at^2$ for P *and* for Q, correct sign for g, cv(5.6) and cv(t)
	$\{s_P = 0/7 - \frac{1}{2}(-g)x(1/7)^2$ and $s_Q = 0/7 + \frac{1}{2}gx(1/7)^2\}$	A1	{$s = vt - \frac{1}{2}at^2$ for P *and* $s = ut + \frac{1}{2}at^2$ for Q}
	$s_P = 3.5$ $s_Q = 1.5$		
	$\{s_P = 0.1$ $s_Q = 0.1\}$	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
	$v_Q^2 = 5.6^2 - 2g[(s+/-2)]$	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	Correct sign for g, correct choice for velocity of zero, cv(5.6)
		M1	
	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
	$v(10) = 4 - 12 + 12 = 4ms^{-1}$ (AG)	A1	Correct formula for v (no +c) and t=10
		[3]	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
	$v = 0.8x20 - 0.04x20^2$ (+ C)	M1	
	v(20) = 16 – 16 = 0 (AG)	DA1	Dependant on M1*
		[5]	
(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 = 56.7m	B1	Accept 56.6 to 56.7, Adding 30 subsequently is not isw,
	OR	[6]	hence B0
	s(10) = 10 – 40 + 60 = 30	B1	
		M1	For integrating v
	$S = 0.4t^2 - 0.04t^3/3$	A1	Accept $0.4t^2 - 0.013t^3$ (+ ct +K, must be linear)
		M1	Using limits of 10 and 20 (limits 0, 10 M0A0B0)
	S(20) - S(10) = 26.6, 26.7	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)	$R = 1.5g\cos 21^o$	B1	
		M1	For using $F = \mu R$
	Frictional force is 10.98N (AG)	A1 [3]	Note 1.2gcos21=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
	$T + 1.5g\sin 21^o - 10.98 = 1.5a$	A2	-A1 for each error to zero
	$1.2g - T = 1.2a$	A2	-A1 for each error to zero
		[5]	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 $2.99 ms^{-1}$	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 $1.69 ms^{-1}$	A1 [4]	Accept art 1.7 from correct work