Kinematics with Constant Acceleration (SUVAT) Exam Questions MS (From OCR 4728)

Q1, (Jun 2009, Q4)

4 i	$v^2 = 7^2 - 2\times9.8\times2.1$ $v = 2.8$ ms^{-1}	M1 A1 A1 [3]	Uses $v^2 = u^2 - 2gs$. Accept $7^2 = u^2 + 2gs$
ii	$v = 0$ $0^2 = 7^2 - 2\times9.8s$ $s = 2.5$ m	B1 M1 A1 [3]	Velocity = 0 at greatest height Uses $0 = u^2 - 2gs$. Accept $7^2 = 2\times9.8s$.
iii	$v = -5.7$ (or $t = 0.71$ oef to reach greatest height) $-5.7 = 7 - 9.8t$ or $5.7 = (0+) 9.8T$ $t = 1.3(0)$ s (1.2959..)	B1 M1 A1 [3]	Allows for change of direction Uses $v = u +$ or $- gt$. Not 1.29 unless obtained from g=9.81 consistently

Q2, (Jun 2008, Q1)

1(i)	900a = 600 -240 a = 0.4 ms^{-2} AG	M1 A1 [2]	N2L with difference of 2 forces, accept 360
(ii)	9 = 5 + 0.4t t = 10 s $9^2 = 5^2 + 2x0.4s$ s = 70 m	M1 A1 M1 A1 [4]	v = u + 0.4t or v = u +(cv 0.4)t or s=(u+v)t/2 or s=ut+0.5xcv(0.4)t^2

Q3, (Jun 2007, Q5)

5(i)	$8.4^2 - 2gs_{max} = 0$ Height is 3.6m (AG)	M1 A1 A1 [3]	Using $v^2 = u^2$ +/– 2gs with v = 0 or u = 0
(ii)	u = 5.6	M1 A1 [2]	Using u^2 =+/- 2g(ans(i) – 2)
(iii)	EITHER (time when at same height) $s+/-2 = 8.4t - ½ gt^2$ and $(s+/-2) = 5.6t - ½ gt^2$ t = 5/7 (0.714)	M1 A1 A1	Using $s = ut + ½ at^2$ for P *and* for Q, a = +/-g, expressions for s terms must differ Or $8.4t (- ½ gt^2) = 5.6t (- ½ gt^2) +/- 2$ 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 v_P = 1.4 and v_Q = -1.4	M1 A1 A1 [6]	Using v = u +at for P *and* for Q, a = +/-g, cv(t) Correct sign for g, cv(5.6), candidates answer for t (including sign) cao

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 $s_Q = 1.5$ {(with t=5/7)	A1	cao
	M1	Using $s = ut + \frac{1}{2}at^2$ for P *and* for Q, a = +/-g, cv(t)
$s = 8.4 \times 0.714 - \frac{1}{2} g \times 0.714^2$ and $s = 5.6 \times 0.714 - \frac{1}{2} g \times 0.714^2$	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
$s_P = 8.4 \times 0.714 - \frac{1}{2} g \times 0.714^2$ 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)
{ $s_P = 0/7 - \frac{1}{2}(-g)(1/7)^2$ and $s_Q = 0/7 + \frac{1}{2} g (1/7)^2$}	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

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. Correct sign for g, cv(5.6), (s+/-2) used only once cao. Verbal explanation essential
cont	$v_P^2 = 8.4^2 - 2g(s+/-2)$ and $v_Q^2 = 5.6^2 - 2g[(s+/-2)]$	A1	Using v = u+at t for P *and* for Q, a = +/-g Correct sign for g, correct choice for velocity of zero, cv(5.6)
	$v_P^2 = v_Q^2$ for all values of s so that the speeds are always the same at the same heights.	A1	
		M1	
	$0 = 8.4 - gt$ 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

Q5, (Jun 2013, Q2)

(i)	$U = 0.5g$ *OR* $U - 0.5g = 0$	M1	Consider descent *OR* ascent. $v = u + at$ with consistent signs for non-zero terms. $U + 0.5g = 0$ is M0 hence A0.
	$U = 4.9$ m s^{-1}	A1	Allow use of 4.9 without penalty in (ii) and (iii) even if 0/2 here.
		[2]	
(ii)	$U^2 = \pm 2gs$	M1	$v^2 = u^2 + 2as$
	$4.9^2 = \pm 2 \times 9.8 \times s$	A1	
	$s = 1.225$ m	A1	+ve, 49/40, 1.22 or 1.23 BoD loss of – sign in final answer
		[3]	
	OR		
	$s = \pm(ut \pm gt^2/2)$ *OR* $s = \pm gt^2/2$	M1	Rise to/fall from greatest height. $S = \pm(vt \pm g\frac{t^2}{2})$ is similar.
	$s = \pm(4.9 \times 0.5 - g \times 0.5^2/2)$ *OR* $s = \pm g \times 0.5^2/2$	A1	
	$s = 1.225$ m	A1	+ve, 1.22 or 1.23 BoD loss of – sign in final answer
	OR		
	$s = \pm Ut/2$	M1	$s = (u + v)t/2$
	$s = \pm 4.9 \times 0.5/2$	A1	
	$s = 1.225$ m	A1	+ve, 1.22 or 1.23 BoD loss of – sign in final answer
(iii)	$v^2 = 2g(s \pm 0.539)$	M1	Overall descent, zero initial speed
	$v^2 = 2 \times 9.8 \times (0.539 + 1.225)$	A1ft	ft cv (1.225), tolerate sign change from (ii)
	$v = 5.88$ ms^{-1}	A1	Exact, isw rounding of 5.88 to 5.9 if 5.88 seen
	OR	**[3]**	
	$v^2 = u^2 \pm 2g \times 0.539$	M1	Motion from projection level down, non-zero initial speed
	$v^2 = 4.9^2 + 2g \times 0.539$	A1ft	ft cv (4.9), tolerate sign change from (i)
	$v = 5.88$ ms^{-1}	A1	Exact, isw rounding of 5.88 to 5.9 if 5.88 seen

Q6, (Jun 2014, Q1i,ii) [Modified]

(i)	$v^2 = 3.5^2 + 2g \times 5$	M1	Uses $v^2 = 3.5^2$ +/– 2g5
	$v = 10.5$ ms^{-1}	A1	
		[2]	
(ii)	$5 = 0.87u - g \times 0.87^2/2$	M1	+/-5 = $0.87u$ +/– $g\ 0.87^2/2$
	$u = 10.0$ m s^{-1}	A1	
		A1	
		[3]	

Q7, (Jun 2015, Q1)

(i)	$v^2 = 14^2 + 2g \times 30$	M1	$v^2 = u^2$ +/– $2gs$
	$v = 28$ m s^{-1}	A1	
		[2]	
(ii)	$s = 14 \times 0.4 + g \times 0.4^2/2$	M1	
	$s = 6.384$ m	A1	Accept 6.38
		[2]	
(iii)	$15 = 28t - gt^2/2$	M1*	Uses $s = vt$ +/– $gt^2/2$
	$4.9t^2 - 28t + 15 = 0$	D*M1	Attempts to solve 3 term QE
	$t = (5.12)\ 0.598$ s	A1	Ignore 5.12 if seen
		[3]	
	OR		
	$28^2 = u^2 + 2g \times 15$	M1*	$v^2 = 14^2 + 2g \times 15$
	$28 = \sqrt{(490)} + gt$	D*M1	
	$t = 0.598$ s	A1	
	OR		
	$15 = 14t + gt^2/2$	M1*	Attempts to solve 3 term QE
	$30 = (14 + 28)t/2$	D*M1	Finding total time.
	$t = 0.598$ s	A1	

Q8, (Jun 2016, Q1)

i		$14^2 = 2gh$ $h = 10$ m $14 = gt$ $t = 1.43$ s *OR* $14 = gt$ $t = 1.43$ s $h = 0\text{x}1.43 + 9.8\text{x}1.43^2/2$ $h = 10(.0)$ m	**M1** **A1** **M1** **A1** **[4]** **M1** **A1** **M1** **A1**	$v^2 = u^2 + /- 2gs$ with $u=0$ -ve final answer A0 $v = u + gt$ with $u=0$ Accept 10/7 There are many alternatives, but following through of wrong answer is allowed only for method marks as the h and t values can be found independently.
ii		$20^2 = 14^2 + 2a15$ $a = 6.8$ m s^{-2}	**M1** **A1** **A1** **[3]**	$v^2 = 14^2 + /- 2as$, $a \neq g$