

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

Q1, (Jun 2009, Q4)

4 i	$v^2 = 7^2 - 2 \times 9.8 \times 2.1$ $v = 2.8 \text{ ms}^{-1}$	M1 A1 A1 [3]	Uses $v^2 = u^2 - 2gs$. Accept $7^2 = u^2 + 2gs$
ii	$v = 0$ $0^2 = 7^2 - 2 \times 9.8s$ $s = 2.5 \text{ m}$	B1 M1 A1 [3]	Velocity = 0 at greatest height Uses $0 = u^2 - 2gs$. Accept $7^2 = 2 \times 9.8s$.
iii	$v = -5.7$ (or $t = 0.71$ oef to reach greatest height) $-5.7 = 7 - 9.8t$ or $5.7 = (0+) 9.8T$ $t = 1.3(0) \text{ s}$ (1.2959..)	B1 M1 A1 [3]	Allows for change of direction Uses $v = u + \text{or} - gt$. Not 1.29 unless obtained from $g=9.81$ consistently

Q2, (Jun 2008, Q1)

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

Q3, (Jun 2007, Q5)

5(i)	$8.4^2 - 2gs_{\text{max}} = 0$ 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 $u^2 = +/- 2g(\text{ans(i)} - 2)$
(iii)	EITHER (time when at same height) $s +/- 2 = 8.4t - \frac{1}{2}gt^2$ and $(s +/- 2) = 5.6t - \frac{1}{2}gt^2$ $t = 5/7$ (0.714) $v_P = 8.4 - 0.714g$ and $v_Q = 5.6 - 0.714g$ $v_P = 1.4$ and $v_Q = -1.4$		M1 A1 A1 M1 A1 A1 [6]	Using $s = ut + \frac{1}{2}at^2$ for P and for Q, $a = +/-g$, expressions for s terms must differ Or $8.4t - \frac{1}{2}gt^2 = 5.6t - \frac{1}{2}gt^2 +/- 2$ Correct sign for g, cv(5.6), +/-2 in only one equation cao 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)

$$v = 8.4 - gt \text{ and } -v = 5.6 - gt$$

$$v = 1.4 \text{ (or } t = 5/7 \text{ (0.714))}$$

(with $v = 1.4$)

$$1.4^2 = 8.4^2 - 2gs_P \text{ and}$$

$$(-1.4)^2 = 5.6^2 - 2gs_Q$$

$$s_P = 3.5 \text{ and } s_Q = 1.5$$

{(with $t = 5/7$)}

$$s = 8.4 \times 0.714 - \frac{1}{2} g \times 0.714^2 \text{ and}$$

$$s = 5.6 \times 0.714 - \frac{1}{2} g \times 0.714^2$$

$$s_P = 3.5 \text{ and } s_Q = 1.5$$

OR (motion related to greatest height and verification)

$$0 = 8.4 - gt \text{ and } 0 = 5.6 - gt$$

$$t = 6/7 \text{ and } t = 4/7$$

$$v_P = 8.4 - 0.714g \text{ and } v_Q = 5.6 - 0.714g$$

$$\{0 = v_P - g/7 \text{ and } v_Q = 0 + g/7\}$$

$$v_P = 1.4 \text{ and } v_Q = -1.4$$

$$s_P = 8.4 \times 0.714 - \frac{1}{2} g \times 0.714^2 \text{ and}$$

$$s_Q = 5.6 \times 0.714 - \frac{1}{2} g \times 0.714^2$$

$$\{s_P = 0/7 - \frac{1}{2}(-g) \times (1/7)^2 \text{ and}$$

$$s_Q = 0/7 + \frac{1}{2} g \times (1/7)^2\}$$

$$s_P = 3.5 \text{ } s_Q = 1.5$$

$$\{s_P = 0.1 \text{ } s_Q = 0.1\}$$

5(iii) OR (without finding exactly where or when)

$$\text{cont } v_P^2 = 8.4^2 - 2g(s+/-2) \text{ and}$$

$$v_Q^2 = 5.6^2 - 2g[(s+/-2)]$$

$v_P^2 = v_Q^2$ for all values of s so that the speeds are always the same at the same heights.

$$0 = 8.4 - gt \text{ and } 0 = 5.6 - gt$$

$t_P = 6/7$ 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.

M1 Using $v = u + at$ for P and for Q , $a = +/-g$

A1 Correct sign for g , cv(5.6)

A1 Only one correct answer is needed

M1 Using $v^2 = u^2 + 2as$ for P and for Q , $a = +/-g$, cv(v)

A1 Correct sign for g , cv(5.6), candidate's answer for v (including - for Q)

A1 cao

M1 Using $s = ut + \frac{1}{2} at^2$ for P and for Q , $a = +/-g$, cv(t)

A1 Correct sign for g , cv(5.6), candidate's answer for t (including sign of t if negative)

A1 cao}

M1 Using $v = u + at$ for P and for Q , $a = +/-g$

A1 Both values correct

$$\text{mid-interval } t = (6/7 + 4/7)/2 = 0.714$$

$$\{\text{Or semi-interval} = (6/7 - 4/7)/2 = 1/7\}$$

A1 cao

M1 $s = ut + \frac{1}{2} at^2$ for P and for Q , correct sign for g , cv(5.6) and cv(t)

$$\{s = vt - \frac{1}{2} at^2 \text{ for } P \text{ and } s = ut + \frac{1}{2} at^2 \text{ for } Q\}$$

A1

A1 cao

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

A1 Using $v = u + at$ for P and for Q , $a = +/-g$

Correct sign for g , correct choice for velocity of zero, cv(5.6)

A1

M1

A1

cao. Verbal explanation essential

A1

Q5, (Jun 2013, Q2)

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

Q6, (Jun 2014, Q1,ii) [Modified]

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

Q7, (Jun 2015, Q1)

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

Q8, (Jun 2016, Q1)

i	$14^2 = 2gh$ $h = 10 \text{ m}$ $14 = gt$ $t = 1.43 \text{ s}$ OR $14 = gt$ $t = 1.43 \text{ s}$ $h = 0 \times 1.43 + 9.8 \times 1.43^2 / 2$ $h = 10(.0) \text{ m}$	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	$20^2 = 14^2 + 2a15$ $a = 6.8 \text{ m s}^{-2}$	M1 A1 A1 [3]	$v^2 = 14^2 + 2as$, $a \neq g$