

Y1M9 XMQs and MS

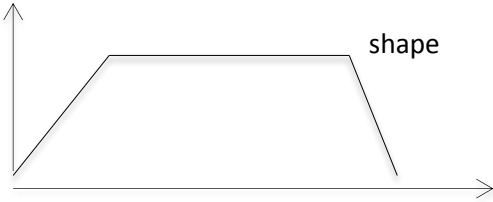
(Total: 55 marks)

1. P32(AS)_2018 Q6 . 4 marks - Y1M9 Constant acceleration
2. P32(AS)_2018 Q7 . 7 marks - Y1M9 Constant acceleration
3. P32(AS)_2019 Q1 . 10 marks - Y1M9 Constant acceleration
4. P32(AS)_2020 Q1 . 12 marks - Y1M9 Constant acceleration
5. P32(AS)_2021 Q1 . 7 marks - Y1M9 Constant acceleration
6. P32(AS)_2022 Q1 . 7 marks - Y1M9 Constant acceleration
7. P32(AS)_2022 Q2 . 8 marks - Y1M9 Constant acceleration

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Section B: Mechanics

Question	Scheme	Marks	AOs
6.	Equation in t only	M1	2.1
	$-2 = 9t - \frac{1}{2} \cdot 10t^2$	A1	1.1b
	$5t^2 - 9t - 2 = 0 = (5t+1)(t-2)$	DM1	1.1b
	$T = 2$ (only)	A1	1.1b
		(4)	
(4 marks)			
Notes:			
<p>M1: Complete method to give equation in t only. This mark is for a complete method for the TOTAL time i.e. for finding sufficient equations, with usual rules, correct no. of terms in each equation but condone sign errors and g does not need to be substituted</p> <p>A1: A correct equation or correct equations (e.g. if they find the speed, 11 ms^{-1}, when the ball strikes the ground and then use that to find the total time or if they split the time (e.g. 0.9s up and 1.1s down or 0.9s + 0.9s + 0.2s))</p> <p>N.B. $g = 10$ must be substituted in all equations used.</p> <p>DM1: Dependent on first M1, for solving a 3 term quadratic to find T or for solving their equations to find T or for solving their equations <u>and adding</u> their split times to find T</p> <p>A1: $T = 2$ only (i.e. A0 if they give two times)</p> <p>N.B. If solving a <u>correct</u> quadratic, the DM1 can be implied by a correct answer i.e. the method does not need to be shown, but if there is no method shown and the answer is wrong then award DM0 A0.</p>			

Question	Scheme	Marks	AOs
7(a) (i)	24 (m s ⁻¹)	B1	1.1b
(ii)	48 (s)	B1	1.1b
(iii)		B1	1.1b
		(3)	
(b)	Equating area under graph to 4800 to give equation in one unknown	M1	3.1b
	$\frac{1}{2}(T + T + 80 + 48) \times 24 = 4800 \quad \text{OR}$ $\left(\frac{1}{2} \times 80 \times 24\right) + 24T + \left(\frac{1}{2} \times 48 \times 24\right) = 4800 \quad \text{oe}$	A1ft	1.1b
	T = 136 so total time is 264 (s)	A1	1.1b
		(3)	
(c)	<p>Accept</p> <p>Either: a smooth change from acceleration to constant velocity or from constant velocity to deceleration.</p> <p>Or have train accelerating and/or decelerating at a variable rate</p> <p>Do not accept e.g.</p> <p>Comments on air resistance or resistive forces, straightness of track, horizontal track, friction, length of train, mass of train, not having train moving with constant velocity.</p> <p><u>B0 if either an incorrect extra is included or an incorrect reason for a valid improvement is included.</u></p> <p><u>N.B.</u> Variable acceleration due to air resistance is B0 BUT Variable acceleration due to variable air resistance is B1</p>	B1	3.5c
		(1)	
(7 marks)			
Notes:			
(a)			
(i) B1: 24 (m s ⁻¹) Must be stated i.e. not just inserted on the graph			

(ii) B1: 48 (s) (Allow – 48 changed to 48) Must be stated i.e. not just inserted on the graph

(iii) B1: A trapezium starting at the origin and ending on the t -axis.

(b)

M1: Complete method to find area of trapezium using trapezium rule with correct structure or using two triangles and a rectangle and equate to 4800 to give equation in *one* unknown

N.B. $\frac{1}{2}(T + 80 + 48) \times 24 = 4800$ is M0 (equivalent to using three triangles)

OR they may use *suvat* on one or more sections (must have $a = 0$ for middle section) and equate total distance travelled to 4800 to give equation in *one* unknown

A1ft: For a correct equation in their unknown **ft** on their 24 and 48 (but must be positive times)

A1: For 264 (s)

(c)

B1:

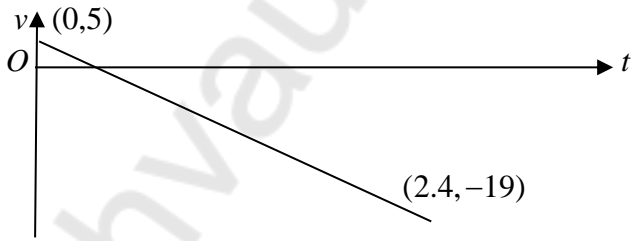
Either: Include time to change from constant accln to constant velocity and/or time to change from constant velocity to constant deceleration oe

Or: Have train accelerating and/or decelerating at a variable rate

8MA0 22: Mechanics AS 1906 Mark Scheme

Question	Scheme	Marks	AOs	Notes	
1 (a)	$V = 30 \text{ (m s}^{-1}\text{)}$	B1	3.4	cao	
		(1)			
(b)		shape	B1	1.1b	Overall shape of the graph, starting at the origin. Dotted vertical line at end is OK but solid vertical line is B0
		figs	B1ft	1.1b	3, 5 and T marked on the t -axis, and ft on their 30 marked on the speed axis. 3 must be where graph reaches a peak. Allow delineators: 3, 2 and $T - 5$ or a mixture
		(2)			
	Using total area = 550 to set up an equation in one unknown , Or they may use <i>suvat</i> on one or more of the sections (but must still be considering all sections) M0 if they use one <i>suvat</i> equation for the whole motion	M1	2.1	Need all sections to be included, with <u>correct structure for each section</u> . e.g. triangle + trapezium + rectangle oe = 550 to give an equation in one unknown (may not be T)	
(c)	$\frac{1}{2} \times 3 \times 30 + \frac{(30+6)}{2} \times 2 + 6(T-5) = 550$	A2 ft	1.1b	ft on their answer to (a). -1 each error. N.B. If '6' is incorrect, treat as one error, unless it is correct ft from their 30.	
	OR: $\frac{1}{2} \times 3 \times 30 + \frac{1}{2} \times 2 \times 24 + 6(T-3) = 550$				
	OR: $\frac{1}{2} \times 3 \times 30 + \frac{1}{2} \times 2 \times 24 + (2 \times 6) + 6(T-5) = 550$				

	Solve for T	M1	1.1b	<u>Attempt to solve for T provided they have tried to find the area using at least 3 sections.</u> (M0 if they only solve for their unknown and never try to find T)
	$T = 83$ (nearest whole number)	A1	1.1b	83 is the only answer
		(5)		
(d)	New value of T would be bigger (ignore their reasons whether correct or not)	B1	3.5a	Clear statement about <u>the value of T</u> <u>Allow 'it would increase, get larger etc'</u> B0 for 'Takes longer' or 'the value of T would be longer'
		(1)		
(e)	e.g. effect of wind; allow for dimensions of parachutist; use a more accurate value for g ; parachutist does not fall vertically after chute opens; smooth changes in v ; time for parachute to open; deceleration not constant (but B0 if they say <i>acceleration</i> not constant); smooth changes in a ; B0 for: moves horizontally; mass/weight of parachutist; upthrust; air pressure; air resistance; terminal velocity	B1	3.5c	Any appropriate refinement <u>of the model</u> . B0 if incorrect (or irrelevant) extras
		(1)		
		(10 marks)		

Question	Scheme	Marks	AOs
1.(a)	$19^2 = (-U)^2 + 2 \times 10 \times 16.8$ (Allow use of $g = 9.8$ for this M mark)	M1	2.1
	$U = 5 *$	A1*	1.1b
		(2)	
	For consistent use of $g = 9.8$ in parts (b), (c) and (d), treat as a MR. i.e. max (b) M1A0 (c)M1A0M(A)0A1ft (d)B1B1ft		
(b)	$19 = -5 + 10T$ OR $16.8 = \frac{(-5+19)}{2} T$ OR $16.8 = -5T + \frac{1}{2} \times 10T^2$ OR $16.8 = 19T - \frac{1}{2} \times 10T^2$	M1	2.1
	$T = 2.4$	A1	1.1b
		(2)	
(c)	$1.2 = -5t + \frac{1}{2} \times 10 \times t^2$	M1	2.1
	$5t^2 - 5t - 1.2 = 0$	A1	1.1b
		M(A)1	1.1b
	$t = 1.2$ (s)	A1	1.1b
		(4)	
(d)		B1 shape	1.1b
	(0,5) and (2.4, -19) Allow these to be marked on the axes.	B1ft	1.1b
		(2)	
(e)	Greater since air resistance would slow the ball down.	B1	3.5a
		(1)	
(f)	Take into account: spin, wind effects, use a more accurate value of g , not model the ball as a particle	B1	3.5c
		(1)	

(12 marks)

Notes:

(a)	M1	Complete method to find U , condone sign errors and use of $g = 9.8$
	A1*	$U = 5$ cao correctly obtained – allow U^2 instead of $(-U)^2$. Allow verification.
(b)	M1	Complete method to find T , condone sign errors
	A1	$T = 2.4$
(c)	M1	Complete method to find t , condone sign errors
	A1	Correct equation with at most one error
	(A)1	Correct equation
	A1	$t = 1.2$ (s)
(d)	B1	Graph could be reflected in the t -axis.
	B1ft	Follow through on their T value. If graph is reflected, $(0, -5)$ and $(2.4, 19)$
(e)	B1	Any similar appropriate comment
(f)	B1	B0 if any incorrect extras e.g. weight/mass included

1. At time $t = 0$, a small stone is thrown vertically upwards with speed 14.7 m s^{-1} from a point A .
At time $t = T$ seconds, the stone passes through A , moving downwards.

The stone is modelled as a particle moving freely under gravity throughout its motion.

Using the model,

- (a) find the value of T , (2)
- (b) find the total distance travelled by the stone in the first 4 seconds of its motion. (4)
- (c) State one refinement that could be made to the model, apart from air resistance, that would make the model more realistic. (1)



Question	Scheme		Marks	AOs
1.(a)	$14.7 = -14.7 + 9.8T$ or $0 = 14.7T - \frac{1}{2} \times 9.8T^2$ or $0 = 14.7 - 9.8 \times \left(\frac{1}{2}T\right)$ oe		M1	3.4
	$T = 3$		A1	1.1b
			(2)	
(b)	$s_1 = \frac{(14.7+0)}{2} \times 1.5$ (11.025 or $\frac{441}{40}$)		M1	1.1b
	$s_2 = \frac{1}{2} \times 9.8 \times 2.5^2$ (30.625 or $\frac{245}{8}$) OR $s_3 = 14.7 \times 1 + \frac{1}{2} \times 9.8 \times 1^2$ (19.6 or $\frac{98}{5}$) OR $-s_3 = 14.7 \times 4 - \frac{1}{2} \times 9.8 \times 4^2$ (- 19.6) (allow omission of - on LHS)		M1	1.1b
	Total distance = $s_1 + s_2$ OR $2s_1 + s_3$		M1	2.1
	$= 41.7 \text{ m or } 42 \text{ m}$		A1	1.1b
			(4)	
(c)	e.g. Take account of the dimensions of the stone (e.g. allow for spin), do not model the stone as a particle, use a more accurate value for g		B1	3.5c
			(1)	
(7 marks)				
Notes: If they use $g = 9.81$ or 10, penalise once for whole question.				
1a	M1	Complete method to find T , condone sign errors (M0 if they only find time to top)		
	A1	$T = 3$ correctly obtained.		
1b	M1	Complete method to find one key distance		
	M1	Correct method to find another key distance		
	M1	Complete method to find the total distance		
	A1	41.7 or 42 (after use of $g = 9.8$)		
1c	B1	B0 if there are incorrect extra refinements but ignore extra incorrect statements.		

Question	Scheme	Marks	AOs
1(a)	Complete method to produce an equation in U only	M1	3.4
	e.g. $10^2 = U^2 + 2 \times g \times 1.8$ oe	A1	1.1b
	OR a complete method where they find T first and use it to find an equation in U only	M1	
	A correct equation in U only.	A1	
	$U = 8$ (<u>only</u> this answer)	A1	1.1b
		(3)	
(b)	Complete method to find an equation in T only: $10 = -8 + gT$ or $1.8 = 10T - \frac{1}{2}gT^2$ or $1.8 = \frac{(-8+10)}{2}T$ or $1.8 = -8T + \frac{1}{2}gT^2$ OR a complete method if they split the time. In both cases, the M1 is only earned on the final line when they try to add the two times to give an equation in T . ALT 1: time up + time down e.g. $0 = 8 - gt_{UP}$ ($\Rightarrow t_{UP} = 0.8$) $h_{UP} = \frac{(8+0)}{2} \times 0.8$ ($= 3.2$) $(h_{UP} + 1.8) = \frac{(0+10)}{2} \times t_{DOWN}$ ($\Rightarrow t_{DOWN} = 1$) $T = t_{UP} + t_{DOWN}$ ALT 2: time to A + time from A to ground e.g. $8 = -8 + gt_A$ ($\Rightarrow t_A = 1.6$) $1.8 = \frac{(8+10)}{2} \times t_{AG}$ ($\Rightarrow t_{AG} = 0.2$) $T = t_A + t_{AG}$	M1	3.4
	$T = 1.8$ oe e.g. 9/5	A1	1.1b
			(2)
(c)	e.g. Use a more accurate (less rounded) value for g (or gravity), use $g = 9.8$ or $g = 9.81$, allow for wind effects, allow for the spin of the stone, include dimensions of stone (not a particle), shape and/or size of stone, allow for variable acceleration. If air resistance is mentioned as an extra, ignore it.	B1	3.5c

			(1)	
(d)		<i>U</i> would be greater. Allow without <i>U</i> , e.g it would be greater, or just 'greater' oe ISW	B1	3.5a
			(1)	
(7 marks)				
Notes:				
1a	M1	Use the model to obtain an equation in <i>U</i> only, condone sign errors, but M0 if using an incorrect formula.		
	A1	A correct equation in <i>U</i> only, <i>g</i> does not need to be substituted (so allow $g = 9.8$ or 9.81)		
	A1	cao (A0 if $g = 10$ has not been used)		
1b	M1	Use the model to obtain an equation in <i>T</i> only , <i>g</i> does not need to be substituted (so allow $g = 9.8$ or 9.81) condone sign errors, but M0 if using an incorrect formula. Follow through on their <i>U</i> where necessary		
	A1	cao (A0 if $g = 10$ has not been used) A0 if they give two answers.		
1c	B1	Any appropriate refinement. B0 if an incorrect extra is given e.g. the mass or weight is mentioned		
1d	B1	cao		

Question	Scheme	Marks	AOs
2(a)		B1	1.1b
		(1)	
(b)	<p>Using <i>total area</i> = 15000 to set up an <i>equation in one unknown</i> Or they may use <i>suvat</i> on one or more sections (but must still be considering <i>all</i> sections)</p> <p>Allow an attempt at a clear explicit verification using $t = 40$ e.g. the following would score M1A1A1*: $4 \times 40 = 160$ then $700 - 40 - 160 = 500$ $\frac{(700 + 500)}{2} \times 25 = 15000 = 15 \text{ km}$ Withhold A1* if they don't include $= 15 \text{ km}$</p> <p>N.B. M0 if a single <i>suvat</i> formula is used for the whole journey.</p>	M1	3.4
	$\frac{1}{2}(700 + 700 - t - 4t) \times 25 = 15000$	A1	1.1b
	OR $\frac{1}{2} \times 25 \times t + 25(700 - t - 4t) + \frac{1}{2} \times 25 \times 4t = 15000$		
	$t = 40 \text{ (s)*}$	A1*	1.1b
		(3)	
(c)	0.63 or 0.625 or $\frac{5}{8}$ oe (m s^{-2}) isw	B1	1.1b/ (2.2a)
		(1)	
(d)	<p>Complete method to find the speed or velocity at $t = 572$ e.g. $\pm \left(25 - \left(32 \times \frac{5}{32} \right) \right)$ or $\pm \left(128 \times \frac{5}{32} \right)$ oe</p>	M1	3.1b
	$20 \text{ (m s}^{-1}\text{)}$	A1	1.1b
		(2)	
(e)	<p>e.g. (the train) cannot instantaneously change acceleration, (the train) won't move with <u>constant</u> acceleration, (the train) won't move with <u>constant</u> speed Allow negatives of these:</p>	B1	3.5b

	e.g. (The train) moving at constant speed, or just 'constant speed' or 'constant acceleration' (is a limitation of the model) Must be a limitation of the model, so friction or air resistance or size of train is B0. N.B. Ignore incorrect reasons following a correct answer.		
		(1)	
(8 marks)			

Notes:		
2a	B1	Overall shape of graph, starting at the origin, with deceleration phase <i>longer</i> than the acceleration phase if nothing on the t -axis but ignore the relative lengths and allow if t (or 40) and $4t$ (or 160) are clearly and correctly marked. Ignore incorrect figs on the axes. This mark can be earned if the graph appears anywhere in qu 2.
2b	M1	Need <i>all</i> sections to be included, with <u>correct structure</u> for each section, with $\frac{1}{2}$'s where appropriate. <u>Allow = 15 or 150 or 1500 etc instead of 15000</u>
	A1	A correct equation in their t only, seen or implied (or with $t = 40$ for verification)
	A1*	cso. At least one line of working with brackets removed and t 's collected, or equivalent
2c	B1	cao
2d	M1	Any complete method, must have correct figs, but condone sign errors
	A1	cao. Must be positive and exact i.e must not come from rounding.
2e	B1	Any appropriate limitation <u>of the model</u> . B0 if any incorrect extra answers .