# Y1M9 XMQs and MS

(Total: 55 marks)

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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

Unless otherwise indicated, wherever a numerical value of $g$ is required, take $g = 9.8\,\text{m}\,\text{s}^{-2}$ and give your answer to either 2 significant figures or 3 significant figures.

**Answer ALL questions. Write your answers in the spaces provided.**

**6.** A man throws a tennis ball into the air so that, at the instant when the ball leaves his hand, the ball is 2 m above the ground and is moving vertically upwards with speed $9\,\text{m}\,\text{s}^{-1}$

The motion of the ball is modelled as that of a particle moving freely under gravity and the acceleration due to gravity is modelled as being of constant magnitude $10\,\text{m}\,\text{s}^{-2}$

The ball hits the ground $T$ seconds after leaving the man's hand.

Using the model, find the value of $T$.

**(4)**

DO NOT WRITE IN THIS AREA

## Section B: Mechanics

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **6.** | Equation in *t* only | M1 | 2.1 |
| | $-2 = 9t - \frac{1}{2} \times 10t^2$ | 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:**

**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

**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))

N.B. *g* = 10 must be substituted in all equations used.

**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*

**A1:** *T* = 2 only (i.e. A0 if they give two times)

*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.

**7.** A train travels along a straight horizontal track between two stations, $A$ and $B$.

In a model of the motion, the train starts from rest at $A$ and moves with constant acceleration $0.3\,\text{m s}^{-2}$ for 80 s.
The train then moves at constant velocity before it moves with a constant deceleration of $0.5\,\text{m s}^{-2}$, coming to rest at $B$.

(a) For this model of the motion of the train between $A$ and $B$,

(i) state the value of the constant velocity of the train,

(ii) state the time for which the train is decelerating,

(iii) sketch a velocity-time graph.

**(3)**

The total distance between the two stations is 4800 m.

(b) Using the model, find the total time taken by the train to travel from $A$ to $B$.

**(3)**

(c) Suggest one improvement that could be made to the model of the motion of the train from $A$ to $B$ in order to make the model more realistic.

**(1)**

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **7(a) (i)** | 24 ( $\text{m s}^{-1}$ ) | 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 |
| | $\frac{1}{2}(T+T+80+48)\times 24 = 4800$ **OR** $(\frac{1}{2}\times 80\times 24)+24T+(\frac{1}{2}\times 48\times 24)=4800$ **oe** | A1**ft** | 1.1b |
| | *T* = 136 so total time is 264 (s) | A1 | 1.1b |
| | | **(3)** | |
| **(c)** | Accept<br>**Either**: a smooth change from acceleration to constant velocity or from constant velocity to deceleration.<br>**Or** have train accelerating and/or decelerating at a variable rate<br><br>Do not accept e.g.<br>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.<br>B0 if either an incorrect extra is included or an incorrect reason for a valid improvement is included.<br>N.B. Variable acceleration due to air resistance is B0 **BUT**<br>Variable acceleration due to **variable** air resistance is B1 | B1 | 3.5c |
| | | **(1)** | |
| | | | **(7 marks)** |

**Notes:**

**(a)**

**(i) B1:** 24 ( $\text{m s}^{-1}$ )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<br>**(iii) B1:** A trapezium starting at the origin and ending on the *t*-axis. |
| **(b)**<br>**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<br>*N.B.* $\frac{1}{2}(T+80+48)\times 24=4800$ is M0 (equivalent to using three triangles)<br>**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<br>**A1ft:** For a correct equation in their unknown **ft** on their 24 and 48 (but must be positive times)<br>**A1:** For 264 (s) |
| **(c)**<br>**B1:**<br>**Either**: Include time to change from constant accln to constant velocity and/or time to change from constant velocity to constant deceleration oe<br>**Or**: Have train accelerating and/or decelerating at a variable rate |

**Answer ALL questions. Write your answers in the spaces provided.**

**1.** At time $t = 0$, a parachutist falls vertically from rest from a helicopter which is hovering at a height of 550 m above horizontal ground.

The parachutist, who is modelled as a particle, falls for 3 seconds before her parachute opens.

While she is falling, and before her parachute opens, she is modelled as falling freely under gravity.

The acceleration due to gravity is modelled as being $10\,\text{m}\,\text{s}^{-2}$.

(a) Using this model, find the speed of the parachutist at the instant her parachute opens.

**(1)**

When her parachute is open, the parachutist continues to fall vertically.

Immediately after her parachute opens, she decelerates at $12\,\text{m}\,\text{s}^{-2}$ for 2 seconds before reaching a constant speed and she reaches the ground with this speed.

The total time taken by the parachutist to fall the 550 m from the helicopter to the ground is $T$ seconds.

(b) Sketch a speed-time graph for the motion of the parachutist for $0 \leqslant t \leqslant T$.

**(2)**

(c) Find, to the nearest whole number, the value of $T$.

**(5)**

In a refinement of the model of the motion of the parachutist, the effect of air resistance is included before her parachute opens and this refined model is now used to find a new value of $T$.

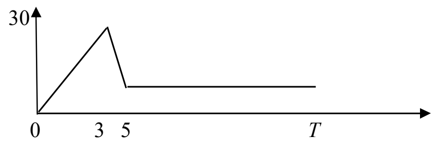
(d) How would this new value of $T$ compare with the value found, using the initial model, in part (c)?

**(1)**

(e) Suggest one further refinement to the model, apart from air resistance, to make the model more realistic.

**(1)**

## 8MA0 22: Mechanics AS 1906 Mark Scheme

| Question | Scheme | Marks | AOs | Notes |
|---|---|---|---|---|
| **1 (a)** | $V = 30$ ( m s$^{-1}$ ) | B1 | 3.4 | cao |
| | | **(1)** | | |
| **(b)** |   shape | B1 | 1.1b | Overall shape of the graph, starting at the origin.<br>Dotted vertical line at end is OK but solid vertical line is B0 |
| | figs | B1**ft** | 1.1b | 3, 5 and $T$ marked on the $t$-axis, and **ft** on their 30 marked on the speed axis.<br>3 must be where graph reaches a peak.<br>Allow delineators: 3, 2 and $T - 5$ or a mixture |
| | | **(2)** | | |
| **(c)** | Using total area = 550 to set up an equation in **one unknown,**<br>Or they may use *suvat* on one or more of the sections (but must still be considering all sections)<br>M0 if they use one *suvat* equation for the whole motion | M1 | 2.1 | Need all sections to be included, with correct structure for each section.<br>e.g. triangle + trapezium + rectangle oe = 550 to give an equation in **one unknown (may not be *T*)** |
| | $\frac{1}{2}\times 3\times 30+\frac{(30+6)}{2}\times 2+6(T-5)=550$<br>**OR**: $\frac{1}{2}\times 3\times 30+\frac{1}{2}\times 2\times 24+6(T-3)=550$<br>**OR**: $\frac{1}{2}\times 3\times 30+\frac{1}{2}\times 2\times 24+(2\times 6)+6(T-5)=550$ | A2 **ft** | 1.1b | **ft** on their answer to (a).<br>-1 each error.<br>**N.B.** If '6' is incorrect, treat as one error, unless it is correct ft from their 30. |
| | Solve for $T$ | M1 | 1.1b | Attempt to solve for $T$ provided they have tried to find the area using at least 3 sections.<br>(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 the value of $T$<br>Allow '*it* would increase, get larger etc'<br>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 *acceleration* not constant); smooth changes in $a$;<br>B0 for: moves horizontally; mass/weight of parachutist; upthrust; air pressure;air resistance; terminal velocity | B1 | 3.5c | Any appropriate refinement of the model.<br>B0 if incorrect (or irrelevant) extras |
| | | **(1)** | | |
| | | **(10 marks)** | | |

**1.** At time $t = 0$, a small ball is projected vertically upwards with speed $U\,\text{m}\,\text{s}^{-1}$ from a point $A$ that is 16.8 m above horizontal ground.

The speed of the ball at the instant immediately before it hits the ground for the first time is $19\,\text{m}\,\text{s}^{-1}$

The ball hits the ground for the first time at time $t = T$ seconds.

The motion of the ball, from the instant it is projected until the instant just before it hits the ground for the first time, is modelled as that of a particle moving freely under gravity.

The acceleration due to gravity is modelled as having magnitude $10\,\text{m}\,\text{s}^{-2}$

Using the model,

(a) show that $U = 5$

**(2)**

(b) find the value of $T$,

**(2)**

(c) find the time from the instant the ball is projected until the instant when the ball is 1.2 m below $A$.

**(4)**

(d) Sketch a velocity-time graph for the motion of the ball for $0 \leqslant t \leqslant T$, stating the coordinates of the start point and the end point of your graph.

**(2)**

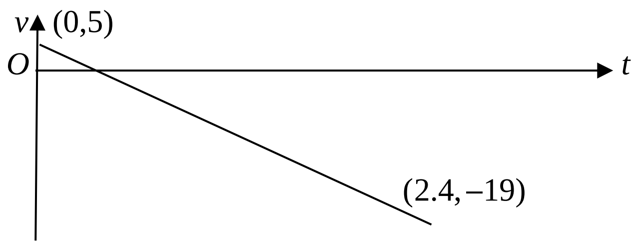
In a refinement of the model of the motion of the ball, the effect of air resistance on the ball is included and this refined model is now used to find the value of $U$.

(e) State, with a reason, how this new value of $U$ would compare with the value found in part (a), using the initial unrefined model.

**(1)**

(f) Suggest one further refinement that could be made to the model, apart from including air resistance, that would make the model more realistic.

**(1)**

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **1.(a)** | $19^2 = (-U)^2 + 2\times10\times16.8$ (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.<br>i.e. max (b) M1A0 (c)M1A0M(A)0A1ft (d)B1B1ft | | |
| **(b)** | $19 = -5 + 10T$<br>**OR** $16.8 = \frac{(-5+19)}{2}T$<br>**OR** $16.8 = -5T + \frac{1}{2}\times10T^2$<br>**OR** $16.8 = 19T - \frac{1}{2}\times10T^2$ | M1 | 2.1 |
| | $T = 2.4$ | A1 | 1.1b |
| | | **(2)** | |
| **(c)** | $1.2 = -5t + \frac{1}{2}\times10\times t^2$ | 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<br>shape | 1.1b |
| | (0,5) and (2.4, −19)<br>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. |
| | B1**ft** | Follow through on their *T* value.<br>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 $14.7\,\mathrm{m\,s^{-1}}$ 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 $\frac{245}{8}$)<br>**OR** $s_3 = 14.7 \times 1 + \frac{1}{2} \times 9.8 \times 1^2$ (19.6 or $\frac{98}{5}$)<br>**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 m or 42 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. |
| | | |

**1.** The point $A$ is 1.8 m vertically above horizontal ground.

At time $t = 0$, a small stone is projected vertically upwards with speed $U\,\text{m s}^{-1}$ from the point $A$.

At time $t = T$ seconds, the stone hits the ground.

The speed of the stone as it hits the ground is $10\,\text{m s}^{-1}$

In an initial model of the motion of the stone as it moves from $A$ to where it hits the ground

- the stone is modelled as a particle moving freely under gravity
- **the acceleration due to gravity is modelled as having magnitude $10\,\text{m s}^{-2}$**

Using the model,

(a) find the value of $U$,

**(3)**

(b) find the value of $T$.

**(2)**

(c) Suggest one refinement, apart from including air resistance, that would make the model more realistic.

**(1)**

In reality the stone will not move freely under gravity and will be subject to air resistance.

(d) Explain how this would affect your answer to part (a).

**(1)**

| 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**<br>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:<br>$10 = -8 + gT$ or $1.8 = 10T - \frac{1}{2}gT^2$ or $1.8 = \frac{(-8+10)}{2}T$<br>or $1.8 = -8T + \frac{1}{2}gT^2$<br>**OR** a **complete** method if they split the time.<br><br>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*.<br><br>**ALT 1**: time up + time down<br>e.g.<br>$0 = 8 - gt_{\text{UP}}$ $(\Rightarrow t_{\text{UP}} = 0.8)$<br>$h_{\text{UP}} = \frac{(8+0)}{2} \times 0.8$ $(= 3.2)$<br>$(h_{\text{UP}} + 1.8) = \frac{(0+10)}{2} \times t_{\text{DOWN}}$ $(\Rightarrow t_{\text{DOWN}} = 1)$<br>$T = t_{\text{UP}} + t_{\text{DOWN}}$<br><br>**ALT 2:** time to *A* + time from *A* to ground<br>e.g.<br>$8 = -8 + gt_A$ $(\Rightarrow t_A = 1.6)$<br>$1.8 = \frac{(8+10)}{2} \times t_{AG}$ $(\Rightarrow t_{AG} = 0.2)$<br>$T = t_A + t_{AG}$ | 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.<br>If air resistance is mentioned as an extra, ignore it. | B1 | 3.5c |

| | | | |
|---|---|---|---|
| | | **(1)** | |
| **(d)** | *U* would be greater.<br>Allow without *U*, e.g it would be greater, or just ‘greater’ oe<br>ISW | B1 | 3.5a |
| | | **(1)** | |
| | | | **(7 marks)** |

**Notes:**

| | | |
|---|---|---|
| **1a** | M1 | Use the model to obtain an equation in *U* only, condone sign errors, but M0 if using an incorrect formula. |
| | A1 | A correct equation in *U* only, *g* 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 *T* only , *g* does not need to be substituted (so allow $g$ = 9.8 or 9.81) condone sign errors, but M0 if using an incorrect formula.<br>Follow through on their *U* where necessary |
| | A1 | cao (A0 if $g$ = 10 has not been used) A0 if they give two answers. |
| **1c** | B1 | Any appropriate refinement.<br>B0 if an incorrect extra is given e.g. the mass or weight is mentioned |
| **1d** | B1 | cao |

**2.** A train travels along a straight horizontal track from station $P$ to station $Q$.

In a model of the motion of the train, at time $t = 0$ the train starts from rest at $P$, and moves with constant acceleration until it reaches its maximum speed of $25\,\mathrm{m\,s^{-1}}$

The train then travels at this constant speed of $25\,\mathrm{m\,s^{-1}}$ before finally moving with constant deceleration until it comes to rest at $Q$.

The time spent decelerating is four times the time spent accelerating.

The journey from $P$ to $Q$ takes 700 s.

Using the model,

(a) sketch a speed-time graph for the motion of the train between the two stations $P$ and $Q$.
**(1)**

The distance between the two stations is 15 km.

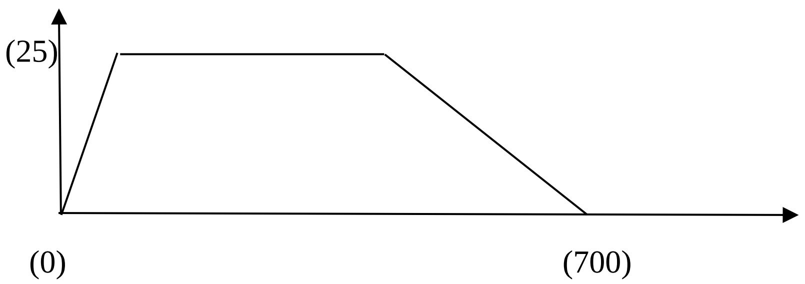
Using the model,

(b) show that the time spent accelerating by the train is 40 s,
**(3)**

(c) find the acceleration, in $\mathrm{m\,s^{-2}}$, of the train,
**(1)**

(d) find the speed of the train 572 s after leaving $P$.
**(2)**

(e) State one limitation of the model which could affect your answers to parts (b) and (c).
**(1)**

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

| | | | |
|---|---|---|---|
| | e.g. (The train) moving at constant speed, or just ‘constant speed’ or ‘constant acceleration’ (is a limitation of the model)<br>Must be a limitation of the model, so friction or air resistance or size of train is B0.<br>**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 *longer* 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.<br>Ignore incorrect figs on the axes.<br>This mark can be earned if the graph appears anywhere in qu 2. |
| **2b** | M1 | Need *all* sections to be included, with correct structure for each section, with $\frac{1}{2}$ ’s where appropriate.<br>Allow = 15 or 150 or 1500 etc instead of 15000 |
| | 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 of the model. B0 if any incorrect extra **answers.** |