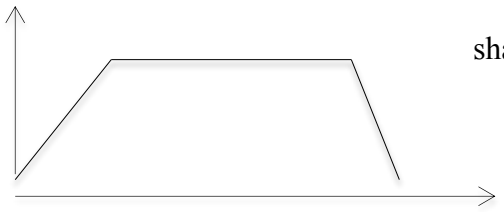
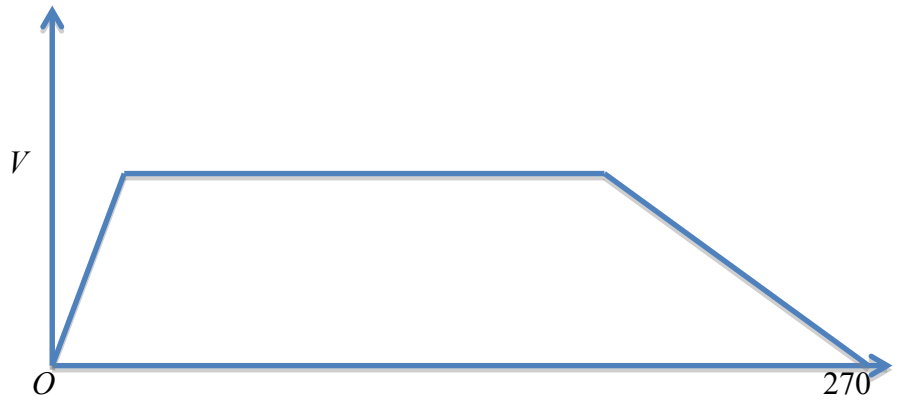
Continued question 5
Notes:
(a) **M1:** For dealing with P($X \geqslant 16$) – they need to use cumulative prob. function on calc **A1:** awrt 0.0509 (from calculator)
(b) **B1**: For both hypotheses in terms of p or π and H_1 must be 2-tail
(c) **M1:** For correct use of tables to find probability associated with critical value **A1:** For the correct lower limit of the CR. Do not award for P($Y \leqslant 2$) **A1:** For the correct upper limit
(d) **B1:** ft on their 0.0355 and (1 – their 0.9520) provided each probability is less than 0.05
(e) **B1:** ft for a comment that relates 12 to their CR and makes a consistent comment relating this to the manager's suspicion
(f) **BI:** For a comment that: gives a suitable reason based on lack of independence **or** the sample not being random **so** the binomial model is not valid

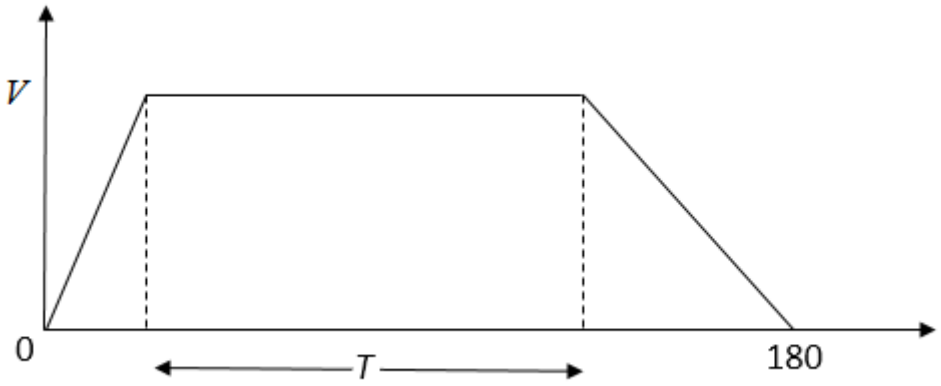
Question	Scheme	Marks	AOs
6.	Using distance = total area under graph (e.g. area of rectangle + triangle **or** trapezium **or** rectangle – triangle)	M1	2.1
	e.g. $D = UT + \frac{1}{2} Th$, where h is height of triangle	A1	1.1b
	Using gradient = acceleration to substitute $h = aT$	M1	1.1b
	$D = U T + \frac{1}{2} aT^2$ *	A1 *	1.1b
		(4)	
			(4 marks)

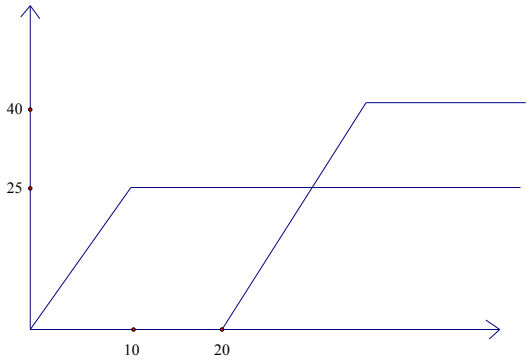
Notes:
M1: For use of distance = total area to give an equation in D, U, T and one other variable **A1:** For a correct equation **M1:** For using gradient = a to eliminate the other variable to give an equation in D, U, T and a *only* **A1*:** For a correct given answer

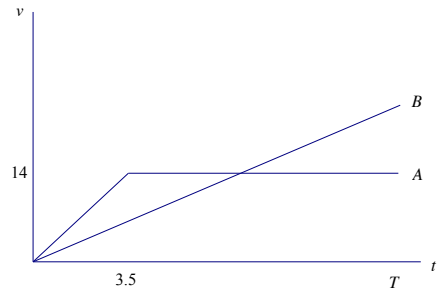
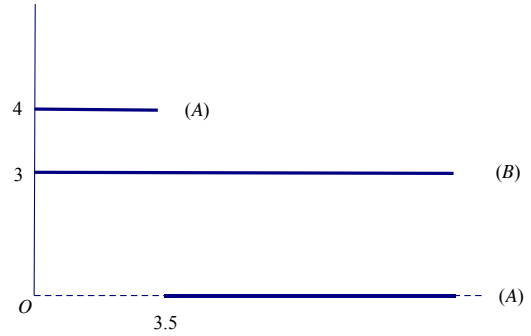
Question	Scheme	Marks	AOs
7(a) (i)	24 ($m\,s^{-1}$)	B1	1.1b
(ii)	48 (s)	B1	1.1b
(iii)	 shape	B1	1.1b
		(3)	
(b)	Equating area under graph to 4800 to give equation in one unknown	M1	3.1b
	$\frac{1}{2}(T+T+80+48)\times 24=4800$ **OR** $(\frac{1}{2}\times 80\times 24)+24T+(\frac{1}{2}\times 48\times 24)=4800$ **oe**	A1**ft**	1.1b
	T = 136 so total time is 264 (s)	A1	1.1b
		(3)	
(c)	Accept **Either**: a smooth change from acceleration to constant velocity or from constant velocity to deceleration. **Or** have train accelerating and/or decelerating at a variable rate Do not accept e.g. 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. B0 if either an incorrect extra is included or an incorrect reason for a valid improvement is included. N.B. Variable acceleration due to air resistance is B0 **BUT** Variable acceleration due to **variable** air resistance is B1	B1	3.5c
		(1)	
			(7 marks)

Question Number	Scheme	Marks
5c	First M1 for a complete method to find the speed / velocity(Could involve two *suvat* equations) Condone sign errors but must have correct numbers in their equation(s) First A1 for a correct equation (or equations) Second A1 for 16 or 16.3 (m s^{-1}) Must be *positive (speed)*	
6a		B1 shape B1 270, V (2)
6b	$\frac{V}{0.6}=\frac{5V}{3}$ **Given answer**	M1A1 (2)
6c	Time decelerating is $5V$	B1
	$\frac{1}{2}V\frac{5V}{3}+(270-5V-\frac{5V}{3})V+\frac{1}{2}V.5V=1500$ **OR:** $\frac{1}{2}(270+270-5V-\frac{5V}{3})V=1500$	M1 A2
	$V^2-81V+450=0$ **Given answer**	**DM1**A1 (6)
6d	$V^2-81V+450=0$ $(V-6)(V-75)=0$ or $V=\frac{81\pm\sqrt{81^2-4\times450}}{2}$	M1 solving
	$V=6$ or 75	A1 A1
	$V=6$ since $(5\times75)>270$ or $V=75$ unrealistic	**B**1 (4)
		14
	Notes	
6a	First B1 for a trapezium with line starting at the origin Second B1 for 270 and V correctly marked	
6b	M1 for $(t=)\frac{V}{0.6}$; **N.B.** M1A0 for V=0.6t then answer Must see division or intermediate step from V=0.6t e.g. Changing 0.6 into 3/5. A1 for $t=\frac{5V}{3}$ **Given answer**	

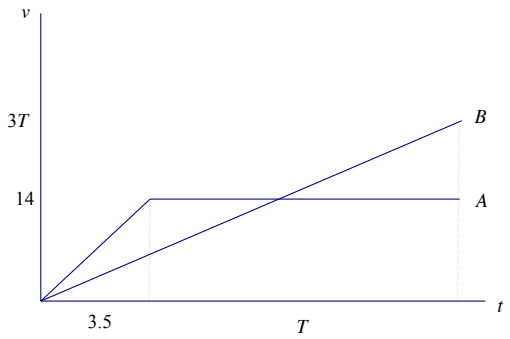
Question Number	Scheme	Marks
6c	B1 for $5V$ identified appropriately First M1 for clear attempt to equate the *total* area under graph to 1500. (Must include all 3 parts (if not using the trapezium rule) with $\frac{1}{2}$ seen at least once to give equation in V only; may use (1 triangle + 1 trapezium) or (rectangle - trapezium) (May use *suvat* for one or more parts of the area) A2 for a correct equation, -1 e.e.o.o. Second **DM**1 dependent on first M1 for multiplying out and collecting terms and putting into appropriate form Third A1 for correct equation. **Given answer**	
6d	First M1 for solving their 3 term quadratic equation for V N.B. This M1 can be implied by two correct roots but if either answer incorrect then an explicit method must be shown for this M mark. First A1 for $V = 6$ Second A1 for $V = 75$ B1 on ePEN but treat as **DM**1, dependent on both previous A marks, for either reason	
7a	$T - 3mg\sin\alpha - F = 3ma$	M1A1
	$4mg - T = 4ma$	M1A1 (4)
7b	$F = \frac{1}{4}R;\ R = 3mg\cos\alpha$	B1; M1A1
	$T - 2.4mg = 3ma$ $4mg - T = 4ma$	M1
	$a = \frac{8g}{35}$ **Given answer**	A1 (5)
7c	Particles have same acceleration	B1 (1)
7d	$v^2 = 2 \times \frac{8g}{35} \times 1.75$ (= $0.8g$)	M1 A1
	$-3mg\sin\alpha - F = 3ma'$	M1
	$a' = -0.8g$	A1
	$0 = 0.8g + 2 \times (-0.8g)s$	M1 A1
	Total distance = 0.5 + 1.75 = 2.25 (m) Accept 2.3 (m)	A1 (7)
		17
	Notes	
7a	First M1 for equation of motion for A with usual rules First A1 for a correct equation Second M1 for equation of motion for B with usual rules Second A1 for a correct equation **N.B.** If using different tension in second equation, M0 for that equation	

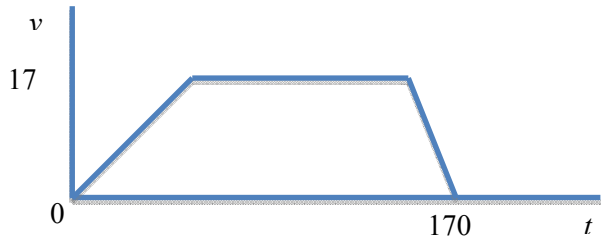
Question Number	Scheme	Marks
7.(a)		B1 shape B1 figs. (V,T,180) (2)
(b)	Time accelerating = $V/1 = V$ Time decelerating = $V/0.5 = 2V$ Time at constant speed, $T = 180 - (2V + V)$ $T = 180 - 3V$ **Printed answer**	M1 A1 (2)
(c)	$\frac{1}{2}(180+180-3V)V = 4800$ $V^2 - 120V + 3200 = 0$ $(V-40)(V-80) = 0$ $V = 40$ or 80 or both, since $(180 - 3 \times 80) < 0$	M1 A1 A1 A1 **DM**1 A1, M1 (7) **11**
	Notes	
7.(a)	First B1 for a trapezium, starting at the origin and finishing on the t-axis. Second B1 for V, T with delineators or marked on the top of the trapezium or oe and 180 correctly positioned.	
(b)	M1 for both Time accelerating = $V/1 = V$ and Time decelerating = $V/0.5 = 2V$ M0 if no working for the $2V$ as it's a 'Show that' or if they use $V/-0.5$ and fudge the –ve sign A1 for $T = 180 - (2V + V) = 180 - 3V$ **Printed answer**	

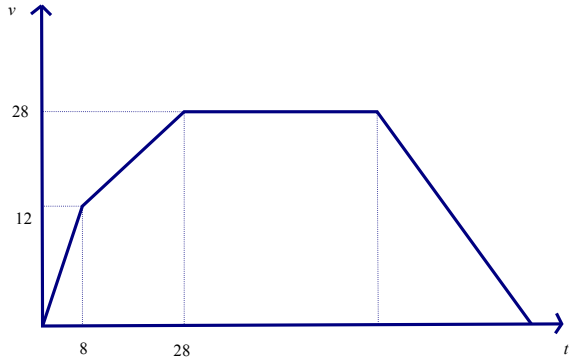
Question	Scheme	Marks	Notes
5. (a)		B1 B1 B1	One graph correct shape Both graphs correct shape, on same sketch and intersecting (with different start times) Figs 10,20,25,40 shown (with 20 as the second start time) Ignore all vertical lines
		(3)	
(b)	$20 + 10$	M1	Complete method
	$= 30$	A1	
		(2)	
(c)	$\frac{40}{t_1 - 20} = \frac{25}{10}$	M1	Complete method to find time when Q reaches 40 m s^{-1}
		A1	Correct unsimplified equation
	$\Rightarrow t_1 = 36$	A1	
Or:	Time to reach 40 m s^{-1} is $\frac{40}{2.5}(=16)$ (M1A1)		
	Time from start $= \frac{40}{2.5} + 20 = 36$ (A1)		(seen or implied)
		M1	Find distance travelled by either train at $t = T$
	$\frac{(T + T - 10)}{2} \times 25$	A1	One correct
	$\frac{(T - 20 + T - 36)}{2} \times 40$	A1ft	Both correct. Follow their 36
	Equate and solve for T	dM1	
	$T = 66\frac{1}{3}$	A1	Accept 66 or better
		(8)	
		13	

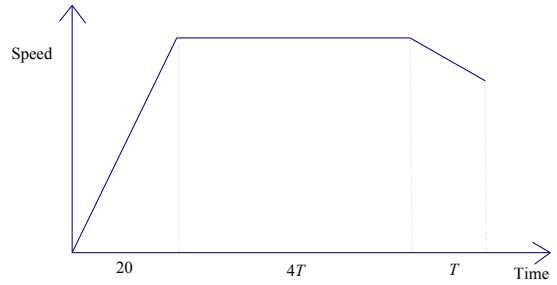
Question Number	Scheme	Marks	Notes
6.(a)	$v = u + at \Rightarrow 14 = 3.5a$	M1	Use of *suvat* to form an equation in a
	$a = 4$	A1(2)	
6.(b)		B1	Graph for A or B
		B1	Second graph correct and both graphs extending beyond the point of intersection
		B1	Values 3.5, 14, T shown on axes, with T not at the point of intersection. Accept labels with delineators.
		(3)	NB 2 separate diagrams scores max B1B0B1
6.(c)	$\frac{1}{2}T.3T$, $\frac{(T+T-3.5)}{2}.14$	M1	Find distance for A or B in terms of T only. Correct area formulae: must see $\frac{1}{2}$ in area formula and be adding in trapezium
		A1	One distance correct
		A1	Both distances correct
	$\frac{1}{2}T.3T = \frac{(T+T-3.5)}{2}.14$ $\frac{1}{2}T.3T = \frac{1}{2}\times 4\times 3.5^2 + 14(T-3.5)$	M1	Equate distances and simplify to a 3 term quadratic in T in the form $aT^2 + bT + c = 0$
	$3T^2 - 28T + 49 = 0$	A1	Correct quadratic
	$(3T-7)(T-7) = 0$	M1	Solve 3 term quadratic for T
	$T = \frac{7}{3}$ or 7	A1	Correct solution(s) - can be implied if only ever see $T = 7$ from correct work.
	but $T > 3.5$, $T = 7$	A1 (8)	
6.(d)	73.5 m	B1 (1)	From correct work only. B0 if extra answers.
6.(e)		B1	(*A*) Condone missing 4
		B1	(*B*) Condone graph going beyond $T = 7$ Must go beyond 3.5. Condone no 3.
		B1 (3)	(*A*) Condone graph going beyond $T = 7$ Must go beyond 3.5. B0 if see a solid vertical line. Sometimes very difficult to see. If you think it is there, give the mark.
		[17]	Condone separate diagrams.

See next page

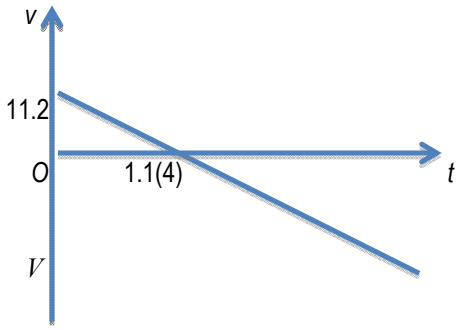
	Alternative for (c) for candidates with a sketch like this:  	B1 B1 B0	Treat as a special case. B1B1B0 on the graph and then max 5/8 for (c) if they do not solve for the T in the question.
	$\frac{1}{2}\times 3\times (T+3.5)^2 = \frac{1}{2}\times 4\times 3.5^2 + 14T$	M1	Use diagram to find area
		A1	One distance correct
		A1	Both distances correct
	$12T^2 - 28T - 49 = 0$	M1	Simplify to a 3 term quadratic in T
		A1	Correct quadratic
	$(2T-7)(6T+7)=0$	M1	Complete method to solve for the T in the question
	$T = \frac{7}{2}$ or $\frac{-7}{6}$	A1	Correct solution(s) - can be implied if only ever see $\text{Total} = 7$
	$\text{Total time} = 7$	A1 (8)	

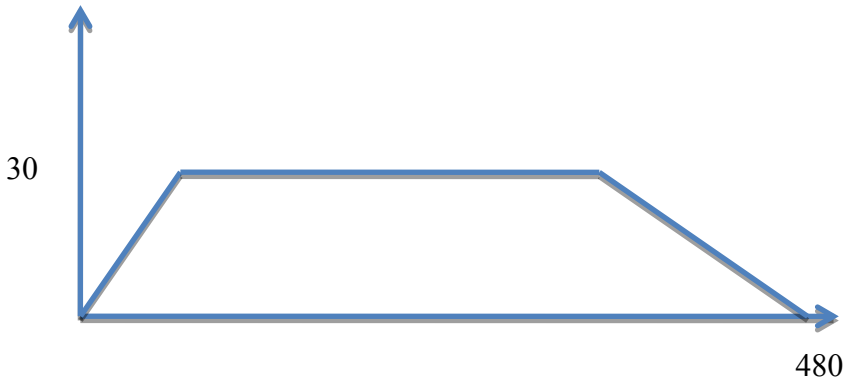
5(a)		B1	shape
		B1	rel grad - RHS steeper than LHS
		B1 (3)	17 and 170 shown
(b)	$T;2T$	B1	Correct ratios of times for acceleration and deceleration seen or implied.
	$\frac{170+(170-3T)}{2}17=2125$ Or $\frac{1}{2}\times T_1\times 17+17(170-(T_1+T_2))+\frac{1}{2}\times 17\times T_2=2125$ Or $2125=\frac{17}{2}(170+T')$	M1	Form an equation for total distance with their times
		A2	-1 each error
	$T=30$ Or $T_1+T_2=90$	A1	Use their equation and the correct ratio to find the value for time decelerating or the total of time accelerating and decelerating
		M1	Use of $v=u+at$ or equivalent
	decel $=\frac{17}{30}$ oe	A1	$(0.5\dot{6})$ 3sf or better. Must be positive.
		(7)	
		10	

Question Number	Scheme	Marks	Notes
6(a)	$v_1 = 8\times1.5\ (=12)$	M1	Use of $v = u + at$ or equivalent for $t = 8$
	$v_2 = 12 + 0.8\times20$	M1	Follow their 12
	$v_2 = 28$ m s^{-1}	A1 (3)	
(b)		B1 B1ft (2)	shape nos: 8,28; 12,28 indicated. Follow their 12, 28
(c)	first 8 s: dist = $\frac{1}{2}\times8\times12\ \ (=48)$	M1 A1ft	Correct method for distance for the triangle (0-8) or the trapezium (8-28) Follow their 12
	next 20 s: dist = $\frac{1}{2}\times(12+28)\times20\ \ (=400)$	A1ft	Follow their 12, 28
	Total dist = 448 m	A1 (4)	Correct answer only (cao)
(d)	$0 = 28^2 - 2\times2.8s$	M1	Find area of right hand triangle or an expression in T for the trapezium (rectangle + triangle).
	$s = \frac{28^2}{2\times2.8}\ (=140)$	A1ft	Follow their 28
	$448 + 140 + 28T = 2000$	DM1	Form an equation in T for their 16, 448 and 140
	$T = \frac{2000-448-140}{28} = 50.4$	A1 (4)	Or better (50.42857...) Accept 50.
		[13]	

Question Number	Scheme	Marks
5a		
	Basic shape 20, $4T$ and T placed correctly	B1 **DB**1
		(2)
5b	Use of $v=u+at$: constant speed $=0.6\times 20=12$ (ms^{-1})	M1A1
	(Speed at end $=12-0.3T$)	
	Using v-t graph: Distance: $705=\frac{12}{2}\left(4T+\left(20+4T\right)\right)+\frac{T}{2}\left(12+\left(12-0.3T\right)\right)$	M1A2
	$=48T+120+12T-0.15T^2=60T+120-0.15T^2$	
	Form 3 term quadratic and solve for T: $\Rightarrow 3T^2-1200T+11700=0 \quad \left(T^2-400T+3900=0\right)$	M1
	$\Rightarrow \left(T-10\right)\left(T-390\right)=0 \qquad T=10$ only	A1
		(7)
	Alternative:	
	Use of $v=u+at$: constant speed $=0.6\times 20=12$ (ms^{-1}) M1A1	
	Using $s=ut+\frac{1}{2}at^2$: $705=\left(0.3\times 400\right)+\left(4T\times 12\right)+\left(12T-0.15T^2\right)$ M1A2	
	$\Rightarrow 0.15T^2-60T+585=0 \ \left(T^2-400T+3900=0\right)$	
	$\Rightarrow \left(T-10\right)\left(T-390\right)=0 \qquad T=10$ only M1A1	
	(7)	
5c	Extra time: $(2\times 20)-$*their T* **OR** $\frac{12-0.3\times \textit{their}T}{0.3}$	B1
	Total time: $20+5T+40-T$ (*their T*)	M1
	$=100$ (s)	A1
		(3)
	Alternative: Total time to decelerate to rest = 12/0.3 = 40 B1	
	Total time A to $C=20+4T+40=100$ M1A1	
		[12]

Question Number	Scheme	Marks
	Notes for question 5	
5a	First B1 for basic shape. Allow if 'extra triangle' on end included, provided *B* clearly marked	
	Second **DB**1 : may use, 20, 20 + 4*T*, 20 + 5*T*	
5b	First M1 for attempt to find constant speed ($v = u + at$ or a = gradient) 20 x 0.6	
	First A1 for 12	
	Second (generous) M1 for clear attempt to use 705 = *total* area under the graph to give an equation in *T* only but must see ½ used somewhere **N.B.** M0 if just a trapezium oe is used	
	Second A1 and Third A1: for any correct equation, -1 e.e.o.o.	
	Third M1 for forming and attempt to solve a 3 term quadratic (need *evidence* of solving e.g. formula or factorising, if *T* values are incorrect) otherwise this M mark can be implied if they state that $T = 10$ with no working. ($T = 390$ NOT needed)	
	Fourth A1 for $T = 10$.	
	N.B. For total area, could see: Trapezium + Rectangle + Triangle $705 = \frac{12}{2}\left(4T + \left(20 + 4T\right)\right) + T(12 - 0.3T) + \frac{1}{2}T \times 0.3T$ Triangle + Rectangle + Trapezium $705 = \frac{1}{2}.20.12 + (4T \times 12) + \frac{1}{2}T\left(12 + 12 - 0.3T\right)$ Triangle + Rectangle + Rectangle + Triangle $705 = \frac{1}{2}.20.12 + (4T \times 12) + T(12 - 0.3T) + \frac{1}{2}T \times 0.3T$ Triangle + Rectangle + Trapezium (at top) $705 = \frac{1}{2}.20.12 + 5T(12 - 0.3T) + \frac{1}{2}0.3T(5T + 4T)$ Rectangle – triangle– triangle $705 = 12(20 + 5T) - \frac{1}{2}.20.12 - \frac{1}{2}T \times 0.3T$	
5c	B1 for either additional time is $\frac{12}{0.3} - T$ **or** time to decelerate is $\frac{12}{0.3}$	
	M1 for a correct method to find the total time, using *their T* $= 20 + 4T + T + \frac{12}{0.3} - T$ **or** $20 + 4T + \frac{12}{0.3}$	
	A1 for 100 cao	

Question Number	Scheme	Marks
4(a)	$0^2 = 11.2^2 - 2gd$ $d = 6.4$ max ht. $= 3.6 + 6.4 = 10$ m	M1 A1 A1 A1 (4)
ALT	$11.2^2 = u^2 - 2g$ x 3.6 $u = 14$ $0^2 = 14^2 - 2gh$ $h = 10$ m	M1 A1 A1 A1 (4)
(b)	$10 = \frac{1}{2}gt^2$ $t = \frac{10}{7}$ Total $= 2\text{x}\frac{10}{7} = 2.9$ or 2.86	M1 A1 A1 **dM1** A1 (5)
(c)		B1 single line **dB1** $V <$ -11.2 B1 11.2 B1 1.1(4) (4) **13**
	Notes	
4(a)	M1 for a complete method to find d (d = distance from A to top) First A1 for a correct equation in d only. Second A1 for $d = 6.4$ Third A1 for 6.4 + 3.6 = 10 (m)	
ALT	M1 for a complete method (must have 2nd equation) to find h First A1 for $u = 14$ Second A1 for correct 2nd equation Third A1 for $h = 10$ (m)	
4(b)	First M1 for a complete method to find an intermediate time (A to top or A to O) First A1 for a correct equation or equations. Second A1 for any intermediate time (e.g. $_At_{TOP} = {}^8/_7$, $_At_O = {}^2/_7$, $_At_O = {}^{18}/_7$, $_At_A =$	

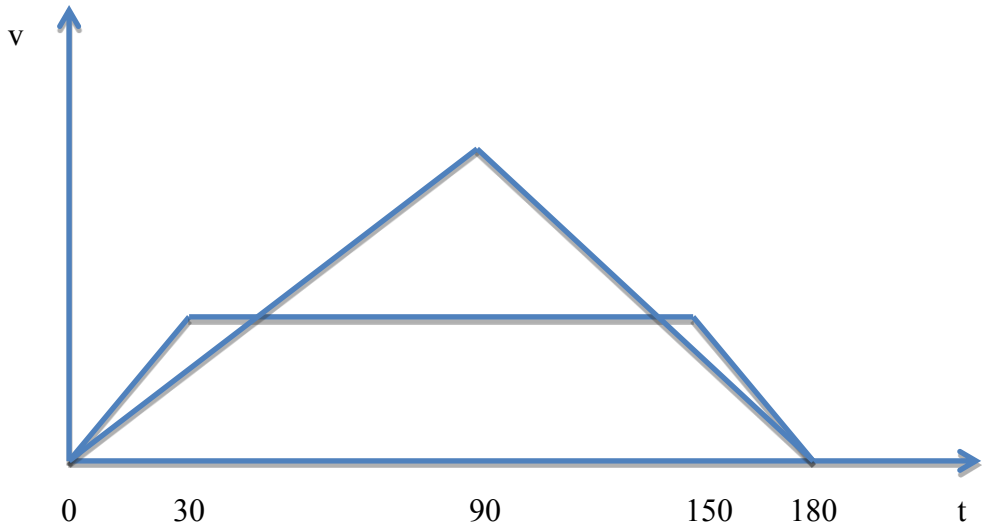
7 (a)	$108 \times 1000/3600 = 30 \text{ m s}^{-1}$	M1 A1 (2)
(b)		B1 shape **DB1 ft** figs (2)
(c)	$12000 = \frac{1}{2} \times 30(480 + 480 - 4T)$ $T = 40$ $a = 30/40 = 0.75 \text{ m s}^{-2}$	M1 A2 A1 M1 A1 (6) **10**

NOTES

Question 7(a)
M1 for 108 x 1000/3600 oe
A1 for 30

Question 7(b)
First B1 for trapezium (B0 for triangle), from the origin, finishing on the *t*-axis.
Second dependent B1 **ft** on their '30' and 480 or 108 and (8/60 oe).

Question 7(c)
First M1 for clear attempt at equating *total* area under a trapezium to distance travelled oe (equation must include at least one '1/2') to give equation in ONE unknown.
A2 for a correct equation , -1 each error. **N.B.** Repeated use of an incorrect v from part (a) is ONE error.
Third A1 for $T = 40$ (or 120)
N.B. (First M1 **only** for ½(480 + *x*).30 = 12000
First A1 for $480 - x = 160$; Second A1 if they divide 160 in ratio 1:3)
(First M0 if they use *s* = the full distance in any single *suvat* equation)
Second M1 (independent) for a complete method to find *a*.
Fourth A1 for 0.75

Question Number	Scheme	Marks
8. (a)		B1 trapezium B1 triangle & overlap B1 figs (3)
(b)	$\frac{1}{2}(90+60).20=1500$ $1500=\frac{1}{2}a.90^2$ $a=\frac{10}{27}$ ms^{-1} or decimal	M1 A1 M1 A1 **ft** A1 (5)
(c)	$\frac{10t}{27}=20$ $t=54$ s $t=126$ s	M1 A1 A1 A1 **ft** (4)
(d)	$\frac{10}{27}\times 90\left(=\frac{100}{3}\right)$ $\frac{100}{3}\times 6-\frac{1}{2}.\frac{10}{27}.6^2\left(=\frac{580}{3}\right)$ $d=\frac{580}{3}-(20\times 6)$ $=\frac{220}{3}$m or decimal	M1 DM1 A1 DM1 A1 (5) **17**