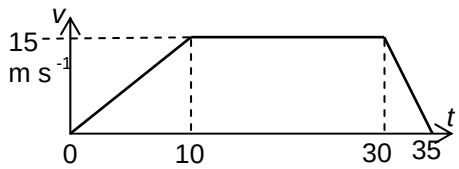
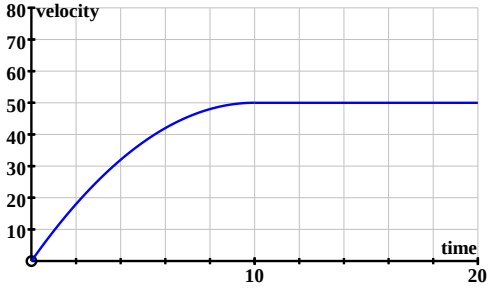
		Mark	Comment	
1(i)		B1 B1 B1	Acc and dec shown as straight lines Horizontal straight section All correct with *v* and times marked and at least one axis labelled. Accept (*t*, *v*) or (*v*, *t*) used.	3
(ii)	Distance is found from the area area is $\frac{1}{2}\times10\times15+20\times15+\frac{1}{2}\times5\times15$ (or $\frac{1}{2}\times(20+35)\times15$) = 412.5 so distance is 412.5 m	M1 A1 A1	At least one area attempted or equivalent *uvast* attempted over one appropriate interval. Award for at least two areas (or equivalent) correct Allow if a trapezium used and only 1 substitution error. FT **their** diagram. cao (Accept 410 or better accuracy)	3
		6		

		mark		sub
2	**either** 70*V* obtained So 70*V* = 1400 and *V* = 20 **or** *V* = 20	 M1 A1 M1 A1 M1 A1 M1 A1	 Attempt at area. If not trapezium method at least one part area correct. Accept equivalent. Or equivalent – need not be evaluated. Equate **their** 70*V* to 1400. Must have attempt at complete areas or equations. cao Attempt to find areas in terms of ratios (at least one correct) Correct total ratio – need not be evaluated. (Evidence may be 800 or 400 or 200 seen). Complete method. (Evidence may be 800/40 or 400/20 or 200/10 seen). cao [Award 3/4 for 20 seen WWW]	
				4

		mark		Sub
3(i)	$\frac{-15}{6} = -2.5$ so -2.5 m s^{-2}	M1 A1	Use of $\Delta v / \Delta t$. Condone use of v/t. Must have - ve sign. Accept no units.	2
(ii)	$\frac{1}{2} \times 10 \times 4 = 20$ m	M1 A1	Attempt at area or equivalent	2
(iii)	Area under graph is $\frac{1}{2} \times 5 \times 5 = 12.5$ (and -ve) closest is $20 - 12.5 = 7.5$ m	M1 A1	May be implied. Area from 4 to 9 attempted. Condone missing –ve sign. Do not award if area beyond 9 is used (as well). cao	2
				6

		mark		
4(i)	Area under curve $0.5\times 2\times 20 + 0.5\times(20+10)\times 4 + 0.5\times 10\times 1$ = 85 m	M1 B1 A1	Attempt to find any area under curve or use const accn results Any area correct (Accept 20 or 60 or 5 without explanation) cao	3
(ii)	$\frac{20-10}{4} = 2.5$ upwards	M1 A1 B1	$\Delta v / \Delta t$ accept ± 2.5 Accept – 2.5 downwards (allow direction specified by diagram etc). Accept 'opposite direction to motion'.	3
(iii)	$v = -2.5t + c$ v = 20 when t = 2 v = – 2.5t + 25	M1 M1 A1	Allow **their** a in the form $v = \pm at + c$ or $v = \pm a(t-2) + c$ cao [Allow $v = 20 - 2.5(t-2)$] [Allow 2/3 for different variable to t used, e.g. x. Allow any variable name for speed]	3
(iv)	Falling with negligible resistance	E1	Accept 'zero resistance', or 'no resistance' seen.	1
(v)	$-1.5\times 4 + 9.5\times 2 + 7 = 20$ $-1.5\times 36 + 9.5\times 6 + 7 = 10$ $-1.5\times 49 + 9.5\times 7 + 7 = 0$	E1 E1	One of the results shown All three shown. Be generous about the 'show'.	2
(vi)	$\int_2^7 (-1.5t^2 + 9.5t + 7)dt$ $= \left[-0.5t^3 + 4.75t^2 + 7t\right]_2^7$ $= \left(-\frac{343}{2} + \frac{19\times 49}{4} + 49\right) - (-4 + 19 + 14)$ = 81.25 m	M1 A1 A1 A1 M1 A1 A1	Limits not required A1 for each term. Limits not required. Condone + c Attempt to use both limits on an integrated expression Correct substitution in **their** expression including subtraction (may be left as an expression). cao.	7
	total	19		

Follow through between parts of Question 5 should be allowed for the value of *h* (when *t* = 10) found in part (iii) if it is used in part (iv) or in part (v)(*A*).						
5	**(i)**		Integrate a to obtain v $v = 10t - \frac{1}{2}t^2 \quad (+c)$ $t = 10 \Rightarrow v = 100 - 50 = 50$ Since $a = 0$ for $t > 10$, $v = 50$ for $t > 10$	**M1** **A1** **M1** **A1** **[4]**	Attempt to integrate Substitution of $t = 10$ to find v Sound argument required for given answer. It must in some way refer to $a = 0$.	
	(ii)		Continuous two part v-t graph  Curve for $0 \le t \le 10$ Horizontal straight line for $10 \le t \le 20$	**B1** **B1** **B1** **[3]**	The graph must cover $t = 0$ to $t = 20$ B0 if no vertical scale is given	

5	**(iii)**		Distance fallen = $\int\left(10t-\frac{1}{2}t^2\right)\mathrm{d}t$	**M1**	Attempt to integrate	
			$d=5t^2-\frac{1}{6}t^3+c \quad (c=0)$	**A1**		
			Height = $1000-d$			
			Height = $1000-5t^2+\frac{1}{6}t^3$	**A1**	This mark should only be given if the signs are correctly obtained.	
			When $t=10$, $h=667$	**B1**	oe	
				[4]		
	(iv)		Time at constant vel $=667\div 50=13.3$	**B1**	FT for h from part (iii)	
			Total time $t=10+13.3=23.3$	**B1**	FT	
				[2]		
	(v)	***A***	Since $500>333$	**M1**	For finding the height at which the crate reaches terminal velocity, eg h = 167, or equivalent relevant calculation. FT for h from part (iii) if used.	
			The box will have reached terminal speed. So there is no improvement	**A1**	Allow either one (or both) of these two statements.	
				[2]		
	(v)	***B***	$v=10t-t^2$ (for $t\leq 5$)	**M1**	Integration to find v	
			Terminal velocity is 25 $\mathrm{m\,s^{-1}}$	**A1**		
			So better	**A1**		
				[3]		

		mark	comment	sub
6(i)	The distance travelled by P is $0.5\times0.5\times t^2$ The distance travelled by Q is $10t$	 B1 B1	 Accept $10t + 125$ if used correctly below.	 2
(ii)	Meet when $0.25t^2 = 125 + 10t$ so $t^2 - 40t - 500 = 0$ Solving $t = 50$ (or -10) Distance is $0.25\times50^2 = 625$ m	M1 F1 A1 A1	All **their** wrong expressions for P and Q distances Allow ± 125 or 125 omitted Award for **their** expressions as long as one is quadratic and one linear. Must have 125 with correct sign. Accept any method that yields (smaller) + ve root of their 3 term quadratic cao Allow –ve root not mentioned cao [SC2 400 m seen]	 5
		7		