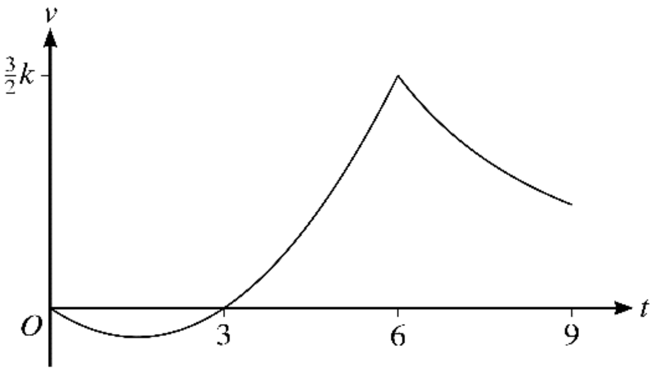
Question			Answer	Marks	AO	Guidance	
12	**(a)**			**B1** **B1** **B1** **[3]**	**1.1** **1.1** **1.1**	Quadratic curve (positive quadratic) passing through the origin and appearing in both quadrants with a minimum turning point in the fourth quadrant Inverse proportional (to t^2) curve (so correct curvature), should not touch the horizontal axis Completely correct graph with both curves meeting at 6 **with values of 3 and 6 on *t* axis** (or clearly stated in their working in part **(a) only**) – this mark is dependent on the previous 2 **B** marks	No scaling on axes required for the first two **B** marks (**so ignore any scaling for the first two marks**) Condone if it appears to be approaching a horizontal asymptote (other than the *t*-axis) for this mark but gradient must not be positive Allow only the *t*-axis as a horizontal asymptote **Value of 9 not required on *t* axis, neither is $\frac{3}{2}k$ on the *v*-axis**
12	**(b)**		1.5 (s) only	**B1** **[1]**	**1.1**	From symmetry or solving $\frac{1}{12}k(2t-3)=0$ www	Any other answer(s) is **B0**

Question			Answer	Marks	AO	Guidance	
12	(c)		**DR**				
			$[k]\frac{1}{12}\int\left(t^2-3t\right)\,\mathrm{d}t=\frac{1}{12}\left(\frac{t^3}{3}-\frac{3}{2}t^2\right)[k]$	**M1***	**2.1**	Attempt to integrate – **both terms with power increased by 1 with one term correct**	Ignore $+c$ omission for **M** marks
			For **both** $[k]\frac{1}{12}\int_0^3\left(t^2-3t\right)\,\mathrm{d}t=-\frac{3}{8}[k]$ **or** $+\frac{3}{8}[k]$ **and** $[k]\frac{1}{12}\int_3^6\left(t^2-3t\right)\,\mathrm{d}t=\frac{15}{8}[k]$ (**but allow correct un-simplified expressions – SEE APPENDIX**)	**B1**	**1.1**	www Condone $[k]\frac{1}{12}\int_0^3\left(t^2-3t\right)\,\mathrm{d}t=+\frac{3}{8}[k]$ Award **B1** for $[k]\frac{1}{12}\int_0^6\left(t^2-3t\right)\,\mathrm{d}t=\frac{18}{8}[k]$ but **B0** for $[k]\frac{1}{12}\int_0^6\left(t^2-3t\right)\,\mathrm{d}t=\frac{12}{8}[k]$	The correct values do not imply the **M** mark as **DR**
			$[k]\int\frac{54}{t^2}\,\mathrm{d}t=-\frac{54}{t}[k]$	**M1***	**1.1**	Attempt to integrate – answer of the form ct^{-1} with $c\neq 1, 54k, 54$	
			$[k]\int_6^9\frac{54}{t^2}\,\mathrm{d}t=3[k]$ (**allow correct un-simplified – SEE APPENDIX**)	**B1**	**1.1**	www	The correct value does not imply the **M** mark as **DR**
			$\frac{3}{8}k+\frac{15}{8}k+3k=84$ or $\frac{18}{8}k+3k=84$	**M1dep***	**3.4**	Forming a linear equation in k with the correct number of relevant terms (e.g. must have taken the modulus of their integral from 0 to 3)	$\frac{1}{12}k\int_0^6\left(t^2-3t\right)\,\mathrm{d}t=\frac{12}{8}k$, or any working that suggests the modulus was not taken between 0 and 3 is **M0**
			$k=16$	**B1** **[6]**	**2.2a**	www	

Additional Guidance for 12(c)
The square brackets around the k in the main scheme means that this may be omitted as they could deal with this constant at the end when they form their equation with the 84 (as the k is a constant factor for both expressions for v)
The first **B** mark is for a correct expression/value **for both** $I_1=[k]\frac{1}{12}\int_0^3\left(t^2-3t\right)\,\mathrm{d}t$ **and** $I_2=[k]\frac{1}{12}\int_3^6\left(t^2-3t\right)\,\mathrm{d}t$ in any un-simplified form: so for I_1 any expression that is equivalent to $\pm\frac{1}{12}\left(\frac{3^3}{3}-\frac{3(3)^2}{2}\right)[k]$ is fine (allow either positive or negative due to the fact that this area is below the t-axis) e.g. $I_1=\pm\frac{1}{12}\left(9-\frac{27}{2}\right)[k]$ or $\pm\frac{9}{24}[k]$ etc. (ISW once a correct un-simplified form is seen) For I_2 any expression that is equivalent to $\frac{1}{12}\left(\frac{6^3}{3}-\frac{3(6)^2}{2}\right)[k]-\frac{1}{12}\left(\frac{3^3}{3}-\frac{3(3)^2}{2}\right)[k]$ is fine e.g. $\frac{1}{12}(72-54)[k]-\frac{1}{12}(9-\frac{27}{2})[k]$ or $\left(\frac{3}{2}+\frac{3}{8}\right)[k]$ etc. If the candidate does not consider these two integrals separately and instead attempts to combine as a single integral (between 0 and 6) then they must consider it correctly (given the applied context) so e.g. $I_{1,2}=[k]\frac{1}{12}\int_0^6\left(t^2-3t\right)\,\mathrm{d}t=-\frac{1}{12}\left(\frac{3^3}{3}-\frac{3(3)^2}{2}\right)[k]+\frac{1}{12}\left(\frac{6^3}{3}-\frac{3(6)^2}{2}\right)[k]-\frac{1}{12}\left(\frac{3^3}{3}-\frac{3(3)^2}{2}\right)[k]$ scores **B1** but $+\frac{1}{12}\left(\frac{3^3}{3}-\frac{3(3)^2}{2}\right)[k]+\frac{1}{12}\left(\frac{6^3}{3}-\frac{3(6)^2}{2}\right)[k]-\frac{1}{12}\left(\frac{3^3}{3}-\frac{3(3)^2}{2}\right)[k]$ is **B0** The second **B** mark is for a correct expression/value for $I_3=54[k]\int_6^9 t^{-2}\,\mathrm{d}t$ in any un-simplified form: e.g. $I_3=54\left(-\frac{1}{9}-(-\frac{1}{6})\right)[k]$ or $54\left(-\frac{1}{9}+\frac{1}{6}\right)[k]$ etc. (ISW once a correct un-simplified form is seen) The third **M** mark is for considering $\lvert I_1\rvert+I_2+I_3=84$ to form a linear equation in k (with the correct number of relevant terms) – this mark is dependent on the first two **M** marks and also they must have taken the modulus or equivalent for their integral between 0 and 3 for this mark e.g. they must have considered $-[k]\frac{1}{12}\int_0^3\left(t^2-3t\right)\,\mathrm{d}t$ **or** $[k]\frac{1}{12}\int_3^0\left(t^2-3t\right)\,\mathrm{d}t$ oe As this question is detailed reasoning the stages as shown in the MS must all be done to award each corresponding mark. So, an answer of k = 16 with no working scores **B1** only.