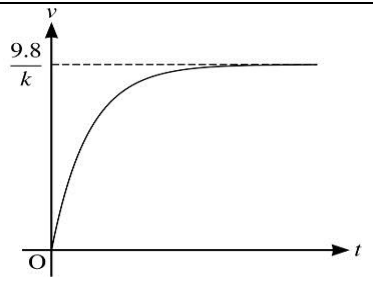
15	**(a)**		$\int \frac{1}{9.8-kv}\,\mathrm{d}v = \int 1\,\mathrm{d}t$	**M1**	**3.1a**	Attempt to separate variables and integrate	Allow up to 3M marks for an attempt with an incorrect rearrangement.
				A1	**1.1b**	Correct rearrangement	
			$-\frac{1}{k}\ln(9.8-kv) = t + c$	**A1**	**1.1b**	Correctly integrated – must include $+c$ somewhere	
			$9.8 - kv = A\mathrm{e}^{-kt}$	**M1**	**1.1a**	Attempt to write in the form $v =$ (Clearing natural logs; may be done after evaluation of the constant)	
			When $t = 0,\ v = 0$ giving $0 = \frac{1}{k}(9.8 - A\mathrm{e}^{-0})$	**M1**	**3.1a**	Using initial conditions leading to a value for the constant; may be done before clearing logs	
			$A = 9.8$				
			Hence $v = \frac{9.8}{k}(1 - \mathrm{e}^{-kt})$	**A1**	**1.1b**	Correct value for A (or $c = -\frac{1}{k}\ln 9.8$)	
				A1	**1.1b**	Must be in the form $v = \ldots$	
				[7]			
			Alternative using a Further Maths method				
			$\frac{\mathrm{d}v}{\mathrm{d}t} + kv = 9.8$	**M1**		Writing in the correct form and using integrating factor	
			Integrating factor $\mathrm{e}^{\int P(t)\,\mathrm{d}t} = \mathrm{e}^{kt}$	**A1**		Correct integrating factor	
			$v\mathrm{e}^{kt} = \int \left(9.8\mathrm{e}^{kt}\right)\mathrm{d}t = \frac{9.8}{k}\mathrm{e}^{kt} + c$	**A1**		Correct equation	
			$v = \frac{9.8}{k} + c\mathrm{e}^{-kt}$	**M1**		Attempt to write in the form $v =$	
			When $t = 0,\ v = 0$ giving $c = -\frac{9.8}{k}$	**M1**		Using initial conditions leading to a value for the constant	
			Hence $v = \frac{9.8}{k}(1 - \mathrm{e}^{-kt})$	**A1**		Correct value for c	
				A1		Must be in the form $v = \ldots$	

15	**(b)**			**B1** **B1** **[2]**	**1.1b** **1.1b**	Graph through (0, 0) with the correct general shape or correct for their *v*. Horizontal asymptote labelled $\frac{9.8}{k}$	Ignore any graph for $t < 0$ Any graph involving $\sqrt{t}$ must be concave
15	**(c)**		As $t \to \infty,\ v \to \frac{9.8}{k} = 7$ $k = 1.4$	**M1** **A1** **[2]**	**3.4** **1.1b**	Recognises the limiting value Any form from correct *v*	Allow M1 for their *v* used, provided it has a non-zero limiting value
			Alternative solution Limiting value when $\frac{dv}{dt} = 0$ $k = \frac{9.8}{7} = 1.4$	**M1** **A1**		Could be implied	
15	**(d)**		$v = 3.5 \Rightarrow 1 - e^{-1.4t} = \frac{3.5}{7}$ Hence $-1.4t = \ln 0.5 \Rightarrow t = 0.495$	**B1** **[1]**	**3.4**	May substitute in other versions of the equation relating *v* and *t* Allow for 0.50 or awrt 0.495	No FT from incorrect expression for *v*