Question Number	Scheme	Marks
3(a)	Correct method to form a differential equation in v and x, separate the variables and integrate to the form $\frac{1}{2}v^2 = Ax^2 + Bx \quad (+C)$ o.e.	M1
	$\left(v\frac{\mathrm{d}v}{\mathrm{d}x} = 4x - 2 \quad \Rightarrow\right) \qquad \frac{1}{2}v^2 = 2x^2 - 2x \quad (+C)$	A1
	$\frac{1}{2}v^2 = 2x^2 - 2x + \frac{1}{2}$ o.e	A1
	$v = 1 - 2x$	A1
		(4)
3(b) ALT1	Method to form a differential equation in x and t , separate the variables and integrate to the form $D\ln(1-2x) = t \qquad (+C)$ o.e.	M1
	$\left(\int \frac{1}{1-2x}\mathrm{d}x = \int \mathrm{d}t \quad \Rightarrow\right) \qquad -\frac{1}{2}\ln(1-2x) = t \ (+C)$	A1
	$(t = 1, x = 0 \Rightarrow C = -1)$ $-\frac{1}{2}\ln(1-2x) = t - 1$ o.e.	A1
	Complete method to obtain v in terms of t For example • $-\frac{1}{2}\ln(v) = t - 1 \ (+C) \quad \Rightarrow \quad v = ...$ in terms of t • $x = \frac{1}{2}(1 - e^{2-2t})$ then differentiate wrt t to obtain v = … in terms of t	dM1
	$(v =) e^{2-2t}$	A1
		(5)
3(b) ALT2	Method to form a differential equation in v and t , separate the variables and integrate to the form $\ln v = Et \ (+C)$ o.e.	M1
	$\left(\int \frac{1}{v}\mathrm{d}v = -2\int \mathrm{d}t \quad \Rightarrow\right) \qquad \ln v = -2t \ (+C)$	A1
	$t \ (t = 1, v = 1 \Rightarrow C = 2)$ $\ln(v) = 2 - 2t$ o.e.	A1
	Obtain v in terms of t	dM1
	$v = e^{2-2t}$	A1
		(5)
		(9)
Notes for question 3		
(a)		

M1	Method using $v\dfrac{\mathrm{d}v}{\mathrm{d}x}$ to form a differential equation in v and x, separate the variables and integrate to the form $\dfrac{1}{2}v^2 = Ax^2 + Bx \quad (+C)$ where A and B are non-zero constants. Condone a missing constant of integration. $\int v\,\mathrm{d}v$ may be implied by sight of $\dfrac{1}{2}v^2$. M0 for use of *suvat*	
A1	A correct equation with or without $+C$	
A1	A fully correct equation including the evaluated constant of integration.	
A1	Correct only	
	N.B. If the answer to (a) is $v = 2x - 1$, the maximum score for (b) is M1A1A0M1A0	
(b) ALT1		
M1	Method using $v = \dfrac{\mathrm{d}x}{\mathrm{d}t}$ to form a differential equation in x and t, separate the variables and solve to the reach the from $D\ln(1-2x) = t \quad (+C)$ where D is a non-zero constant. Condone a missing constant of integration. M0 for use of *suvat*	
A1	Correct equation in x and t, with or without C **N.B**. if they start with $v = 2x - 1$, allow M1A1 for $\dfrac{1}{2}\ln(2x-1) = t \ (+C)$	
A1	Correct equation in x and t with the evaluated constant of integration.	
dM1	Dependent on previous M. A complete method to obtain v as an exponential function in terms of t only. • $-\dfrac{1}{2}\ln(v) = t - 1 \quad \Rightarrow \quad v = \ldots$ in terms of t • $x = \dfrac{1}{2}(1 - e^{2-2t})$ then differentiate wrt t to obtain $v = \ldots$ in terms of t	
A1	Correct answer only	
(b) ALT 2		
M1	Method to form a differential equation in v and t, separate the variables and integrate to the form $\ln v = Et \ (+C)$ where E is a non-zero constant. Condone a missing constant of integration. $\left\{\dfrac{\mathrm{d}v}{\mathrm{d}t} = -2\dfrac{\mathrm{d}x}{\mathrm{d}t} \quad \Rightarrow \quad \dfrac{\mathrm{d}v}{\mathrm{d}t} = -2v \quad \Rightarrow \quad \ln v = -2t \ (+C)\right\}$ M0 for use of *suvat*	
A1	Correct equation in v and t, with or without C **N.B**. if they start with $v = 2x - 1$, allow M1A1 for $\ln v = Et \ (+C)$	
A1	A correct equation in v and t	
dM1	Dependent on previous M. A complete method to obtain v as an exponential function in terms of t only.	
A1	Correct answer only	