Question Number	Scheme	Marks
2(a)	$\frac{dV}{dx} = 3x^2$	M1 (B1 on EPEN)
	$\frac{dx}{dt} = \frac{dx}{dV} \times \frac{dV}{dt} = \frac{5}{3x^2}$	**d**M1A1
		(3)
	Alternative 1	
	$V = x^3 \Rightarrow x = V^{\frac{1}{3}} \Rightarrow \frac{dx}{dV} = \frac{1}{3}V^{-\frac{2}{3}}$	M1 (B1 on EPEN)
	$\frac{dx}{dt} = \frac{dx}{dV} \times \frac{dV}{dt} = \frac{5}{3V^{\frac{2}{3}}} = \frac{5}{3x^2}$	**d**M1A1
	Alternative 2	
	$\frac{dV}{dt} = 5 \Rightarrow V = 5t + c$	M1 (B1 on EPEN)
	$V = x^3 \Rightarrow x^3 = 5t + c \Rightarrow 3x^2 \frac{dx}{dt} = 5$ or $V = x^3 \Rightarrow x^3 = 5t + c \Rightarrow 3x^2 = 5\frac{dt}{dx}$	**d**M1
	$\frac{dx}{dt} = \frac{5}{3x^2}$	A1
(b)	$\frac{dx}{dt} = \frac{5}{3 \times 4^2} = \frac{5}{48}$	M1A1
		(2)
		(5 marks)

Note this is now being marked as M1dM1A1 not B1M1A1

(a) **Ignore any units associated with any of the expressions/values in this question.**

M1: Differentiates $V = x^3$ to obtain $\frac{dV}{dx} = ...x^2$ (seen or implied)

dM1: Attempts to use $\frac{dx}{dt} = \frac{dx}{dV} \times \frac{dV}{dt}$ or equivalent e.g. $\frac{dV}{dt} = \frac{dx}{dt} \times \frac{dV}{dx}$ with their $\frac{dV}{dx}$ and $\frac{dV}{dt}$ where $\frac{dV}{dx} = kx^2$ and $\frac{dV}{dt}$ is a constant to obtain an expression of the form $\frac{\alpha}{x^2}$ oe.

May be implied by their working.

Depends on the previous mark.

A1: $\frac{dx}{dt} = \frac{5}{3x^2}$ or equivalent e.g. $\frac{5}{3}x^{-2}$ or $5 \times \frac{1}{3x^2}$. Apply isw once a correct expression is seen.

Alternative 1:

M1: Differentiates $x = V^{\frac{1}{3}}$ to obtain $\frac{\mathrm{d}x}{\mathrm{d}V} = ...V^{-\frac{2}{3}}$ (seen or implied)

dM1: Attempts to use $\frac{\mathrm{d}x}{\mathrm{d}t} = \frac{\mathrm{d}x}{\mathrm{d}V} \times \frac{\mathrm{d}V}{\mathrm{d}t}$ or equivalent e.g. $\frac{\mathrm{d}V}{\mathrm{d}t} = \frac{\mathrm{d}x}{\mathrm{d}t} \times \frac{\mathrm{d}V}{\mathrm{d}x}$ with their $\frac{\mathrm{d}x}{\mathrm{d}V}$ and $\frac{\mathrm{d}V}{\mathrm{d}t}$ where $\frac{\mathrm{d}x}{\mathrm{d}V} = kV^{-\frac{2}{3}}$ and $\frac{\mathrm{d}V}{\mathrm{d}t}$ is a constant and changes back to x to obtain an expression of the form $\frac{\alpha}{x^2}$ oe. May be implied by their working.

Depends on the previous mark.

A1: $\frac{\mathrm{d}x}{\mathrm{d}t} = \frac{5}{3x^2}$ or equivalent e.g. $\frac{5}{3}x^{-2}$ or $5 \times \frac{1}{3x^2}$. Apply isw once a correct expression is seen.

Alternative 2:

M1: Uses $\frac{\mathrm{d}V}{\mathrm{d}t} = 5$ and integrates wrt t to obtain $V = 5t + c$ or $V = 5t$

dM1: Replaces V with x^3 and differentiates wrt t or wrt x to obtain $\alpha x^2 \frac{\mathrm{d}x}{\mathrm{d}t} = \beta$ or $\alpha x^2 = \beta \frac{\mathrm{d}t}{\mathrm{d}x}$

Depends on the previous mark.

A1: $\frac{\mathrm{d}x}{\mathrm{d}t} = \frac{5}{3x^2}$ or equivalent e.g. $\frac{5}{3}x^{-2}$ or $5 \times \frac{1}{3x^2}$. Apply isw once a correct expression is seen.

(b)

M1: Substitutes $x = 4$ into their expression for $\frac{\mathrm{d}x}{\mathrm{d}t}$

A1: $\frac{5}{48}$ or the exact equivalent. Ignore any units, correct or incorrect, and just look for the value.
Do not allow e.g. 0.104… unless the correct exact value is seen previously, then apply isw.

Question Number	Scheme	Marks
3	$8y\dfrac{\mathrm{d}y}{\mathrm{d}x} = x\mathrm{e}^{-y^2} \rightarrow \int 8y\mathrm{e}^{y^2}\,\mathrm{d}y = \int x\,\mathrm{d}x$	B1
	$4\mathrm{e}^{y^2} = \dfrac{x^2}{2}\ (+c)$	M1A1
	$4 = \dfrac{5^2}{2} + c \Rightarrow c = ...$	**d**M1
	$y^2 = \ln\left(\dfrac{x^2-17}{8}\right)$	A1
		(5 marks)

B1: Separates the variables correctly with some indication of integration.

Allow any correct separation e.g. $8\int \dfrac{y}{\mathrm{e}^{-y^2}}\mathrm{d}y = \int x\,\mathrm{d}x$, $\int y\mathrm{e}^{y^2}\mathrm{d}y = \dfrac{1}{8}\int x\,\mathrm{d}x$, $\int \dfrac{y}{\mathrm{e}^{-y^2}}\mathrm{d}y = \int \dfrac{x}{8}\,\mathrm{d}x$

Award for any of the above with at least one integral sign. If there are no integral signs then there must be an attempt to integrate at least one side.

Condone the omission of dx or dy as long as the intention is clear.

M1: For integrating $...y\mathrm{e}^{y^2}$ correctly to obtain $...\mathrm{e}^{y^2}$

May be implied by a substitution e.g. $u = y^2 \Rightarrow \int 8y\mathrm{e}^{y^2}\mathrm{d}y = \int \dfrac{8y}{2y}\mathrm{e}^u\mathrm{d}u = 4\mathrm{e}^u\ (+c)$

Incorrect attempts to integrate $...y\mathrm{e}^{y^2}$ e.g. by parts will generally score no more marks.

A1: Fully correct equation with or without a constant of integration e.g.

$4\mathrm{e}^{y^2} = \dfrac{x^2}{2}\ (+c)$, $8\mathrm{e}^{y^2} = x^2\ (+c)$, $\mathrm{e}^{y^2} = \dfrac{x^2}{8}\ (+c)$ etc.

dM1: **Depends on the first method mark.**

Substitutes in $y = 0$ and $x = 5$ and proceeds to find a value for c.

A1: Correct equation: $y^2 = \ln\left(\dfrac{x^2-17}{8}\right)$ oe e.g.

$y^2 = \ln\left(\dfrac{x^2}{8} - \dfrac{17}{8}\right)$, $y^2 = \ln\dfrac{1}{8}\left(x^2-17\right)$, $y^2 = \ln\left(x^2-17\right) - \ln 8$ etc.

Brackets must be present if necessary e.g. in $y^2 = \ln\left(\dfrac{x^2}{8} - \dfrac{17}{8}\right)$ but not in e.g. $y^2 = \ln\dfrac{x^2-17}{8}$

Apply isw once the correct answer is seen.