Question Number	Scheme	Marks
1(a)	$2y^2-3y=7+13\Rightarrow 2y^2-3y-20=0\Rightarrow y=...$	M1
	$y=-\frac{5}{2}$ and $y=4$	A1
		(2)
(b)	$2y^2\rightarrow 4y\frac{\mathrm{d}y}{\mathrm{d}x}$	B1
	$-6xy\rightarrow \pm...x\frac{\mathrm{d}y}{\mathrm{d}x}\pm...y$	M1
	$4y\frac{\mathrm{d}y}{\mathrm{d}x}-6x\frac{\mathrm{d}y}{\mathrm{d}x}-6y=14\mathrm{e}^{2x-1}$	A1
	$4(4)\frac{\mathrm{d}y}{\mathrm{d}x}-6\left(\frac{1}{2}\right)\frac{\mathrm{d}y}{\mathrm{d}x}-6(4)=14\mathrm{e}^{2\left(\frac{1}{2}\right)-1}\Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x}=...$	M1
	$y-"4"="\frac{38}{13}"\left(x-\frac{1}{2}\right)$	M1
	$38x-13y+33=0$	A1
		(6)
		(8 marks)

(a)

M1: Attempts all of the following

- substitutes $x=\frac{1}{2}$ into the equation for *C* (condoning slips),
- collect terms and forms a 3TQ in *y* (terms do not need to be on one side of the equation and the '= 0' may be implied by subsequent working)
- solves their 3TQ in *y* using usual rules (including via a calculator) to find at least one value for *y*. If a calculator is used, the values must be correct for their 3TQ

A1: Achieves both values $-\frac{5}{2}$, 4 following the award of M1

(b)

B1: $2y^2 \rightarrow 4y\dfrac{\mathrm{d}y}{\mathrm{d}x}$ o.e. For example, accept $2y^2 \rightarrow 2\times 2y\dfrac{\mathrm{d}y}{\mathrm{d}x}$

M1: Attempts the product rule on $-6xy$. Look for $\pm\alpha x\dfrac{\mathrm{d}y}{\mathrm{d}x}\pm\beta y$

Don't be concerned by the signs here unless they state and use an incorrect product rule $vu'-uv'$

A1: Fully correct differentiation $4y\dfrac{\mathrm{d}y}{\mathrm{d}x}-6x\dfrac{\mathrm{d}y}{\mathrm{d}x}-6y=14\mathrm{e}^{2x-1}$ o.e. Allow un-simplified versions

You may see versions like $4y\,\mathrm{d}y-6x\,\mathrm{d}y-6y\,\mathrm{d}x=14\mathrm{e}^{2x-1}\,\mathrm{d}x$ or $4yy'-6xy'-6y=14\mathrm{e}^{2x-1}$ which is acceptable. If they write $\dfrac{\mathrm{d}y}{\mathrm{d}x}=4y\dfrac{\mathrm{d}y}{\mathrm{d}x}-6x\dfrac{\mathrm{d}y}{\mathrm{d}x}-6y-14\mathrm{e}^{2x-1}=0$ this will be A0 unless the $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ on the left subsequently disappears and is ignored.

M1: Attempts to substitute in $x=\dfrac{1}{2}$ with their positive *y* value to find a value for the gradient of the tangent. It is dependent upon having exactly two terms in $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ one each from the differentiation of $2y^2$ and $6xy$. This can be implied by a correct value for their $\dfrac{\mathrm{d}y}{\mathrm{d}x}$. Allow slips if they attempt to make $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ the subject before substituting in $x=\dfrac{1}{2}$ with their positive *y* value. FYI $\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{6y+14\mathrm{e}^{2x-1}}{4y-6x}\rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{24+14}{16-3}=\dfrac{38}{13}$

M1: Uses the value for their $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ with the point $\left(\dfrac{1}{2},a\right)$ where *a* is their positive *y* coordinate to find the equation of the tangent. If they have two positive *y* values, use of either one would be OK for this mark. It must follow some attempt at differentiating the equation for *C*. If the form $y=mx+c$ is used the method must proceed as far as $c=\ldots$

A1: $38x-13y+33=0$ (or any integer multiple of this). The order of the terms is not important

Question Number	Scheme	Marks
2	$\dfrac{\mathrm{d}V}{\mathrm{d}t} = \pm k$	B1
	$V = \dfrac{4}{3}\pi r^3 \rightarrow \dfrac{\mathrm{d}V}{\mathrm{d}r} = 4\pi r^2$	B1
	$\pm k = \lambda r^2 \times \dfrac{\mathrm{d}r}{\mathrm{d}t}$	M1
	$\dfrac{\mathrm{d}r}{\mathrm{d}t} = \dfrac{\pm k}{4\pi r^2} \Rightarrow \dfrac{\mathrm{d}r}{\mathrm{d}t} \propto \dfrac{1}{r^2}$ ✓ *	A1*
		(4 marks)

B1: States or uses $\dfrac{\mathrm{d}V}{\mathrm{d}t} = k$ or $\dfrac{\mathrm{d}V}{\mathrm{d}t} = -k$ (We don't know if k is positive or negative).

Ignore any reference to units even if they are incorrect. E.g. $\dfrac{\mathrm{d}V}{\mathrm{d}t} = k$ cm^3 / sec

B1: States or uses $\dfrac{\mathrm{d}V}{\mathrm{d}r} = 4\pi r^2$ o.e.

M1: Uses a correct chain rule e.g. $\dfrac{\mathrm{d}V}{\mathrm{d}t} = \dfrac{\mathrm{d}V}{\mathrm{d}r} \times \dfrac{\mathrm{d}r}{\mathrm{d}t}$ or equivalent with $\dfrac{\mathrm{d}V}{\mathrm{d}t} = \pm k$ and $\dfrac{\mathrm{d}V}{\mathrm{d}r} = \lambda r^2$

A1*: Completes the proof by looking for the following three elements

- achieves $\dfrac{\mathrm{d}r}{\mathrm{d}t} = \dfrac{\pm k}{4\pi r^2}$
- Offers a valid reason why $\dfrac{\mathrm{d}r}{\mathrm{d}t} \propto \dfrac{1}{r^2}$
- gives a minimal conclusion

All previous marks must have been awarded

Examples of acceptable reasons and acceptable conclusions are;

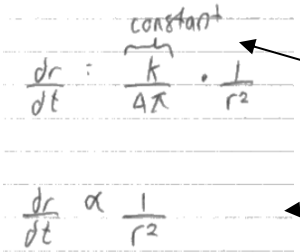
E.g. I $\dfrac{\mathrm{d}r}{\mathrm{d}t} = -\dfrac{k}{4\pi r^2} = -\dfrac{c}{r^2}$, hence proven (Note that c cannot be k)

E.g. II $\dfrac{\mathrm{d}r}{\mathrm{d}t} = \dfrac{k}{4\pi r^2}$, as $\dfrac{k}{4\pi}$ is a constant $\dfrac{\mathrm{d}r}{\mathrm{d}t} \propto \dfrac{1}{r^2}$

Eg. III $\dfrac{\mathrm{d}r}{\mathrm{d}t} = -\dfrac{k}{4\pi r^2}$ as k and π are constants, it is true

E.g. IV $\dfrac{\mathrm{d}r}{\mathrm{d}t} = -\dfrac{k}{4\pi r^2} = -\dfrac{k}{4\pi} \times \dfrac{1}{r^2}$ or $\left(-\dfrac{k}{4\pi}\right) \times \dfrac{1}{r^2}$ ✓

E.g.V.



Reason

Conclusion