Question Number	Scheme	Marks
1	Volume $= \int_0^8 \frac{16\pi}{(x+2)^2}(\mathrm{d}x)$ oe e.g. $\pi\int_0^8\left(\frac{4}{x+2}\right)^2(\mathrm{d}x)$	B1
	$\int \frac{16}{(x+2)^2}\mathrm{d}x = \frac{-16}{(x+2)}$ or e.g. $u = x+2 \Rightarrow \int \frac{16}{(x+2)^2}\mathrm{d}x = \int \frac{16}{u^2}\mathrm{d}u = \frac{-16}{u}$	M1 A1
	$\left[\frac{-16\pi}{(x+2)}\right]_0^8 = \frac{-16\pi}{10} - \left(\frac{-16\pi}{2}\right)$ or e.g. $\left[\frac{-16\pi}{u}\right]_2^{10} = \frac{-16\pi}{10} - \left(\frac{-16\pi}{2}\right)$	M1
	$= \frac{32}{5}\pi$	A1
		(5)
		(5 marks)

B1: Correct expression for the volume in terms of x including the limits (which may be implied by later work). Condone omission of the "dx" but the correct integral with the correct limits and the 16π included must be seen or implied.

M1: For $\int \frac{\ldots}{(x+2)^2}(\mathrm{d}x) \to \frac{\ldots}{x+2}$ oe e.g. $\ldots(x+2)^{-1}$ where "…" are non-zero constants.

Or e.g. $\int \frac{\ldots}{(x+2)^2}\mathrm{d}x = \int \frac{\ldots}{u^2}(\mathrm{d}u) \to \frac{\ldots}{u}$ oe e.g. $\ldots u^{-1}$ where "…" are non-zero constants.

A1: $\int \frac{16}{(x+2)^2}(\mathrm{d}x) = \frac{-16}{(x+2)}$ or $\frac{-16}{u}$ where $u = x + 2$. Ignore any reference to π which could be 2π or e.g. 180°. The limits are not required for this mark so you can ignore any that are given.

M1: Substitutes the limits 0 and 8 into their attempted integration of $\frac{\ldots}{(x+2)^2}$ or e.g. 2 and 10 into their attempted integration of $\frac{\ldots}{u^2}$ and subtracts either way round. Allow this mark following poor attempts at integration, e.g. $\int \frac{\ldots}{(x+2)^2}(\mathrm{d}x) \to \ln(x+2)^2$ but it must be a "changed" function e.g. not $\int \frac{\ldots}{(x+2)^2}(\mathrm{d}x) \to \frac{\ldots}{(x+2)^2}$ and it must an expression that can be evaluated e.g. not expressions containing $\frac{1}{x}$ or e.g. $\ln x$ that cannot be evaluated at $x = 0$

If the integration is incorrect and the substitution of limits is not seen explicitly then you may need to check their answer.

A1: $\frac{32}{5}\pi$ or exact equivalent e.g. $\frac{64\pi}{10}$, 6.4π following fully correct work. $\frac{32}{5}\pi + c$ is A0.

Note $\int_0^8 \frac{16\pi}{(x+2)^2}\mathrm{d}x = \frac{32}{5}\pi$ on its own scores B1M0A0M0A0

Question Number	Scheme	Marks
2(a)	$2^x \to 2^x \ln 2$	B1
	$y^2 \to ...y\dfrac{dy}{dx}$	M1
	$4x^2y \to ...x^2\dfrac{dy}{dx} + ...xy$	M1
	$3 + 10y\dfrac{dy}{dx} + 4x^2\dfrac{dy}{dx} + 8xy = 10 \times 2^x \ln 2$	A1
	$\left(10y + 4x^2\right)\dfrac{dy}{dx} = 10 \times 2^x \ln 2 - 3 - 8xy \Rightarrow \dfrac{dy}{dx} = ...$	M1
	$\dfrac{dy}{dx} = \dfrac{10 \times 2^x \ln 2 - 3 - 8xy}{10y + 4x^2}$	A1
		(6)

B1: Correct differentiation $2^x \to 2^x \ln 2$

M1: For $y^2 \to ...y\dfrac{dy}{dx}$ where ... is a non-zero constant.

M1: For $4x^2y \to ...x^2\dfrac{dy}{dx} + ...xy$ where ... are non-zero constants.

A1: Correct differentiation e.g.

$3 + 10y\dfrac{dy}{dx} + 4x^2\dfrac{dy}{dx} + 8xy = 10 \times 2^x \ln 2$ or e.g. $3 + 10y\dfrac{dy}{dx} + 4x^2\dfrac{dy}{dx} + 8xy - 10 \times 2^x \ln 2 = 0$

Condone a spurious $"\dfrac{dy}{dx} ="$ e.g. $\dfrac{dy}{dx} = 3 + 10y\dfrac{dy}{dx} + 4x^2\dfrac{dy}{dx} + 8xy = 10 \times 2^x \ln 2$

M1: A valid attempt to make $\dfrac{dy}{dx}$ the subject by factorising $\dfrac{dy}{dx}$ from exactly two **different** terms in $\dfrac{dy}{dx}$ which have come from differentiating $5y^2$ and $4x^2y$ and then dividing by the terms in the bracket. Note that here, 2 **different** terms means terms such as $y\dfrac{dy}{dx}$ and $x^2\dfrac{dy}{dx}$ and not e.g. $y\dfrac{dy}{dx}$ and $3y\dfrac{dy}{dx}$. Look for $(... \pm ...)\dfrac{dy}{dx} = ... \Rightarrow \dfrac{dy}{dx} = ...$ which may be implied.

$\dfrac{dy}{dx}$ must be non-zero and in terms of x **and** y.

Condone slips provided the intention is clear and the above conditions are satisfied.

For those candidates who had a spurious $\dfrac{dy}{dx} = ...$ at the start, they may incorporate this in their rearrangement in which case they will have 3 terms in $\dfrac{dy}{dx}$ and so score M0.

A1: $\dfrac{dy}{dx} = \dfrac{10 \times 2^x \ln 2 - 3 - 8xy}{10y + 4x^2}$ or any equivalent correct expression e.g. $\dfrac{2^x \ln 2 - 0.3 - 0.8xy}{y + 0.4x^2}$

Note than some candidates may divide though by 10 initially e.g.

$3x + 5y^2 + 4x^2y = 10\left(2^x\right) + 35 \Rightarrow 0.3x + 0.5y^2 + 0.4x^2y = 2^x + 3.5$ and full marks are available for equivalent work in (a) and (b). Note that 2^x may appear correctly as $e^{x\ln 2}$.

2(b)	At $x = 0$ $5y^2 = 45 \Rightarrow y = 3$ $x = 0, y = 3 \Rightarrow \dfrac{dy}{dx} = \dfrac{10 \times 2^0 \ln 2 - 3 - 8 \times 0 \times 3}{10 \times 3 + 4 \times 0^2} = \dfrac{10\ln 2 - 3}{30}$	M1 A1
		(2)

Notes:

M1: Full method of finding the gradient.

Requires:

- substituting $x = 0$ into the equation for C and finding a non-zero value for y. Do not be concerned about the processing as long as they are using $x = 0$ in the equation for C and finding a non-zero value for y
- substituting $x = 0$ and their non-zero y at $x = 0$ into their $\dfrac{dy}{dx}$ to find a numerical value

This may be implied by their value.

Condone slips in copying their $\dfrac{dy}{dx}$ from part (a) if the intention is clear.

If they have a "ln x" term on the rhs then condone "ln 0" appearing as part of their substitution but if no substitution is shown in such cases, score M0

A1: $\dfrac{10\ln 2 - 3}{30}$ oe e.g. $\dfrac{1}{3}\ln 2 - \dfrac{1}{10}$, $\dfrac{\ln 2^{10} - 3}{30}$, $\dfrac{\ln 1024 - 3}{30}$ **<u>from correct work.</u>**

Apply isw once a correct answer is seen.

There must **be no other answers** e.g. some candidates use $y = \pm 3$ to give 2 gradients.

There are many different incorrect expressions for $\dfrac{dy}{dx}$ that will give the correct answer here so this must follow a correct $\dfrac{dy}{dx}$ in part (a).

		(8 marks)