Question Number	Scheme	Marks
8(i)	Provides a counter example E.g. $\sqrt{2}\times\sqrt{8}=4$	B1 **(1)**
(ii)	Knows that odd numbers are of the form $2k+1,\quad (k\in\mathbb{N})$	B1
	Attempts $(2k+1)^3+3(2k+1)+2=....$	M1
	$=8k^3+12k^2+12k+6$	A1
	$=4\times\left(2k^3+3k^2+3k+1\right)+2$ Which is even but not a multiple of 4. Hence proven	A1* **(4)** **(5 marks)**

(i)

B1: Provides a counter example and shows that the statement is not always true.
The correct result must be written out showing that it is rational (that is, giving it in a rational form)
So $\sqrt{2}\times\sqrt{8}=\sqrt{16}$ is insufficient but $\frac{\pi}{2}\times\frac{6}{\pi}=\frac{6}{2}$ is acceptable

(ii)

A proof attempted by substituting odd numbers n = 1, 3, 5 etc into n^3+3n+2 will not score any marks

B1: Knows that odd numbers are of the form $2k\pm1$ using any variable apart from n
Other variations may be used, for example $2k\pm3$, $2k\pm5$, etc but will be much less common.
Note that use of $4k+1$ is flawed as it doesn't pick up all the odd numbers so on its own scores B0

M1: Attempts to expand $(2k+1)^3+3(2k+1)+2$ or $(2k-1)^3+3(2k-1)+2$ using any variable including n.
Generally, look for a minimum of $(2k+1)^3+3(2k+1)+2\rightarrow$ a cubic expression in k
As with the B mark, other variations may be used, for example $2k\pm3$ but will be much less common.
The use of $n=4k+1$ in n^3+3n+2 and expanded to a cubic form can be awarded this M mark only

A1: A correct expansion for $(2k+1)^3+3(2k+1)+2$ Allow the use of any variable including n
Look for $8k^3+12k^2+12k+6$ …
but …allow any correct expression that allows the problem to be solved e.g. $4(2k+1)\left(k^2+k+1\right)+2$
FYI the correct expansion for $(2k-1)^3+3(2k-1)+2$ is $8k^3-12k^2+12k-2$

A1*: Requires the candidate to have fully correct algebra, scored all 3 previous marks and
1) prove/show that the result is even
2) prove/show that the result is not a multiple of 4
3) give a minimal conclusion

Examples of expressions, for $n = 2k + 1,$ that show the result is even;

- $8k^3 + 12k^2 + 12k + 6$ with a statement saying that it is a sum of even numbers
- $\left(8k^3 + 12k^2 + 12k + 6\right) \div 2 = 4k^3 + 6k^2 + 6k + 3$
- $8k^3 + 12k^2 + 12k + 6 = 2\left(4k^3 + 6k^2 + 6k + 3\right)$

Examples of expressions, for $n = 2k + 1,$ that show the result is not a multiple of 4

- $8k^3 + 12k^2 + 12k + 6 = 2\left(4k^3 + 6k^2 + 6k + 3\right)$ with some statement alluding to the fact that another factor of 2 cannot be taken out of the $\left(4k^3 + 6k^2 + 6k + 3\right)$
- $\left(8k^3 + 12k^2 + 12k + 6\right) \div 4 = 2k^3 + 3k^2 + 3k + \frac{3}{2}$
- $8k^3 + 12k^2 + 12k + 6 = 4\left(2k^3 + 3k^2 + 3k + 1.5\right)$

Examples of expressions, for $n = 2k + 1,$ that show the result is both even but not a multiple of 4

- $8k^3 + 12k^2 + 12k + 6 = 4\left(2k^3 + 3k^2 + 3k + 1\right) + 2$
- $8k^3 + 12k^2 + 12k + 6 = 4 \times \left(2k^3 + 3k^2 + 3k\right) + 6$

Question Number	Scheme	Marks
	$y=\dfrac{9x^2\left(5-\sqrt{x}\right)}{5}$	
9(a)	$y=9x^2-\dfrac{9}{5}x^{\frac{5}{2}}\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=18x-\dfrac{9}{2}x^{\frac{3}{2}}$	M1, A1
	$18x-\dfrac{9}{2}x^{\frac{3}{2}}=0\Rightarrow x^{\frac{1}{2}}=(4)$	dM1
	$(16, 460.8)$	A1, A1
		(5)
(b)	$5-\sqrt{x}=0\Rightarrow x=25$	M1, A1
		(2)
(c)	$\int 9x^2-\dfrac{9}{5}x^{\frac{5}{2}}\mathrm{d}x=3x^3-\dfrac{18}{35}x^{\frac{7}{2}}$	M1A1
	Shaded area $=\underline{(25-16)\times 460.8}-\left[3x^3-\dfrac{18}{35}x^{\frac{7}{2}}\right]_{16}^{25}$	<u>M1</u>, dM1
	$=1312.7$	A1
		(5)
		(12 marks)

(a)

M1: Attempts to differentiate. In most cases this will involve multiplying out and differentiating each term. Look for a sum of two terms with one correct index.

So, score for either $y=ax^2\pm...\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=px\pm....$ or $y=...\pm bx^{\frac{5}{2}}\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=...\pm qx^{\frac{3}{2}}$

It is possible to differentiate using the product rule.

In this case look for the correct form. E.g $y=\dfrac{9x^2\left(5-\sqrt{x}\right)}{5}\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=\left(5-\sqrt{x}\right)\times...x+...x^2\times...x^{-\frac{1}{2}}$

You may see attempts using the product or quotient rules so look carefully at what is written

A1: $\dfrac{\mathrm{d}y}{\mathrm{d}x}=18x-\dfrac{9}{2}x^{\frac{3}{2}}$ o.e but allow this un-simplified.

FYI, using the product rule, the correct unsimplified answer is $\left(5-\sqrt{x}\right)\times\dfrac{18x}{5}+\dfrac{9x^2}{5}\times-\dfrac{1}{2}x^{-\frac{1}{2}}$

dM1: Sets their $px\pm qx^{\frac{3}{2}}=0$ or $px\pm qx^{\frac{1}{2}}=0$ (from a slip on the fractional index) and proceeds using correct index work to $\alpha x^{\pm\frac{1}{2}}=\beta$

Other methods exist, such as squaring, but look for correct index work with the coefficients squared as well. The demand of candidates is to show their working and it will be applied in this question on this mark.

If candidates go from $18x-\dfrac{9}{2}x^{\frac{3}{2}}=0$ to $x=16$ without intermediate working they will lose this mark.

They can be awarded the next two marks however.

A1: x coordinate of 16 **following correct differentiation and** $\dfrac{\mathbf{d}y}{\mathbf{d}x}=0$.