Question Number	Scheme	Marks
8 (i)	Substitutes a value e.g. $n=6$ into n^2+3n+1 where n^2+3n+1 is **not prime**	M1
	Correct calculation for that value e.g $n^2+3n+1=55$ And conclusion "which is not prime"	A1
		(2)
(ii)	Attempts to find n^2-2 for either odds or evens E.g Attempts $(2p+1)^2-2$ or $(2p)^2-2$	M1
	Achieves either $(2p+1)^2-2=4p^2+4p-1$ or $(2p)^2-2=4p^2-2$ and shows or gives a reason why the expression is not a multiple of 4 where required (see notes)	A1
	Attempts to find n^2-2 for both odds and evens (See above)	dM1
	Achieves both $(2p+1)^2-2=4p^2+4p-1$ and $(2p)^2-2=4p^2-2$ and shows or gives reasons why these are not multiples of 4 where required (see notes) With a conclusion that they are not multiples of 4. *	A1*
		(4)
		(6 marks)

(i)

M1: Substitutes a value into n^2+3n+1 where n^2+3n+1 is not prime. (Does not have to be evaluated) Possible values are $n=6,11,13,16$ etc. Condone slips substituting in or if they have evaluated incorrectly provided the intention was to substitute in a valid value for *n*. (Note that $n=0$ is not acceptable)

A1: A correct calculation for the value and a conclusion. There must be some reference to not being prime or they show that the number is divisible by e.g. 5 and state that it is false/not true

e.g. $6^2+3\times6+1=55$ which is not prime (so not true) is M1A1

e.g. when $n=11$ then $n^2+3n+1=155$ $155\div5=31$ so false is M1A1

e.g. $6^2+3\times6+1=55$ so false is M1A0

Values of *n* up to 50 for which n^2+3n+1 is not prime:

n	n^2+3n+1	n	n^2+3n+1
6	55	31	1055
11	155	32	1121
13	209	33	1189
16	305	35	1331
17	341	36	1405
21	505	39	1639
22	551	41	1805
24	649	42	1891
26	755	46	2255
28	869	48	2449
		50	2651

(ii) **There should be no errors in the algebra but allow e.g. invisible brackets to be "recovered". Withhold the final mark if *n* is used instead of *k***

M1: Uses algebra to describe odds e.g. $n = 2p+1$ or evens e.g. $n = 2p$ and attempts $n^2 - 2$ (allow equivalent representation of odd or even e.g. $n = 2k + 2$ **or** $2n \pm 5$)

Condone arithmetical slips and condone the use of e.g. $n = 2n$ and $n = 2n \pm 1$

A1: They must

- achieve a correct expanded $n^2 - 2$ for either odds or evens
- show or give an explanation why the expression is not a multiple of 4 (other than the trivial case when $n = 2p$.

e.g. $(2p+1)^2 - 2 = 4p^2 + 4p - 1$ which is 1 less than a multiple of 4 is A1 (explanation)

Do not accept e.g. "you cannot take 4 out as a common factor" as this is insufficient and should be shown, e.g. $(2p+1)^2 - 2 = 4p^2 + 4p - 1 = 4\left(p^2 + p\right) - 1$ is A1 (shows)

For the case when $n = 2p \Rightarrow (2p)^2 - 2 = 4p^2 - 2$ it does not need to be followed by an explanation as it is clearly not a multiple of 4 but if one is given then it must be correct. e.g. when divided by 4 gives $p^2 - \frac{1}{2}$

They must have evaluated numbers with indices so do not accept $2^2 p^2 - 2$

dM1: Attempts to find $n^2 - 2$ for both odds and evens (See above)

A1: Fully correct proof. They must

- achieve a correct expanded $n^2 - 2$ for both odds and evens
- show or gives a reason as to why each expression is not a multiple of 4 (other than for $n = 2p$)
- make a concluding overall statement. "Hence not a multiple of 4 (for all $n \in \mathbb{N}$)_" Accept "hence proven", "statement proved", "QED" **if they have stated for each separate case that the expression is not a multiple of 4.**

Attempts using $4k,\ 4k+1,\ 4k+2,\ 4k+3$ should be applied similarly to the main scheme above:

M1: Attempts **at least two of the four cases** from e.g. $4k,\ 4k+1,\ 4k+2,\ 4k+3$ (but could be others e.g. $4k-2,\ 4k-1,\ 4k,\ 4k+1$

A1: They must

- achieve two correct expanded $n^2 - 2$
- show or give a reason as to why the two expressions are not a multiple of 4 (same examples as in notes above for main scheme).

	$n^2 - 2$
$4k-3$	$16k^2 - 24k + 7$
$4k-2$	$16k^2 - 16k + 2$
$4k-1$	$16k^2 - 8k - 1$
$4k$	$16k^2 - 2$
$4k+1$	$16k^2 + 8k - 1$
$4k+2$	$16k^2 + 16k + 2$
$4k+3$	$16k^2 + 24k + 7$

dM1: Attempts to find $n^2 - 2$ for all four cases (see above)

A1: Fully correct proof (see above)

Question Number	Scheme	Marks
9 (i)	States or uses $\tan x = \dfrac{\sin x}{\cos x}$	B1
	$\sin x \tan x = 5 \Rightarrow \sin^2 x = 5\cos x \Rightarrow 1-\cos^2 x = 5\cos x$	M1A1
	$\cos^2 x + 5\cos x - 1 = 0 \Rightarrow \left(\cos x =\right) \dfrac{-5 \pm \sqrt{29}}{2} \Rightarrow x =$ awrt $78.9°, 281.1°$	M1dM1A1
		(6)
(ii)	(a) $A = 5$	B1
		(1)
	(b) $2\theta - \dfrac{3\pi}{8} = \dfrac{3\pi}{2} \Rightarrow \theta = ...$	M1
	$\theta = \dfrac{15\pi}{16}$	A1
	y coordinate $Q = -3$ (or $2 - "A"$)	B1ft
		(3)
	(c) Sets $0 = "5"\sin\left(2\theta - \dfrac{3\pi}{8}\right) + 2 \Rightarrow \sin\left(2\theta - \dfrac{3\pi}{8}\right) = \pm\dfrac{2}{"5"}$	M1
	$\sin\left(2\theta - \dfrac{3\pi}{8}\right) = \pm\dfrac{2}{5} \Rightarrow \left(2\theta - \dfrac{3\pi}{8}\right) = \arcsin\left(\pm\dfrac{2}{5}\right) = ...$	dM1
	One of $\theta = 0.38,\ 2.4,\ 3.5,\ 5.5,\ 6.7,\ 8.6,\ 9.8....$	A1
	$\theta =$ awrt 5.51	A1
		(4)
		Total 14

(i) **Do not penalise working in another variable or if the variable is omitted at times in their working.**
e.g. sin instead of $\sin x$ is condoned as a slip or $\cos^2 x$ as $\cos x^2$.They are required to show the stages of working but not to the same level of accuracy in their presentation as a "show" or "prove" question.

B1: States or uses $\tan x = \dfrac{\sin x}{\cos x}$ (may be seen as $\sin x \tan x \Rightarrow \tan^2 x \cos x$)

M1: Uses $\pm\sin^2 x \pm \cos^2 x = \pm 1$ to set up a quadratic equation in cos *x* only. If terms have been collected on one side condone the omission of = 0. May form the equation $\tan^2 x \cos x = 5$ and use the identity $\pm 1 \pm \tan^2 x = \pm\sec^2 x$ proceeding to a quadratic in cos *x* only

$$\text{e.g.} \Rightarrow \cos x(\sec^2 - 1) = 5 \Rightarrow \frac{1}{\cos x} - \cos x = 5 \Rightarrow 1 - \cos^2 x = 5\cos x$$

or alternatively, square both sides and proceed to a quartic in cos *x* only.

A1: Correct 3TQ (or quartic) in cos *x*. The three terms do not need to be on the same side of the equation. The =0 may be implied by further work. e.g. attempting to solve the quadratic. Alternatively award for the quartic equation $\cos^4 x - 27\cos^2 x + 1 = 0$

M1: Attempts to solve their 3TQ (or quartic) in cos *x*. Usual rules apply for solving the quadratic. Accept via a calculator but at least one root must be correct (you may need to check this)
They cannot proceed from the 3TQ directly to an angle for *x*; this is M0 and no further marks can be scored.
Accept either root as a rounded decimal to 2sf e.g. for the correct quadratic it would be awrt 0.19 or awrt -5.2

dM1: Attempts to find one value for *x* in the given range using their root. You may need to check this. It is dependent on the previous method mark. Accept in radians. It is acceptable to proceed from the roots of their quadratic directly to an angle in the given range to score this mark. May be implied by awrt 79 or awrt 281 (or in radians awrt 1.4 or awrt 4.9)

A1: awrt $x = 78.9°, 281.1°$ (must be in degrees) and no others in the range.