Outcome	AEq9	Student can consistently:	Solve a quadratic equation by completing the square.

How the topic is examined	- Examined through test paper questions. - Questions can appear on either calculator or non-calculator papers. - It is unlikely to ask students to 'solve using completing the square'. Instead it will ask students to write a given quadratic expression in the form $(x+a)^2+b$. A supplementary question will then ask students to solve the equation. - In the previous GCSE, questions on this topic were quite rare, but it is likely that these questions will get more emphasis on the new GCSE.
Prior knowledge	- Students should be confident with: - Simplifying expressions (AEx2) - Solving equations using the quadratic formula (AEq7) - Factorising quadratic expressions (AEx7) - Completing the square (AEx10) - Simplifying a surd (NS3)
Suggested tuition approaches	- Students should be made aware that completing the square is one of the most useful methods when working with quadratic expressions. - Completing the square for a quadratic function has multiple uses: - It allows you to go and solve equations. - You can use it to prove the quadratic formula (AEq7) - You can use it to sketch a quadratic graph and determine the line of symmetry and co-ordinates of the turning point. - You can use it to rearrange more complicated formulae. - Students might be interested to know why it is called completing the square. The following link gives a nice visual explanation. https://en.wikipedia.org/wiki/Completing_the_square - For the highest attaining students you may want to go through how completing the square is related to the quadratic formula. http://www.purplemath.com/modules/sqrquad2.htm - It is recommended that you leave your answer in surd form unless the question asks for it in another form. - In order for students to solve an equation using the method of completing the square they have to follow these steps: - Ensure first that the equation equals zero. - Complete the square by writing the equation in the form $(x\pm a)^2-b=0$

- o Now add b to both sides.
- o Now square root both sides. Remember when you square root a number you get a positive and negative answer. We can denote this using the $\pm$ symbol. Remember to simplify the surd if you can.
- o Now add or subtract a on to both sides to leave x on its own.
- o This should be the answer. Leave your answer in surd form, unless otherwise asked.

- Here is a typical exam problem.
  - (a) Write $x^2 - 8x + 3$ in the form $(x + a)^2 + b$
  - (b) Hence solve $x^2 - 8x + 3 = 0$

Part (a) was answered in AEx10 and we will use the answer to this to work out part (b)

Some students will go back to the original question and complete the square again or use a different method (e.g. quadratic formula), however marks will be awarded for continuing from where they left off in part (a). The key word is hence, this is implying students should use what they have already done.

This is where we left off in part (a)
$$(x - 4)^2 - 13 = 0$$

Now we will add 13 to both sides
$$(x - 4)^2 = 13$$

Now square root both sides. Remember you get the positive and negative square root when you do so.

$$- 4 = \pm\sqrt{13}$$

Simplify the surd if you can (NS3) – in this example you cannot do that. Now add 4 to both sides.
$$= \pm\sqrt{13} + 4$$
There are two solutions here $x = +\sqrt{13} + 4$ and $x = -\sqrt{13} + 4$

Common errors and misconceptions	- See (AEx10) for notes on where students might go wrong with completing the square. - When students come to solve an equation using completing the square they can get the steps wrong and forget to do the inverse (e.g. they add instead of subtracting etc…) - Often students forget that when they square root a number you get the positive and negative square root. This is denoted by the $\pm$ symbol. - Students often extend the square root when they add/subtract a to both sides. For example $x = +\sqrt{13+4}$
Suggested resources	- Questions - http://www.cimt.org.uk/projects/mepres/allgcse/pr10-es.pdf (pp 75 - 77) - https://corbettmaths.files.wordpress.com/2013/02/completing-the-square-pdf.pdf - Past GCSE Questions - https://corbettmaths.files.wordpress.com/2013/02/completing-the-square-pdf.pdf - Video tutorial - http://corbettmaths.com/2013/12/29/completing-the-square-video-10/