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Year 10 Mathematics
Quadratic Algebra II [3.2]
Workshop

Error Logbook:



New Ideas/Concepts	Didn't Read Question
Pg / Q #: _____ Notes:	Pg / Q #: _____ Notes:
Algebraic/Arithmetic/ Calculator Input Mistake	Working Out Not Detailed Enough
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Section A: Recap

Sub-Section [3.2.1]: Carry Out the Process of Completing the Square



Completing the Square for Monic expression



➤ To complete the square of a quadratic expression: $x^2 + bx + c$.

🔗 **Step 1:** Halve the coefficient of the middle (x) term, $\frac{b}{2}$.

🔗 **Step 2:** Square $x + \frac{b}{2}$ (Note: b can be $+$ or $-$).

🔗 **Step 3:** In order to keep the original quadratic the same, subtract $\left(\frac{b}{2}\right)^2$ from the expression.

🔗 **Step 4:** Keep constant c in the equation.

➤ So, we can write the formula as $\left(x + \frac{b}{2}\right)^2 - \left(\frac{b}{2}\right)^2 + c$.

➤ If you ever forget how to do it, you can watch these two TikTok videos!



Completing the Square for Non-Monic Expressions



➤ To complete the square of a quadratic expression:

$$ax^2 + bx + c$$

➤ **Step 1:** Take out the factor a for the first two terms:

$$a\left(x^2 + \frac{bx}{a}\right) + c$$

➤ **Step 2:** Halve the coefficient of the middle (x) term, $\frac{b}{a}$.

➤ **Step 3:** Square $x + \frac{b}{2a}$ (Note: $\frac{b}{2a}$ can be + or -).

➤ **Step 4:** In order to keep the original quadratic the same, subtract $\left(\frac{b}{2a}\right)^2$ from the expression in the bracket.

➤ **Step 5:** Keep constant c in the equation.

$$ax^2 + bx + c = a\left(x + \frac{b}{2a}\right)^2 - \frac{b^2}{4a} + c$$

Question 1

Complete the square for the following quadratic expression.

a. $x^2 - 10x + 1$

b. $2x^2 + 6x + 1$

Question 2 Additional Question.

Complete the square for the following quadratic expression.

a. $3x^2 - 12x + 2$

b. $x^2 + 2x + 5$

Sub-Section [3.2.2]: Factorise by First Completing the Square



Factorising Monic Expression by Completing the Square

$$x^2 + bx + c$$

- **Step 1:** Complete the square by using the formula:

$$x^2 + bx + c = \left(x + \frac{b}{2}\right)^2 - \left(\frac{b}{2}\right)^2 + c$$

- **Step 2:** Simplify the expression and combine like terms $-\left(\frac{b}{2}\right)^2$ and c .
- **Step 3:** Factorise using the difference between two squares.

$$a^2 - b^2 = (a + b)(a - b)$$



Factorising Non-Monic Expression by Completing the Square

$$ax^2 + bx + c$$

- **Step 1:** Complete the square using the formula:

$$ax^2 + bx + c = a\left(x + \frac{b}{2a}\right)^2 - \frac{b^2}{4a} + c$$

- **Step 2:** Simplify the expression and combine like terms $-\frac{b^2}{4a}$ and c .
- **Step 3:** Factorise using the difference between two squares:

$$a^2 - b^2 = (a + b)(a - b)$$

Question 3

Factorise the following quadratics using the method of completing the square:

a. $x^2 + 6x + 4$

b. $7x^2 - 14x + 1$

Question 4 Additional Question.

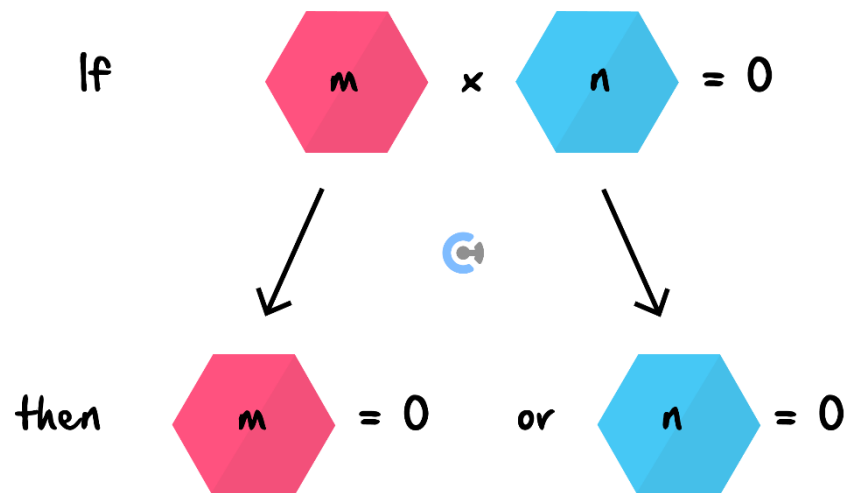
Factorise the following quadratics using the method of completing the square:

a. $5x^2 + 20x + 4$

b. $x^2 - 8x + 11$

Sub-Section [3.2.3]: Solve a Quadratic Equation Using Factorisation & the Null Factor Law

➤ The null factor law simply states:



Question 5

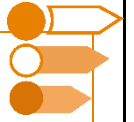
Solve the following equations:

a. $m^2 = 14m$

b. $n^2 - n - 20 = 0$

c. $2x^2 - 20x - 32 = 0$

Sub-Section [3.2.4]: Use the Quadratic Formula to Solve a Quadratic Equation



The Quadratic Formula

► For any quadratic equation $ax^2 + bx + c = 0$, the general formula of solutions is:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Where a, b are the coefficients of x^2, x respectively, and c is the constant term.

Question 6

Solve the quadratic equation $x^2 - 7x + 9 = 0$ using the quadratic formula. Leave your answer in surd form.

Question 7 Additional Question.

Solve the quadratic equation $4x^2 - 10x + 4 = 0$ using the quadratic formula.

Sub-Section [3.2.5]: Use the Discriminant to Determine the Number of Solutions of a Quadratic Equation



The Discriminant

- The discriminant, often denoted by Δ (Delta), is the part inside the square root of the quadratic formula.

$$\text{Discriminant} = \Delta = b^2 - 4ac$$

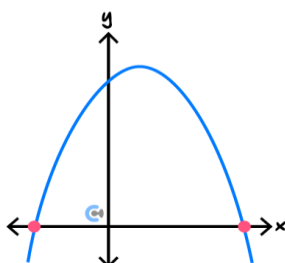
- The discriminant gives us very useful information about the number of unique solutions that exist in the quadratic equation.

If $\Delta > 0$, 2 distinct real solutions exist.

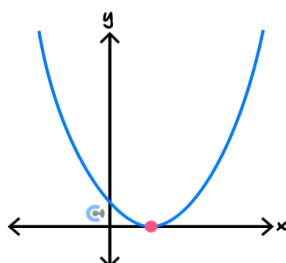
If $\Delta = 0$, 1 real solution exists.

If $\Delta < 0$, no real solutions exist.

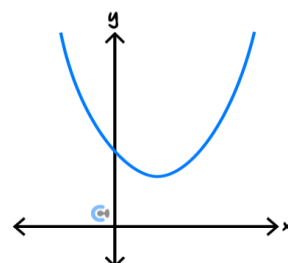
- Corresponding graph for each scenario.



Two real solution
 $\Delta > 0$



One real solution
 $\Delta = 0$



No real solution
 $\Delta < 0$

Question 8

Find the discriminant for each of the following quadratic equations. Hence, state the number of real solutions they have. You do not need to solve the equations.

a. $x^2 - 4x + 10 = 0$

b. $2x^2 - 5\sqrt{2}x + 4 = 0$

Question 9 Additional Question.

Find the discriminant for each of the following quadratic equations. Hence, state the number of real solutions they have. You do not need to solve the equations.

a. $4x^2 + 4x + 1 = 0$

b. $9x^2 - 1 = 0$

Section B: Short Answer Questions (22 Marks)

Question 10 (2 marks)

Determine how many solutions the following equation has:

$$x^2 + 3x + 1 = 7x - 1$$

Question 11 (4 marks)

Complete the square by finding the missing values.

a. $\left(x - \frac{\square}{8}\right)^2 = x^2 - \frac{10}{8}x + \frac{\square}{64}$. (2 marks)

b. $x^2 - 5x + \square = (x - \square)^2$. (2 marks)

Question 12 (6 marks)

Solve for x using factorisation.

a. $\frac{9+3x}{2x} = x$. (3 marks)

b. $(x - 3)^2 = 2x + 2$. (3 marks)

Question 13 (4 marks)

If the equation $(1 + k^2)x^2 + 2kqx + q^2 - p^2 = 0$ has a unique real solution, then find q^2 in terms of p and k .

Question 14 (3 marks) **Extension.**

Solve the following equation for x .

$$x^4 - 13x^2 + 36 = 0$$

Question 15 (3 marks) Extension.

Find the value(s) of m for which the graphs of $y = mx + 2$ and $y = x^2 + 3x + 2$ have One point of intersection.

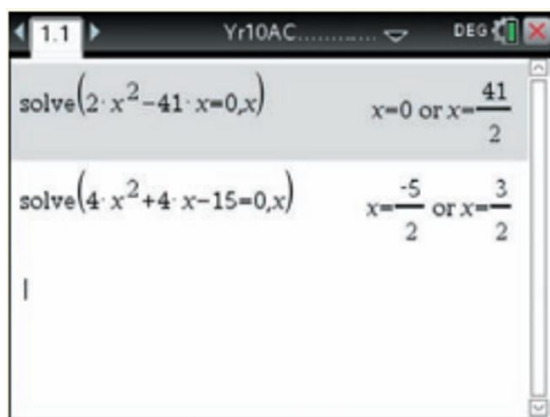
Section C: Technology Recap

Calculator Commands: Solving Equations Using CAS



TI-Nspire

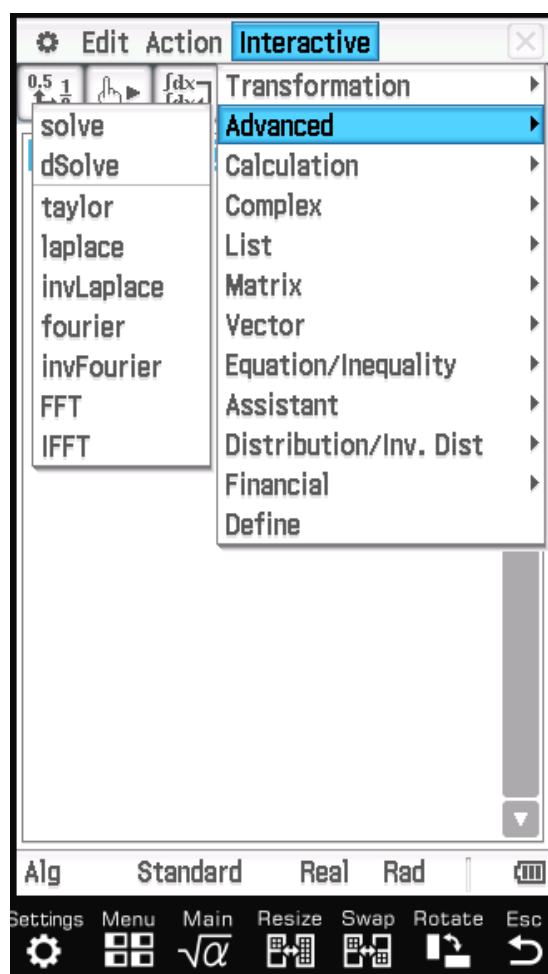
- In a Calculator page use Menu > Algebra > Solve and type as shown ending with x .



- Note: If your answers are decimal then change the Calculation Mode to Auto in Settings on the Home Screen.
- Use Menu > Algebra > Solve and type as shown.

Casio ClassPad

- In the Main application, type and highlight the equation.
- Tap Interactive > Advanced > Solve.



- Tap OK.

$$\text{solve}(2 \cdot x^2 + 3 \cdot x - 1 = 0, x)$$

$$\left\{ x = \frac{-\sqrt{17}}{4} - \frac{3}{4}, x = \frac{\sqrt{17}}{4} - \frac{3}{4} \right\}$$

□

Question 16

Solve:

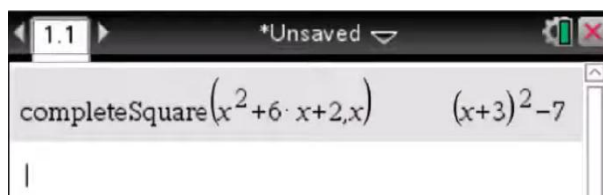
$$x^2 - x - 210 = 0$$

Calculator Commands: Factorising Via CAS



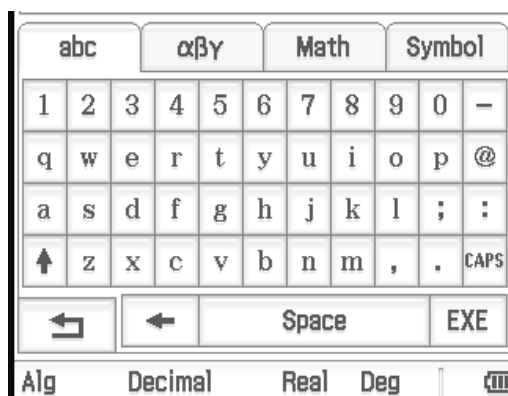
TI-Nspire

- Menu > 3 Algebra > 5 Complete the Square.

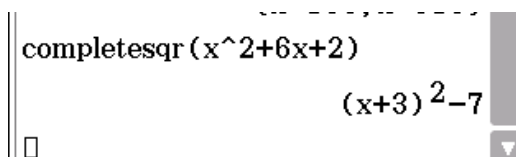


Casio ClassPad

- Add keyboard, select 'abc'.



- Type in 'completesqr' and enter the expression in the bracket.



Question 17

Factorise the expression by completing the square:

$$x^2 - 9x + 1$$

Section D: Extended Response Questions (16 Marks)

Question 18 (6 marks)

Lucas is a cyclist riding along a curved track. His speed S (in metres per second) along the track at any position x (in metres) is given by:

$$S = -2x^2 + 8x + 6$$

- a. Express the equation in the form of $S = a(x - h)^2 + k$. (2 marks)

- b. Hence or otherwise, determine the maximum speed and the position x where it occurs. (1 mark)

- c. Use the null factor law to find the exact positions where Lucas's speed is zero. Express the answers as surd form. (2 marks)

- d. Hence or otherwise, determine if Lucas stops beyond 5 metres. (1 mark)

Question 19 (10 marks)

Dreamworld on the Gold Coast, Australia, features a ride called The Giant Drop, where riders are lifted to a great height before being released in free fall. The height h (in metres) of a rider on The Giant Drop can be modelled by:

$$h = -5t^2 + 20t + 115$$

Where t is the time (in seconds) after launch, and v_0 is the initial upward velocity in metres per second. The tower itself is 115 metres tall, and the ride propels passengers 16 metres above the tower before they fall.

- a. Find the time t when the rider reaches its maximum height. (2 marks)

- b. Determine how long the rider spends above 130 metres before falling back below this height. (3 marks)

- c. Determine how many times the rider reaches the launch height of 115 *meters* by calculating the discriminant of the quadratic equation. (2 marks)

- d. Solve for t when $h = 115\text{ m}$ using the quadratic formula to verify the total ride time. (3 marks)



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Year 10 Mathematics

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