



Solving polynomial equations

Year 10 Mathematics

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Learning Objectives

By the end of the lesson, I would hope that you have an understanding and be able to apply to questions the following concepts:

- To know how to find a factor of a polynomial using the factor theorem
- To be able to factorise a polynomial using division by a known factor
- To be able to apply the Null Factor Law to solve a polynomial equation in factorised form



Recap of past learning

When we did all that work on Quadratic equations, we found the Null Factor Law really important. Why? Because it told us the roots of the equations. These were the x-axis crossing points of the curve. We found these by **solving the quadratic**.

A lot of the work you will need to do later in Mathematics is sketch curves. To do this, axis crossing points are really important. We also need to know turning points (but we will get to this soon!).

We are now going to extend the work we have been doing to look at solving polynomials.

Needless to say, we are going to need to factorise and then solve using the Null Factor Law!



Recap: Factorising and solving a quadratic

Let's just remember the process of solving a quadratic.

$$\text{solve } x^2 - 3x - 40 = 0.$$

$$x^2 - 3x - 40 = 0$$

$$x^2 + 5x - 8x - 40 = 0$$

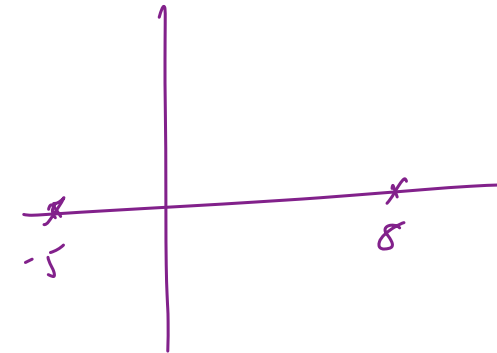
$$x(x + 5) - 8(x + 5) = 0$$

$$(x + 5)(x - 8) = 0$$

$$x + 5 = 0 \quad x - 8 = 0$$

$$x = -5 \quad x = 8$$

$$\begin{array}{r|l} -40 & \\ 1 & -40 \\ 2 & -20 \\ 4 & -10 \\ \hline 5 & -8 \end{array}$$



Remember that Solve means something very specific in Mathematics.

In every case we are finding coordinates. Be careful when you read the questions what they are asking you to find.

Question: What does a number being a factor mean? It means there is no remainder.



Factorising a cubic

We are now going to join all the work we have been doing to allow us to factorise a cubic.

Again, this is a process. There are no short cuts. You need to make sure you are proficient in doing this.

Factorise $P(x) = x^3 + 6x^2 + 5x - 12$

$$\begin{array}{r} x^2 + 7x + 12 \\ x-1 \overline{) x^3 + 6x^2 + 5x - 12} \\ \underline{-x^3 - x^2} \\ 7x^2 + 5x \\ \underline{-7x^2 - 7x} \\ 12x - 12 \\ \underline{-12x - 12} \\ 0 \end{array}$$

$$x = 1$$

$$x - 1 = 0$$

$$P(x) = (x-1)(x^2 + 7x + 12)$$

$$\begin{array}{r} 12 \\ 3 \overline{) 4} \\ 3 \end{array}$$
$$(x+3)(x+4)$$

$$P(x) = (x-1)(x+3)(x+4)$$

$$0 =$$

$$\begin{array}{l} x = 1 \\ x = -3 \\ x = -4 \end{array}$$



Example: Using the Null Factor Law

Solve for x .

a $(x - 1)(x + 2)(x + 5) = 0$

$$\begin{aligned}x - 1 &= 0 \\x &= \underline{\underline{1}} \\ \text{or } x + 2 &= 0 \\x &= \underline{\underline{-2}}\end{aligned}$$

$$\begin{aligned}\text{or } x + 5 &= 0 \\x &= \underline{\underline{-5}}\end{aligned}$$

b $(2x - 3)(x + 7)(3x + 1) = 0$

$$\begin{aligned}2x - 3 &= 0 & \text{or } x + 7 &= 0 & \text{or } 3x + 1 &= 0 \\2x &= 3 & x &= \underline{\underline{-7}} & 3x &= -1 \\x &= \underline{\underline{\frac{3}{2}}} & & & x &= \underline{\underline{-\frac{1}{3}}}\end{aligned}$$



Example: Factorising and solving

Solve $x^3 + 2x^2 - 5x - 6 = 0$.

$$x \neq 1$$

$$x + 1 = 0$$

$$\begin{array}{r} x^2 + x - 6 \\ x+1 \overline{) \cancel{x^3} + 2x^2 - 5x - 6} \\ \underline{- \cancel{x^3} + x^2} \\ x^2 - 5x \\ \underline{- x^2 + x} \\ -6x - 6 \\ \underline{- -6x - 6} \\ 0 \end{array}$$

$$\therefore (x+1)(x^2 + x - 6) = 0$$

$$x^2 + x - 6 \quad \begin{array}{r} -6 \\ -2 \overline{) 3} \end{array}$$

$$(x-2)(x+3)$$

$$\therefore (x+1)(x-2)(x+3) = 0$$

$$\therefore x+1=0 \quad x-2=0 \quad x+3=0$$

$$x = \underline{\underline{-1}}$$

$$x = \underline{\underline{2}}$$

$$x = \underline{\underline{-3}}$$



Example: Thinking about the questions

Not all quadratics need to be divided. There are a number of ways to factorise and you need to choose the best. How many solutions will the following have?

$$x^4 + x^2 = 0$$

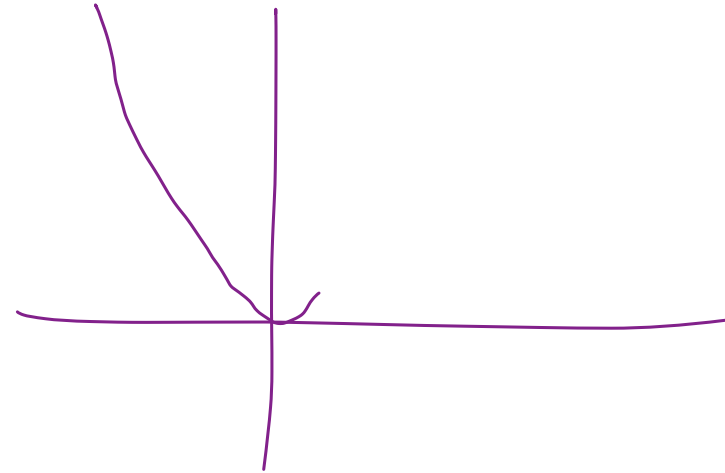
$$x^2(x^2 + 1) = 0$$

$$x^2 = 0$$

$$\underline{\underline{x = 0}}$$

$$x^2 + 1 = 0$$

$$\cancel{x^2 = -1}$$

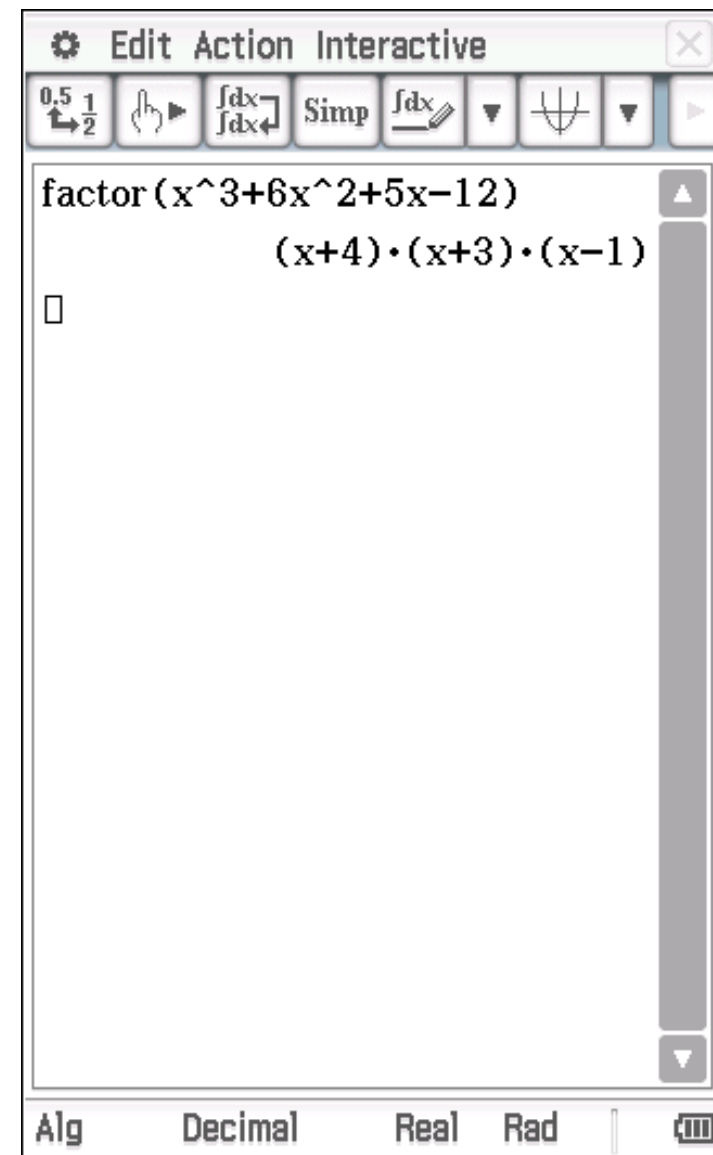


Remember to use your CAS!

As you get into later parts of this course it's important to make sure (**even if the question doesn't ask you to**) to use the CAS to see what the graph looks like!

You can also use the CAS to factorise polynomials for you! This will be looked at more in the next lesson/video.

Factorise $P(x) = x^3 + 6x^2 + 5x - 12$



Learning Objectives: Recapped

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