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Linear Simultaneous Equations

IGCSE Mathematics

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1 Introduction to Simultaneous Equations

Note

Simultaneous equations are a powerful algebraic tool used to find unknown values that satisfy two or more conditions at the same time. They appear in almost every area of mathematics and science, from calculating costs and speeds to modelling real-world situations.

In this chapter, we will explore:

- What simultaneous equations are and what a solution means
- Solving by the **substitution method**
- Solving by the **elimination method**
- Solving **graphically**
- Forming and solving simultaneous equations from word problems
- Special cases: no solution and infinitely many solutions

2 Key Definitions

Definition

A **linear equation** in two variables x and y is an equation of the form:

$$ax + by = c$$

where a, b, and c are constants and a, b are not both zero. When plotted on a coordinate grid, a linear equation produces a **straight line**.

Examples of linear equations:

- $3x + 5y = 14$
- $x - 4y = -7$
- $6x + y = 9$

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Definition

A pair of **simultaneous equations** is a set of two (or more) equations containing the same unknowns, all of which must be **satisfied at the same time**.
The **solution** to a pair of simultaneous equations is the pair of values (x, y) that makes **both** equations true simultaneously.
Example:

$$\begin{cases} x + y = 9 \\ x - y = 3 \end{cases}$$

The solution is $x = 6$, $y = 3$, because:

- $6 + 3 = 9$ ✓
- $6 - 3 = 3$ ✓

Note

What does the solution represent geometrically?
Each linear equation in two variables represents a straight line on a graph. The solution to a pair of simultaneous equations is the **point of intersection** of the two lines — the single point that lies on both lines at the same time.

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3 The Substitution Method

Method

Solving Simultaneous Equations by Substitution
Steps:

Step 1: Choose one equation and rearrange it to make either x or y the subject

Step 2: **Substitute** this expression into the other equation

Step 3: Solve the resulting equation (it will now have only one unknown)

Step 4: Substitute the value found back into the rearranged expression to find the other unknown

Step 5: Check: substitute both values into the *original* equations to verify

Best for: Equations where one variable has a coefficient of 1 or -1 (easy to rearrange without introducing fractions).

Preview ends here

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