CBSE • CLASS 10 • MATHEMATICS

MATHEMATICS BEYOND THE FORMULA

CHAPTER 3 • PAIR OF LINEAR EQUATIONS IN TWO VARIABLES

Don't Memorize Mathematics. Understand, Visualise and Discover It.

The KalviYogi 8D Way: Discover • Visualise • Understand • Derive • Solve • Apply • Challenge • Recall

Every solution with COMPLETE steps — one by one, nothing skipped

Graphical Method • Substitution • Elimination • Consistency & the Ratio Test

Five-Level Practice • 25 MCQs • Case Studies • Model Tests • Board PYQs

Smart Memory System • Mastery Tracker

Two unknowns? Two equations. Two lines. One meeting point.

Learn to find it — by picture, and by algebra.

Based on the latest rationalised NCERT textbook • Simple English • Full Colour
Next Generation Guide • First Edition

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01 Chapter Introduction

8D • DISCOVER — WHY SHOULD I LEARN THIS?

A single equation like x + y = 10 has **endless answers**: (1, 9), (2, 8), (3, 7), (4.5, 5.5)... Life, however, rarely gives us only one clue. The shopkeeper gives you **two clues** — the total number of items *and* the total cost. The taxi meter follows **two rules** — a fixed charge *and* a per-kilometre charge. When **two clues** act on **two unknowns** at the same time, the answer becomes exact and unique. That is the world of this chapter.

Here is the beautiful part: every linear equation in two variables is secretly a **straight line**. Two equations = two lines. And two lines on a page can do only three things — **cross once, run parallel forever, or lie exactly on top of each other**. By the end of this chapter you will be able to *see* which of the three will happen **before** solving, just by comparing three small ratios.

What you will master in this chapter

- Turning a real-life story into a **pair of linear equations** — the modelling step every word problem begins with.
- The **graphical method**: tables of values, plotted lines, and reading the solution off the meeting point.
- **Consistent vs inconsistent** pairs, and dependent pairs with infinitely many solutions.
- The **ratio test** — comparing a_1/a_2, b_1/b_2, c_1/c_2 — and **why it works** (derived from slopes in Section 06, never just memorised).
- The **substitution method** and the **elimination method**, step by step, and how to choose between them.
- Word problems of every board type: ages, fractions, two-digit numbers, taxi fares, bank notes, library charges.

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Your Chapter Map — 18 Stops, One Journey

This chapter is a journey with 18 stops, plus a full practice stadium at the end. Tick each stop as you finish it.

Discover & Visualise	Understand & Derive	Solve, Apply, Recall
☐ 01 Chapter Introduction ☐ 02 Prerequisite Knowledge ☐ 03 Real-Life Story ☐ 04 Visual Concepts (CPA)	☐ 05 Mathematical Foundations ☐ 06 Derivations: Why the Ratio Test Works ☐ 08 Multiple Solution Methods ☐ 10 Common Mistakes	☐ 07 Detailed Solved Examples (NCERT) ☐ 09 Hands-on Activities ☐ 11 Graded Practice (5 Levels) ☐ 12 Mathematical Reasoning
☐ 13 Real-Life Applications ☐ 14 Competency: 5 Case Studies + Assertion–Reason	☐ 15 Olympiad Challenges ☐ 16 Chapter Mind Map	☐ 17 Active Recall ☐ 18 Mastery Tracker

How to use this chapter (read this first!)

1. **Never read a solution passively.** Cover the steps, try yourself, then uncover one step at a time.
2. Every solution shows **Step 1, Step 2, Step 3...** with a small *Why* note in purple handwriting — the reason behind the step. Examiners award marks for these steps, not just for the final answer.
3. For every graphical solution, the **table of values** is shown before the graph — in the board exam, that table itself carries marks.
4. After Section 07, test yourself in Sections 11–15 and the Model Tests **before** opening the Answer Key.
5. Finish with the Mind Map (16), closed-book Recall (17) and your Mastery Tracker (18) — and return on Days 3, 7, 14, 21 and 30 as the Smart Memory schedule directs.

DIGITAL COMPANION: Simulations, video lessons and online tests for this chapter are part of the KalviYogi Digital Ecosystem. QR code and link activate with the KalviYogi app/website at print.

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02 Prerequisite Knowledge

THE TOOLS YOU ALREADY OWN — ONE VARIABLE, POINTS AND LINES

This chapter stands on three earlier skills. Refresh them here — five minutes now will save you fifty minutes later.

1. Solving a linear equation in ONE variable

You already know how to undo operations one by one. Example: $3x - 5 = 10 \rightarrow 3x = 15 \rightarrow x = 5$. The golden rules: whatever you do to one side, do to the other; a term that jumps across the = sign changes its sign. In this chapter you will use this skill *inside* bigger problems — every method finally lands on one equation in one variable.

2. Points on the Cartesian plane

Every pair (x, y) is one point: x tells you how far to walk along the horizontal axis, y how far up the vertical axis. The four regions are the quadrants: (+, +) first, (−, +) second, (−, −) third, (+, −) fourth. The meeting point of the axes is the origin O(0, 0).

3. One equation in two variables = one straight line

Take $x + y = 5$. Its solutions are pairs: (0, 5), (1, 4), (2, 3), (5, 0), (7, −2)... infinitely many. Plot them and they fall exactly on one straight line. **Every solution is a point on the line; every point on the line is a solution.** This single fact powers the whole graphical method.

4. Building a table of values

To draw the line of $ax + by = c$: choose an easy x, compute y; repeat for a second x; a third point is your safety check. Favourite easy choices: $x = 0$ (gives the y-intercept) and $y = 0$ (gives the x-intercept). Two points fix the line — the third point proves you made no arithmetic slip.

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Quick Check — Are You Ready? (5 Questions)

Try all five without looking back. Answers are given below — cover them with your hand first!

Q1. Solve: $2x + 3 = 11$.

Q2. Solve: $5y - 3 = 2y + 9$.

Q3. In which quadrant does the point $(-3, -2)$ lie? And the point $(4, -1)$?

Q4. If $y = 2x - 1$, find y when $x = 3$, and find x when $y = 9$.

Q5. Does the point (2, 5) satisfy $x + y = 7$? Does it satisfy $x - y = 3$? What does your answer mean on the graph?

Answers — check only after trying

Q1. $2x = 8$, so **$x = 4$**.

Q2. $5y - 2y = 9 + 3 \rightarrow 3y = 12$, so **$y = 4$**.

Q3. $(-3, -2)$: both negative — **third quadrant**. $(4, -1)$: x positive, y negative — **fourth quadrant**.

Q4. $x = 3 \rightarrow y = 2(3) - 1 = \mathbf{5}$. $y = 9 \rightarrow 9 = 2x - 1 \rightarrow 2x = 10 \rightarrow \mathbf{x = 5}$.

Q5. $2 + 5 = 7$ — **yes**, (2, 5) lies on the line $x + y = 7$. $2 - 5 = -3 \neq 3$ — **no**, (2, 5) does NOT lie on the line $x - y = 3$. A point satisfies an equation exactly when it lies on that equation's line.

TOPPER TIP: Got 4 or 5 right? You are fully ready. Got fewer? Re-read the four cards on the previous page once, then come back — do not skip this step.

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03 Real-Life Mathematical Story

DISCOVER • VISUALISE — THE FRUIT MARKET PUZZLE

Before any formula, live the problem. Read this story slowly — the two equations will walk out of the story by themselves.

*Saturday morning. The fruit market near **Anitha's** home is loud with bargaining. Anitha has exactly ₹340 in her purse and a list from her mother: buy some mangoes and some oranges for the family.*

*At the first stall she buys **3 kg of mangoes and 2 kg of oranges** — and the purse is empty. Total: ₹340. She notes the purchase in her phone and walks home, thinking: what is the price of one kilogram of each fruit? One bill, two unknown prices. The bill gives her one equation — but one equation with two unknowns has endless answers. Mango at ₹100 and orange at ₹20 fits. Mango at ₹60 and orange at ₹80 also fits! She needs a **second clue**.*

*Next morning, her brother **Ravi** goes to the same stall and buys **2 kg of mangoes and 3 kg of oranges** for **₹310**. Two bills. Two clues. Anitha smiles — now the prices have nowhere to hide.*

Let the price of 1 kg of mangoes be ₹x and of 1 kg of oranges be ₹y. Anitha's bill says: **3x + 2y = 340**. Ravi's bill says: **2x + 3y = 310**. Two equations, two unknowns — a **pair of linear equations in two variables**. Let us catch the prices, one step at a time.

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Solving the Story — Step by Step

STORY PROBLEM

Anitha: 3 kg mangoes + 2 kg oranges cost ₹340. Ravi: 2 kg mangoes + 3 kg oranges cost ₹310. Find the price per kg of each fruit.

THINK FIRST: Two unknown prices, two bills. If I can make the two equations talk to each other — add them, subtract them — one unknown should disappear.

1. Write the two clues as equations. Let mangoes cost ₹x per kg and oranges ₹y per kg. Anitha's bill: 3x + 2y = 340 ...(1). Ravi's bill: 2x + 3y = 310 ...(2).
Why: A word problem is solved twice — first in words, then in symbols. Choosing clear letters is Step Zero of every solution.

2. Add the two equations, left side with left side and right side with right side: (3x + 2x) + (2y + 3y) = 340 + 310, so **5x + 5y = 650**. Divide by 5: **x + y = 130** ...(3).
Why: Adding is legal because equals added to equals stay equal. Notice the trick: together, the two bills bought 5 kg of each fruit — the sum equation has a real meaning!

3. Subtract equation (2) from equation (1): (3x − 2x) + (2y − 3y) = 340 − 310, so **x − y = 30** ...(4).
Why: Anitha bought 1 kg more mangoes and 1 kg less oranges than Ravi, and paid ₹30 more — so 1 kg of mangoes costs ₹30 more than 1 kg of oranges.

4. Add (3) and (4): 2x = 160, so **x = 80**.
Why: The y cancels perfectly — this 'add and subtract' dance is the seed of the elimination method you will master in Section 07.

5. Put x = 80 in (3): 80 + y = 130, so **y = 50**.
Why: Always finish the pair — a solution means BOTH values.

6. Verify with Ravi's bill (the equation you did not use last): 2(80) + 3(50) = 160 + 150 = 310 and Anitha's: 3(80) + 2(50) = 240 + 100 = 340.
Why: Checking in BOTH original bills takes ten seconds and makes the answer bullet-proof.

ANSWER: Mangoes cost ₹80 per kg and oranges cost ₹50 per kg.

TOPPER TIP: *Remember the shape of this story. Ages, fares, notes, digits — nearly every word problem in this chapter is the Fruit Market Puzzle wearing a different costume.*

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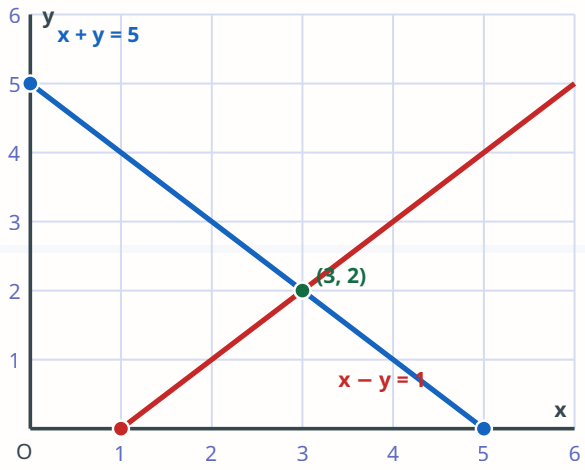
04 Visual Concept Explanation

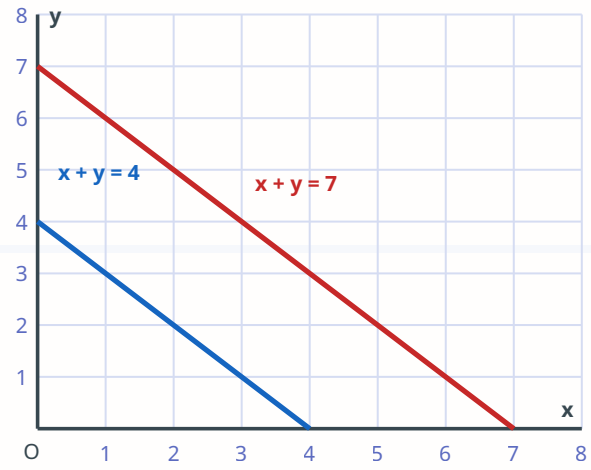
SINGAPORE CPA — CONCRETE → PICTORIAL → ABSTRACT

Concrete. Hold the story in your hands: two shopping bills, each mixing the same two fruits. Every bill is a balance — the left pan (fruit) exactly balances the right pan (money).

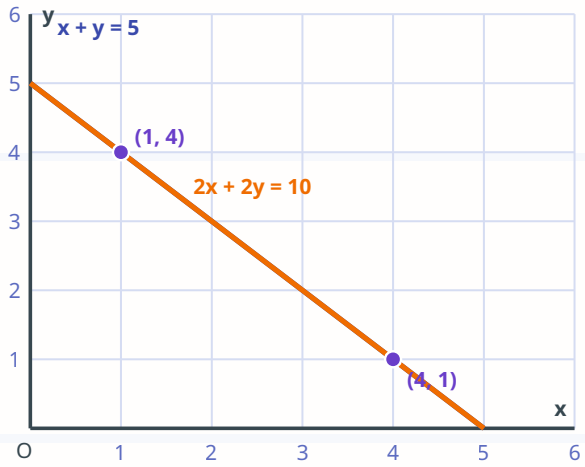
Pictorial. Now draw each equation as a line. A solution of the *pair* must satisfy *both* equations, so it must lie on *both* lines. Two lines on a plane can meet in only three ways — and each way has a different story to tell:



Picture 1 — The lines CROSS once.
One common point (3, 2): exactly **one solution**. The pair is **consistent**.



Picture 2 — The lines are PARALLEL.
They never meet: **no solution**. The pair is **inconsistent** — the two clues contradict each other.



Picture 3 — The lines COINCIDE.
One line drawn twice: **infinitely many solutions**. The pair is consistent and **dependent** — the second clue repeats the first.

The three pictures at a glance

Cross → 1 solution → consistent.
Parallel → 0 solutions → inconsistent.
Coincide → infinitely many → consistent, dependent.

There is no fourth picture. Two straight lines in a plane have no other way to be — Reasoning 3 (Section 12) proves even 'exactly two solutions' is impossible.

Abstract. Pictures are honest but slow. In Section 05 you will learn to read the same three stories directly from the coefficients — and in Section 06 you will *derive* why that reading can never fail.

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Visual Concepts — Reading a Meeting Point

Look again at Picture 1. The blue line x + y = 5 carries all pairs that add to 5. The red line x − y = 1 carries all pairs whose difference is 1. The green point (3, 2) is the **only** point sitting on both lines — 3 + 2 = 5 and 3 − 2 = 1. That is why "solving a pair" and "finding the meeting point" are the same sentence in two languages.

The three pictures — your permanent memory hook

Cross → one solution → the two clues agree on exactly one answer.
Parallel → no solution → the two clues can never be true together.
Coincide → infinitely many solutions → the two clues are really one clue said twice.

Why a graph alone is not enough

A graph is drawn by hand, on squared paper, with a pencil of some thickness. If the true meeting point were (22/5, 8/5) = (4.4, 1.6) — a real CBSE 2023 board question you will meet in the PYQ section — reading it exactly off a drawing is nearly impossible. So we use the graph to **understand**, and algebra (substitution and elimination) to be **exact**. This chapter gives you both.

TOPPER TIP: *In the exam, when a question says 'solve graphically', the drawing IS the answer — draw it carefully, with a table of values and a sharp pencil. When it just says 'solve', reach for algebra.*

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05 Mathematical Foundations

UNDERSTAND — THE PRECISE IDEAS, WORD BY WORD

A **linear equation in two variables** is any equation that can be written as **ax + by + c = 0**, where a, b, c are real numbers and a, b are not both zero. Its graph is always a straight line. A **pair** of such equations, considered together, is:

$$a_1x + b_1y + c_1 = 0 \quad \text{and} \quad a_2x + b_2y + c_2 = 0$$

The four foundation definitions

Solution of the pair: a pair (x, y) that satisfies BOTH equations at the same time — geometrically, a point lying on both lines.
Consistent pair: a pair that has at least one solution (the lines cross, or coincide).
Inconsistent pair: a pair that has no solution at all (the lines are parallel and distinct).
Dependent pair: a consistent pair with infinitely many solutions — the two equations carry the same information (coincident lines).

The Ratio Test — the whole chapter in one table

Compare	Lines	Solutions	Type
$a_1/a_2 \neq b_1/b_2$	Intersecting	Exactly one	Consistent
$a_1/a_2 = b_1/b_2 \neq c_1/c_2$	Parallel	None	Inconsistent
$a_1/a_2 = b_1/b_2 = c_1/c_2$	Coincident	Infinitely many	Consistent, dependent

Warning: the c-values must be read from the form ax + by + c = 0, signs included. 2x + 3y = 7 becomes 2x + 3y − 7 = 0, so c = −7, not 7!

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Foundations — The Three Methods at a Glance

You will solve pairs by three methods. Each is a different road to the same meeting point.

Method 1 — Graphical

For EACH equation: build a table of at least three (x, y) pairs → plot the points → draw the line. The coordinates of the meeting point are the solution. If the lines are parallel, report "no solution"; if they coincide, report "infinitely many solutions".

Method 2 — Substitution

1. From one equation, write one variable in terms of the other (y = ... or x = ...). 2. Substitute this expression into the OTHER equation — now it has one variable only. 3. Solve it. 4. Put the value back into the expression from Step 1 to get the second variable. 5. Verify in both original equations.

Method 3 — Elimination

1. Multiply one or both equations by suitable numbers so that the coefficients of one variable become equal (or opposite). 2. Add or subtract the equations — that variable is eliminated. 3. Solve the resulting one-variable equation. 4. Substitute back into either original equation for the second variable. 5. Verify in both original equations.

TOPPER TIP: *Method choice in one line: a coefficient of 1 or −1 somewhere? Substitute. Coefficients already matching or easy multiples? Eliminate. The question demands a picture? Go graphical.*

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06 Formula Derivations

8D • DERIVE — WHY THE RATIO TEST CAN NEVER FAIL

Most guides order you to memorise the ratio table. We will **earn** it — twice. First from the geometry of slopes, then from pure algebra. After these two pages, you will never be able to forget the table, because you will be able to rebuild it from scratch in an empty room.

Derivation A — The Slope Story

1 Take one line in the form $ax + by + c = 0$, with $b \neq 0$. Shift terms: $by = -ax - c$. Divide by b: **$y = -(a/b)\,x - (c/b)$**.

Why: Every non-vertical line can be written as y = (slope) x + (intercept). Comparing the two forms reads off both numbers at once.

2 So for our line: **slope $m = -a/b$** and **y-intercept $k = -c/b$**. For the pair, $m_1 = -a_1/b_1$, $k_1 = -c_1/b_1$, and similarly m_2, k_2 with subscript 2.

Why: The slope measures steepness and direction; the intercept measures where the line crosses the y-axis. Two numbers completely describe a line's position.

3 Two lines **intersect** exactly when they point in different directions — that is, when $m_1 \neq m_2$. Now $m_1 \neq m_2$ means $a_1/b_1 \neq a_2/b_2$; cross-multiplying gives $a_1b_2 \neq a_2b_1$, which is the same as **$a_1/a_2 \neq b_1/b_2$**.

Why: Cross-multiplication is just multiplying both sides by b_1b_2 — legal, and it turns the slope condition into the ratio condition. This is the first row of the table, derived.

4 Two lines are **parallel** exactly when $m_1 = m_2$ but $k_1 \neq k_2$ (same direction, different heights — they can never meet). $m_1 = m_2$ gives $a_1/a_2 = b_1/b_2$; and $k_1 \neq k_2$ means $c_1/b_1 \neq c_2/b_2$, i.e. $c_1/c_2 \neq b_1/b_2$. Together: **$a_1/a_2 = b_1/b_2 \neq c_1/c_2$**.

Why: Second row of the table, derived. Parallel is 'same slope, shifted up or down'.

5 Two lines **coincide** exactly when $m_1 = m_2$ AND $k_1 = k_2$ — same direction, same height, same line. That gives **$a_1/a_2 = b_1/b_2 = c_1/c_2$**.

Why: Third row, derived. (Vertical lines, where b = 0, obey the same ratio rules — the algebra of Derivation B covers every case without exception.)

DERIVED: Intersecting ⇔ $a_1/a_2 \neq b_1/b_2$ | Parallel ⇔ $a_1/a_2 = b_1/b_2 \neq c_1/c_2$ | Coincident ⇔ all three ratios equal.

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Derivation B — The Algebra Story (Where Elimination is Born)

Now forget pictures. Start with the pair in the form $a_1x + b_1y = c_1$ and $a_2x + b_2y = c_2$, and try to force y to disappear.

1. Multiply the first equation by b_2: $a_1b_2\,x + b_1b_2\,y = c_1b_2$ ...(i)
   Why: Multiplying every term of an equation by the same non-zero number never changes its solutions — the line stays the same line. We choose b_2 to make the y-coefficients match.

2. Multiply the second equation by b_1: $a_2b_1\,x + b_1b_2\,y = c_2b_1$ ...(ii)
   Why: Now both equations carry the identical y-term $b_1b_2\,y$ — the trap is set.

3. Subtract (ii) from (i). The y-terms cancel exactly, leaving ONE equation in x alone: $\mathbf{(a_1b_2 - a_2b_1)\,x = c_1b_2 - c_2b_1}$.
   Why: This is the elimination method itself, written in general letters! Every elimination you will ever do is this step with numbers instead of letters.

4. Case 1: if $a_1b_2 - a_2b_1 \neq 0$, we can divide and get exactly ONE value of x (and then exactly one y). Note $a_1b_2 \neq a_2b_1$ is precisely $a_1/a_2 \neq b_1/b_2$.
   Why: Unique solution ⇔ the first row of the ratio table — derived a second time, with no geometry at all.

5. Case 2: if $a_1b_2 - a_2b_1 = 0$ but $c_1b_2 - c_2b_1 \neq 0$, the equation becomes $0 \cdot x =$ (a non-zero number) — impossible for every x. No solution; the pair is inconsistent, and the ratios say $a_1/a_2 = b_1/b_2 \neq c_1/c_2$.
   Why: 0 = 5 is a false statement no x can rescue — that is exactly what 'parallel' means in algebra.

6. Case 3: if BOTH quantities are 0, the equation becomes $0 \cdot x = 0$ — true for every x. Infinitely many solutions; the ratios are all equal.
   Why: 0 = 0 gives no information — the second equation was the first one in disguise all along.

DERIVED: The ratio table is not a rule to memorise — it is the three possible fates of one subtraction.

TOPPER TIP: *Forgot the table in the exam hall? Redo Derivation B with letters on your rough sheet — thirty seconds, and the whole table is back.*

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07 Detailed Solved Examples

8D • SOLVE — NCERT CHAPTER EXAMPLES & EXERCISES 3.1–3.3, EVERY STEP SHOWN

This is the heart of the chapter: the complete NCERT set for the rationalised textbook — the chapter's own representation examples, then **Exercise 3.1** (graphical method and the ratio test), **Exercise 3.2** (substitution) and **Exercise 3.3** (elimination). Every solution shows each step in order, with the reason for the step. For graphical questions you always get the **table of values first, then the graph** — exactly as the examiner wants to see it.

How NCERT builds this chapter

Chapter Examples: three real situations (ages, sports equipment, fruit prices) are first written as pairs of equations and drawn — algebra and geometry side by side.
Exercise 3.1: solve graphically; judge pairs by comparing ratios.
Exercise 3.2: the substitution method, including six story problems.
Exercise 3.3: the elimination method, including five story problems.

PIN POINT

One pair, three fates. Before solving anything, glance at the ratios: a_1/a_2 vs b_1/b_2. Different → one answer exists. Equal → check c_1/c_2 to separate 'never' from 'always'.

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NCERT Chapter Example 1 — Aftab and His Daughter (Ages)

EXAMPLE 1

Aftab tells his daughter: "Seven years ago, I was seven times as old as you were then. Also, three years from now, I shall be three times as old as you will be." Represent this situation algebraically and graphically.

THINK FIRST: Two unknown present ages. Each sentence about the past/future becomes one equation. Then each equation becomes one line.

1. Let Aftab's present age be x years and his daughter's present age be y years.
Why: Always declare your letters with units — the examiner reads this line first.

2. Seven years ago: Aftab was (x − 7) and his daughter was (y − 7). The first sentence says x − 7 = 7(y − 7). Expand: x − 7 = 7y − 49, so **x − 7y = −42** ...(1).
Why: 'Seven times as old as you were THEN' — both ages must travel back 7 years. Forgetting to subtract from the daughter's age is the classic slip here.

3. Three years from now: Aftab will be (x + 3) and his daughter (y + 3). The second sentence says x + 3 = 3(y + 3). Expand: x + 3 = 3y + 9, so **x − 3y = 6** ...(2).
Why: Same care in the future direction: both ages gain 3 years.

4. Build a table for (1): x = 7y − 42. Taking y = 6, 7, 12 gives x = 0, 7, 42 — points (0, 6), (7, 7), (42, 12).
Why: Choose y-values that make x a whole number — plotting stays clean.

5. Build a table for (2): x = 3y + 6. Taking y = 0, 4, 12 gives x = 6, 18, 42 — points (6, 0), (18, 4), (42, 12).
Why: Notice (42, 12) appearing in BOTH tables — the meeting point is announcing itself.

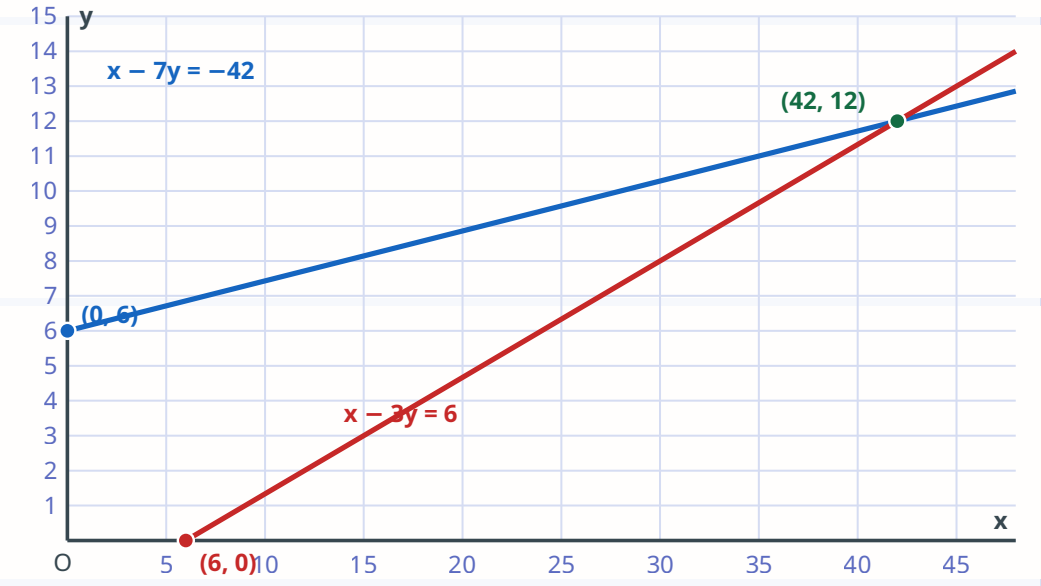
6. Plot both lines (graph below). They intersect at exactly one point: **(42, 12)**.
Why: One crossing point = one pair of ages that fits both sentences.

7. Check: 7 years ago they were 35 and 5, and 35 = 7 × 5. Three years from now they will be 45 and 15, and 45 = 3 × 15.
Why: Verifying against the STORY (not just the equations) catches modelling errors, not only arithmetic errors.

ANSWER: Aftab is 42 years old and his daughter is 12 years old. Algebraically: x − 7y = −42 and x − 3y = 6; graphically the two lines meet at (42, 12).

CBSE-STYLE MARKING SCHEME: 1 mark for the two correct equations • 1 mark for the two tables of values • 1 mark for the graph and the meeting point (3 marks).

NCERT Chapter Example 1 — The Graph



The two age-lines meet only at (42, 12) — one father, one daughter, one answer.

Read the graph like an examiner

The blue line carries every (present age of Aftab, present age of daughter) pair satisfying the 'seven years ago' sentence; the red line carries the 'three years hence' sentence. Their crossing point (42, 12) is the ONLY pair of ages satisfying both sentences at once — that is what 'solving a pair' means, drawn.

TOPPER TIP: *On graph paper, always mark the meeting point with a dot and label its coordinates — an unlabelled crossing earns no mark for the answer.*

NCERT Chapter Example 2 — The Cricket Coach (Representation)

EXAMPLE 2

The coach of a cricket team buys 3 bats and 6 balls for ₹3900. Later, she buys another bat and 3 more balls of the same kind for ₹1300. Represent this situation algebraically and geometrically.

THINK FIRST: Two unknown prices again — but watch the ending: this pair teaches that a graph can also reveal a 'strange' answer.

1. Let one bat cost ₹x and one ball cost ₹y. First purchase: **3x + 6y = 3900** ...(1). Second purchase: **x + 3y = 1300** ...(2).
   Why: Each purchase is one balance: items on the left, money on the right.
2. Table for (1): y = (3900 − 3x)/6. Taking x = 0, 300, 500 gives y = 650, 500, 400 — points (0, 650), (300, 500), (500, 400).
3. Table for (2): y = (1300 − x)/3. Taking x = 100, 400, 1300 gives y = 400, 300, 0 — points (100, 400), (400, 300), (1300, 0).
4. Plot both lines (graph below). They meet at **(1300, 0)** — on the x-axis itself.
   Why: Mathematically the pair is consistent with the single solution x = 1300, y = 0.
5. Read the meaning honestly: the 'solution' says a ball costs ₹0, which no shop allows. NCERT uses this example to show that a pair of equations always has a graphical story — but a real-life answer must also make real-life sense.
   Why: A model is a mirror of the story, not the story itself. When the mirror shows nonsense, the data itself was artificial — a lesson every modeller must learn.

ANSWER: Algebraically: 3x + 6y = 3900 and x + 3y = 1300. Geometrically the lines meet at (1300, 0).

CBSE-STYLE MARKING SCHEME: 1 mark for the two equations • 1 mark for tables • 1 mark for the graph (3 marks).

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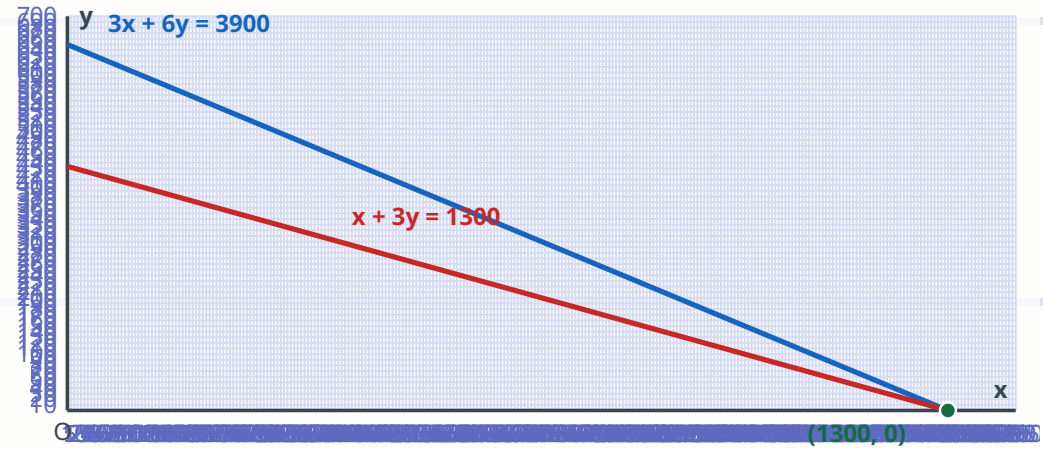
NCERT Chapter Example 2 — The Graph



The two purchase-lines meet at (1300, 0) — on the x-axis itself.

When the graph 'lies' politely

The mathematics is flawless: the lines DO meet at (1300, 0). The story is what protests — a ball cannot cost ₹0. NCERT's lesson: always ask whether a mathematical answer is also a sensible answer. In board word problems the data is honest, but your own modelling errors can produce the same kind of nonsense — the sense-check is your alarm bell.

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NCERT Chapter Example 3 — Apples and Grapes (Parallel Lines)

EXAMPLE 3

The cost of 2 kg of apples and 1 kg of grapes on a day was found to be ₹160. After a month, the cost of 4 kg of apples and 2 kg of grapes is ₹300. Represent the situation algebraically and geometrically.

THINK FIRST: The second bill looks like double the first — 4 kg and 2 kg — but the money is NOT double (₹300 ≠ ₹320). Prices changed during the month! The graph should expose the contradiction.

1. Let apples cost ₹x per kg and grapes ₹y per kg. Day one: **2x + y = 160** ...(1). After a month: **4x + 2y = 300** ...(2).

2. Divide (2) throughout by 2: **2x + y = 150** ...(2′). Now compare (1) and (2′): identical left sides, different right sides.
Why: Simplifying an equation before comparing is legal and often reveals the secret immediately.

3. Table for (1): y = 160 − 2x. Taking x = 0, 40, 80 gives y = 160, 80, 0. Table for (2′): y = 150 − 2x. Taking x = 0, 50, 75 gives y = 150, 50, 0.

4. Plot both lines (graph below): they are **parallel** — they never meet.
Why: Same left side means same slope (both fall by 2 for every 1 step right); different constants keep them apart forever.

5. Ratio check: a_1/a_2 = 4/2... using (1) and (2) directly: 2/4 = 1/2, 1/2, and 160/300 = 8/15. Since $a_1/a_2 = b_1/b_2 \neq$ c-ratio, the pair is **inconsistent** — no single pair of prices can satisfy both days, exactly because prices changed.
Why: The ratio test and the picture agree — they always do. That agreement is what Section 06 proved.

ANSWER: Algebraically: 2x + y = 160 and 4x + 2y = 300. Geometrically the lines are parallel — the pair has no solution (inconsistent).

CBSE-STYLE MARKING SCHEME: 1 mark for the equations • 1 mark for tables • 1 mark for the parallel graph and conclusion (3 marks).

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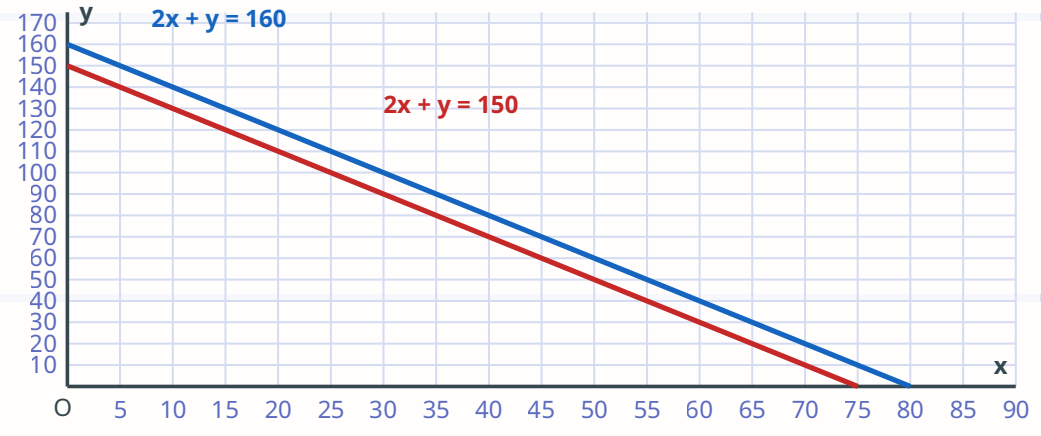
NCERT Chapter Example 3 — The Graph



Two parallel price-lines: the two days can never agree on one pair of prices.

Parallel lines are information, not failure

A pair with no solution is the mathematics RAISING ITS HAND: 'your two clues cannot describe one fixed situation.' Here it detected that prices changed during the month. Whenever your equations turn out parallel in a word problem, re-read the story — something in it changed, or something in your translation did.

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Exercise 3.1 Q1(i) — The Mathematics Quiz (Graphical)

EXERCISE 3.1 • Q1(i)

Form the pair of linear equations and find the solution graphically: 10 students of Class X took part in a Mathematics quiz. If the number of girls is 4 more than the number of boys, find the number of boys and girls who took part in the quiz.

THINK FIRST: Total students give one equation; '4 more girls than boys' gives the second. Then draw both lines.

1. Let the number of boys be x and the number of girls be y. Total: **x + y = 10** ...(1). Girls are 4 more than boys: **y = x + 4**, i.e. **−x + y = 4** ...(2).
   Why: Translate each sentence separately — one sentence, one equation. Never try to swallow a whole problem in one gulp.
2. Table for (1): y = 10 − x. x = 0, 3, 10 gives y = 10, 7, 0 — points (0, 10), (3, 7), (10, 0).
3. Table for (2): y = x + 4. x = 0, 3, 6 gives y = 4, 7, 10 — points (0, 4), (3, 7), (6, 10).
   Why: The point (3, 7) sits in both tables — expect it on both lines.
4. Plot the two lines (graph below). They intersect at **(3, 7)**.
5. Read off: x = 3 boys, y = 7 girls. Check: 3 + 7 = 10 and 7 = 3 + 4.
   Why: The graphical answer must be stated in the words of the question — 'boys' and 'girls', not just x and y.

ANSWER: 3 boys and 7 girls took part in the quiz.

CBSE-STYLE MARKING SCHEME: 1 mark for forming the equations • 1 mark for tables • 1 mark for graph and answer (3 marks).

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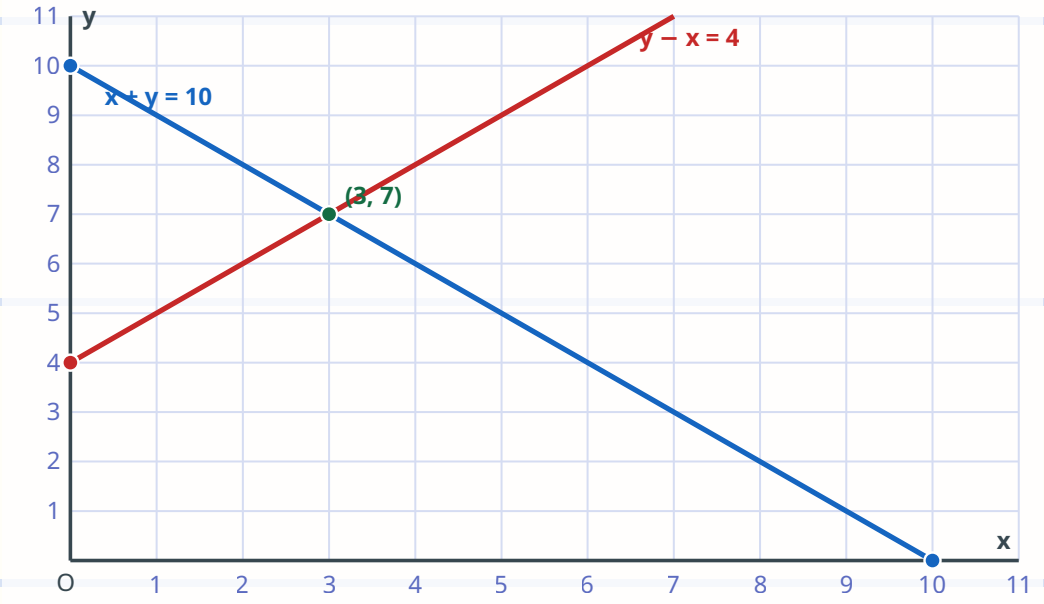
Exercise 3.1 Q1(i) — The Graph



x + y = 10 (blue) and y − x = 4 (red) cross at (3, 7): 3 boys, 7 girls.

PIN POINT

Table first, graph second, answer third. In graphical questions the examiner's marks are split exactly in that order — a beautiful graph with no table still loses its first mark.

Exercise 3.1 Q1(ii) — Pencils and Pens (Graphical)

EXERCISE 3.1 • Q1(ii)

Form the pair of linear equations and find the solution graphically: 5 pencils and 7 pens together cost ₹50, whereas 7 pencils and 5 pens together cost ₹46. Find the cost of one pencil and one pen.

THINK FIRST: Prices are the unknowns. Each shopping combination is one equation. The numbers 5 and 7 swap places between the two bills — a pattern worth noticing.

1. Let one pencil cost ₹x and one pen cost ₹y. First bill: **5x + 7y = 50** ...(1). Second bill: **7x + 5y = 46** ...(2).
2. Table for (1): y = (50 − 5x)/7. x = 10, 3, −4 gives y = 0, 5, 10 — points (10, 0), (3, 5), (−4, 10). *Why: Choose x-values that make the division exact. A negative x is useless as a price but perfectly legal as a point on the line — the line does not stop where the story stops.*
3. Table for (2): y = (46 − 7x)/5. x = 3, 8, −2 gives y = 5, −2, 12 — points (3, 5), (8, −2), (−2, 12).
4. Plot both lines (graph below). They intersect at **(3, 5)**.
5. So one pencil costs ₹3 and one pen costs ₹5. Check: 5(3) + 7(5) = 15 + 35 = 50; 7(3) + 5(5) = 21 + 25 = 46.

ANSWER: One pencil costs ₹3 and one pen costs ₹5.

CBSE-STYLE MARKING SCHEME: 1 mark for the equations • 1 mark for tables • 1 mark for graph and answer (3 marks).



Exercise 3.1 Q2 — Intersecting, Parallel or Coincident?

EXERCISE 3.1 • Q2

On comparing the ratios a_1/a_2, b_1/b_2 and c_1/c_2, find out whether the lines representing the following pairs of linear equations intersect at a point, are parallel or coincident: (i) $5x - 4y + 8 = 0$, $7x + 6y - 9 = 0$ (ii) $9x + 3y + 12 = 0$, $18x + 6y + 24 = 0$ (iii) $6x - 3y + 10 = 0$, $2x - y + 9 = 0$.

THINK FIRST: No solving, no drawing — just read the three ratios for each pair and let the table from Section 05 speak.

1. (i) Read the coefficients: $a_1 = 5$, $b_1 = -4$, $c_1 = 8$; $a_2 = 7$, $b_2 = 6$, $c_2 = -9$. Ratios: $a_1/a_2 = 5/7$ and $b_1/b_2 = -4/6 = -2/3$.
   Why: Write both equations in the form $ax + by + c = 0$ FIRST, and copy the signs with the numbers — b_1 is -4, not 4.

2. Since $5/7 \neq -2/3$, i.e. $a_1/a_2 \neq b_1/b_2$, the lines **intersect at exactly one point**. (The c-ratio is not even needed.)
   Why: The moment the first two ratios differ, the verdict is 'intersecting' — stop there and save time.

3. (ii) $a_1 = 9$, $b_1 = 3$, $c_1 = 12$; $a_2 = 18$, $b_2 = 6$, $c_2 = 24$. Ratios: $9/18 = 1/2$, $3/6 = 1/2$, $12/24 = 1/2$.
   Why: Every coefficient of the second equation is exactly double the first — expect coincidence.

4. All three ratios are equal, so the lines are **coincident**.

5. (iii) $a_1 = 6$, $b_1 = -3$, $c_1 = 10$; $a_2 = 2$, $b_2 = -1$, $c_2 = 9$. Ratios: $6/2 = 3$, $-3/-1 = 3$, $10/9$. So $a_1/a_2 = b_1/b_2 = 3 \neq 10/9 = c_1/c_2$.
   Why: $-3/-1 = +3$ — two negatives make a positive. Sign slips in this step are the number-one cause of wrong verdicts in Q2-type questions.

6. First two ratios equal but the c-ratio different → the lines are **parallel**.

ANSWER: (i) Intersecting at a point (ii) Coincident (iii) Parallel.

CBSE-STYLE MARKING SCHEME: 1 mark per part: ½ for the correct ratios, ½ for the correct conclusion (3 marks).

PIN POINT

The ratio test is a 20-second question. $a_1/a_2 \neq b_1/b_2$ → intersecting. First two equal → compare with c_1/c_2: equal → coincident, not equal → parallel.

Exercise 3.1 Q3 — Consistent or Inconsistent?

EXERCISE 3.1 • Q3

On comparing the ratios, find out whether the following pairs of linear equations are consistent or inconsistent: (i) 3x + 2y = 5; 2x − 3y = 7 (ii) 2x − 3y = 8; 4x − 6y = 9 (iii) (3/2)x + (5/3)y = 7; 9x − 10y = 14 (iv) 5x − 3y = 11; −10x + 6y = −22 (v) (4/3)x + 2y = 8; 2x + 3y = 12.

THINK FIRST: 'Consistent' only asks: does at least one solution exist? Intersecting AND coincident pairs are both consistent; only the parallel pair is inconsistent. Convert each equation to ax + by + c = 0 form mentally as you read the ratios.

1. (i) $a_1/a_2 = 3/2$; $b_1/b_2 = 2/-3 = -2/3$. Not equal → intersecting → **consistent** (unique solution).

2. (ii) $a_1/a_2 = 2/4 = 1/2$; $b_1/b_2 = -3/-6 = 1/2$; $c_1/c_2 = -8/-9 = 8/9$. First two equal, third different → parallel → **inconsistent**.
Why: The second equation is 'almost' double the first — 2×(2x − 3y) = 4x − 6y would need 16 on the right, not 9. Almost-double is the parallel trap.

3. (iii) $a_1/a_2 = (3/2)/9 = 1/6$; $b_1/b_2 = (5/3)/-10 = -1/6$. Not equal → intersecting → **consistent**.
Why: With fractions, divide carefully: (3/2) ÷ 9 = 3/18 = 1/6.

4. (iv) $a_1/a_2 = 5/-10 = -1/2$; $b_1/b_2 = -3/6 = -1/2$; $c_1/c_2 = -11/22 = -1/2$. All equal → coincident → **consistent** (infinitely many solutions).
Why: The second equation is exactly −2 times the first — same line, new costume.

5. (v) $a_1/a_2 = (4/3)/2 = 2/3$; $b_1/b_2 = 2/3$; $c_1/c_2 = -8/-12 = 2/3$. All equal → coincident → **consistent** (infinitely many solutions).
Why: Multiply the first equation by 3/2 and you get the second exactly — spotting the multiple is the fastest ratio test of all.

ANSWER: (i) Consistent (ii) Inconsistent (iii) Consistent (iv) Consistent (v) Consistent.

CBSE-STYLE MARKING SCHEME: ½ mark per part for ratios and ½ for the verdict (5 parts).

Exercise 3.1 Q4 — Consistent? If Yes, Solve Graphically

EXERCISE 3.1 • Q4

Which of the following pairs of linear equations are consistent/inconsistent? If consistent, obtain the solution graphically: (i) x + y = 5, 2x + 2y = 10 (ii) x − y = 8, 3x − 3y = 16 (iii) 2x + y − 6 = 0, 4x − 2y − 4 = 0 (iv) 2x − 2y − 2 = 0, 4x − 4y − 5 = 0.

THINK FIRST: Run the ratio test on all four first. Only the consistent ones earn a graph.

1. (i) Ratios: 1/2, 1/2, −5/−10 = 1/2 — all equal → coincident → **consistent**, infinitely many solutions.

2. (i) Graph: both equations draw the SAME line x + y = 5 (left graph below). Every point of the line is a solution: (0, 5), (1, 4), (2, 3), (3, 2), (4, 1), (5, 0), ...
Why: For a coincident pair, 'the solution' is the whole line — listing a few of its points is the correct way to answer.

3. (ii) Ratios: 1/3, −1/−3 = 1/3, −8/−16 = 1/2. First two equal, third different → parallel → **inconsistent**. No graph needed.
Why: 3x(x − y) would give 24, not 16 — the second equation contradicts the first.

4. (iii) Ratios: 2/4 = 1/2, 1/−2 = −1/2. Not equal → intersecting → **consistent** with a unique solution.

5. (iii) Tables: for 2x + y = 6: x = 0, 2, 3 gives y = 6, 2, 0. For 4x − 2y = 4, i.e. 2x − y = 2: x = 0, 2, 3 gives y = −2, 2, 4. The lines (right graph below) meet at **(2, 2)**.
Why: Check (2, 2): 2(2) + 2 = 6 and 4(2) − 2(2) = 4.

6. (iv) Ratios: 2/4 = 1/2, −2/−4 = 1/2, −2/−5 = 2/5. First two equal, third different → parallel → **inconsistent**.

ANSWER: (i) Consistent — infinitely many solutions, e.g. (1, 4), (2, 3), (3, 2) (ii) Inconsistent (iii) Consistent — x = 2, y = 2 (iv) Inconsistent.

CBSE-STYLE MARKING SCHEME: 1 mark per part (ratio verdict; plus graph where consistent).

Exercise 3.1 Q5 — The Rectangular Garden (Graphical)

EXERCISE 3.1 • Q5

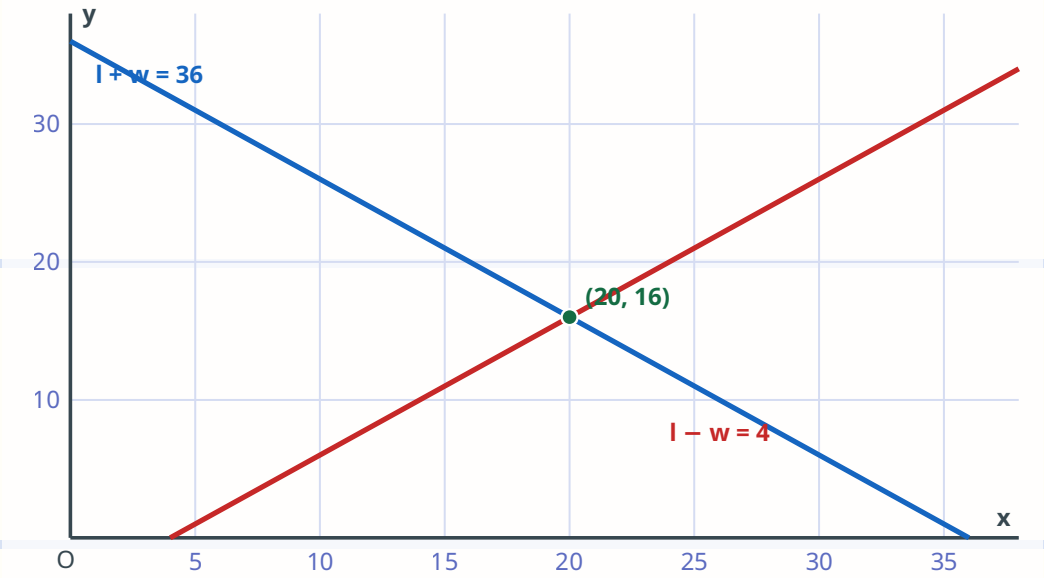
Half the perimeter of a rectangular garden, whose length is 4 m more than its width, is 36 m. Find the dimensions of the garden (graphically).

THINK FIRST: 'Half the perimeter' of a rectangle is simply length + width. The story hands you both equations in one breath.

1. Let the length be l m and the width be w m. Length is 4 more than width: **l = w + 4**, i.e. l − w = 4 ...(1). Half perimeter: **l + w = 36** ...(2).
   Why: For a rectangle, perimeter = 2(l + w), so half the perimeter is l + w — a fact worth remembering for every garden/field problem.
2. Table for (2): w = 36 − l. l = 0, 20, 36 gives w = 36, 16, 0 — points (0, 36), (20, 16), (36, 0).
   Why: Here x-axis carries l and y-axis carries w.
3. Table for (1): w = l − 4. l = 4, 20, 36 gives w = 0, 16, 32 — points (4, 0), (20, 16), (36, 32).
4. Plot both lines (graph below): they meet at **(20, 16)**.
5. So length = 20 m and width = 16 m. Check: 20 = 16 + 4 and half perimeter = 20 + 16 = 36 m.

ANSWER: The garden is 20 m long and 16 m wide.

CBSE-STYLE MARKING SCHEME: 1 mark for the equations • 1 mark for tables • 1 mark for graph and dimensions (3 marks).



Exercise 3.1 Q6 — Inventing a Partner Equation

EXERCISE 3.1 • Q6

Given the linear equation 2x + 3y − 8 = 0, write another linear equation in two variables such that the geometrical representation of the pair so formed is: (i) intersecting lines (ii) parallel lines (iii) coincident lines.

THINK FIRST: This time YOU choose the second equation — the ratio test tells you exactly what freedom you have in each case.

1. The given line has $a_1 = 2$, $b_1 = 3$, $c_1 = -8$. Let your invented equation be $a_2x + b_2y + c_2 = 0$.

2. (i) Intersecting needs $a_1/a_2 \neq b_1/b_2$. Choose $a_2 = 1$, $b_2 = 1$: then $2/1 \neq 3/1$. Answer (one of many): **x + y − 4 = 0**.
Why: Any equation whose x:y coefficient pattern is NOT 2:3 will cross the given line.

3. (ii) Parallel needs $a_1/a_2 = b_1/b_2 \neq c_1/c_2$. Keep the 2:3 pattern but change the constant: **2x + 3y − 5 = 0**. Check: $2/2 = 3/3 = 1 \neq -8/-5$.
Why: Same left side, different constant — the simplest parallel partner of all.

4. (iii) Coincident needs all three ratios equal. Multiply the given equation by 2: **4x + 6y − 16 = 0**. Check: $2/4 = 3/6 = -8/-16 = 1/2$.
Why: Any non-zero multiple of the given equation draws the same line.

ANSWER: (i) x + y − 4 = 0 (many answers possible) (ii) 2x + 3y − 5 = 0 (iii) 4x + 6y − 16 = 0.

CBSE-STYLE MARKING SCHEME: 1 mark per part, with the ratio condition stated (3 marks).

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Exercise 3.1 Q7 — The Triangle on the x-axis

EXERCISE 3.1 • Q7

Draw the graphs of the equations x − y + 1 = 0 and 3x + 2y − 12 = 0. Determine the coordinates of the vertices of the triangle formed by these lines and the x-axis, and shade the triangular region.

THINK FIRST: A triangle needs three vertices: the two points where the lines cut the x-axis, and the point where the lines cut each other.

1. Table for x − y + 1 = 0, i.e. y = x + 1: x = −1, 0, 2 gives y = 0, 1, 3 — points (−1, 0), (0, 1), (2, 3).

2. Table for 3x + 2y − 12 = 0, i.e. y = (12 − 3x)/2: x = 0, 2, 4 gives y = 6, 3, 0 — points (0, 6), (2, 3), (4, 0).
Why: The shared point (2, 3) appears in both tables again — it must be the top vertex.

3. Vertex 1 — first line meets the x-axis where y = 0: from its table, **(−1, 0)**. Vertex 2 — second line meets the x-axis where y = 0: **(4, 0)**. Vertex 3 — the lines meet each other at **(2, 3)**.
Why: On the x-axis, y is always 0 — that single fact finds two of the three vertices.

4. Draw both lines, mark the three vertices and shade the triangle they form with the x-axis (graph below).
Why: Optional check: base = 5 units (from −1 to 4), height = 3, so area = ½ × 5 × 3 = 7.5 sq. units.

ANSWER: Vertices of the triangle: (−1, 0), (4, 0) and (2, 3).

CBSE-STYLE MARKING SCHEME: 1 mark for the two tables • 1 mark for the graph • 1 mark for the vertices and shading (3 marks).

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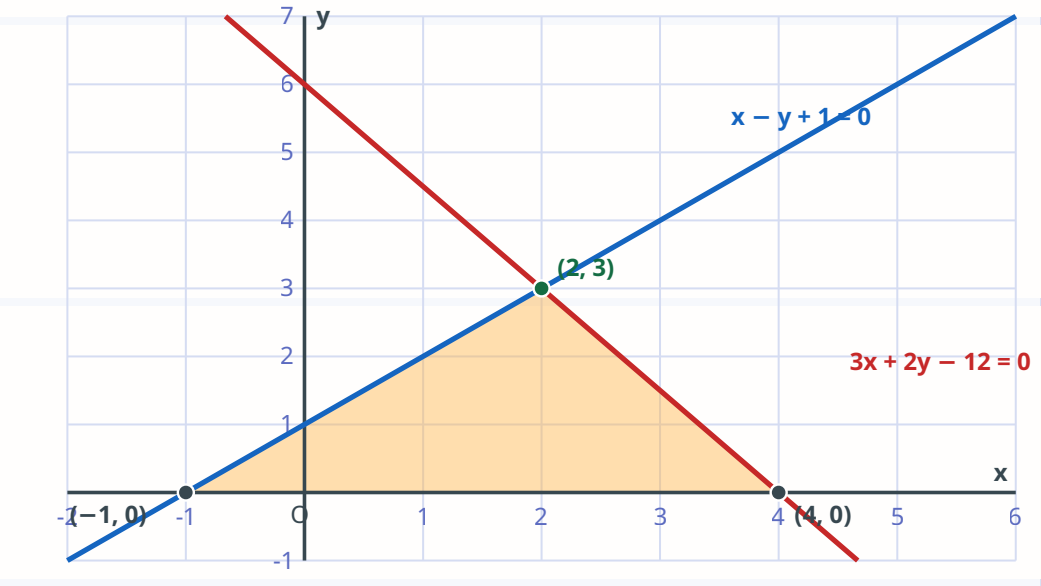
Exercise 3.1 Q7 — The Graph and the Shaded Triangle



Vertices: (−1, 0), (4, 0) and (2, 3). The shaded triangle has base 5 units and height 3 units — area 7.5 sq. units.

TOPPER TIP: *Shade with light, even strokes and outline the triangle firmly — in the board exam the shading itself carries the final mark of this question.*

Exercise 3.2 Q1 (i)–(iii) — Substitution Method

EXERCISE 3.2 • Q1(i)

Solve by the substitution method: x + y = 14; x − y = 4.

THINK FIRST: The coefficient of y in the first equation is 1 — y is begging to be isolated.

1. From (1): **y = 14 − x** ...(3).
   Why: Step 1 of substitution: express ONE variable through the other, choosing the equation where this is cheapest.
2. Substitute (3) into (2): x − (14 − x) = 4, so x − 14 + x = 4, giving 2x = 18.
   Why: The brackets matter: minus a bracket flips every sign inside — −(14 − x) = −14 + x.
3. Solve: **x = 9**.
4. Put x = 9 in (3): y = 14 − 9 = **5**.
   Why: Use the SIMPLE expression (3) for the back-substitution, not a complicated original.
5. Verify: 9 + 5 = 14 and 9 − 5 = 4.

ANSWER: x = 9, y = 5.

CBSE-STYLE MARKING SCHEME: ½ mark for expressing y • 1 mark for the one-variable equation and x • ½ mark for y (2 marks).

PIN POINT

Substitution cue: reach for substitution when some variable stands with coefficient 1 or −1 — it can be isolated without fractions.

EXERCISE 3.2 • Q1(ii)

Solve by the substitution method: s − t = 3; s/3 + t/2 = 6.

THINK FIRST: Isolate s from the first equation (coefficient 1), then clear the fractions in the second by multiplying through by 6.

1. From (1): **s = t + 3** ...(3).
2. Substitute (3) into (2): (t + 3)/3 + t/2 = 6. Multiply every term by 6 (the LCM of 3 and 2): 2(t + 3) + 3t = 36.
   Why: Multiplying an equation by the LCM of the denominators deletes all fractions in one move — do it BEFORE substituting if you prefer; the order is your choice.
3. Expand and solve: 2t + 6 + 3t = 36 → 5t = 30 → **t = 6**.
4.

Exercise 3.2 Q1 (iii)–(iv) — When Substitution Reveals a Secret

EXERCISE 3.2 • Q1(iii)

Solve by the substitution method: 3x − y = 3; 9x − 3y = 9.

THINK FIRST: Isolate y from the first equation. Then watch carefully — something unusual is about to happen, and it is the most instructive moment of this exercise.

1. From (1): **y = 3x − 3** ...(3).
2. Substitute (3) into (2): 9x − 3(3x − 3) = 9. Expand: 9x − 9x + 9 = 9.
3. The x-terms cancel completely and we are left with **9 = 9** — a statement that is ALWAYS true, whatever x may be.
   Why: When substitution ends in an identity like 9 = 9, the second equation gave no new information: indeed 9x − 3y = 9 is exactly 3 × (3x − y = 3). The two 'equations' are one equation wearing two coats.
4. So the pair has **infinitely many solutions**: every pair (x, 3x − 3) works — for example (0, −3), (1, 0), (2, 3), (3, 6)...
   Why: Geometrically the two lines coincide — ratio check: 3/9 = −1/−3 = −3/−9 = 1/3, all equal, exactly as Section 05 promised.

ANSWER: Infinitely many solutions: all pairs (x, y) with y = 3x − 3.

CBSE-STYLE MARKING SCHEME: 1 mark for the substitution • 1 mark for recognising the identity and concluding infinitely many solutions (2 marks).

EXERCISE 3.2 • Q1(iv)

Solve by the substitution method: 0.2x + 0.3y = 1.3; 0.4x + 0.5y = 2.3.

THINK FIRST: Decimals are fractions in disguise. Multiply both equations by 10 first and the problem becomes whole-number friendly.

1. Multiply (1) and (2) by 10: **2x + 3y = 13** ...(1′) and **4x + 5y = 23** ...(2′).
   Why: Scaling an equation by 10 changes nothing about its solutions — but it changes everything about your comfort.
2. From (1′): 3y = 13 − 2x, so **y = (13 − 2x)/3** ...(3).
3. Substitute (3) into (2′): 4x + 5(13 − 2x)/3 = 23. Multiply by 3: 12x + 65 − 10x = 69, so 2x = 4 and **x = 2**.
4.

Exercise 3.2 Q1 (v)–(vi) — Surds and Fractions

EXERCISE 3.2 • Q1(v)

Solve by the substitution method: √2 x + √3 y = 0; √3 x − √8 y = 0.

THINK FIRST: Do not fear the surds — √2, √3, √8 are just numbers. Treat them as coefficients and walk the same road. (Recall √8 = 2√2.)

1. From (1): √3 y = −√2 x, so **y = −√2 x/√3** ...(3).

2. Substitute (3) into (2): √3 x − √8 · (−√2 x/√3) = 0. The minus signs cancel: √3 x + (√16/√3) x = 0, since √8 × √2 = √16 = 4. So √3 x + 4x/√3 = 0.
Why: √8 · √2 = √(8 × 2) = √16 = 4 — surds multiply inside one root. This is the only 'new' skill in the question.

3. Multiply by √3: 3x + 4x = 0, so 7x = 0 and **x = 0**.

4. Put x = 0 in (3): **y = 0**. Verify: √2(0) + √3(0) = 0; √3(0) − √8(0) = 0.
Why: Both lines pass through the origin with different slopes — they can meet only at (0, 0). The algebra agrees with the picture.

ANSWER: x = 0, y = 0.

CBSE-STYLE MARKING SCHEME: 1 mark for the substitution with correct surd handling • 1 mark for x = 0, y = 0 (2 marks).

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Exercise 3.2 Q1 (vi) — Fractions, Cleared First

EXERCISE 3.2 • Q1(vi)

Solve by the substitution method: 3x/2 − 5y/3 = −2; x/3 + y/2 = 13/6.

THINK FIRST: Two fraction-heavy equations. Multiply each by 6 — the LCM of 2, 3 and 6 — before doing anything else.

1. (1) × 6: **9x − 10y = −12** …(1′). (2) × 6: **2x + 3y = 13** …(2′).
   Why: Check the multiplication term by term: (3x/2)×6 = 9x; (−5y/3)×6 = −10y; −2×6 = −12. One missed term is the classic error here.
2. From (2′): **x = (13 − 3y)/2** …(3).
3. Substitute (3) into (1′): 9(13 − 3y)/2 − 10y = −12. Multiply by 2: 117 − 27y − 20y = −24, so −47y = −141 and **y = 3**.
4. Put y = 3 in (3): x = (13 − 9)/2 = **2**. Verify: 3(2)/2 − 5(3)/3 = 3 − 5 = −2; 2/3 + 3/2 = 4/6 + 9/6 = 13/6.

ANSWER: x = 2, y = 3.

CBSE-STYLE MARKING SCHEME: ½ mark for clearing fractions • 1 mark for substitution and y • ½ mark for x (2 marks).

Exercise 3.2 Q2 — Solve, Then Find m

EXERCISE 3.2 • Q2

Solve 2x + 3y = 11 and 2x − 4y = −24, and hence find the value of m for which y = mx + 3.

THINK FIRST: The word 'hence' is an instruction: first solve the pair, then feed the solution into the line y = mx + 3, which must pass through that very point.

1. From (1): **x = (11 − 3y)/2** ...(3).
Why: Substitution is the named method of this exercise — use it even if elimination looks tempting.

2. Substitute (3) into (2): (11 − 3y) − 4y = −24, because 2x = 11 − 3y. So 11 − 7y = −24, giving 7y = 35 and **y = 5**.
Why: Substituting 2x as a block (instead of x) halves the fraction work — watch for such gifts whenever a coefficient repeats.

3. Put y = 5 in (3): x = (11 − 15)/2 = **−2**. Verify: 2(−2) + 3(5) = −4 + 15 = 11; 2(−2) − 4(5) = −4 − 20 = −24.

4. Now use the solution in y = mx + 3: the point (−2, 5) lies on this line, so 5 = m(−2) + 3, giving −2m = 2 and **m = −1**.
Why: 'y = mx + 3 passes through the solution point' — a point lies on a line exactly when its coordinates satisfy the line's equation (Section 02, Quick Check Q5!).

ANSWER: x = −2, y = 5, and m = −1.

CBSE-STYLE MARKING SCHEME: 1 mark for x and y by substitution • 1 mark for using the point in y = mx + 3 • 1 mark for m = −1 (3 marks).

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Exercise 3.2 Q3 (i)–(ii) — Numbers and Angles

EXERCISE 3.2 • Q3(i)

Form the pair of linear equations and solve by substitution: The difference between two numbers is 26 and one number is three times the other. Find them.

1. Let the larger number be x and the smaller be y. Difference: **x − y = 26** ...(1). One is three times the other: **x = 3y** ...(2).
   Why: Equation (2) is ALREADY in substituted form — this is the friendliest word problem in the chapter.
2. Substitute (2) into (1): 3y − y = 26, so 2y = 26 and **y = 13**.
3. From (2): x = 3(13) = **39**. Check: 39 − 13 = 26 and 39 = 3 × 13.

ANSWER: The numbers are 39 and 13.

CBSE-STYLE MARKING SCHEME: 1 mark for the pair of equations • 1 mark for substitution • 1 mark for the answer with check (3 marks).

EXERCISE 3.2 • Q3(ii)

Form the pair of linear equations and solve by substitution: The larger of two supplementary angles exceeds the smaller by 18°. Find them.

1. Let the larger angle be x° and the smaller be y°. Supplementary angles sum to 180°: **x + y = 180** ...(1). Larger exceeds smaller by 18°: **x = y + 18** ...(2).
   Why: 'Supplementary' is a vocabulary word carrying an equation: x + y = 180. (Complementary would carry 90.)
2. Substitute (2) into (1): (y + 18) + y = 180, so 2y = 162 and **y = 81**.
3. From (2): x = 81 + 18 = **99**. Check: 99 + 81 = 180 and 99 − 81 = 18.

ANSWER: The angles are 99° and 81°.

CBSE-STYLE MARKING SCHEME: Same split as Q3(i) (3 marks).

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Exercise 3.2 Q3 (iii)–(iv) — Bats, Balls and Taxi Fares

EXERCISE 3.2 • Q3(iii)

Form the pair of linear equations and solve by substitution: The coach of a cricket team buys 7 bats and 6 balls for ₹3800. She buys 3 bats and 5 balls for ₹1750 later. Find the cost of each bat and each ball.

1. Let a bat cost ₹x and a ball cost ₹y. Purchases: **7x + 6y = 3800** ...(1) and **3x + 5y = 1750** ...(2).
   Why: Compare with Chapter Example 2 — same costume, but this time the numbers are honest and the answer is sensible.
2. From (2): 3x = 1750 − 5y, so **x = (1750 − 5y)/3** ...(3).
3. Substitute (3) into (1): 7(1750 − 5y)/3 + 6y = 3800. Multiply by 3: 12250 − 35y + 18y = 11400, so −17y = −850 and **y = 50**.
   Why: Multiply through by 3 BEFORE expanding — fractions first, arithmetic second.
4. Put y = 50 in (3): x = (1750 − 250)/3 = 1500/3 = **500**. Check: 7(500) + 6(50) = 3500 + 300 = 3800; 3(500) + 5(50) = 1500 + 250 = 1750.

ANSWER: One bat costs ₹500 and one ball costs ₹50.

CBSE-STYLE MARKING SCHEME: 1 mark for equations • 1 mark for substitution working • 1 mark for both prices with check (3 marks).

EXERCISE 3.2 • Q3(iv)

Form the pair of linear equations and solve by substitution: In a city, taxi charges consist of a fixed charge together with the charge for the distance covered. For a distance of 10 km, the charge paid is ₹105 and for a journey of 15 km, the charge paid is ₹155. What are the fixed charges and the charge per km? How much does a person have to pay for travelling a distance of 25 km?

1. Let the fixed charge be ₹x and the charge per km be ₹y. For 10 km: **x + 10y = 105** ...(1). For 15 km: **x + 15y = 155** ...(2).
   Why: Total fare = fixed part + (rate × distance). Every fare problem in every exam is this one line.
2. From (1): **x = 105 − 10y** ...(3).
3. Substitute (3) into (2): (105 − 10y) + 15y = 155, so 5y = 50 and **y = 10**.
   Why: Notice how the fixed charge vanishes on subtraction — the extra 5 km cost exactly the extra ₹50. The algebra is just that observation, formalised.
4. Put y = 10 in (3): x = 105 − 100 = **5**. So fixed charge = ₹5 and rate = ₹10 per km.

Exercise 3.2 Q3 (v)–(vi) — A Fraction and Two Ages

EXERCISE 3.2 • Q3(v)

Form the pair of linear equations and solve by substitution: A fraction becomes 9/11 if 2 is added to both the numerator and the denominator. If 3 is added to both the numerator and the denominator, it becomes 5/6. Find the fraction.

1. Let the fraction be x/y. First condition: (x + 2)/(y + 2) = 9/11. Cross-multiply: 11(x + 2) = 9(y + 2), so **11x − 9y = −4** ...(1).
   Why: Cross-multiplication turns a fraction condition into a linear equation — always expand both sides fully before collecting terms.
2. Second condition: (x + 3)/(y + 3) = 5/6. Cross-multiply: 6(x + 3) = 5(y + 3), so **6x − 5y = −3** ...(2).
3. From (2): 6x = 5y − 3, so **x = (5y − 3)/6** ...(3). Substitute (3) into (1): 11(5y − 3)/6 − 9y = −4. Multiply by 6: 55y − 33 − 54y = −24, so **y = 9**.
4. Put y = 9 in (3): x = (45 − 3)/6 = 42/6 = **7**. Check: (7 + 2)/(9 + 2) = 9/11; (7 + 3)/(9 + 3) = 10/12 = 5/6.
   Why: Verify fraction answers in the ORIGINAL fraction language — it is the fastest check in this whole family of problems.

ANSWER: The fraction is 7/9.

CBSE-STYLE MARKING SCHEME: 1 mark for the two equations • 1 mark for substitution • 1 mark for the fraction with check (3 marks).

EXERCISE 3.2 • Q3(vi)

Form the pair of linear equations and solve by substitution: Five years hence, the age of Jacob will be three times that of his son. Five years ago, Jacob's age was seven times that of his son. What are their present ages?

1. Let Jacob's present age be x years and his son's be y years. Five years hence: Jacob x + 5, son y + 5, and x + 5 = 3(y + 5), so **x − 3y = 10** ...(1).
   Why: Both people age together — add 5 to BOTH ages, subtract 5 from BOTH ages. (Remember Aftab from the chapter examples!)
2. Five years ago: x − 5 = 7(y − 5), so **x − 7y = −30** ...(2).
3. From (1): **x = 3y + 10** ...(3). Substitute (3) into (2): (3y + 10) − 7y = −30, so −4y = −40 and **y = 10**.
4. From (3): x = 3(10) + 10 = **40**. Check: in 5 years, 45 and 15, and 45 = 3 × 15; 5 years ago, 35 and 5, and 35 = 7 × 5.

Exercise 3.3 Q1 (i)–(ii) — Elimination Method

EXERCISE 3.3 • Q1(i)

Solve by the elimination method (and substitution method): x + y = 5; 2x − 3y = 4.

THINK FIRST: Elimination plan: make the y-coefficients match. Multiply (1) by 3 so both equations carry 3y — with opposite signs, ready to be added away.

1. (1) × 3: **3x + 3y = 15** …(1′). Keep (2): 2x − 3y = 4.
   Why: Multiply EVERY term, including the right side. A half-multiplied equation is the most common elimination error in the country.
2. Add (1′) and (2): 5x = 19, so **x = 19/5**.
   Why: +3y and −3y destroy each other — that was the whole point of Step 1.
3. Put x = 19/5 in (1): 19/5 + y = 5, so y = 5 − 19/5 = **6/5**.
4. Substitution cross-check (NCERT asks for both methods): from (1), y = 5 − x. In (2): 2x − 3(5 − x) = 4 → 5x − 15 = 4 → x = 19/5, then y = 6/5. Same answer, second road.
   Why: Two methods agreeing is the strongest verification there is.
5. Final verify: 19/5 + 6/5 = 25/5 = 5; 2(19/5) − 3(6/5) = (38 − 18)/5 = 4.

ANSWER: x = 19/5, y = 6/5.

CBSE-STYLE MARKING SCHEME: 1 mark for making coefficients equal • 1 mark for x • 1 mark for y (3 marks). Fractional answers are welcome — do not 'round' them away.

PIN POINT

Elimination cue: choose the variable whose coefficients are closest to a common multiple. Match the coefficients, then ADD if signs are opposite, SUBTRACT if signs are the same.

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Exercise 3.3 Q1 (ii) — Elimination, Second Pair

EXERCISE 3.3 • Q1(ii)

Solve by the elimination method (and substitution method): 3x + 4y = 10; 2x − 2y = 2.

1. (2) × 2: **4x − 4y = 4** ...(2′). Now the y-terms are +4y and −4y.
2. Add (1) and (2′): 7x = 14, so **x = 2**.
3. Put x = 2 in (1): 6 + 4y = 10, so 4y = 4 and **y = 1**.
4. Substitution cross-check: from (2), x = 1 + y. In (1): 3(1 + y) + 4y = 10 → 7y = 7 → y = 1, x = 2.
   Final verify: 3(2) + 4(1) = 10; 2(2) − 2(1) = 2.

ANSWER: x = 2, y = 1.

CBSE-STYLE MARKING SCHEME: Same split as Q1(i) (3 marks).

Exercise 3.3 Q1 (iii)–(iv) — Harder Coefficients

EXERCISE 3.3 • Q1(iii)

Solve by the elimination method (and substitution method): 3x − 5y − 4 = 0; 9x = 2y + 7.

THINK FIRST: First drag both equations into the open: 3x − 5y = 4 and 9x − 2y = 7. The x-coefficients 3 and 9 are natural multiples — eliminate x.

1. Rewrite: **3x − 5y = 4** ...(1) and **9x − 2y = 7** ...(2).
   Why: 9x = 2y + 7 means 9x − 2y = 7 — move the y-term across with its sign flipped.
2. (1) × 3: **9x − 15y = 12** ...(1′). Subtract (2) from (1′): (9x − 15y) − (9x − 2y) = 12 − 7, so −13y = 5 and **y = −5/13**.
   Why: Subtracting a negative term adds it: −15y − (−2y) = −13y. Say this line aloud as you write it — sign errors live here.
3. Put y = −5/13 in (1): 3x − 5(−5/13) = 4, so 3x = 4 − 25/13 = 27/13 and **x = 9/13**.
4. Verify in (2): 9(9/13) = 81/13; 2(−5/13) + 7 = −10/13 + 91/13 = 81/13. Substitution method (from (2): x = (2y + 7)/9, substituted in (1)) leads to the same pair.
   Why: An answer with 13 in the denominator looks suspicious but is perfectly correct — NCERT deliberately includes one such question so you learn to trust correct working over pretty numbers.

ANSWER: x = 9/13, y = −5/13.

CBSE-STYLE MARKING SCHEME: 1 mark for standard form • 1 mark for elimination • 1 mark for both values (3 marks).

EXERCISE 3.3 • Q1(iv)

Solve by the elimination method (and substitution method): x/2 + 2y/3 = −1; x − y/3 = 3.

THINK FIRST: Clear the fractions first: multiply (1) by 6 and (2) by 3. Then the x-coefficients match for free.

1. (1) × 6: **3x + 4y = −6** ...(1′). (2) × 3: **3x − y = 9** ...(2′).
2. Subtract (2′) from (1′): 4y − (−y) = −6 − 9, so 5y = −15 and **y = −3**.
3. Put y = −3 in (2): x − (−3)/3 = 3, so x + 1 = 3 and **x = 2**.
   Why: Work in the ORIGINAL equation (2) here — it is shorter than its multiplied twin.
4.

Exercise 3.3 Q2 (i)–(ii) — A Fraction and Two Ages, Again

EXERCISE 3.3 • Q2(i)

Form the pair of linear equations and solve by elimination: If we add 1 to the numerator and subtract 1 from the denominator, a fraction reduces to 1. It becomes 1/2 if we only add 1 to the denominator. What is the fraction?

1. Let the fraction be x/y. First condition: (x + 1)/(y − 1) = 1, so x + 1 = y − 1, giving **x − y = −2** ...(1).
   Why: 'Reduces to 1' means numerator EQUALS denominator — no cross-multiplication even needed.
2. Second condition: x/(y + 1) = 1/2, so **2x − y = 1** ...(2).
3. Subtract (1) from (2): (2x − y) − (x − y) = 1 − (−2), so **x = 3**.
   Why: The y-terms were already identical — elimination needed no multiplication at all. Always look before you multiply!
4. Put x = 3 in (1): 3 − y = −2, so **y = 5**. Check: (3 + 1)/(5 − 1) = 4/4 = 1; 3/(5 + 1) = 3/6 = 1/2.

ANSWER: The fraction is 3/5.

CBSE-STYLE MARKING SCHEME: 1 mark for the equations • 1 mark for elimination • 1 mark for the fraction with check (3 marks).

EXERCISE 3.3 • Q2(ii)

Form the pair of linear equations and solve by elimination: Nuri is 3 times as old as Sonu. Ten years later, Nuri will be twice as old as Sonu. How old are Nuri and Sonu?

1. Let Nuri's present age be x years and Sonu's be y years. Now: **x = 3y**, i.e. x − 3y = 0 ...(1).
2. Ten years later: Nuri x + 10, Sonu y + 10, and x + 10 = 2(y + 10), so **x − 2y = 10** ...(2).
   Why: x + 10 = 2y + 20 → x − 2y = 10. Expand the bracket fully before collecting.
3. Subtract (1) from (2): (x − 2y) − (x − 3y) = 10 − 0, so **y = 10**.
4. From (1): x = 3(10) = **30**. Check: 30 = 3 × 10; in ten years, 40 and 20, and 40 = 2 × 20.

ANSWER: Nuri is 30 years old and Sonu is 10 years old.

CBSE-STYLE MARKING SCHEME: Same split as Q2(i) (3 marks).

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Exercise 3.3 Q2 (iii) — The Two-Digit Number

EXERCISE 3.3 • Q2(iii)

Form the pair of linear equations and solve by elimination: The sum of the digits of a two-digit number is 9. Also, nine times this number is twice the number obtained by reversing the order of the digits. Find the number.

1. Let the tens digit be x and the units digit be y. The number itself is **10x + y**, and the reversed number is **10y + x**.
   Why: A two-digit number is NOT xy and NOT x + y: the tens digit carries a weight of 10. This single line is the whole secret of digit problems.
2. Sum of digits: **x + y = 9** ...(1).
3. Nine times the number is twice the reversed number: 9(10x + y) = 2(10y + x). Expand: 90x + 9y = 20y + 2x. Collect: 88x − 11y = 0. Divide by 11: **8x − y = 0** ...(2).
   Why: Divide a whole equation by a common factor (11 here) whenever you can — smaller numbers, fewer slips.
4. Add (1) and (2): 9x = 9, so **x = 1**. From (1): y = 9 − 1 = **8**.
   Why: The y-coefficients are +1 and −1 — a ready-made elimination pair.
5. The number is 10(1) + 8 = **18**. Check: digits sum to 9; 9 × 18 = 162 and 2 × 81 = 162.
   Why: State the NUMBER (18), not merely the digits — the question asked for the number.

ANSWER: The number is 18.

CBSE-STYLE MARKING SCHEME: 1 mark for expressing the number and its reverse • 1 mark for the equations • 1 mark for elimination and the number (3 marks).

Exercise 3.3 Q2 (iv)–(v) — Bank Notes and Library Charges

EXERCISE 3.3 • Q2(iv)

Form the pair of linear equations and solve by elimination: Meena went to a bank to withdraw ₹2000. She asked the cashier to give her ₹50 and ₹100 notes only. Meena got 25 notes in all. Find how many notes of ₹50 and ₹100 she received.

1. Let the number of ₹50 notes be x and of ₹100 notes be y. Count of notes: **x + y = 25** ...(1). Value of notes: **50x + 100y = 2000** ...(2).
   Why: Two different totals — a count total and a value total — give the two equations. Confusing them is the classic error in note problems.
2. Divide (2) by 50: **x + 2y = 40** ...(2′). Subtract (1) from (2′): y = 40 − 25 = **15**.
3. From (1): x = 25 − 15 = **10**. Check: 10 + 15 = 25 notes; 10(50) + 15(100) = 500 + 1500 = ₹2000.

ANSWER: Meena received ten ₹50 notes and fifteen ₹100 notes.

CBSE-STYLE MARKING SCHEME: 1 mark for the two equations • 1 mark for elimination • 1 mark for both counts with check (3 marks).

Exercise 3.3 Q2 (v) — The Library's Fixed Charge

EXERCISE 3.3 • Q2(v)

Form the pair of linear equations and solve by elimination: A lending library has a fixed charge for the first three days and an additional charge for each day thereafter. Saritha paid ₹27 for a book kept for seven days, while Susy paid ₹21 for the book she kept for five days. Find the fixed charge and the charge for each extra day.

1 Let the fixed charge (first three days) be ₹x and the extra charge per day be ₹y. Saritha kept the book 7 days = 3 + 4 extra days: **x + 4y = 27** ...(1). Susy kept it 5 days = 3 + 2 extra days: **x + 2y = 21** ...(2).

Why: Only the days AFTER the first three are charged at the daily rate; 7 days means 4 extra days, not 7. This is the trap the question is built around.

2 Subtract (2) from (1): 2y = 6, so **y = 3**.

Why: The fixed charge cancels on subtraction — the difference in bills is purely the difference in extra days.

3 Put y = 3 in (2): x = 21 − 6 = **15**. Check: Saritha: 15 + 4(3) = 27; Susy: 15 + 2(3) = 21.

ANSWER: The fixed charge is ₹15 and the charge for each extra day is ₹3.

CBSE-STYLE MARKING SCHEME: 1 mark for the equations (with correct extra days) • 1 mark for elimination • 1 mark for both charges (3 marks).

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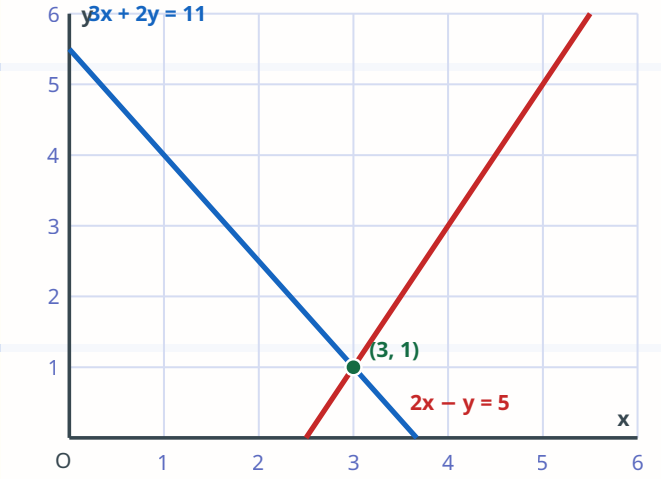
08 Multiple Solution Methods

8D • CHALLENGE — ONE PAIR, THREE ROADS

Take one pair and walk all three roads to its answer: **3x + 2y = 11 ...(1)** and **2x − y = 5 ...(2)**.

Road 1 — Graphical

For (1): y = (11 − 3x)/2. x = 1, 3 gives y = 4, 1 — points (1, 4), (3, 1).
For (2): y = 2x − 5. x = 2, 3 gives y = −1, 1 — points (2, −1), (3, 1).
The lines meet at **(3, 1)**.



Road 2 — Substitution

From (2): y = 2x − 5 ...(3).
In (1): 3x + 2(2x − 5) = 11 → 3x + 4x − 10 = 11 → 7x = 21 → **x = 3**.
In (3): y = 2(3) − 5 = **1**.

Road 3 — Elimination

(2) × 2: 4x − 2y = 10 ...(2′).
Add (1) and (2′): 7x = 21 → **x = 3**.
In (1): 9 + 2y = 11 → 2y = 2 → **y = 1**.

Three roads, one meeting point: **x = 3, y = 1**. Verify: 3(3) + 2(1) = 11; 2(3) − 1 = 5.

PIN POINT

Same answer, three roads — that is your safety net. In the exam, solve by the fastest road; if time remains, cross-check by a second road instead of re-reading the first.

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Multiple Methods — Which Road, When?

Situation	Best road	Why
The question says "graphically"	Graphical — no choice!	The drawing, table and reading-off ARE the marks.
A variable has coefficient 1 or −1	Substitution	Isolating it creates no fractions (e.g. y = 2x − 5 above).
Coefficients are equal, opposite, or easy multiples	Elimination	One multiplication (or none) clears a variable.
Big swapped coefficients like 62x + 43y, 43x + 62y	Add & subtract trick	Adding gives x + y, subtracting gives x − y (a real CBSE 2024 pattern — see PYQs).
You only need consistency, not the solution	Ratio test — no solving at all	Three divisions answer the question in seconds.
Decimals or fractions everywhere	First scale the equations clean, then eliminate	Whole numbers make every later step safer.

The add–subtract trick, once more with feeling

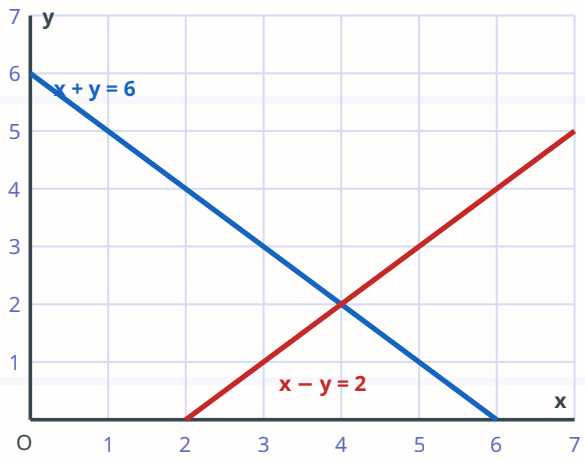
Whenever the coefficients of x and y are **swapped** between the two equations — ax + by = p and bx + ay = q — do not multiply anything. **Add** the equations to get (a + b)(x + y) = p + q, and **subtract** them to get (a − b)(x − y) = p − q. Two tiny equations replace one messy elimination. You used it in the Fruit Market Story; CBSE used it in 2024. It will serve you for years.

TOPPER TIP: *In a 3-mark question, the method named in the question is compulsory — 'by substitution' means substitution, even if elimination is quicker. Marks follow instructions.*

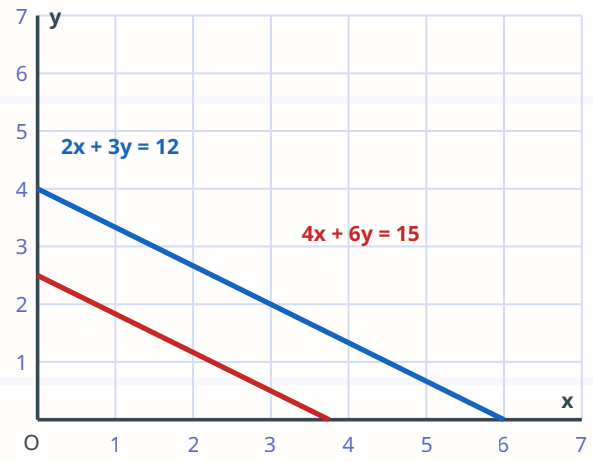
09 Interactive Simulations & Hands-on Activities

TRY IT YOURSELF — LEARN BY DOING

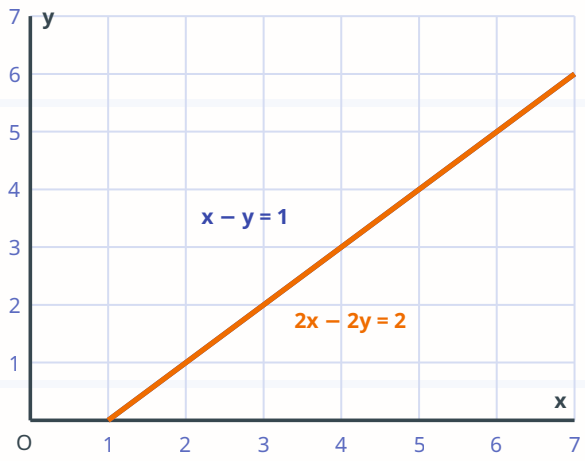
Activity 1 — The Graph Lab. On graph paper, draw all three pairs below yourself FIRST (tables of values, sharp pencil). Only then compare with the printed graphs. For each pair, write: intersecting / parallel / coincident, and the number of solutions.



Pair A: x + y = 6; x − y = 2



Pair B: 2x + 3y = 12; 4x + 6y = 15



Pair C: x − y = 1; 2x − 2y = 2

Your verdict table — fill it in

Pair	Picture	Solutions
A		
B		
C		

Write 'intersecting', 'parallel' or 'coincident' in the Picture column — then check yourself on the Activity Answers page.

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Activities 2 and 3 — Detectives and Surveys

Activity 2 — The Ratio Detective. Without drawing anything, classify these pairs by ratios alone, then check one of them by drawing: (a) $3x + 2y = 8$, $6x + 4y = 16$ (b) $3x + 2y = 8$, $6x + 4y = 20$ (c) $3x + 2y = 8$, $2x + 3y = 8$.

Activity 3 — The Price Survey. Visit (or imagine) two shops. Note the price of the SAME two items at both shops — for example, a notebook and a pen. Pretend you only know two mixed bills (like Anitha's). Form the pair of equations, solve, and recover both unit prices. Then check against the real price tags. You have just done market research with Class 10 algebra.

DIGITAL COMPANION: An interactive line-explorer (drag the coefficients, watch the lines cross, separate or merge) accompanies this chapter in the KalviYogi Digital Ecosystem. QR code and link activate with the KalviYogi app/website at print.

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Activity Answers — Check After Trying

Activity 1

Pair A: Intersecting at (4, 2) — one solution: x = 4, y = 2. Ratios: 1/1 ≠ 1/−1 confirms it.

Pair B: Parallel — no solution. Ratios: 2/4 = 3/6 = 1/2 ≠ 12/15 = 4/5.

Pair C: Coincident — infinitely many solutions; the second equation is exactly twice the first. Ratios: 1/2 = −1/−2 = −1/−2.

Activity 2

(a) 3/6 = 2/4 = −8/−16 = 1/2 — coincident, infinitely many solutions. **(b)** 3/6 = 2/4 = 1/2 ≠ −8/−20 = 2/5 — parallel, no solution. **(c)** 3/2 ≠ 2/3 — intersecting, one solution (in fact x = y = 8/5 — try solving it!).

TOPPER TIP: *Activities feel like play, but they are secretly the Day-3 and Day-7 recall tasks of your Smart Memory plan. Doing them properly now makes revision almost free later.*

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10 Common Mistakes

LEARN FROM OTHER STUDENTS' ERRORS — BEFORE THEY BECOME YOURS

COMMON MISTAKE: Reading c with the wrong sign in the ratio test. For $2x + 3y = 7$, students write $c_1 = 7$. **Right way:** first rewrite as $2x + 3y - 7 = 0$, so $c_1 = -7$. The ratio test only works on the $ax + by + c = 0$ form.

COMMON MISTAKE: Multiplying only SOME terms during elimination. From $x + y = 5$, students write $(1)\times 3$ as $3x + y = 15$. **Right way:** EVERY term is multiplied: $3x + 3y = 15$. Touch every term with the multiplier — no exceptions.

COMMON MISTAKE: Sign collapse when subtracting equations. $(9x - 15y) - (9x - 2y)$ written as $-17y$. **Right way:** subtracting a negative adds: $-15y - (-2y) = -13y$. Write the bracket, flip every sign inside, then combine.

COMMON MISTAKE: In age problems, moving only ONE person through time: 'five years ago Jacob was $x - 5$ and his son was y'. **Right way:** time moves everyone: son was $y - 5$. If one age travels, all ages travel.

COMMON MISTAKE: Writing a two-digit number as xy or as $x + y$. For digits 4 and 7, the number is not 47 by luck of writing — it is $10(4) + 7$. **Right way:** number = 10 × (tens digit) + (units digit); reversed = 10 × (units) + (tens).

COMMON MISTAKE: Library/hostel problems: charging the daily rate for ALL days. Saritha's 7 days billed as $x + 7y$. **Right way:** the fixed charge already covers the first three days; only $7 - 3 = 4$ days earn the daily rate: $x + 4y$.

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Common Mistakes 7–8 — and the Verification Habit

COMMON MISTAKE: Stopping after finding x. A 'solution' with only x = 3 written earns half the marks and zero satisfaction. **Right way:** a pair is solved only when BOTH values stand together, and the final line names them: x = 3, y = 1.

COMMON MISTAKE: Verifying in a MODIFIED equation instead of the original. If you multiplied wrongly at Step 1, checking inside the multiplied equation blesses your own error. **Right way:** substitute into the two ORIGINAL equations printed in the question — every time, both of them.

The 10-second habit that fixes half of all mistakes

Before you turn the page on any solution, spend ten seconds: put your (x, y) into the first original equation — does it balance? Into the second — does it balance? Toppers are not students who never err; they are students whose errors never survive ten seconds.

PIN POINT

0 = 0 means infinitely many solutions. 0 = 5 means no solution. When everything cancels during elimination or substitution, do not panic — the 'empty' result IS the answer; read it.

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11 Graded Practice Problems

FIVE LEVELS — CLIMB ONE LEVEL AT A TIME • ANSWERS IN THE ANSWER KEY

All questions in this section are original KalviYogi practice questions. Solve them in your notebook with full steps — the Answer Key at the end of the chapter gives the final answers and, for the harder levels, the key first step.

LEVEL 1 • FOUNDATION

L1.1 Solve: $x + y = 8$ and $x - y = 2$.

L1.2 Solve: $2x + y = 11$ and $x + y = 7$.

L1.3 Without solving, classify the pair $2x + 3y = 7$ and $4x + 6y = 10$: intersecting, parallel or coincident? How many solutions?

L1.4 Solve: $3x - y = 5$ and $x + y = 3$.

L1.5 The point (2, 1) is a solution of $3x + ky = 7$. Find k.

L1.6 Write any one linear equation whose graph is parallel to the graph of $x + 2y = 4$. Justify your choice with ratios.

LEVEL 2 • SKILL BUILDER

L2.1 Solve by substitution: $3x + 2y = 13$ and $x + y = 5$.

L2.2 Solve by elimination: $5x - 3y = 11$ and $2x + 3y = 17$.

L2.3 Solve: $x/3 + y/4 = 3$ and $x - y = -5$.

L2.4 The sum of two numbers is 74 and their difference is 26. Find the numbers.

L2.5 Solve: $4x + 3y = 20$ and $x - y = -2$.

L2.6 For what values of k does $kx + 2y = 5$ and $3x + y = 1$ have a unique solution?

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Graded Practice — Levels 3, 4 and 5

LEVEL 3 • APPLICATION

L3.1 A cab charges a fixed booking fee plus a per-km rate. A ride of 8 km costs ₹148 and a ride of 12 km costs ₹212. Find the fixed fee and the per-km rate, and the cost of a 20 km ride.

L3.2 A father is three times as old as his son. In 12 years, he will be twice as old as his son. Find their present ages.

L3.3 Three notebooks and two pens cost ₹95. Two notebooks and three pens cost ₹80. Find the cost of each.

L3.4 The length of a rectangle exceeds its width by 5 m and its perimeter is 54 m. Find its length and width.

LEVEL 4 • ADVANCED REASONING

L4.1 Solve without long multiplication: $99x + 101y = 499$ and $101x + 99y = 501$.

L4.2 Find k so that $2x + 3y = 7$ and $(k + 1)x + (2k - 1)y = 4k + 1$ have infinitely many solutions.

L4.3 Solve: $2/x + 3/y = 13$ and $5/x - 4/y = -2$. (Hint: set $u = 1/x$ and $v = 1/y$ first.)

LEVEL 5 • MATHEMATICAL GENIUS

L5.1 Given $x + y = 5$ and $x - y = 1$, first find x and y; then, WITHOUT finding them again, evaluate $x^2 - y^2$, xy and $x^3 - y^3$. Which identity made each evaluation one line long?

L5.2 A two-digit number is 4 times the sum of its digits. The number obtained by reversing the digits is 27 more than the original number. Find the number.

> **TOPPER TIP:** *Stuck at a level? Drop one level down, solve two questions there, and climb back. Staircases are climbed one step at a time — that is true for this chapter and for the staircase in the logo of mathematics itself.*

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Concept MCQs 1–13 — One Mark Each, Board Style

Choose the single correct option. Work them out — guessing teaches nothing. Answers with one-line explanations are in the Answer Key.

MCQ 1. The pair $x + y = 5$ and $x - y = 1$ has the solution
(A) (2, 3) (B) (3, 2) (C) (4, 1) (D) (5, 0)

MCQ 2. The lines $2x + 3y = 7$ and $4x + 6y = 15$ are
(A) intersecting (B) parallel (C) coincident (D) perpendicular

MCQ 3. A pair of linear equations has a unique solution exactly when
(A) $a_1/a_2 = b_1/b_2$ (B) $a_1/a_2 \neq b_1/b_2$ (C) $a_1/a_2 = b_1/b_2 = c_1/c_2$ (D) $a_1 + a_2 = b_1 + b_2$

MCQ 4. The pair $x + 2y = 6$ and $2x + 4y = 12$ has
(A) no solution (B) a unique solution (C) infinitely many solutions (D) exactly two solutions

MCQ 5. If (2, 1) is a solution of $3x + ky = 8$, then k equals
(A) 1 (B) 2 (C) 3 (D) 5

MCQ 6. The lines $x = 3$ and $y = -2$
(A) are parallel (B) intersect at (3, −2) (C) are coincident (D) intersect at (−2, 3)

MCQ 7. The pair $kx + 2y = 5$ and $3x + y = 1$ has a unique solution for
(A) $k = 6$ (B) $k = 3$ (C) every k except 6 (D) $k = 2$ only

MCQ 8. Two numbers have sum 35 and difference 13. The numbers are
(A) 24 and 11 (B) 25 and 10 (C) 23 and 12 (D) 26 and 9

MCQ 9. If $2x + y = 7$ and $x - y = 2$, then x equals
(A) 2 (B) 3 (C) 4 (D) 5

MCQ 10. Which pair has NO solution?
(A) $x + y = 4$; $x - y = 2$ (B) $2x + y = 6$; $4x + 2y = 12$ (C) $x + 2y = 5$; $2x + 4y = 8$ (D) $3x - y = 2$; $x + y = 6$

MCQ 11. A consistent pair whose lines coincide is called
(A) inconsistent (B) dependent (C) impossible (D) perpendicular

MCQ 12. If $x + y = 0$ and $x - y = 0$, then (x, y) is
(A) (1, 1) (B) (0, 0) (C) (1, −1) (D) (−1, 1)

MCQ 13. To eliminate y from $3x + 2y = 7$ and $5x - 3y = 1$, multiply the first equation by ___ and the second by ___
(A) 3 and 2 (B) 2 and 3 (C) 5 and 3 (D) 3 and 5

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Concept MCQs 14–25

MCQ 14. If $2x + 3y = 12$ and $x = 3$, then y equals
(A) 1 (B) 2 (C) 3 (D) 4

MCQ 15. Which of the following is NOT a linear equation in two variables?
(A) $2x + 3y = 5$ (B) $x + y^2 = 4$ (C) $3x - y = 0$ (D) $x/2 + y/3 = 1$

MCQ 16. The graph of $ax + by + c = 0$ (a, b not both zero) is always
(A) a circle (B) a parabola (C) a straight line (D) a curve through the origin

MCQ 17. The lines $5x - 4y + 8 = 0$ and $7x + 6y - 9 = 0$ are
(A) parallel (B) coincident (C) intersecting (D) the same as the axes

MCQ 18. The value of k for which $x + 2y = 5$ and $2x + ky = 10$ represent coincident lines is
(A) 2 (B) 3 (C) 4 (D) 5

MCQ 19. Two supplementary angles are equal. Each angle measures
(A) 45° (B) 60° (C) 90° (D) 120°

MCQ 20. The pair $3x + 2y = 5$ and $2x - 3y = 7$ is
(A) inconsistent (B) consistent (C) dependent (D) parallel

MCQ 21. A single linear equation in two variables, by itself, has
(A) no solution (B) exactly one solution (C) exactly two solutions (D) infinitely many solutions

MCQ 22. For substitution in $x + 3y = 6$, the cleanest first step is
(A) $x = 6 - 3y$ (B) $x = 6 + 3y$ (C) $y = 6 + x$ (D) $3y = x - 6$

MCQ 23. A two-digit number whose tens digit is x and units digit is y equals
(A) xy (B) $x + y$ (C) $10x + y$ (D) $10y + x$

MCQ 24. A taxi charges a fixed ₹20 plus ₹12 per km. The fare for 9 km is
(A) ₹108 (B) ₹128 (C) ₹148 (D) ₹96

MCQ 25. If a pair of linear equations is consistent, its lines are
(A) always parallel (B) always intersecting (C) intersecting or coincident (D) always coincident

TOPPER TIP: *Finished all 25? Score yourself honestly in the Mastery Tracker (Section 18). Below 20 means: revisit Sections 05 and 07 before the Model Tests.*

12 Mathematical Reasoning

JUSTIFY AND PROVE — FULL SOLUTIONS

REASONING 1

For which value(s) of k does the pair kx + 3y = k − 3 and 12x + ky = k have NO solution? Justify every step.

THINK FIRST: The first two ratios give candidates; only the third ratio can separate 'no solution' from 'infinitely many'. Never announce k before testing both candidates in all three ratios.

1. Write the condition for no solution: $a_1/a_2 = b_1/b_2 \neq c_1/c_2$. Here $a_1 = k$, $b_1 = 3$, $c_1 = -(k - 3) = 3 - k$; $a_2 = 12$, $b_2 = k$, $c_2 = -k$.
   Why: Move everything to the left FIRST: kx + 3y − (k − 3) = 0. The c-term is −(k−3), the single most-lost mark in this famous question.
2. From k/12 = 3/k: cross-multiply to get $k^2 = 36$, so **k = 6 or k = −6**.
   Why: Two candidates survive the first two ratios. The third ratio must now judge them — this is where the question separates toppers from the rest.
3. Test k = 6 in the third ratio: $c_1/c_2 = (3 - 6)/(-6) = 1/2$, and k/12 = 1/2 too. All three ratios equal → the lines are COINCIDENT — infinitely many solutions, NOT 'no solution'. Reject k = 6.
4. Test k = −6: $c_1/c_2 = (3 + 6)/6 = 3/2$, while k/12 = −1/2. First two ratios equal (−1/2), third different → parallel lines → no solution. Accept k = −6.

ANSWER: k = −6 only. (For k = 6 the pair has infinitely many solutions — the same pair of equations is a famous board favourite in BOTH costumes.)

PIN POINT

When k^2 appears, BOTH roots must face the third ratio. k = 6 and k = −6 look like twins, but one gives coincident lines and the other parallel lines.

REASONING 2

Solve the pair 148x + 231y = 527 and 231x + 148y = 610 — without multiplying any equation by a two-digit number.

1. Add the equations: (148 + 231)x + (231 + 148)y = 527 + 610, i.e. 379x + 379y = 1137. Divide by 379: **x + y = 3** ...(3).
   Why: The coefficients are swapped (148 ↔ 231) — the add-subtract trick of Section 08 was built for exactly this shape.
2.

Reasoning 3 — Why 'Exactly Two Solutions' is Impossible

REASONING 3

A student claims: "My pair of linear equations has exactly two solutions." Prove that the student must be wrong.

THINK FIRST: This is why the ratio table has exactly three rows — geometry forbids a fourth.

1. Suppose, for contradiction, that the pair has two DIFFERENT solutions, say (x_1, y_1) and (x_2, y_2).
   Why: Proof by contradiction: assume the claim, follow it honestly, and let it defeat itself. (You met this weapon in Chapter 1, against √2.)

2. A solution of the pair lies on BOTH lines. So both points lie on the first line, and both points lie on the second line.
   Why: A point satisfies an equation exactly when it lies on that equation's line — Section 02.

3. But through two distinct points there passes exactly ONE straight line. So the 'first line' and the 'second line' are the same line — the lines coincide.
   Why: Two points fix a line completely; neither line has anywhere else to go.

4. Coincident lines share EVERY point — so the pair has infinitely many solutions, contradicting 'exactly two'.
   Why: Therefore a pair can have 0, 1 or infinitely many solutions — never exactly two, never exactly seventeen. The trichotomy of Section 04 is complete.

ANSWER: A pair of linear equations can never have exactly two solutions. The only possibilities are: none, one, or infinitely many.

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13 Real-Life Applications

8D • APPLY — THE CHAPTER AT WORK IN THE WORLD

APPLICATION 1

Railway fares: 2 adult tickets and 3 child tickets on a train cost ₹740 in total, while 3 adult tickets and 2 child tickets cost ₹860. Find the fare of one adult ticket and one child ticket.

THINK FIRST: Two mixed bills, two unknown fares — the Fruit Market Puzzle at the railway station.

1. Let an adult ticket cost ₹x and a child ticket ₹y. Then **2x + 3y = 740** ...(1) and **3x + 2y = 860** ...(2).
2. Add: 5x + 5y = 1600, so x + y = 320 ...(3). Subtract (1) from (2): x − y = 120 ...(4).
   Why: Swapped coefficients again (2,3 and 3,2) — the add-subtract trick is becoming a reflex.
3. Add (3) and (4): 2x = 440, so **x = 220**. From (3): y = 320 − 220 = **100**.
4. Check: 2(220) + 3(100) = 440 + 300 = 740; 3(220) + 2(100) = 660 + 200 = 860.

ANSWER: An adult ticket costs ₹220 and a child ticket costs ₹100.

APPLICATION 2

A boat goes 40 km downstream in 2 hours and returns 24 km upstream in 2 hours. Find the speed of the boat in still water and the speed of the stream.

1. Let the boat's speed in still water be x km/h and the stream's speed be y km/h.
   Downstream speed = x + y; upstream speed = x − y.
   Why: The stream is a helper going down and an opponent coming up — that is why it adds once and subtracts once.
2. Downstream: 2(x + y) = 40, so **x + y = 20** ...(1). Upstream: 2(x − y) = 24, so **x − y = 12** ...(2).
   Why: Distance = speed × time, applied twice.
3. Add (1) and (2): 2x = 32, so **x = 16**. From (1): **y = 4**.
4. Check: downstream 20 km/h × 2 h = 40 km; upstream 12 km/h × 2 h = 24 km.

ANSWER: The boat's speed in still water is 16 km/h and the stream's speed is 4 km/h.

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Real-Life Applications 3 and 4

APPLICATION 3

A hostel charges a fixed monthly fee plus a daily mess charge. A student who stays 20 days pays ₹1800 in all, while a student who stays 30 days pays ₹2500. Find the fixed fee and the daily mess charge.

1. Let the fixed fee be ₹x and the daily charge be ₹y. Then **x + 20y = 1800** ...(1) and **x + 30y = 2500** ...(2).
   Why: Same skeleton as the taxi problem — a fixed part plus a rate part. Recognising skeletons is the real skill of this chapter.
2. Subtract (1) from (2): 10y = 700, so **y = 70**.
   Why: Ten extra days cost ₹700 — the fixed fee never even appears in this step.
3. Put y = 70 in (1): x = 1800 − 1400 = **400**. Check: 400 + 30(70) = 400 + 2100 = 2500.

ANSWER: The fixed fee is ₹400 and the daily mess charge is ₹70.

APPLICATION 4

A rectangular plot is fenced with 70 m of wire (its perimeter). Its length is 5 m more than twice its width. Find the length and width of the plot.

1. Let the length be l m and the width be w m. Perimeter: 2(l + w) = 70, so **l + w = 35** ...(1). Length condition: **l = 2w + 5** ...(2).
   Why: '5 more than twice the width' = 2w + 5 — translate word by word, in order.
2. Substitute (2) into (1): (2w + 5) + w = 35, so 3w = 30 and **w = 10**.
3. From (2): l = 2(10) + 5 = **25**. Check: perimeter = 2(25 + 10) = 70 m and 25 = 2(10) + 5.

ANSWER: The plot is 25 m long and 10 m wide.

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14 Competency-Based Questions

FIVE CASE STUDIES • ASSERTION–REASON — BOARD EXAM STYLE, FULLY SOLVED

CBSE case-study questions give you a real situation and ask four linked questions. Read the passage once, build the model, and the four answers usually fall one after another. All five cases below are original KalviYogi cases in board format.

Case Study 1 — The City Metro Card

A city metro charges a fixed boarding charge plus a per-kilometre fare. Ravi's card shows a deduction of ₹46 for a ride of 8 km. Sana's card shows ₹70 for a ride of 14 km. Let the fixed charge be ₹x and the per-km fare be ₹y.

CASE 1 (i)

Form the pair of linear equations for the two rides.

1 Ravi: fixed + 8 km of fare: **x + 8y = 46** ...(1). Sana: **x + 14y = 70** ...(2).
Why: Total fare = fixed charge + rate × distance — the taxi skeleton in a metro uniform.

ANSWER: x + 8y = 46 and x + 14y = 70.

CASE 1 (ii)

Find the per-kilometre fare.

1 Subtract (1) from (2): 6y = 24, so **y = 4**.
Why: Six extra kilometres cost ₹24 — the fixed charge cancels, as always.

ANSWER: The per-kilometre fare is ₹4.

CASE 1 (iii)

Find the fixed boarding charge.

1 Put y = 4 in (1): x = 46 − 8(4) = 46 − 32 = **14**.

ANSWER: The fixed boarding charge is ₹14.

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Case Study 1 — The City Metro Card (continued)

CASE 1 (iv)

How much will a ride of 20 km cost?

1

Fare = x + 20y = 14 + 20(4) = 14 + 80 = **94**.

Why: Once the model is built, new questions are one-line substitutions.

ANSWER: A 20 km ride costs ₹94.

Extend the case — try before you check

1. What does a 30 km ride cost? 2. Two friends ride 8 km and 14 km on one card — what is their combined fare, and why is it NOT simply 46 + 70 counted twice over? 3. The metro introduces a day pass at ₹120 for unlimited rides. For what total distance does the pay-per-ride model cost the same as the pass?

Answers: 1. 14 + 30(4) = ₹134. 2. ₹46 + ₹70 = ₹116 — it IS the sum of the two separate fares, because each ride pays its own fixed charge; the trap is to merge the distances first (22 km on one ride would cost 14 + 88 = ₹102, which is cheaper — two fixed charges versus one). 3. 14 + 4d = 120 → d = 26.5 km.

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Case Study 2 — The Sports Academy

Case Study 2 — Admission and Monthly Fees

A sports academy charges a one-time admission fee plus a monthly training fee. Karthik paid ₹2900 in total at the end of 2 months (admission + 2 months). Meera paid ₹5300 in total at the end of 5 months. Let the admission fee be ₹x and the monthly fee be ₹y.

CASE 2 (i)

Form the pair of linear equations.

1 Karthik: **x + 2y = 2900** ...(1). Meera: **x + 5y = 5300** ...(2).

ANSWER: x + 2y = 2900 and x + 5y = 5300.

CASE 2 (ii)

Find the monthly training fee.

1 Subtract (1) from (2): 3y = 2400, so **y = 800**.

ANSWER: The monthly fee is ₹800.

CASE 2 (iii)

Find the one-time admission fee.

1 Put y = 800 in (1): x = 2900 − 1600 = **1300**.

ANSWER: The admission fee is ₹1300.

CASE 2 (iv)

What will a student pay in total for 8 months of training?

1 Total = x + 8y = 1300 + 8(800) = 1300 + 6400 = **7700**.

ANSWER: ₹7700 in total for 8 months.

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Case Study 3 — Furniture for the New Classroom

Case Study 3 — Chairs and Tables

A school is furnishing a new classroom. The bill for 3 chairs and 2 tables is ₹2450. Another bill for 2 chairs and 3 tables is ₹2550. Let one chair cost ₹x and one table cost ₹y.

CASE 3 (i)

Form the pair of linear equations.

1. First bill: **3x + 2y = 2450** ...(1). Second bill: **2x + 3y = 2550** ...(2).

ANSWER: 3x + 2y = 2450 and 2x + 3y = 2550.

CASE 3 (ii)

Find the cost of one chair.

1. Add (1) and (2): 5x + 5y = 5000, so x + y = 1000 ...(3). Subtract (1) from (2): −x + y = 100, so y − x = 100 ...(4).
   Why: Swapped coefficients (3,2)/(2,3) — add and subtract, as the Story taught.
2. Add (3) and (4): 2y = 1100, so y = 550. From (3): x = 1000 − 550 = **450**.

ANSWER: One chair costs ₹450.

CASE 3 (iii)

Find the cost of one table.

1. From the working above, **y = 550**. Check: 3(450) + 2(550) = 1350 + 1100 = 2450; 2(450) + 3(550) = 900 + 1650 = 2550.

ANSWER: One table costs ₹550.

CASE 3 (iv)

The school later buys 4 chairs and 4 tables. Find the bill.

1. 4x + 4y = 4(x + y) = 4(1000) = **4000** — equation (3) answers this directly, without separate prices!
   Why: Sometimes the question asks for a COMBINATION you already own. Look before you compute.

ANSWER: The bill is ₹4000.

Case Study 4 — The Parking Lot

Case Study 4 — Parking Charges

A mall parking charges a car ₹x and a bike ₹y for the day. On Monday, 3 cars and 5 bikes paid ₹200 in total. On Tuesday, 5 cars and 3 bikes paid ₹280 in total.

CASE 4 (i)

Form the pair of linear equations.

1. Monday: **3x + 5y = 200** ...(1). Tuesday: **5x + 3y = 280** ...(2).

ANSWER: 3x + 5y = 200 and 5x + 3y = 280.

CASE 4 (ii)

Find the charge for one car.

1. Add: 8x + 8y = 480, so x + y = 60 ...(3). Subtract (1) from (2): 2x − 2y = 80, so x − y = 40 ...(4).
2. Add (3) and (4): 2x = 100, so **x = 50**.

ANSWER: One car is charged ₹50.

CASE 4 (iii)

Find the charge for one bike.

1. From (3): y = 60 − 50 = **10**. Check: 3(50) + 5(10) = 200; 5(50) + 3(10) = 280.

ANSWER: One bike is charged ₹10.

CASE 4 (iv)

A family arrives in 2 cars with 4 bikes. What do they pay?

1. 2x + 4y = 2(50) + 4(10) = 100 + 40 = **140**.

ANSWER: They pay ₹140.

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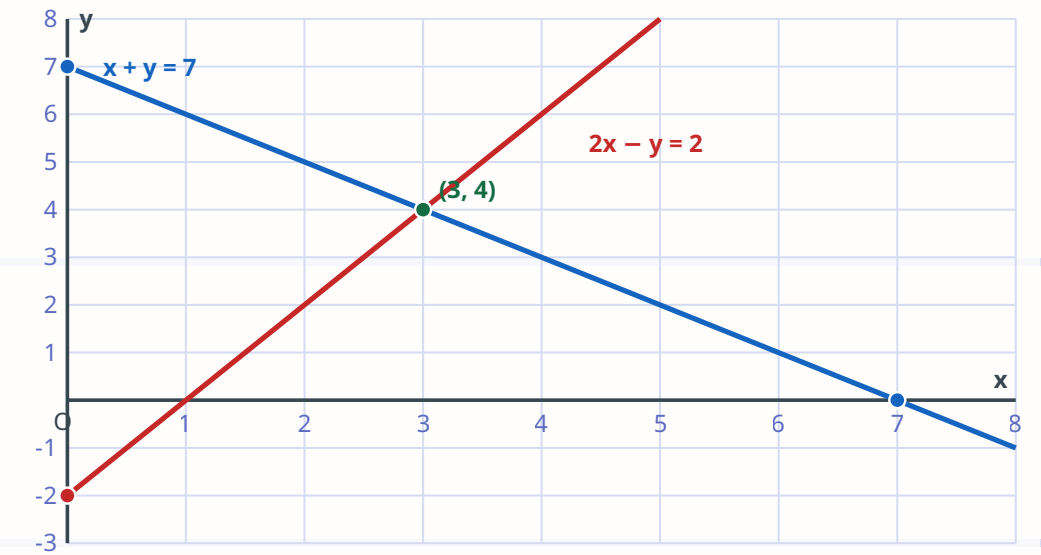
Case Study 5 — Reading a Graph (Visual Case)

Case Study 5 — Two Lines in a Weather Chart

A Class 10 student plotted two straight lines on graph paper while studying this chapter: line L_1 passes through (0, 7) and (7, 0); line L_2 passes through (0, −2) and (1, 0). The lines intersect at (3, 4), as shown.



CASE 5 (i)

Write the equation of line L_1.

1 L_1 joins (0, 7) and (7, 0): at every point of it, the coordinates add to 7 — check (0, 7): 0 + 7 = 7; (7, 0): 7 + 0 = 7. So L_1 is **x + y = 7**.

Why: When intercepts are this friendly, the equation often reads itself off the axis crossings.

ANSWER: L_1: x + y = 7.

CASE 5 (ii)

Write the equation of line L_2.

1 Test the candidate 2x − y = 2 at both known points: (0, −2): 0 + 2 = 2; (1, 0): 2 − 0 = 2. So L_2 is **2x − y = 2**.

Why: Verifying a guessed equation at TWO points proves it — one point could be luck, two points fix a line.

ANSWER: L_2: 2x − y = 2.

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Case Study 5 — Reading a Graph (continued)

CASE 5 (iii)

State the solution of the pair, and verify it algebraically.

1 From the graph, the lines meet at **(3, 4)**. Verify: $3 + 4 = 7$ and $2(3) - 4 = 2$.

ANSWER: The solution is x = 3, y = 4.

CASE 5 (iv)

Is the pair consistent? Give one more point that lies on L_1 only.

1 The lines intersect, so the pair is **consistent** with a unique solution. Any point with coordinates summing to 7 but not satisfying $2x - y = 2$ lies on L_1 only — for example **(2, 5)**: $2 + 5 = 7$, but $2(2) - 5 = -1 \neq 2$.

ANSWER: Consistent. Example point on L_1 only: (2, 5).

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Assertion–Reason Questions 1–10

For each question choose: **(a)** Both A and R are true and R is the correct explanation of A. **(b)** Both A and R are true but R is NOT the correct explanation of A. **(c)** A is true but R is false. **(d)** A is false but R is true. Answers with reasons are in the Answer Key.

AR 1. Assertion (A): The pair $2x + 3y = 5$ and $4x + 6y = 10$ has infinitely many solutions. **Reason (R):** For this pair, $a_1/a_2 = b_1/b_2 = c_1/c_2$.

AR 2. Assertion (A): The pair $x + y = 4$ and $x - y = 2$ has a unique solution. **Reason (R):** The lines representing the pair are parallel.

AR 3. Assertion (A): The pair $3x + 2y = 8$ and $6x + 4y = 20$ has no solution. **Reason (R):** Here $a_1/a_2 = b_1/b_2 \neq c_1/c_2$.

AR 4. Assertion (A): If a pair of linear equations is consistent, then its lines always intersect. **Reason (R):** Coincident lines also form a consistent pair.

AR 5. Assertion (A): (3, 2) is a solution of $x + y = 5$ and $2x - y = 4$. **Reason (R):** A point that satisfies both equations lies at the intersection of their lines.

AR 6. Assertion (A): $kx + 2y = 5$ and $3x + y = 1$ have a unique solution for every value of k. **Reason (R):** The pair has a unique solution exactly when $k \neq 6$.

AR 7. Assertion (A): The graph of every linear equation in two variables is a straight line. **Reason (R):** All solutions of $ax + by + c = 0$, when plotted, lie on one straight line.

AR 8. Assertion (A): The pair $5x - 3y = 11$ and $-10x + 6y = -22$ represents coincident lines. **Reason (R):** The second equation is exactly -2 times the first.

AR 9. Assertion (A): The substitution method cannot be applied to $3x - y = 3$ and $9x - 3y = 9$. **Reason (R):** This pair has infinitely many solutions.

AR 10. Assertion (A): The pair $x = 5$ and $y = 3$ has exactly one solution. **Reason (R):** A vertical line and a horizontal line intersect at exactly one point.

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15 Olympiad & Foundation Challenges

8D • CHALLENGE — TEN PROBLEMS FOR STUDENTS WHO THINK DEEP

OLYMPIAD 1

Solve: 6x + 5y = 37 and 5x + 6y = 40.

1. Add: 11x + 11y = 77, so **x + y = 7** ...(3). Subtract the second from the first: **x − y = −3** ...(4).
Why: Swapped coefficients (6,5)/(5,6) — by now your hand should reach for add-subtract before your brain finishes reading.

2. Add (3) and (4): 2x = 4, so **x = 2**; from (3), **y = 5**. Check: 12 + 25 = 37; 10 + 30 = 40.

ANSWER: x = 2, y = 5.

OLYMPIAD 2

The sum of the digits of a two-digit number is 11. The number obtained by reversing the digits is 27 less than the original number. Find the number.

1. Let the tens digit be x and the units digit be y. Digits: **x + y = 11** ...(1). Original number 10x + y; reversed 10y + x.

2. Reversed = original − 27: 10y + x = 10x + y − 27, so 9y − 9x = −27, i.e. **x − y = 3** ...(2).
Why: Reversing changes a number by 9 × (difference of digits) — a jewel worth remembering: (10x + y) − (10y + x) = 9(x − y).

3. Add (1) and (2): 2x = 14, so x = 7; then y = 4. The number is **74**. Check: 7 + 4 = 11; reversed 47, and 74 − 47 = 27.

ANSWER: The number is 74.

OLYMPIAD 3

A chemist has a 20% acid solution and a 50% acid solution. How many litres of each must she mix to obtain 10 litres of a 35% acid solution?

1. Let x litres of the 20% solution and y litres of the 50% solution be mixed. Total volume: **x + y = 10** ...(1).

2. Count the pure acid: 0.20x + 0.50y must equal 35% of 10 = 3.5 litres. So **0.2x + 0.5y = 3.5**, i.e. 2x + 5y = 35 ...(2).
Why: In mixture problems, write one equation for the total amount and one for the precious ingredient — here, the acid itself.

3. From (1): x = 10 − y. In (2): 2(10 − y) + 5y = 35, so 3y = 15 and **y = 5**; then **x = 5**. Check acid: 0.2(5) + 0.5(5) = 1 + 2.5 = 3.5.

Olympiad Challenges 4–6

OLYMPIAD 4

Solve: 49x + 51y = 499 and 51x + 49y = 501.

1. Add: 100x + 100y = 1000, so **x + y = 10** ...(3). Subtract the first from the second: 2x − 2y = 2, so **x − y = 1** ...(4).

2. Add (3) and (4): 2x = 11, so **x = 11/2**; from (3), **y = 9/2**. Check: 49(11/2) + 51(9/2) = (539 + 459)/2 = 998/2 = 499.
Why: Fractional answers in an olympiad problem are not a warning sign — they are often the design.

ANSWER: x = 11/2, y = 9/2.

OLYMPIAD 5

The sum of the digits of a two-digit number is 7. If 27 is added to the number, the digits are reversed. Find the number.

1. Let the digits be x (tens) and y (units): **x + y = 7** ...(1). The number is 10x + y; adding 27 gives the reversed number 10y + x.

2. 10x + y + 27 = 10y + x, so 9x − 9y = −27, i.e. **y − x = 3** ...(2).
Why: Adding a multiple of 9 reverses or preserves digit order in a controlled way — the 9(x − y) jewel from Olympiad 2 again.

3. Add (1) and (2): 2y = 10, so y = 5; then x = 2. The number is **25**. Check: 2 + 5 = 7; 25 + 27 = 52, the reverse.

ANSWER: The number is 25.

OLYMPIAD 6

Solve for x and y: 3/x + 2/y = 12 and 1/x + 1/y = 5 (x, y ≠ 0).

1. Set u = 1/x and v = 1/y. The pair becomes **3u + 2v = 12** ...(1) and **u + v = 5** ...(2) — an ordinary linear pair in disguise.
Why: Substitution of VARIABLES (not just expressions) is a higher form of the substitution method: rename the awkward objects until the problem looks familiar.

2. From (2): u = 5 − v. In (1): 3(5 − v) + 2v = 12, so 15 − v = 12 and **v = 3**; then **u = 2**.

3. Translate back: x = 1/u = **1/2** and y = 1/v = **1/3**. Check: 3/(1/2) + 2/(1/3) = 6 + 6 = 12; 1/(1/2) + 1/(1/3) = 2 + 3 = 5.
Why: Never forget the return journey: the question asked for x and y, not for u and v.

Olympiad Challenges 7–8

OLYMPIAD 7

Ten years ago, a father was four times as old as his son. Ten years from now, he will be twice as old as his son. Find their present ages.

1. Let the father's present age be x and the son's be y. Ten years ago: x − 10 = 4(y − 10), so **x − 4y = −30** ...(1).
2. Ten years hence: x + 10 = 2(y + 10), so **x − 2y = 10** ...(2).
3. Subtract (1) from (2): 2y = 40, so **y = 20**. From (2): x = 10 + 2(20) = **50**.
   Why: The x-coefficients were already equal — elimination asked for a single subtraction.
4. Check: ten years ago, 40 and 10 — 40 = 4 × 10. Ten years hence, 60 and 30 — 60 = 2 × 30.

ANSWER: The father is 50 years old and the son is 20 years old.

Olympiad Challenge 8 — Discussing a Parameter

OLYMPIAD 8

Discuss the nature of the pair 2x + 3y = 5 and 4x + ky = 10 for different values of k: for which k is the solution unique, and for which k are there infinitely many? Can the pair ever have no solution?

1. Compare ratios: $a_1/a_2 = 2/4 = 1/2$ and $c_1/c_2 = -5/-10 = 1/2$ — these two never change with k. Only $b_1/b_2 = 3/k$ moves.
   Why: A 'discuss' question is answered by cases. Fix what is fixed; watch what moves.

2. Case k = 6: $b_1/b_2 = 3/6 = 1/2$. All three ratios equal → coincident lines → **infinitely many solutions**.
   Why: Indeed at k = 6 the second equation is exactly twice the first.

3. Case k ≠ 6: $b_1/b_2 \neq 1/2 = a_1/a_2$ → intersecting lines → **unique solution**.

4. No solution would need $a_1/a_2 = b_1/b_2 \neq c_1/c_2$ — but a_1/a_2 and c_1/c_2 are BOTH permanently 1/2, so the '≠' can never happen. **No value of k gives 'no solution'.**
   Why: Sometimes the deepest answer in mathematics is 'that case is impossible' — with a reason.

ANSWER: Unique solution for every k ≠ 6; infinitely many solutions for k = 6; no solution for no value of k.

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Olympiad Challenges 9–10

OLYMPIAD 9

Two cars start at the same time from towns A and B, 300 km apart, and travel towards each other. They meet after 3 hours. If the faster car travels 20 km/h faster than the slower one, find the speed of each car.

1. Let the speeds be x km/h (faster) and y km/h (slower). Moving towards each other, their speeds ADD: in 3 hours together they cover 3(x + y) = 300, so **x + y = 100** ...(1).
Why: For objects moving towards each other, the gap closes at the SUM of the speeds — the physical picture writes the equation.
2. Speed difference: **x − y = 20** ...(2). Add (1) and (2): 2x = 120, so **x = 60**; then **y = 40**.
3. Check: in 3 hours the cars cover 180 km and 120 km — total 300 km , and 60 − 40 = 20.

ANSWER: The faster car travels at 60 km/h and the slower at 40 km/h.

OLYMPIAD 10

If the length of a rectangle is increased by 3 m and its width decreased by 2 m, its area decreases by 8 m². If the length is decreased by 2 m and the width increased by 3 m, its area increases by 12 m². Find the length and width.

1. Let the length be l m and the width be w m; the area is lw. First change: (l + 3)(w − 2) = lw − 8. Expand the left side: lw − 2l + 3w − 6 = lw − 8. The lw cancels! We get **−2l + 3w = −2** ... (1).
Why: An area problem that becomes LINEAR — the product terms cancel because both sides contain the same lw. Expansion is the key that unlocks it.
2. Second change: (l − 2)(w + 3) = lw + 12. Expand: lw + 3l − 2w − 6 = lw + 12, so **3l − 2w = 18** ...(2).
3. Eliminate l: (1) × 3 gives −6l + 9w = −6; (2) × 2 gives 6l − 4w = 36. Add: 5w = 30, so **w = 6**.
4. Put w = 6 in (1): −2l + 18 = −2, so **l = 10**. Check areas: original 10 × 6 = 60. First change: 13 × 4 = 52 = 60 − 8. Second change: 8 × 9 = 72 = 60 + 12.

ANSWER: The rectangle is 10 m long and 6 m wide.

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Find the Error — 10 Broken Solutions (Part 1)

Each solution below contains exactly one error. Your job: find it, name it, and write the corrected step. Answers are discussed right under each item — cover them while you hunt!

FIND THE ERROR 1. Solve $x + y = 7$ and $x - y = 3$. Shown: adding gives $2x = 10$, so $x = 5$. Then from $x + y = 7$, $y = 5 - 7 = -2$. Answer $(5, -2)$.

SHOWN SOLUTION: $y = 5 - 7 = -2$ — the rearrangement was done in the wrong direction.

The error: From $x + y = 7$ we get $y = 7 - x = 7 - 5 = \mathbf{2}$, not $x - 7$. Correct answer: **(5, 2)**. When you rearrange, the term that moves changes side AND the variable stays on its own side: $y = 7 - x$.

FIND THE ERROR 2. Classify $2x - 3y = 8$ and $4x - 6y = 9$. Shown: $a_1/a_2 = 1/2$, $b_1/b_2 = -3/6 = -1/2$. Since the ratios differ, the lines intersect.

SHOWN SOLUTION: b_1/b_2 was computed as $-3/6$ — but b_2 is -6, not 6.

The error: $b_1/b_2 = (-3)/(-6) = \mathbf{1/2}$. So $a_1/a_2 = b_1/b_2 = 1/2 \neq 8/9 = c_1/c_2$ (with signs, $-8/-9$) — the lines are **parallel**; the pair is inconsistent. Copy coefficients WITH their signs.

FIND THE ERROR 3. Solve $x + y = 5$ and $2x - 3y = 4$ by elimination. Shown: multiply the first equation by 3: $3x + y = 15$.

SHOWN SOLUTION: Only two of the three terms were multiplied — the y-term was left behind.

The error: Multiplying an equation multiplies EVERY term: $3x + \mathbf{3y} = 15$. Adding $2x - 3y = 4$ then gives $5x = 19$, $x = 19/5$, $y = 6/5$ (Exercise 3.3 Q1(i)).

FIND THE ERROR 4. Ages: 'Five years ago, a father was 7 times as old as his son.' Shown: the equation is $x - 5 = 7y$.

SHOWN SOLUTION: Only the father travelled back in time; the son stayed in the present.

The error: Five years ago the son was $y - 5$, so the equation is $x - 5 = 7(\mathbf{y - 5})$. In age problems, time moves every person in the story.

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Find the Error — Part 2

FIND THE ERROR 5. Digits: 'The sum of the digits of a two-digit number is 9.' Shown: the number is x + y, so x + y = 9 is also the number's value equation; with the second condition the student writes 9(9) = 2(9) and gets stuck.

SHOWN SOLUTION: x + y is the SUM of the digits, not the number. The number's value was never written down.

The error: If the digits are x (tens) and y (units), the number is **10x + y** and its reverse is 10y + x. The second condition becomes 9(10x + y) = 2(10y + x), leading to the number 18 (Exercise 3.3 Q2(iii)).

FIND THE ERROR 6. Solve x + y = 14 and x − y = 4 by substitution. Shown: y = 14 − x; then x − (14 − x) = x − 14 − x = −14 = 4, which is false, so the pair has no solution.

SHOWN SOLUTION: The bracket was opened wrongly: −(14 − x) became −14 − x.

The error: Minus in front of a bracket flips EVERY sign inside: x − (14 − x) = x − 14 **+ x** = 2x − 14 = 4, so x = 9 and y = 5. A 'false' result from substitution usually means a sign error, not an inconsistent pair.

FIND THE ERROR 7. Library: Saritha kept a book for 7 days and paid ₹27. Shown: x + 7y = 27, where x is the fixed charge for the first three days and y the daily charge.

SHOWN SOLUTION: The daily rate was charged for all 7 days, double-charging the first three days that the fixed charge already covers.

The error: Only 7 − 3 = 4 days are extra: **x + 4y = 27**. (Answer: fixed ₹15, daily ₹3 — Exercise 3.3 Q2(v).)

FIND THE ERROR 8. Graph of x + y = 5. Shown table: x = 0 gives y = 0; x = 5 gives y = 5; the student plots (0, 0) and (5, 5) and draws the line through them.

SHOWN SOLUTION: Both table entries are wrong — neither point even satisfies x + y = 5 (0 + 0 = 0; 5 + 5 = 10).

The error: y = 5 − x: x = 0 → y = **5**; x = 5 → y = **0**. Points (0, 5) and (5, 0). Test every table entry IN the equation before plotting — a 5-second habit.

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Find the Error — Part 3

FIND THE ERROR 9. Elimination: subtract 9x − 2y = 7 from 9x − 15y = 12. Shown: (9x − 15y) − (9x − 2y) = −17y = 5.

SHOWN SOLUTION: −15y − (−2y) was written as −17y — the double negative was added instead of flipped.

The error: −15y + 2y = **−13y**, so −13y = 5 and y = −5/13 (Exercise 3.3 Q1(iii)). Subtracting a negative term is the single most expensive sign error in this chapter.

FIND THE ERROR 10. Solve 3x − y = 3 and 9x − 3y = 9. Shown: substitution gives 9 = 9; the student concludes 'the equations cancel out, so there is NO solution.'

SHOWN SOLUTION: The conclusion is backwards. 9 = 9 is an identity — true for every x — not a contradiction like 9 = 5.

The error: An identity after substitution means the second equation carried no new information (it is 3 × the first): the pair has **infinitely many solutions**. A FALSE statement (0 = 5) would mean no solution; a TRUE statement (0 = 0) means infinitely many.

TOPPER TIP: If you found 8 or more errors unaided, your sign-and-sense checking is exam-ready. Note the ones that fooled you in your Error Tracker (Section 18).

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Previous Year Questions — Real CBSE Board Questions

These questions are reproduced from actual CBSE Class 10 board papers, with the year and paper identified wherever verified. Solve them exactly as you would in the hall — then check the worked solutions.

CBSE 2023 • MAIN EXAM, BASIC (430/4/3, Q1) • 1 MARK MCQ

The value of k for which the equations 3x − y + 8 = 0 and 6x − ky + 16 = 0 represent coincident lines is: (A) 1/2 (B) −1/2 (C) 2 (D) −2.

THINK FIRST: Coincident means all three ratios equal. The a-ratio and c-ratio are fixed numbers — they will tell us what the b-ratio must be.

1. $a_1/a_2 = 3/6 = 1/2$ and $c_1/c_2 = 8/16 = 1/2$.
   Why: Read c from the +8 and +16 already sitting in standard form — no sign work needed here.
2. Coincidence needs $b_1/b_2 = 1/2$ as well: $-1/-k = 1/2$, so $1/k = 1/2$ and **k = 2**.

ANSWER: Option (C): k = 2.

CBSE-STYLE MARKING SCHEME: 1 mark for the correct option.

CBSE 2023 • COMPARTMENT, STANDARD (30/C/1, Q4) • 1 MARK MCQ

The condition for which the pair of equations ax + 2y = 7 and 3x + by = 16 represent parallel lines is: (A) ab = 7/16 (B) ab = 6 (C) ab = 3 (D) ab = 2.

THINK FIRST: Parallel begins with $a_1/a_2 = b_1/b_2$. Both unknowns live in that one equation.

1. Parallel lines: a/3 = 2/b. Cross-multiply: **ab = 6**.
   Why: Cross-multiplication: a · b = 3 · 2. (The c-ratio 7/16 ≠ a/3 automatically since ab = 6 forces a/3 = 2/b and the constants are not in that proportion — the board's condition is the standard one.)

ANSWER: Option (B): ab = 6.

CBSE-STYLE MARKING SCHEME: 1 mark for the correct option.

Previous Year Questions — MCQ 3: The 'Not Equal To' Pattern

CBSE 2024 • MAIN EXAM, BASIC (430/2/3, Q14) • 1 MARK MCQ

The value of p for which the pair of equations $-2x + 3y - 9 = 0$ and $4x + py + 7 = 0$ has a unique solution is: (A) $p \neq 6$ (B) $p = 6$ (C) $p = -6$ (D) $p \neq -6$.

THINK FIRST: Unique solution needs $a_1/a_2 \neq b_1/b_2$ — an inequality, so the answer will be a 'not equal to' statement.

1 $-2/4 \neq 3/p$, i.e. $-1/2 \neq 3/p$. Cross-multiplying the equality case: $p = 3 \div (-1/2) = -6$ would BREAK uniqueness, so uniqueness holds exactly when **$p \neq -6$**.

Why: Solve the forbidden case first (where the ratios WOULD be equal), then exclude it — the standard way to handle every '≠' condition.

ANSWER: Option (D): $p \neq -6$.

CBSE-STYLE MARKING SCHEME: 1 mark for the correct option.

Previous Year Questions — Short Answer

CBSE 2023 • MAIN EXAM, BASIC (430/1/1, Q24)

Solve for x and y: x + y = 6 and 2x − 3y = 4.

THINK FIRST: Substitution from the first equation — and do not be surprised by fractions; this board answer is fractional by design.

1. From (1): **y = 6 − x** ...(3). Substitute in (2): 2x − 3(6 − x) = 4, so 2x − 18 + 3x = 4, giving 5x = 22 and **x = 22/5**.
2. From (3): y = 6 − 22/5 = **8/5**. Verify: 22/5 + 8/5 = 30/5 = 6; 2(22/5) − 3(8/5) = (44 − 24)/5 = 4.
   Why: This is the question Section 04 warned about: no graph could ever give you 22/5 exactly. Algebra earns its keep.

ANSWER: x = 22/5, y = 8/5.

CBSE-STYLE MARKING SCHEME: 1 mark for the one-variable equation • 1 mark for both values (2 marks).

CBSE 2024 • MAIN EXAM, STANDARD (30/1/1, Q21)

Solve the following system of linear equations: 7x − 2y = 5 and 8x + 7y = 15, and verify your answer.

THINK FIRST: The word 'verify' is printed in the question — the verification is part of the answer, not an optional extra.

1. (1) × 7: 49x − 14y = 35. (2) × 2: 16x + 14y = 30. Add: 65x = 65, so **x = 1**.
   Why: Eliminate y: coefficients 2 and 7 become 14 and 14 with opposite signs.
2. Put x = 1 in (1): 7 − 2y = 5, so **y = 1**.
3. Verify in (1): 7(1) − 2(1) = 5. Verify in (2): 8(1) + 7(1) = 15.
   Why: Both originals checked, as ordered.

ANSWER: x = 1, y = 1 — verified in both equations.

CBSE-STYLE MARKING SCHEME: 1 mark for elimination • ½ mark for x • ½ mark for y and verification (2 marks).

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Previous Year Questions — The Swapped-Coefficient Specials

CBSE 2024 • COMPARTMENT, STANDARD (30/S/1, Q30)

Find the values of x and y from the following pair of linear equations: 62x + 43y = 167 and 43x + 62y = 148.

THINK FIRST: 62 and 43 are swapped between the equations — CBSE is testing whether you see the add–subtract door instead of the multiplication wall.

1. Add: 105x + 105y = 315. Divide by 105: **x + y = 3** ...(3).
2. Subtract the second from the first: 19x − 19y = 19. Divide by 19: **x − y = 1** ...(4).
3. Add (3) and (4): 2x = 4, so **x = 2**; from (3), **y = 1**. Verify: 62(2) + 43(1) = 124 + 43 = 167; 43(2) + 62(1) = 86 + 62 = 148.
   Why: Ninety seconds with structure, versus ten minutes with 62 × 43. The board rewards the eye, not the arm.

ANSWER: x = 2, y = 1.

CBSE-STYLE MARKING SCHEME: 1 mark for forming x + y and x − y • 1 mark for both values (2–3 marks).

CBSE 2023 • COMPARTMENT, BASIC (430/C/2, Q33)

36 pens and 24 pencils together cost ₹780, while 24 pens and 36 pencils together cost ₹720. Find the cost of one pen and of one pencil.

1. Let a pen cost ₹x and a pencil ₹y: **36x + 24y = 780** ...(1) and **24x + 36y = 720** ...(2). Divide both by 12: **3x + 2y = 65** ...(1′) and **2x + 3y = 60** ...(2′).
   Why: Divide FIRST — both equations share the factor 12. Small numbers are a gift; accept gifts.
2. Add (1′) and (2′): 5x + 5y = 125, so x + y = 25 ...(3). Subtract (2′) from (1′): x − y = 5 ...(4).
3. Add (3) and (4): 2x = 30, so **x = 15**; then **y = 10**. Check: 36(15) + 24(10) = 540 + 240 = 780; 24(15) + 36(10) = 360 + 360 = 720.

ANSWER: One pen costs ₹15 and one pencil costs ₹10.

CBSE-STYLE MARKING SCHEME: 1 mark for the equations • 1 mark for simplifying/solving • 1 mark for both prices (3 marks).

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Previous Year Questions — The Famous k

CBSE BOARD EXAM QUESTION (asked in the board examination; a perennial favourite)

For what value of k will the following pair of linear equations have infinitely many solutions? kx + 3y − (k − 3) = 0 and 12x + ky − k = 0.

THINK FIRST: This is the mirror image of Reasoning 1 (Section 12), where the same pair was asked for NO solution. Together they are the most repeated parameter question in CBSE history.

1. Infinitely many solutions need $a_1/a_2 = b_1/b_2 = c_1/c_2$: here that is $k/12 = 3/k = (k - 3)/k$.
   Why: The equations are already in standard form — $c_1 = -(k - 3)$ and $c_2 = -k$, and the two minus signs cancel inside the ratio.
2. From $k/12 = 3/k$: $k^2 = 36$, so $k = 6$ or $k = -6$.
3. Test both in $3/k = (k - 3)/k$, i.e. $3 = k - 3$ (for $k \neq 0$): this forces **k = 6**. ($k = -6$ fails: $3/-6 = -1/2$ but $(-6 - 3)/-6 = 3/2$.)
   Why: Both candidates must face the third ratio — the same lesson as Reasoning 1, from the other side.
4. Conclusion: for **k = 6**, all three ratios equal 1/2 and the lines coincide.

ANSWER: k = 6.

CBSE-STYLE MARKING SCHEME: 1 mark for the condition • 1 mark for $k^2 = 36$ • 1 mark for rejecting −6 via the third ratio (3 marks).

PIN POINT

Board pattern recognition: swapped coefficients (62, 43) → add & subtract. Parameter k in two places → ratios + test BOTH roots. The words 'and verify' → verification carries marks. CBSE repeats PATTERNS, not just questions.

16

Chapter Mind Map

THE WHOLE CHAPTER ON ONE PAGE — REVISE FROM HERE

PAIR OF LINEAR EQUATIONS IN TWO VARIABLES

$a_1x + b_1y + c_1 = 0$ • $a_2x + b_2y + c_2 = 0$ • a solution = a point on BOTH lines

THE THREE PICTURES

Intersecting → 1 solution → consistent
Parallel → 0 solutions → inconsistent
Coincident → infinitely many → consistent, dependent
Never exactly two — proved in Reasoning 3.

↔

THE RATIO TEST

$a_1/a_2 \neq b_1/b_2$ → unique
$a_1/a_2 = b_1/b_2 \neq c_1/c_2$ → none
all three equal → infinitely many
Derived from slopes AND from elimination (Sec. 06).
Read c from ax + by + c = 0!

↔

GRAPHICAL METHOD

Table of values (3 points per line) → plot → draw → read the meeting point.
Parallel → 'no solution'.
Coincident → list points of the line.

SUBSTITUTION

Isolate a variable (coefficient 1 is cheapest) → substitute into the OTHER equation → solve → back-substitute → verify.
Ends in 0 = 0? Infinitely many. Ends in 0 = 5? None.

↔

ELIMINATION

Scale to equal coefficients → add (opposite signs) or subtract (same signs) → solve → back-substitute → verify.
Swapped coefficients? Add & subtract directly.

↔

WORD PROBLEMS

Declare x, y → one sentence = one equation.
Ages: move everyone through time. Digits: 10x + y.
Fares/fees: fixed + rate × quantity.
Notes: one equation counts notes, one counts value.

The one-line summary

Two lines can only cross, run parallel, or coincide — the ratios tell you which, substitution and elimination find the point, and verification in BOTH original equations makes the answer unbreakable.

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Pin-Point Flash Cards — Cards 1–8

How to use these cards

Cut along the dashed borders and keep the 16 cards in your pocket or pencil box. Revise them on your Smart Memory days (Day 3, Day 7, Day 14, Day 21, Day 30): read the title, SAY the fact aloud from memory, then flip to check. Any card you cannot say instantly goes back into the 'today' pile. Ninety seconds a day — and the whole chapter lives in your head.

UNIQUE SOLUTION

$a_1/a_2 \neq b_1/b_2$ → the lines intersect at exactly ONE point.

NO SOLUTION

$a_1/a_2 = b_1/b_2 \neq c_1/c_2$ → the lines are PARALLEL and never meet.

INFINITELY MANY SOLUTIONS

$a_1/a_2 = b_1/b_2 = c_1/c_2$ → the lines COINCIDE — one line drawn twice.

CONSISTENT

A pair with AT LEAST ONE solution: intersecting or coincident lines.

INCONSISTENT

A pair with NO solution: parallel, distinct lines.

DEPENDENT PAIR

A consistent pair with infinitely many solutions — the second equation repeats the first.

WHAT IS A SOLUTION?

A pair (x, y) satisfying BOTH equations — the point lying on BOTH lines.

EVERY EQUATION IS A LINE

The graph of ax + by + c = 0 is always a straight line; every solution is a point on it.

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Pin-Point Flash Cards — Cards 9–16

THE c-SIGN TRAP

Read c only from ax + by + c = 0. For 2x + 3y = 7, c = −7, never 7.

SUBSTITUTION CUE

Use it when a variable has coefficient 1 or −1 — isolate it without fractions.

ELIMINATION CUE

Make one variable's coefficients equal: ADD if signs are opposite, SUBTRACT if they are the same.

SWAPPED COEFFICIENTS?

ax + by = p, bx + ay = q → ADD for x + y, SUBTRACT for x − y. No big multiplications!

THE 0 = 0 / 0 = 5 RULE

Everything cancels? 0 = 0 → infinitely many solutions. 0 = 5 → no solution.

VERIFY — ALWAYS

Substitute your (x, y) into BOTH ORIGINAL equations. Ten seconds; unbreakable answers.

GRAPHICAL SOLUTION

Solution = coordinates of the intersection point. Your table of values carries marks — show 3 points per line.

WORD-PROBLEM FIRST STEP

Declare x and y in words, with units. One sentence of the story = one equation.

TOPPER TIP: *Make your own 17th card: the mistake YOU made most recently, written as a rule. Personal cards are remembered longest — that is why the Error Tracker exists.*

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17 Active Recall

8D • RECALL — CLOSE THE BOOK, THEN ANSWER

No peeking. Answer all fifteen in your notebook from memory alone — the struggle to remember IS the learning. Answers are in the Answer Key.

Rapid Questions (10)

R1. State the ratio conditions for (a) a unique solution, (b) no solution, (c) infinitely many solutions.

R2. Solve mentally: $x + y = 13$ and $x - y = 7$.

R3. Is (4, 3) a solution of $2x + y = 11$ and $x - y = 1$? How do you check?

R4. Classify the pair $5x + 2y = 9$ and $10x + 4y = 15$ without solving.

R5. Solve by substitution: $y = 3x$ and $x + y = 16$.

R6. Solve by elimination: $5x + 2y = 19$ and $5x - 2y = 11$.

R7. Find k if $x + 3y = 7$ and $2x + ky = 14$ are coincident.

R8. Two numbers differ by 5 and add up to 31. Find them.

R9. A taxi charges a fixed ₹40 plus ₹15 per km. Write the fare F for a ride of d km as an equation.

R10. The lines of a pair are parallel and distinct. How many solutions does the pair have? What is such a pair called?

Recall Prompts (5) — say each aloud, in full sentences

P1. Define a consistent pair and an inconsistent pair.

P2. Define a dependent pair. Give one example.

P3. When is substitution the smartest method? When is elimination?

P4. State the add–subtract trick: for which shape of pair does it work, and what does adding give?

P5. Write the general form of a pair of linear equations in two variables, and say what a 'solution' of the pair means geometrically.

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18 Self-Assessment & Mastery Tracker

KALVIYOGI SMART MEMORY SYSTEM — LEARN IT, THEN KEEP IT

Learning once is not learning forever. Your brain keeps what it revisits on a schedule. Follow this plan — each visit is short, and each has a named job.

Day	Your activity	Done
Day 0	Pre-learning assessment: attempt the Quick Check (Section 02) and Rapid Questions R1–R5 cold. Note your score honestly.	☐
Day 1	Learn the chapter (Sections 01–08) and complete Level 1–2 practice.	☐
Day 3	Without-book recall: Flash Cards 1–16 aloud + Active Recall (Section 17).	☐
Day 7	Independent problem-solving: **Day 7 Mini-Test** (next pages) + Level 3 practice.	☐
Day 14	Mixed practice: Model Test A + Find-the-Error re-check + Flash Cards.	☐
Day 21	Long-term recall test: **Day 21 Mini-Test** + Model Test B.	☐
Day 30	Chapter mastery assessment: **Day 30 Mini-Test** + Model Test C + PYQ set, timed.	☐

Error Tracker — every error is a lesson with your name on it

Question / source	What went wrong	The rule I now follow

Method Recall Tracker — can you still do it without the book?

☐ Ratio test (all three cases) ☐ Graphical method with table ☐ Substitution ☐ Elimination ☐ Add–subtract trick ☐ Ages ☐ Digits ☐ Fares & fees ☐ Notes & value ☐ Verification habit

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Mastery Tracker — Concept Scores and Learning Time

Concept Mastery Score — rate yourself 0 (lost), 1 (shaky), 2 (solid) after each test day

Concept	Day 7	Day 21	Day 30
Forming equations from stories			
Graphical method & tables of values			
Ratio test & consistency			
Substitution method			
Elimination method			
Word problems: ages, digits, fares, notes			
Parameter (k) questions			

Mastery target: every row at 2 by Day 30. Any row still at 0 or 1 → revisit that section, redo its NCERT questions, and re-test after two days.

Learning Time Tracker

Session	Minutes	Session	Minutes
Learning (Day 1)		Day 14 mixed practice	
Day 3 recall		Day 21 test	
Day 7 test		Day 30 mastery	

TOPPER TIP: *Your Day 7, Day 21 and Day 30 Mini-Tests are printed on the next three pages. Sit them like real exams: timed (20 minutes each), no book, no phone. Answers are in the Answer Key.*

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Smart Memory Mini-Test — Day 7

Day 7 Mini-Test — 10 questions, 20 minutes, closed book. Full steps in your notebook; answers in the Answer Key.

1. Solve: $x + y = 9$ and $x - y = 5$.

2. Classify the pair $3x + 2y = 6$ and $6x + 4y = 12$ (intersecting / parallel / coincident) and state the number of solutions.

3. Solve by substitution: $y = 2x$ and $x + y = 12$.

4. Find k so that $2x + ky = 6$ and $4x + 6y = 14$ represent parallel lines.

5. Solve by elimination: $3x + 2y = 12$ and $x + 2y = 8$.

6. Two numbers add up to 50 and differ by 14. Find them.

7. Does the point (4, 1) satisfy BOTH $2x - y = 7$ and $x + y = 6$? Justify.

8. Write the x-intercept and y-intercept points of the line $2x + 3y = 6$.

9. Two supplementary angles differ by 40°. Find them.

10. Solve: $x + y = 5$ and $3x - y = 3$.

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Smart Memory Mini-Test — Day 21

Day 21 Mini-Test — 10 questions, 20 minutes, closed book. Full steps in your notebook; answers in the Answer Key.

1. Solve: $5x - 2y = 8$ and $3x + 2y = 8$.

2. Classify the pair $4x - 2y = 6$ and $6x - 3y = 9$.

3. A fraction becomes 5/9 if 2 is added to both the numerator and the denominator. If 1 is subtracted from the numerator alone, it becomes 2/7. Find the fraction.

4. Find k so that $kx + 2y = 4$ and $2x + y = 3$ have no solution.

5. Solve: $x + y = 11$ and $2x - y = 4$.

6. A mother is four times as old as her daughter. In 6 years, she will be three times as old. Find their present ages.

7. Solve: $0.5x + 0.5y = 2.5$ and $0.3x - 0.1y = 0.7$. (Clear the decimals first.)

8. Write down one inconsistent pair of linear equations and prove it is inconsistent using ratios.

9. The sum of the digits of a two-digit number is 13. The number is 27 more than the number obtained by reversing its digits. Find the number.

10. Solve: $4x + 3y = 24$ and $2x - 3y = -6$.

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Smart Memory Mini-Test — Day 30 (Mastery)

Day 30 Mini-Test — 10 questions, 20 minutes, closed book. Full steps in your notebook; answers in the Answer Key.

1. Solve: 5x + 3y = 21 and 2x + 3y = 12.

2. Classify the pair x − 2y = 3 and 3x − 6y = 12.

3. Solve: 8x + 5y = 44 and 3x + 5y = 29.

4. A taxi's fixed charge plus 6 km costs ₹92; the same fixed charge plus 10 km costs ₹132. Find the fixed charge and the per-km rate.

5. Find k so that 3x + ky = 9 and 6x + 6y = 18 represent coincident lines.

6. Solve: x/2 + y/3 = 8 and x − y = −9.

7. The perimeter of a rectangle is 44 m and its length exceeds its width by 4 m. Find both dimensions.

8. Solve using the add–subtract trick: 53x + 47y = 247 and 47x + 53y = 253.

9. Is (0, 5) the solution of x + y = 5 and 2x + y = 5? Is it the ONLY solution? Justify both answers.

10. The sum of two numbers is 96. The larger number is 8 more than three times the smaller. Find both numbers.

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Chapter Model Test A — Basics (20 Marks, 40 Minutes)

Section A — MCQs (1 mark each)

A1. The solution of $x + y = 4$ and $x - y = 2$ is (A) (3, 1) (B) (1, 3) (C) (2, 2) (D) (4, 0)

A2. The lines $2x + y = 5$ and $4x + 2y = 10$ are (A) parallel (B) coincident (C) intersecting (D) perpendicular

A3. A pair has a unique solution exactly when (A) $a_1/a_2 = b_1/b_2$ (B) $a_1/a_2 \neq b_1/b_2$ (C) all ratios are equal (D) $c_1 = c_2$

A4. The point (1, 2) is a solution of (A) $x + y = 4$ (B) $x - y = 2$ (C) $x + y = 3$ (D) $2x + y = 6$

Section B — Short answers (2 marks each)

B1. Solve: $3x + y = 11$ and $x - y = 1$.

B2. Classify the pair $5x - 2y = 8$ and $10x - 4y = 20$ using ratios.

B3. Solve by substitution: $x = 2y$ and $x + y = 9$.

Section C — (3 marks each)

C1. Solve graphically: $x + y = 5$ and $x - y = 1$. (Show tables of values.)

C2. The sum of two numbers is 64 and their difference is 18. Find the numbers.

Section D — (4 marks)

D1. Four chairs and three tables cost ₹3100. Two chairs and one table cost ₹1300. Find the cost of one chair and one table, solving by elimination.

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Chapter Model Test B — Standard (20 Marks, 40 Minutes)

Section A — MCQs (1 mark each)

A1. The pair x + ky = 4 and 2x + 6y = 8 is coincident when k equals (A) 2 (B) 3 (C) 4 (D) 6

A2. Which pair has no solution?
(A) x + y = 3; 2x + 2y = 6 (B) 3x + y = 7; 6x + 2y = 9 (C) x − y = 1; x + y = 2 (D) 2x − y = 4; x + y = 5

A3. The solution of 2x − y = 3 and x + y = 6 is (A) (2, 4) (B) (3, 3) (C) (4, 2) (D) (1, 5)

A4. A fare is ₹30 fixed plus ₹15 per km. The fare for 7 km is
(A) ₹105 (B) ₹120 (C) ₹135 (D) ₹150

Section B — Short answers (2 marks each)

B1. Solve by elimination: 4x + 3y = 19 and 2x − 3y = 5.

B2. Solve 3x + 2y = 13 and x + y = 5, and hence find m if y = mx + 1 passes through the solution point.

B3. Determine, with ratios, whether 6x − 3y = 12 and 2x − y = 4 are consistent. If yes, state the number of solutions.

Section C — (3 marks each)

C1. A fraction becomes 8/11 if 3 is added to both the numerator and the denominator. If 2 is subtracted from both, it becomes 1/2. Find the fraction.

C2. A is 27 years older than B. Ten years from now, A will be twice as old as B. Find their present ages.

Section D — Case (4 × 1 mark)

D1. A city bus charges a fixed boarding fee plus a per-km fare. A 5 km ride costs ₹65 and a 9 km ride costs ₹105. (i) Form the pair of equations, taking the fixed fee as ₹x and the per-km fare as ₹y. (ii) Find the per-km fare. (iii) Find the fixed fee. (iv) Find the fare for 15 km.

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Chapter Model Test C — Advanced (20 Marks, 40 Minutes)

Section A — MCQs (1 mark each)

A1. For the pair 6x + 5y = 37 and 5x + 6y = 40, the value of x − y is (A) 3 (B) −3 (C) 7 (D) −7

A2. Which pair has the solution (2, 3)?
(A) 3x + 2y = 11; x − y = 1 (B) 3x + 2y = 12; x − y = −1 (C) x + y = 6; 2x − y = 0 (D) 2x + 3y = 12; x + y = 4

A3. The pair 2x + 3y = 7 and 4x + 6y = k has infinitely many solutions when k equals
(A) 7 (B) 10 (C) 14 (D) 21

A4. If x + y = 10 and x − y = 4, then xy equals (A) 40 (B) 24 (C) 21 (D) 14

Section B — Short answers (2 marks each)

B1. Solve: 4/x + 3/y = 18 and 1/x − 1/y = 1 (x, y ≠ 0).

B2. Find k so that kx + 2y = 7 and 6x + 3y = 11 have no solution.

B3. Solve using the add–subtract trick: 37x + 43y = 197 and 43x + 37y = 203.

Section C — (3 marks each)

C1. The sum of a two-digit number and the number obtained by reversing its digits is 110. The digits differ by 2, and the tens digit is the larger one. Find the number.

C2. Show that the three lines x + y = 5, 2x − y = 4 and 3x + y = 11 are concurrent (pass through a single common point), and find that point.

Section D — Case (4 × 1 mark)

D1. A sweet maker mixes a 30% sugar syrup with a 60% sugar syrup to prepare 12 litres of 45% syrup. (i) Form the pair of equations for the litres x (of 30%) and y (of 60%). (ii) Find x. (iii) Find y. (iv) Verify the sugar content of your mixture.

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Answer Key — Graded Practice (Section II)

Level 1 — Foundation

L1.1 x = 5, y = 3. **L1.2** x = 4, y = 3. **L1.3** Parallel (1/2 = 1/2 ≠ 7/10 in c-ratio, using standard form −7/−10): no solution. **L1.4** x = 2, y = 1. **L1.5** 3(2) + k(1) = 7 → k = 1. **L1.6** Any equation with x:y pattern 1:2 but a different constant, e.g. 2x + 4y = 9 (ratios 1/2 = 2/4 ≠ −4/−9).

Level 2 — Skill Builder

L2.1 x = 3, y = 2. **L2.2** Add the equations: 7x = 28 → x = 4, y = 3. **L2.3** x = 3, y = 8 (clear fractions: 4x + 3y = 36 with x − y = −5). **L2.4** 50 and 24. **L2.5** x = 2, y = 4. **L2.6** Unique solution iff k/3 ≠ 2/1, i.e. all k ≠ 6.

Level 3 — Application

L3.1 Fixed fee ₹20; per-km rate ₹16; 20 km ride = 20 + 20(16) = ₹340. **L3.2** Father 36 years, son 12 years. **L3.3** Notebook ₹25, pen ₹10. **L3.4** Length 16 m, width 11 m.

Level 4 — Advanced Reasoning

L4.1 Add: 200(x + y) = 1000 → x + y = 5. Subtract: −2x + 2y = −2 → y − x = −1. Hence x = 3, y = 2. **L4.2** Coincidence needs 2/(k + 1) = 3/(2k − 1) = 7/(4k + 1). From the first and third: 2(4k + 1) = 7(k + 1) → k = 5 (check: 2/6 = 3/9 = 7/21 = 1/3). **L4.3** With u = 1/x, v = 1/y: 2u + 3v = 13, 5u − 4v = −2 → u = 2, v = 3 → x = 1/2, y = 1/3.

Level 5 — Mathematical Genius

L5.1 x = 3, y = 2. $x^2 - y^2 = (x - y)(x + y) = 1 \times 5 =$ **5**. $xy = ((x + y)^2 - (x - y)^2)/4 = (25 - 1)/4 =$ **6**. $x^3 - y^3 = (x - y)(x^2 + xy + y^2) = 1 \times (9 + 6 + 4) =$ **19** (with $x^2 + y^2 = (x + y)^2 - 2xy = 25 - 12 = 13$, so $x^2 + xy + y^2 = 13 + 6 = 19$). **L5.2** Digits x, y: 10x + y = 4(x + y) → y = 2x; reversed exceeds original by 27 → 9(y − x) = 27 → y − x = 3. Hence x = 3, y = 6 — the number is **36**.

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Answer Key — Concept MCQs (with one-line explanations)

MCQ 1. (B) — 3 + 2 = 5 and 3 − 2 = 1.

MCQ 2. (B) — Ratios 1/2, 1/2, but constants 7 vs 15 are not in ratio 1/2 — parallel.

MCQ 3. (B) — Unique solution ⇔ $a_1/a_2 \neq b_1/b_2$.

MCQ 4. (C) — The second equation is exactly twice the first — coincident.

MCQ 5. (B) — 3(2) + k(1) = 8 → k = 2.

MCQ 6. (B) — A vertical and a horizontal line meet at (3, −2).

MCQ 7. (C) — Unique iff k/3 ≠ 2, i.e. k ≠ 6 — every other k works.

MCQ 8. (A) — x = (35 + 13)/2 = 24, y = 11.

MCQ 9. (B) — Adding: 3x = 9 → x = 3 (then y = 4).

MCQ 10. (C) — Ratios 1/2, 1/2, 5/8 — parallel, no solution.

MCQ 11. (B) — Coincident + consistent = dependent.

MCQ 12. (B) — Adding gives 2x = 0; then y = 0.

MCQ 13. (A) — First × 3 gives 6y; second × 2 gives −6y — they cancel on adding.

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Answer Key — MCQs 14–25 and Assertion–Reason

MCQ 14. (B) — $6 + 3y = 12 \rightarrow y = 2$.

MCQ 15. (B) — y^2 makes $x + y^2 = 4$ non-linear.

MCQ 16. (C) — Every linear equation in two variables graphs as a straight line.

MCQ 17. (C) — $5/7 \neq -4/6$ — intersecting (Exercise 3.1 Q2(i)).

MCQ 18. (C) — $1/2 = 2/k \rightarrow k = 4$, and the c-ratio $5/10 = 1/2$ agrees.

MCQ 19. (C) — $x + x = 180 \rightarrow x = 90°$.

MCQ 20. (B) — $3/2 \neq 2/-3$ — intersecting, hence consistent.

MCQ 21. (D) — One equation, two unknowns: a whole line of solutions.

MCQ 22. (A) — x stands with coefficient 1 — isolate it directly.

MCQ 23. (C) — Tens digit × 10 + units digit.

MCQ 24. (B) — $20 + 12 \times 9 = 20 + 108 = 128$.

MCQ 25. (C) — Consistent = intersecting OR coincident.

Assertion–Reason (Section 14)

AR1 (a) — ratios are 1/2, 1/2, 1/2; R states exactly why A holds.

AR2 (c) — A is true ($1/1 \neq 1/-1$, solution (3, 1)); R is false — the lines intersect, they are not parallel.

AR3 (a) — $3/6 = 2/4 = 1/2 \neq 8/20 = 2/5$; R is the correct explanation.

AR4 (d) — A is false (coincident pairs are consistent without intersecting); R is true.

AR5 (a) — $3 + 2 = 5$ and $6 - 2 = 4$; R explains the geometry of it.

AR6 (d) — A is false: $k = 6$ destroys uniqueness. R is true.

AR7 (a) — R is precisely the reason A holds.

AR8 (a) — $-2 \times (5x - 3y = 11)$ gives $-10x + 6y = -22$ exactly; R explains A.

AR9 (d) — A is false: substitution works and reveals the identity $9 = 9$. R is true.

AR10 (a) — $x = 5$ (vertical) and $y = 3$ (horizontal) meet only at (5, 3); R explains A.

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Answer Key — Active Recall and Mini-Tests

Active Recall (Section 17)

R1 Unique: $a_1/a_2 \neq b_1/b_2$; none: $a_1/a_2 = b_1/b_2 \neq c_1/c_2$; infinitely many: all three equal. **R2** (10, 3). **R3** Yes — 2(4) + 3 = 11 and 4 − 3 = 1; check by substituting into both equations. **R4** Parallel: 5/10 = 2/4 = 1/2 ≠ 9/15 = 3/5 (c-ratio with signs: −9/−15). **R5** x = 4, y = 12. **R6** x = 3, y = 2. **R7** k = 6. **R8** 18 and 13. **R9** F = 40 + 15d. **R10** Zero solutions; the pair is inconsistent.

P1 Consistent: at least one solution exists. Inconsistent: none exists. **P2** Dependent: consistent with infinitely many solutions, e.g. x + y = 5 with 2x + 2y = 10. **P3** Substitution when a variable has coefficient ±1; elimination when coefficients are equal/opposite/easy multiples. **P4** For swapped coefficients ax + by = p, bx + ay = q: adding gives (a + b)(x + y) = p + q. **P5** $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$; a solution is a point lying on both lines.

Day 7 Mini-Test

1 (7, 2). **2** Coincident — infinitely many solutions. **3** x = 4, y = 8. **4** k = 3 (a-ratio 2/4 = 1/2; parallel needs k/6 = 1/2, and the c-ratio −6/−14 = 3/7 ≠ 1/2 confirms parallel, not coincident). **5** x = 2, y = 3. **6** 32 and 18. **7** No: 2(4) − 1 = 7 but 4 + 1 = 5 ≠ 6 — it satisfies only the first equation. **8** x-intercept (3, 0); y-intercept (0, 2). **9** 110° and 70°. **10** x = 2, y = 3.

Day 21 Mini-Test

1 x = 2, y = 1. **2** Coincident (all ratios 2/3). **3** 3/7. **4** k = 4 (k/2 = 2/1; c-ratio 4/3 ≠ 2 confirms 'no solution', not coincidence). **5** x = 5, y = 6. **6** Mother 48, daughter 12. **7** x = 3, y = 2. **8** Example: x + y = 4 and 2x + 2y = 10 — ratios 1/2 = 1/2 ≠ 4/10. **9** 85. **10** x = 3, y = 4.

Day 30 Mini-Test

1 x = 3, y = 2. **2** Parallel (1/3 = 1/3 ≠ 3/12). **3** x = 3, y = 4. **4** Fixed ₹32; ₹10 per km. **5** k = 3. **6** x = 6, y = 15. **7** Length 13 m, width 9 m. **8** x = 2, y = 3. **9** Yes, it satisfies both (0 + 5 = 5; 0 + 5 = 5); and it is the ONLY solution because the ratios 1/2 ≠ 1/1 show the lines intersect. **10** 74 and 22.

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Answer Key — Chapter Model Tests

Model Test A — Basics

A1 (A). **A2** (B). **A3** (B). **A4** (C). **B1** x = 3, y = 2. **B2** Ratios 1/2, 1/2, 2/5 — parallel (inconsistent). **B3** y = 3, x = 6. **C1** Lines meet at (3, 2): x = 3, y = 2. **C2** 41 and 23. **D1** Chair ₹400, table ₹500.

Model Test B — Standard

A1 (B) k = 3. **A2** (B) — ratios 1/2, 1/2, 7/9. **A3** (B). **A4** (C) ₹135. **B1** x = 4, y = 1. **B2** x = 3, y = 2; then 2 = 3m + 1 → m = 1/3. **B3** All ratios equal 3 — consistent, infinitely many solutions (coincident). **C1** 5/8. **C2** A is 44, B is 17. **D1** (i) x + 5y = 65, x + 9y = 105. (ii) ₹10 per km. (iii) Fixed ₹15. (iv) 15 + 15(10) = ₹165.

Model Test C — Advanced

A1 (B) −3. **A2** (B). **A3** (C) k = 14. **A4** (C) 21. **B1** u = 1/x = 3, v = 1/y = 2 → x = 1/3, y = 1/2. **B2** k = 4 (k/6 = 2/3; c-ratio 7/11 ≠ 2/3). **B3** x = 3, y = 2 (add: 80(x + y) = 400; subtract: −6x + 6y = −6). **C1** 64 (digits sum to 10 and differ by 2: 6 and 4). **C2** The first two lines meet at (3, 2), and 3(3) + 2 = 11, so the third line passes through the same point — concurrent at (3, 2). **D1** (i) x + y = 12 and 0.3x + 0.6y = 5.4. (ii) x = 6 litres. (iii) y = 6 litres. (iv) Sugar = 0.3(6) + 0.6(6) = 1.8 + 3.6 = 5.4 litres = 45% of 12.

TOPPER TIP: Scored below 14/20 on a Model Test? The test has told you exactly which section to revisit — that is not failure, that is a map.

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Revision Card — Chapter 3 on One Page

The pair and its three fates

$a_1x + b_1y + c_1 = 0$, $a_2x + b_2y + c_2 = 0$.

Intersecting ($a_1/a_2 \neq b_1/b_2$): one solution, consistent.

Parallel ($a_1/a_2 = b_1/b_2 \neq c_1/c_2$): no solution, inconsistent.

Coincident (all ratios equal): infinitely many solutions, consistent and dependent.

The three methods

Graphical: table (3 points) → plot → read the meeting point.
Substitution: isolate (coefficient ±1 first) → substitute → solve → back-substitute.
Elimination: equalise coefficients → add/subtract → solve → back-substitute.
Add–subtract: swapped coefficients → add for x + y, subtract for x − y.
Always: verify in BOTH original equations.

Word-problem dictionary

Ages: past/future shifts apply to EVERY person. **Digits:** number = 10x + y; reverse = 10y + x; reversal changes the number by 9(x − y). **Fares & fees:** total = fixed + rate × quantity; watch for 'first three days free inside the fixed charge'. **Notes & coins:** one equation counts items, the other counts value. **Fractions:** cross-multiply each condition into a linear equation.

Traps that cost marks every year

c read without its sign • multiplying only some terms • −(a − b) opened wrongly • answering with only x • verifying in a modified equation • announcing both k-roots without testing them in the third ratio.

End of Chapter 3 — Pair of Linear Equations in Two Variables.

Next: Chapter 4 — Quadratic Equations. | 369 Tesla • KalviYogi • Edunivra Pvt Ltd

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