1 Recurring Decimals

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TERMINATING OR RECURRING?

- Write the **denominator** in **prime factor form**.
- Only **2s and/or 5s** → **terminating**.
- **Any other prime** → **recurring**.
- Simplify the fraction **first**.

TESTING FRACTIONS

$\frac{3}{50} = \frac{3}{2\times5^2}$ → **terminating**

$\frac{19}{75} = \frac{19}{3\times5^2}$ → **recurring** (has a 3)

$\frac{7}{8}, \frac{3}{20}, \frac{3}{25}$ → **terminating**

$\frac{1}{3}, \frac{1}{6}, \frac{7}{55}$ → **recurring**

DOT NOTATION

- $0.\dot{4}$ means 0.4444…
- $0.\dot{2}\dot{7}$ means 0.272727…
- Dots go on the **first and last** digit of the repeating block.

CONVERTING TO A FRACTION

1. Let **x** = the decimal; write the digits out a few times.
2. **Multiply** by 10, 100 or 1000 — one 0 per repeating digit.
3. **Subtract** the two lines so the decimals cancel.
4. **Divide** to find x, then **simplify**.

ONE REPEATING DIGIT

Convert $0.\dot{2}$

$x = 0.2222\ldots$

$10x = 2.2222\ldots$

Subtract: $9x = 2$

$\mathbf{x = \frac{2}{9}}$

TWO REPEATING DIGITS

Convert $0.\dot{5}\dot{4}$

$x = 0.545454\ldots$

$100x = 54.545454\ldots$

Subtract: $99x = 54$

$x = \frac{54}{99} = \mathbf{\frac{6}{11}}$

WHICH POWER OF 10?

Repeating	Multiply by	Gives
1 digit	10	9x
2 digits	100	99x
3 digits	1000	999x

MORE PRACTICE

$0.\dot{7} = \mathbf{\frac{7}{9}}$

$0.\dot{2}\dot{7} = \frac{27}{99} = \mathbf{\frac{3}{11}}$

Every recurring decimal is a **rational** number.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✕ Multiplying by the **wrong power of 10** for the block length.
- ✕ Not lining the decimals up, so they **do not cancel**.
- ✕ Forgetting to **simplify** the final fraction.
- ✕ Testing for terminating **before simplifying** the fraction.
- ✕ Thinking a recurring decimal is **irrational**.

Revise it: convert $0.\dot{7}$ and $0.\dot{2}\dot{7}$ with the answers covered.

2 Parallel & Perpendicular Lines

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THE TWO RULES

Parallel: $m_1 = m_2$

Perpendicular: $m_1 \times m_2 = -1$

- Always rearrange to $y = mx + c$ first.

NEGATIVE RECIPROCAL

- To get the perpendicular gradient: **flip it and change the sign**.
- $m = 2 \rightarrow -\frac{1}{2}$
- $m = -\frac{3}{4} \rightarrow \frac{4}{3}$
- $m = -1 \rightarrow 1$

FINDING A PARALLEL LINE

Line parallel to $y = 3x + 1$ through (2, 11).

Same gradient: $m = 3$

$y = 3x + c$

$11 = 3(2) + c \rightarrow c = 5$

$\mathbf{y = 3x + 5}$

FINDING A PERPENDICULAR LINE

Perpendicular to $y = 2x - 3$ through (4, 1).

New gradient: $-\frac{1}{2}$

$1 = -\frac{1}{2}(4) + c \rightarrow c = 3$

$\mathbf{y = -\frac{1}{2}x + 3}$

REARRANGING FIRST

- $2y = 6x + 4 \rightarrow y = 3x + 2$, so $m = 3$.
- $4x + 2y = 10 \rightarrow y = -2x + 5$, so $m = -2$.
- Reading m **before** rearranging is a very common slip.

FINDING THE LINE THROUGH TWO POINTS

Through (1, 4) and (3, 10):

$m = \frac{10 - 4}{3 - 1} = 3$

$4 = 3(1) + c \rightarrow c = 1$

$\mathbf{y = 3x + 1}$

QUICK CHECKS

- Perpendicular gradients have **opposite signs** (one up, one down).
- Multiply them — you must get **−1**.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✕ Using the **reciprocal without the minus**, or the minus without flipping.
- ✕ Not **rearranging** into $y = mx + c$ before reading the gradient.
- ✕ Finding m correctly but then **not finding c**.
- ✕ Substituting the point into the **original** line rather than the new one.
- ✕ Leaving the answer as a gradient when a **full equation** was asked for.

Revise it: find a parallel and a perpendicular line through a given point.

3 Graphical Inequalities

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SOLID OR DASHED?

Sign	Line	Why
≤ ≥	**Solid**	points on it count
< >	**Dashed**	points on it do not

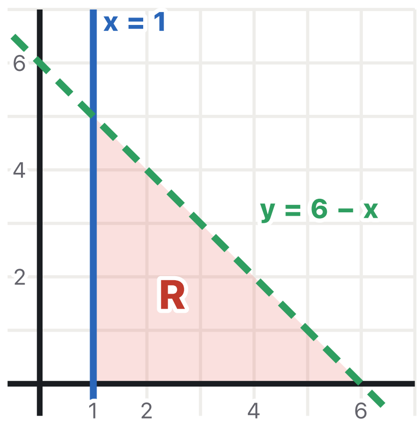
THE METHOD

1. Draw each line as if it were =.
2. Solid for ≤ ≥, dashed for < >.
3. **Test a point** to find the correct side.
4. Shade and **label** the region **R**.

TESTING A POINT

- Use (0, 0) whenever the line does not pass through it.
- $y < 2x + 1$ at (0,0): $0 < 1$ **true**, so shade the side containing the origin.

A SHADED REGION



Solid lines are included; the **dashed** line is not.

WORKED EXAMPLE

Shade the region: $x \geq 1$, $y \geq 0$, $y < 6 - x$

$x = 1$ — solid vertical line.

$y = 0$ — solid, the x-axis.

$y = 6 - x$ — **dashed**.

Test (2, 1): $1 < 4$ **true** → shade that side.

READING A REGION

- Write one inequality **per boundary line**.
- Check the **sign direction** by testing a point inside the region.
- Match **solid/dashed** to ≤≥ or <>.

INTEGER POINTS

- Count only points **inside** the region.
- Points on a **solid** line count; on a **dashed** line they do not.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✕ Solid and dashed lines the **wrong way round**.
- ✕ Shading the **wrong side** — always test a point.
- ✕ Not **labelling** the region **R**.
- ✕ Shading over the region so the lines cannot be seen.
- ✕ Including points on a **dashed** boundary when listing integer solutions.

Revise it: sketch the three boundaries and shade R.

4 Graphical Simultaneous Equations

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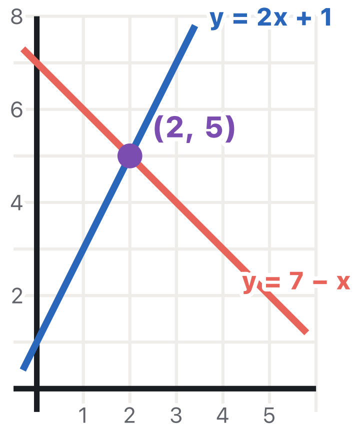
THE BIG IDEA

- The **solution** is where the graphs **cross**.
- The point of intersection satisfies **both** equations at once.
- Write the answer as x = ... and y = ...

TWO LINES CROSSING



Read the **x** and **y** of the crossing point.

THE METHOD

1. Rearrange each equation to y = mx + c.
2. Draw **both** lines accurately on the same axes.
3. Find where they **cross**.
4. Read off **x** and **y**, then **check** in both equations.

DRAWING THE LINES

- Use a **table of values**, or plot c and step by the gradient.
- Use a **ruler** and extend right across the grid.
- Plot at least **three** points — the third checks the other two.

CHECKING

- Put your x and y into **both** equations.
- Both must be **true** — if not, re-read the crossing point.

CURVE AND LINE

- A **curve** and a **line** can cross **twice** — giving **two** pairs of solutions.
- Read off **both** crossing points.
- A tangent touches once → **one** solution.
- No crossing → **no** solutions.

SOLVING AN EQUATION FROM A GRAPH

- To solve $x^2 = 4$, draw $y = x^2$ and y = 4.
- The **x-values** where they cross are the solutions.
- Here x = 2 and x = −2.

ACCURACY

- Graphical answers are **estimates** — read to the nearest small square.
- If an exact answer is needed, use the **algebra** method (Part 5).

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✕ Giving only **x** when both **x and y** are needed.
- ✕ Reading the crossing point off the **wrong axis**.
- ✕ Missing the **second** intersection with a curve.
- ✕ Drawing lines **freehand** so the crossing point is inaccurate.
- ✕ Not **checking** the answer in both equations.

Revise it: draw two lines and read off where they cross.

5 Linear Simultaneous Equations

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ELIMINATION METHOD

1. **Match** the coefficients of one letter.
2. **Add** if the signs differ, **subtract** if they are the same.
3. Solve for the letter that is left.
4. **Substitute** back to find the other letter.
5. **Check** in the equation you did not use.

MATCHING FIRST

$3x + 2y = 12$ ❶

$x + y = 5$ ❷

❷ × 2: $2x + 2y = 10$

❶ − that: $x = 2$

$2 + y = 5$ → $\mathbf{y = 3}$

Check in ❶: $6 + 6 = 12$ ✓

FORMING THE EQUATIONS

3 teas and 2 coffees cost £7.40.

1 tea and 2 coffees cost £4.60.

$3t + 2c = 7.40$

$t + 2c = 4.60$

Subtract: $2t = 2.80$ → **t = £1.40**

$1.40 + 2c = 4.60$ → **c = £1.60**

SIGNS DIFFER → ADD

$2x + y = 11$

$3x - y = 9$

Add: $5x = 20$ → $\mathbf{x = 4}$

$2(4) + y = 11$ → $\mathbf{y = 3}$

SAME SIGNS → SUBTRACT

- If both terms are $+2y$ (or both $-2y$), **subtract**.
- If one is $+2y$ and the other $-2y$, **add**.
- Subtracting a negative is where most sign errors happen.

SETTING OUT

- **Number** your equations ❶ ❷ and say what you did.
- Line up the **x** terms, **y** terms and numbers in columns.
- Give **both** answers with units where needed.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✗ **Adding when you should subtract** (or the reverse) — check the signs.
- ✗ Multiplying only **part** of an equation when matching coefficients.
- ✗ Sign errors when subtracting a **negative** term.
- ✗ Finding one letter and **stopping**.
- ✗ Not **checking** in the second equation.

Revise it: solve both worked examples with the answers covered.

Non-Linear Graphs

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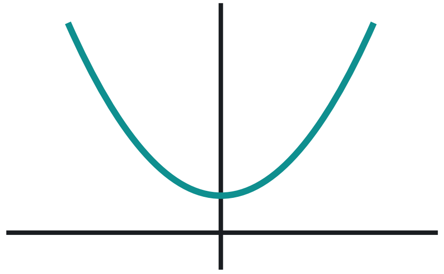
QUADRATIC — A PARABOLA

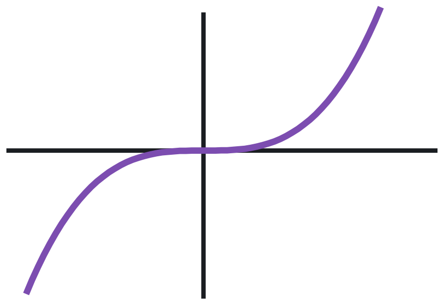


U-shaped. If x^2 is **negative** it flips upside down.

QUADRATICS

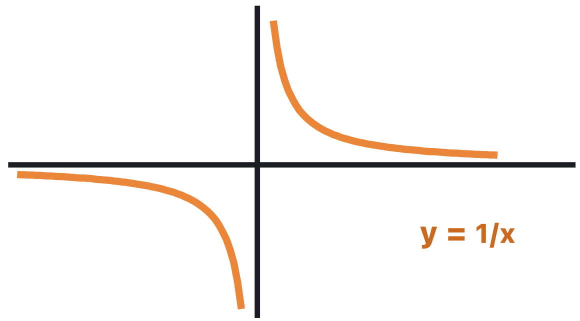
- Highest power is x^2.
- Symmetrical about a vertical line through the **turning point**.
- The turning point is the **minimum** (or maximum if flipped).
- Crosses the x-axis where $y = 0$ — the **roots**.

CUBIC



Always **increasing** — flattens at the origin but never turns back.

RECIPROCAL



Two branches. Never touches either axis.

RECOGNISING THE SHAPE

Equation	Shape
$y = mx + c$	Straight line
$y = x^2$	Parabola (U)
$y = -x^2$	Parabola (∩)
$y = x^3$	S-shape
$y = 1/x$	Two branches

DRAWING A CURVE

- Make a **table of values** — be careful squaring negatives.
- Plot every point, then join with a **smooth curve**.
- **Never** join curve points with straight lines.
- Do not draw a **flat bottom** at the turning point.

USING THE GRAPH

- **Roots:** where the curve crosses $y = 0$.
- **Turning point:** the lowest or highest point.
- Draw a horizontal line to solve $y =$ a number.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✕ Joining points with **straight lines** instead of a smooth curve.
- ✕ Squaring a negative wrongly in the table: $(-3)^2 = 9$, not -9.
- ✕ A **flat** or pointed turning point instead of a smooth curve.
- ✕ Giving only **one** root when a parabola has two.
- ✕ Joining the **two branches** of a reciprocal graph.