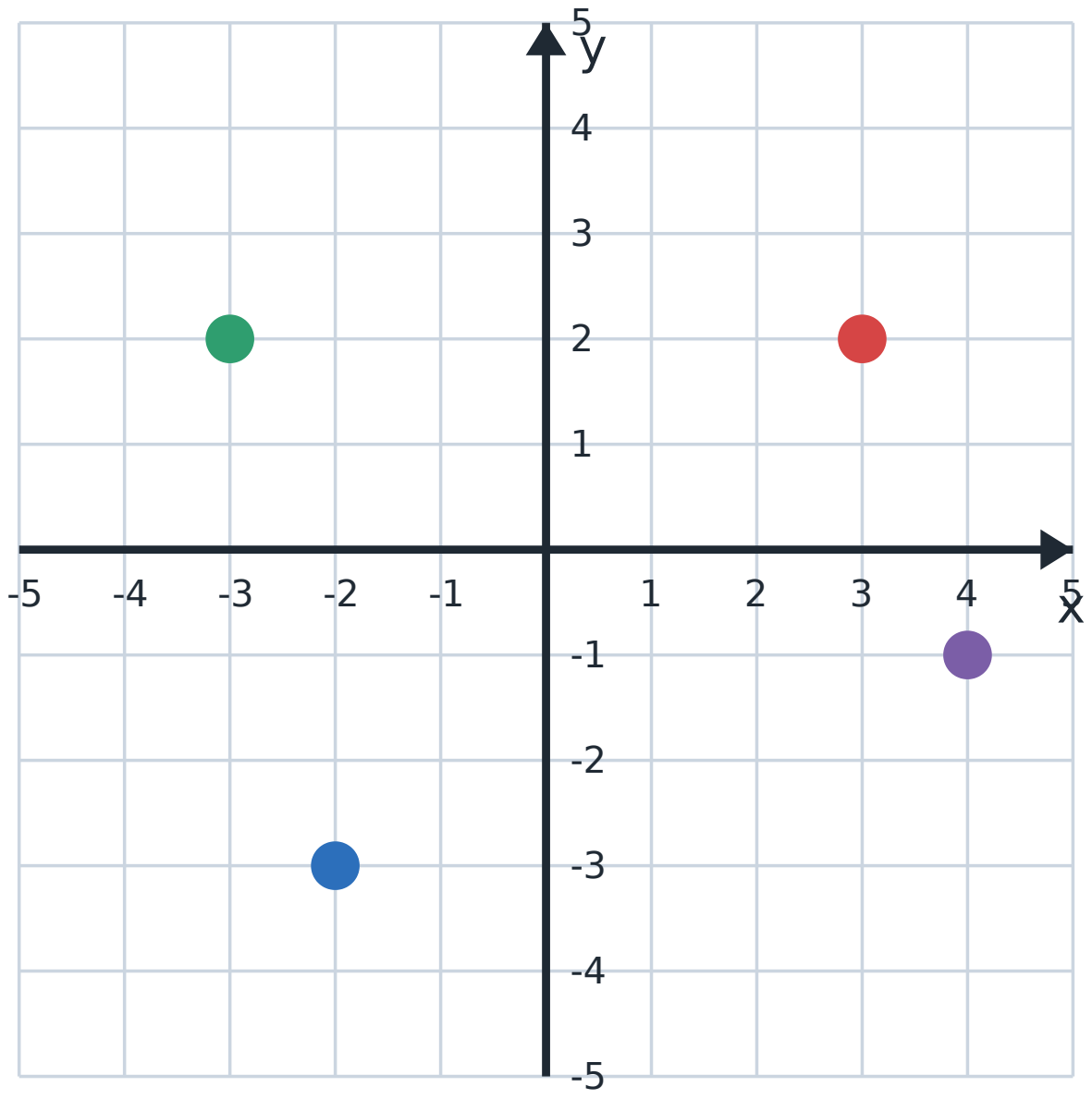
Extension & Challenge — Coordinates, Transformations & Angles

Part A — The Cartesian Plane

The Cartesian plane has two number lines: the horizontal **x**-axis and the vertical **y**-axis. A point is written (x, y) — across first, then up or down. The axes divide the plane into four **quadrants**.

> **Worked example.** To plot $(-3, 2)$: start at the origin, move 3 left (because x is negative), then 2 up. That point sits in the 2nd quadrant.



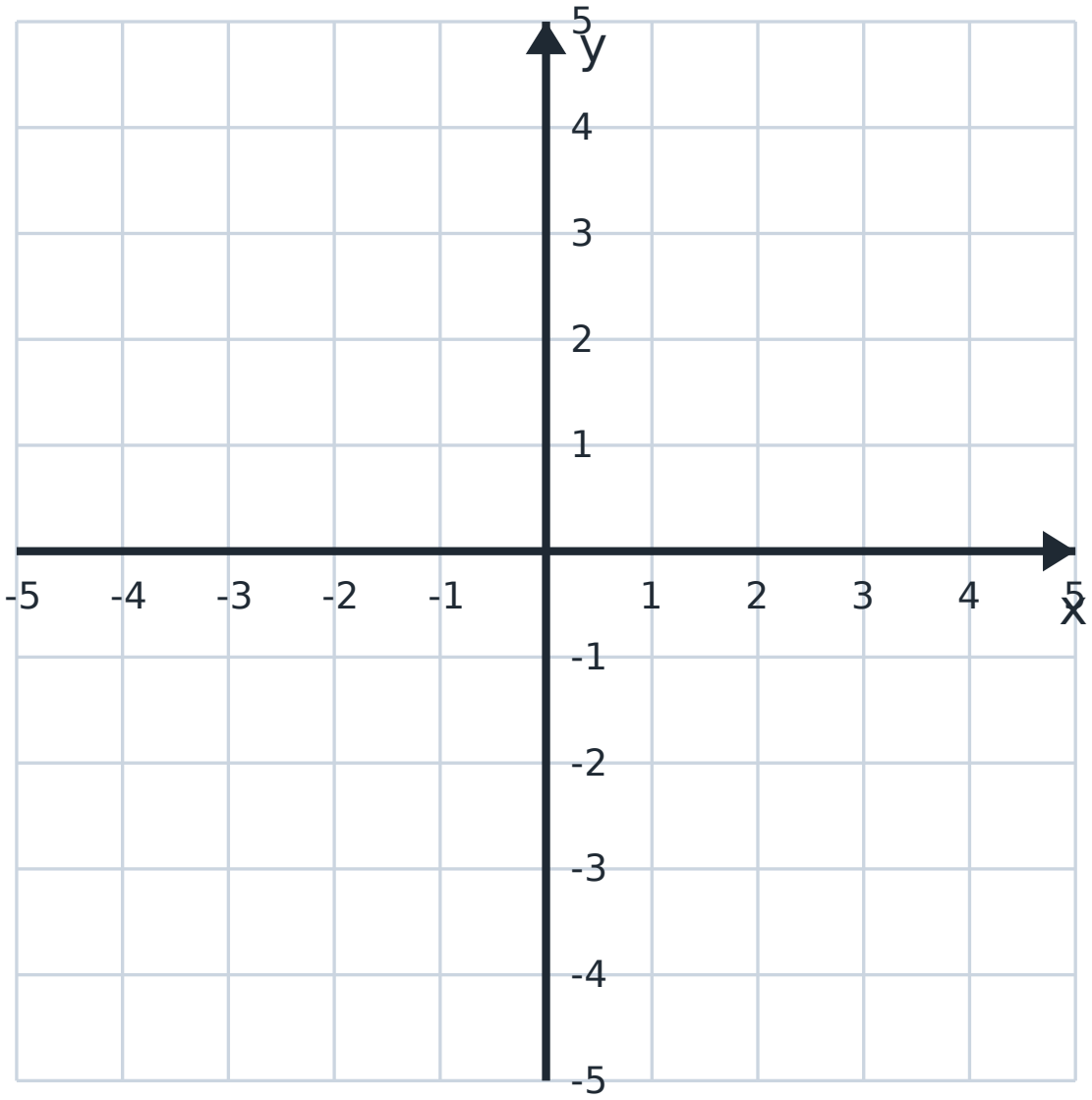
Four points plotted on the Cartesian plane.

1 Write the coordinates of each plotted point.

Red: _____ Green: _____ Blue: _____ Purple: _____

2 Which quadrant (1st, 2nd, 3rd or 4th) is each point in?

3 On the blank grid below, plot and label these points: $P(-4, 3)$, $Q(0, -2)$, $R(5, 5)$, $S(-1, -4)$.



Plot your points here.

4 Three corners of a square are $(1, 1)$, $(1, 4)$ and $(4, 4)$. What are the coordinates of the fourth corner?

Answer: _____

5 Reflect the point $(3, 2)$ in the x-axis. What are the new coordinates?

Answer: _____

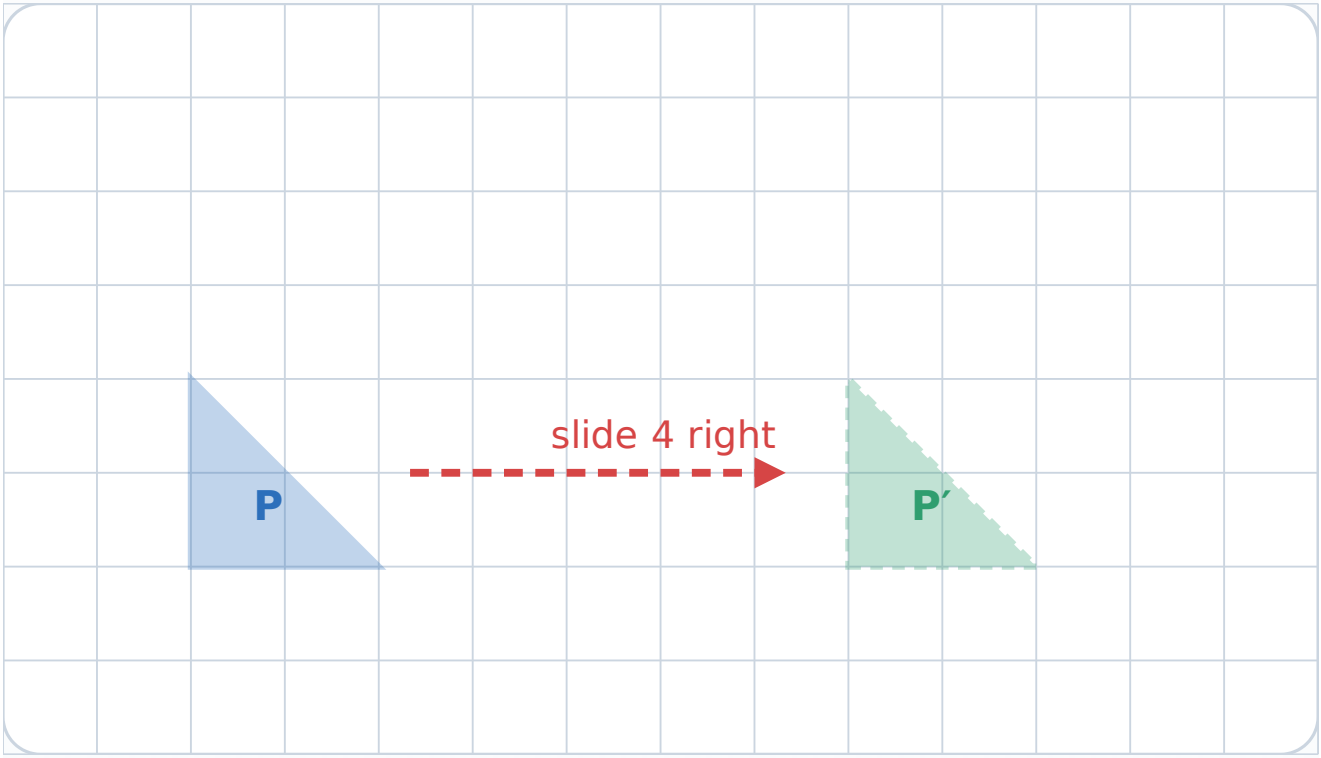
6 **Reasoning.** A point sits in the 1st quadrant. Its x and y values are equal and add to 8. What is the point?

Answer: _____

Part B — Transformations

There are three transformations that keep a shape the same size and shape (congruent): a **translation** (slide), a **reflection** (flip), and a **rotation** (turn).

> **Worked example.** Sliding a shape 4 right and 0 up is a translation. Every point moves the same way, so a corner at $(1, 2)$ lands at $(5, 2)$.



Triangle P is translated (slid) 4 units right to P′.

1 Describe the transformation that maps triangle P onto triangle P' above. Use the correct word and say how far and in which direction.

2 A vertex of triangle P is at $(2, 3)$. After the slide of 4 units right, where is that vertex?

Answer: _____

3 Name the transformation in each case:

(a) a shape is flipped over a mirror line _____

(b) a shape is turned about a point _____

(c) a shape is slid without turning _____

4 After a transformation, a shape is the same size and the same shape but facing the opposite way. Which transformation was it most likely to be? Explain.

5 **Reasoning.** Which of translation, reflection and rotation keep a shape **congruent** (identical in size and shape)?

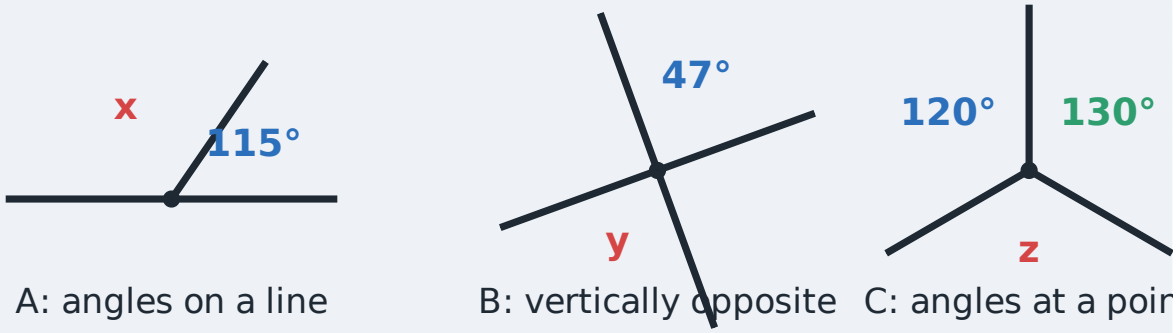
6 **Open challenge.** Write a set of instructions to move a shape from the bottom-left of a grid to the top-right using exactly two different transformations.

Part C — Angles

Three angle facts unlock most problems: angles on a straight line add to $180°$, angles at a point add to $360°$, and vertically opposite angles are equal.

> **Worked example.** Two angles lie on a straight line and one is $115°$. The other is $180° - 115° = 65°$.

Find the missing angles



Diagrams A, B and C for the angle challenges.

1 Find each missing angle in the diagram above. Give a reason for each.

(a) $x =$ _____ (angles on a line)

(b) $y =$ _____ (vertically opposite)

(c) $z =$ _____ (angles at a point)

2 Two angles sit on a straight line. One is $130°$. What is the other?

Answer: _____

3 Four angles meet at a point. Three of them are $90°$, $100°$ and $80°$. Find the fourth.

Answer: _____

4 Classify each angle as acute, right, obtuse or reflex: $45°$, $90°$, $135°$, $220°$.

5 The three angles of a triangle are $60°$, $70°$ and one unknown. Find the unknown angle.

Answer: _____

6 **Prove it.** Explain why vertically opposite angles are *always* equal. (Hint: both share an angle on a straight line.)