# Coordinate geometry: the Cartesian plane

Lesson plan and teacher's notes · Form 2 Mathematics · 1 period of 40 minutes

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|---|---|---|---|
| **School** | (write school name) | **Teacher** | (write name) |
| **Date** | (date) | **Class** | Form 2 |
| **Subject** | Mathematics | **Enrolment** | Boys ___ Girls ___ Total ___ |
| **Time** | 40 minutes | **Topic** | Coordinate geometry: the Cartesian plane |

Learners describe a location in more than one way, name the parts of the Cartesian plane, and plot and read points written as ordered pairs (x, y). The lesson ends with a human coordinate plane outside the classroom.

## Specific outcomes

By the end of the lesson, learners should be able to:

1. Describe a location in more than one way
2. Name the x-axis, the y-axis, the origin and the quadrants of the Cartesian plane
3. Plot a point from an ordered pair (x, y)
4. Read the coordinates of a point on the plane

## Prior knowledge

- Number lines
- Counting steps left, right, up and down
- Using a ruler to draw straight lines

## Teaching and learning materials

- chalk and board
- ruler
- squared paper or exercise books
- chalk or string to mark a large grid on the ground
- bottle tops or small stones as points

## References

Ministry of Education (CDC) Form 2 Mathematics syllabus and module; 25Schools learners' note: Coordinate geometry: the Cartesian plane.

## Lesson development

| Stage and time | Teacher activities | Learner activities |
|---|---|---|
| **Introduction**<br>**5 min** | Ask learners to describe where the school office is so that a visitor finds it without guessing. Collect relative position, directions with landmarks and a grid reference such as (C, 4). | Describe the same place in two or three ways. |
| **Development: the Cartesian plane**<br>**10 min** | Draw a horizontal and a vertical number line crossing each other. Name the x-axis, the y-axis, the origin (0, 0) and the four quadrants. | Copy the diagram and label the axes, the origin and the four parts. |
| **Development: plotting and reading**<br>**12 min** | Show how to plot (3, 2): start at the origin, 3 steps right, then 2 steps up. Show that (3, 2) and (2, 3) are different points. Show how to read a point by counting along the x-axis first. | Plot four points and read the coordinates of four points given on the board. |
| **Development: human coordinate plane**<br>**10 min** | Mark a large grid on the ground, label the origin and the axes, and call out moves such as 2 steps to the right and 3 steps up. | Take turns to stand on the origin and walk to each point called out. |
| **Conclusion**<br>**3 min** | Ask why the order of x and y matters. Set the homework. | Answer and copy the homework. |

## Teacher's content notes

Read these before the lesson. They are what you need to know, not what to copy onto the board.

### Describing where something is

Coordinate geometry is the part of mathematics that locates and describes the position of points on a plane using ordered pairs (x, y). It is used in maps and GPS, in architecture and engineering, in computer graphics and in the navigation systems of cars and aeroplanes. A place at school can be described by a relative position, by directions with landmarks, or by a grid reference such as (C, 4). A grid gives a position that anyone can find without guessing.

### The Cartesian plane

The Cartesian plane is a system used to locate points on a plane. It is made by drawing a horizontal number line, the x-axis, and a vertical number line, the y-axis, crossing each other. The point where the axes meet is the origin, written (0, 0). It is the reference point for locating every other point. The two axes divide the plane into four parts called quadrants.

### Plotting and reading ordered pairs

A point is written as an ordered pair (x, y). The x-coordinate always comes first and the y-coordinate second. The order matters, because (3, 2) and (2, 3) are different points. To plot (3, 2), start at the origin, move 3 steps to the right along the x-axis, then 2 steps up. To read a point, count how many steps it is from the origin along the x-axis first, then up or down.

### Human coordinate plane

Mark a large grid on the ground, label the origin and the two axes, and let one learner stand on the origin. When the teacher calls out a move, such as 2 steps to the right and 3 steps up, the learner walks to that point.

## Questions to ask during the lesson

| Question | Expected answer |
|---|---|
| A visitor does not know the school and asks where the staff room is. (a) Give a relative position. (b) Give directions using a landmark. (c) Say why a grid reference such as (C, 4) is better than the first two. | (a) For example behind the classroom. (b) For example walk straight and turn left at the office. (c) A grid gives a position anyone can find without guessing. |
| A learner draws two number lines that cross on the board. (a) Say which line is horizontal and which is vertical. (b) Give the coordinates of the point where they meet. (c) State how many quadrants the plane has. | (a) The x-axis is horizontal and the y-axis is vertical. (b) (0, 0). (c) Four. |
| A learner is told to plot the point (4, 1) from the origin. (a) State how many steps to move along the x-axis. (b) State how many steps to move up. (c) Say which coordinate you use first. | (a) 4 steps right. (b) 1 step up. (c) The x-coordinate. |
| Two learners claim that (3, 2) and (2, 3) are the same point. (a) Say how to plot (3, 2). (b) Say how to plot (2, 3). (c) Say whether they are the same and why. | (a) 3 right then 2 up. (b) 2 right then 3 up. (c) No, because the order of x and y matters. |

## Worked examples for the board

### Example 1: two learners on the grid

Learner A starts at the origin and moves 3 steps right, then 2 steps up. So the point is (3, 2). Learner B moves 3 steps up, then 2 steps right, so B is 2 right and 3 up and the point is (2, 3). The points are different because the order of x and y matters.

### Example 2: plotting a point

To plot (4, 1) start at the origin. Move 4 steps right along the x-axis, then 1 step up. Mark the point.

### Example 3: reading a point

A point is 5 steps to the right of the origin and 2 steps up. Count along the x-axis first, so the x-coordinate is 5, then up, so the y-coordinate is 2. The point is (5, 2).

## Board plan

Write the title. Left: three ways to describe a place. Centre: the Cartesian plane with the axes, the origin and the point (3, 2). Right: the steps for plotting a point, then the two points (3, 2) and (2, 3).

| Part | What it is |
|---|---|
| x-axis | The horizontal number line |
| y-axis | The vertical number line |
| Origin | The point where the axes meet, (0, 0) |
| Quadrant | One of the four parts into which the axes divide the plane |
| Ordered pair | (x, y) with x first and y second |

Parts of the Cartesian plane

## Mistakes to expect

| Learners often think | Put it right |
|---|---|
| (3, 2) and (2, 3) are the same point. | The order matters. (3, 2) is 3 right and 2 up. (2, 3) is 2 right and 3 up. They are different points. |
| The y-coordinate comes first when plotting. | The x-coordinate always comes first and the y-coordinate second. Count along the x-axis first, then up. |
| The origin is at (1, 1). | The origin is where both x and y are zero, so it is written (0, 0). |
| The x-axis is the vertical line. | The x-axis is the horizontal number line and the y-axis is the vertical number line. |

## Differentiation

### Learners who struggle

Give learners squared paper with the axes already drawn and labelled. Say the rule aloud with them: along the corridor first, then up the stairs.

### Learners who finish early

Ask learners who finish early to plot four points that they choose, join them in order, and describe the shape to a partner by giving only the ordered pairs.

### Hearing or visual impairment

For learners with visual impairment, make the axes with string or raised lines and let learners feel and walk the steps on the ground grid. For learners with hearing impairment, write each move on the board, such as 2 right and 3 up, and show it with gestures before the walk.

### No projector, no printing

Draw the grid on the ground with chalk or a stick, or on the board. Use stones or bottle tops as points. No squared paper is needed if learners rule a grid in their exercise books.

### If time is short

Teach the parts of the Cartesian plane and how to plot a point. Leave the human coordinate plane for the next lesson.

## Evaluation

| Question or task | A correct answer shows |
|---|---|
| A visitor asks a learner how to find the school library. (a) Give a relative position. (b) Give directions with a landmark. (c) Give a grid reference of the form (letter, number) and say why it is clear to anyone. | (a) For example next to the office. (b) For example walk straight and turn left at the office. (c) For example (C, 4). A grid names a place so anyone can find it without guessing. |
| Learner A starts at the origin and moves 3 steps right then 2 steps up, and learner B starts at the origin and moves 3 steps up then 2 steps right. (a) Give the point where A stops. (b) Give the point where B stops. (c) Say whether they stop at the same point and why. | (a) (3, 2). (b) (2, 3). (c) No, because the order of x and y matters. |
| A teacher draws a horizontal line and a vertical line crossing at a point on the board. (a) Name the horizontal line and the vertical line. (b) Name the point where they meet and give its coordinates. (c) State how many quadrants the plane has. | (a) The x-axis and the y-axis. (b) The origin, (0, 0). (c) Four. |

### Homework

A learner marks a grid on the ground and wants to place a stone at (4, 1) and another at (1, 4). (a) Say how to plot (4, 1) from the origin. (b) Say how to plot (1, 4) from the origin. (c) Say whether the two stones are at the same place and why.

## Extra practice with answers

| Question | Answer |
|---|---|
| 1. A learner starts at the origin of a ground grid and the teacher calls out 2 steps to the right and 3 steps up. (a) Say where she stands. (b) Write the ordered pair. (c) Say which number is the x-coordinate. | (a) 2 right and 3 up from the origin. (b) (2, 3). (c) 2. |
| 2. A learner plots the points (1, 4), (4, 1) and (0, 0) on a grid. (a) Say how to plot (1, 4). (b) Say how to plot (4, 1). (c) Say what the point (0, 0) is called. | (a) 1 right then 4 up. (b) 4 right then 1 up. (c) The origin. |
| 3. A point on a plane is 6 steps right of the origin and 3 steps up. (a) Give the x-coordinate. (b) Give the y-coordinate. (c) Write the ordered pair. | (a) 6. (b) 3. (c) (6, 3). |

| | |
|---|---|
| 4. A class marks a large grid on the ground and labels the origin and the two axes. (a) Say what must be labelled first. (b) Say what the learner on the origin does when told 2 right and 3 up. (c) Say why this is a good way to practise. | (a) The origin and the two axes. (b) Walks 2 steps right then 3 steps up. (c) Learners walk the steps and see how the coordinates place a point. |
| 5. A learner says there are three quadrants because the plane has three parts. (a) Say what divides the plane into quadrants. (b) State the number of quadrants. (c) Say what x and y are at the origin. | (a) The two axes. (b) Four. (c) Both are zero. |

### Answers to the learners' check-yourself questions

1. Which axis is horizontal, and which is vertical?
   **The x-axis is horizontal and the y-axis is vertical.**
2. What are the coordinates of the origin?
   **(0, 0).**
3. How many quadrants does the Cartesian plane have?
   **Four.**
4. Starting at the origin, how do you plot the point (4, 1)?
   **Move 4 steps right along the x-axis, then 1 step up.**
5. Are (3, 2) and (2, 3) the same point? Explain.
   **No. In an ordered pair the x-coordinate comes first, so (3, 2) is 3 right and 2 up, while (2, 3) is 2 right and 3 up.**
6. Your group draws a grid map of your classroom. The door is at (A, 1), the teacher's desk is at (C, 4) and the window is at (E, 2). (a) Give the grid reference of the desk. (b) Describe the position of the desk to a visitor in two other ways. (c) Say which method you think is the most accurate and wh
   **(a) (C, 4). (b) For example, relative position: the desk is at the front, in the middle of the room; directions: walk straight from the door and the desk is on the far side. (c) The grid reference, because it names one exact place and does not depend on the person guessing.**
7. In a human coordinate plane game on the school ground, the teacher tells learner A, who stands on the origin, to move 4 steps to the right and 3 steps up. Then learner B, also starting at the origin, is told to move 3 steps to the right and 4 steps up. (a) Write the ordered pair for each learner. (b
   **(a) Learner A is at (4, 3) and learner B is at (3, 4). (b) No, they stand at different places. (c) The order matters: the x-coordinate (steps right) comes first and the y-coordinate (steps up) second, so swapping them gives a different point.**

## Teacher's reflection

What went well:

What I will change next time:

Learners who need follow-up: