

# Grade 10 Mathematics Lesson Plan

## Position Vectors

<b>Strand:</b>	<b>Measurement and Geometry</b>
<b>Sub-Strand:</b>	Vectors I
<b>Specific Learning Outcome:</b>	Determine position vectors in different situations
<b>Duration:</b>	40 minutes
<b>Key Inquiry Question:</b>	How is Vectors I applied in day-to-day life?
<b>Learning Resources:</b>	CBC Grade 10 textbooks, graph paper, rulers, pencils, colored markers

### Lesson Structure Overview

Phase	Duration	Focus
<b>Problem-Solving and Discovery</b>	15 minutes	Anchor activity: Discovering position vectors
<b>Structured Instruction</b>	10 minutes	Formalizing position vector notation
<b>Practice and Application</b>	10 minutes	Worked examples and finding position vectors
<b>Assessment</b>	5 minutes	Exit ticket to check understanding

### Phase 1: Problem-Solving and Discovery (15 minutes)

#### Anchor Activity: Discovering Position Vectors

Objective: Students will plot points on graph paper, draw directed lines from the origin to various points, and discover how to represent position vectors.

#### Materials Needed:

- Graph paper (one sheet per student)
- Rulers
- Pencils and colored markers
- Coordinate plane drawn on board or chart paper

#### Activity Steps (Activity 2.9.5 from textbook):

1. Step 1: Draw the x and y axis on the graph paper.
2. Step 2: Plot the following points: A(1,1), B(3,5), C(2,1), D(4,-3) on the graph.
3. Step 3: Draw a directed line from the origin O to point A to represent OA.
4. Step 4: Draw another directed line from the origin O to point B to represent OB.
5. Step 5: Determine the position vector of A relative to the origin.
6. Step 6: Determine the position vector of B relative to the origin.
7. Step 7: Discuss and share your findings with the rest of the class.

### **Guiding Questions:**

8. What is the position of point A relative to the origin?
9. How do we write the position vector of A?
10. What is the difference between a position vector and a regular vector?
11. How do we find the position vector of any point on the plane?
12. Can you think of real-world examples where we need to describe position relative to a starting point?

### **Teacher Role During Discovery:**

- Circulate among students, ensuring they plot points correctly.
- Ask probing questions: Where is the origin? What is the position of point A?
- For struggling students: Let us draw the line from O to A together. What are the coordinates of A?
- For early finishers: Can you find the position vectors of points C and D?
- Guide students to articulate: A position vector starts from the origin and points to a specific location.
- Identify 2-3 students with clear findings to share with the class.

## **Phase 2: Structured Instruction (10 minutes)**

### **Formalizing Position Vector Notation**

After students have completed the anchor activity and shared their findings, the teacher formalizes the concept of position vectors.

### **Key Takeaway: What is a Position Vector?**

A position vector is a vector that starts from the origin  $O(0,0)$  and points to a specific point in the plane. It describes the position of a point relative to the origin.

**How to Find a Position Vector:**

For a point  $P(x, y)$  in the plane, the position vector  $OP$  is found by subtracting the origin coordinates from the point coordinates:

$$OP \text{ equals } (x \text{ minus } 0, y \text{ minus } 0) \text{ equals } (x, y)$$

**Example from Textbook:**

Points  $A(2,3)$  and  $B(5,1)$  are located in the plane relative to origin point  $O$ .

The position vector of  $A$  is:  $OA \text{ equals } (2 \text{ minus } 0, 3 \text{ minus } 0) \text{ equals } (2, 3)$

The position vector of  $B$  is:  $OB \text{ equals } (5 \text{ minus } 0, 1 \text{ minus } 0) \text{ equals } (5, 1)$

Similarly, for point  $A$  in the plane its position vector  $OA$  is denoted by lowercase  $a$ . Also for point  $B$  in the plane its position vector  $OB$  is denoted by lowercase  $b$ .

**Key Points:**

- A position vector always starts from the origin  $O(0,0)$ .
- The position vector of point  $P(x, y)$  is simply  $(x, y)$ .
- Position vectors are often denoted by lowercase letters:  $a, b, c$ , etc.
- Position vectors help us describe the location of points in the plane.

**Scaffolding Strategies to Address Misconceptions:**

- Misconception: Position vectors can start from any point. Clarification: No, position vectors always start from the origin  $O(0,0)$ .
- Misconception: Position vector is the same as the point. Clarification: No, a point is a location, while a position vector describes movement from the origin to that location.
- Misconception: I need to subtract coordinates. Clarification: Yes, but since the origin is  $(0,0)$ , you are just subtracting zero, so the result is the same as the point coordinates.
- Misconception: Position vectors are different from column vectors. Clarification: No, position vectors are written using column vector notation  $(x, y)$ .

### Phase 3: Practice and Application (10 minutes)

#### Worked Example from Textbook:

Example 2.9.19: Find the position vector of A and B.

Given: Point A(6, -2) and Point B(4, -4)

Solution:

The position vector of A is OA equals (6 minus 0, negative 2 minus 0) equals (6, negative 2)

Similarly the position vector of B is OB equals (4 minus 0, negative 4 minus 0) equals (4, negative 4)

#### Additional Practice Problems:

Problem 1: Find the position vector of point P(7, 3).

Solution: OP equals (7, 3)

Problem 2: Find the position vector of point Q(-2, 5).

Solution: OQ equals (negative 2, 5)

Problem 3: If the position vector of point R is (3, -4), what are the coordinates of R?

Solution: R(3, negative 4)

### Phase 4: Assessment (5 minutes)

#### Exit Ticket:

Students complete the following questions individually.

Scenario: A student is participating in a treasure hunt on the school sports field. They start at the center of the field, which we will call Point M. The student walks 30 meters directly North to a flag at Point N.

1. Write the vector representing this movement using arrow notation.
2. If this vector is assigned the letter b, write it using tilde notation.
3. If we set up a coordinate system with M at the origin and North as the positive y direction, what is the position vector of N?

**Answer Key:**

1. MN with arrow on top (or  $\overrightarrow{MN}$ )
2. b with tilde on top (or  $\tilde{b}$ )
3. ON equals (0, 30) since the student moved 0 meters East/West and 30 meters North

### Differentiation Strategies

**For Struggling Learners:**

- Provide pre-drawn coordinate planes with the origin clearly marked.
- Use color coding: one color for the origin, another for the point.
- Start with points in the first quadrant (positive x and y) to simplify.
- Provide step-by-step templates for finding position vectors.
- Allow use of calculators if needed.
- Pair struggling students with confident problem solvers.

**For On-Level Learners:**

- Encourage students to create their own position vector problems.
- Ask students to explain why position vectors always start from the origin.
- Provide mixed practice with points in all four quadrants.
- Challenge students to find patterns in position vectors.

### For Advanced Learners:

- Explore the relationship between position vectors and displacement vectors.
- Investigate: If we know the position vectors of two points, how can we find the vector between them?
- Apply position vectors to real-world navigation and GPS problems.
- Explore three-dimensional position vectors with x, y, and z components.
- Challenge: Given position vectors  $a$  equals  $(3, 4)$  and  $b$  equals  $(1, 2)$ , find the vector from A to B.

### Extension Activity

#### Real-World Application: GPS Treasure Hunt

Work in pairs or small groups

Situation: You are designing a GPS treasure hunt game. Players start at a central location (the origin) and must find treasures hidden at various locations.

Tasks:

13. Set up a coordinate system with the starting point at the origin  $O(0,0)$ .
14. Choose 5 treasure locations and assign coordinates to each (e.g., Treasure 1 at  $(10, 15)$ ).
15. Write the position vector for each treasure location.
16. Calculate the distance from the origin to each treasure using the Pythagorean theorem.
17. Which treasure is closest to the starting point? Which is farthest?
18. If a player is at Treasure 1 and wants to go to Treasure 2, what vector describes this movement?
19. Create a map showing all treasure locations and their position vectors.
20. Present your treasure hunt to the class.

### Real-World Applications of Position Vectors:

- GPS Navigation: GPS systems use position vectors to describe locations relative to a reference point.
- Robotics: Robots use position vectors to track their location and navigate to target positions.
- Computer Graphics: Position vectors describe the location of objects in 2D and 3D space.

- Aviation: Air traffic control uses position vectors to track aircraft positions.
- Surveying: Land surveyors use position vectors to map terrain and property boundaries.

### Teacher Reflection Prompts

- Did students successfully plot points and draw position vectors from the origin?
- Were students able to distinguish between position vectors and regular vectors?
- What misconceptions emerged during the lesson, and how were they addressed?
- Did students understand that position vectors always start from the origin?
- What adjustments would improve this lesson for future classes?