Grade 10 Mathematics Lesson Plan

Column Vectors

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

Lesson Structure Overview

Phase	Duration	Focus
Problem-Solving and Discovery	15 minutes	Anchor activity: Plotting points and representing vectors
Structured Instruction	10 minutes	Formalizing column vector notation and operations
Practice and Application	10 minutes	Worked examples and vector operations
Assessment	5 minutes	Exit ticket to check understanding

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

Anchor Activity: Discovering Column Vectors

Objective: Students will plot points on graph paper, draw directed lines between points, and discover how to represent vectors using column notation with horizontal and vertical displacements.

Materials Needed:

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

Activity Steps:

1. Step 1: Draw the x axis and y axis on the graph paper.
2. Step 2: Plot point A(1,1) and point B(5,3) on the graph.
3. Step 3: Draw a directed line (arrow) from point A to point B.
4. Step 4: Count the horizontal displacement (how many units right or left) and the vertical displacement (how many units up or down).
5. Step 5: Represent vector AB in terms of its components as (x, y) where x is the horizontal displacement and y is the vertical displacement.
6. Step 6: Discuss and share your findings with the rest of the class.

Guiding Questions:

7. What is the horizontal displacement from A to B?
8. What is the vertical displacement from A to B?
9. How can we write this vector using numbers?
10. What happens if we go from B to A instead?
11. Can you think of real-world examples where we need to describe movement in two directions?

Teacher Role During Discovery:

- Circulate among students, ensuring they plot points correctly.
- Ask probing questions: How many units did you move right? How many units up?
- For struggling students: Let us count together. From x equals 1 to x equals 5, how many units is that?
- For early finishers: Can you plot point C(2,6) and find vector BC?
- Guide students to articulate: A vector has two parts - horizontal movement and vertical movement.
- Identify 2-3 students with clear findings to share with the class.

Phase 2: Structured Instruction (10 minutes)

Formalizing Column Vector Notation

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

Key Takeaway: What is a Column Vector?

A column vector is a vector expressed in the form of (a, b), where a is the horizontal displacement along the x axis and b is the vertical displacement along the y axis.

Example:

The vector OP illustrates a displacement from the origin O(0,0) to the point P(4,5). This consists of a horizontal displacement of 4 units along the x axis and a vertical displacement of 5 units along the y axis. We write this as OP equals (4, 5).

Vector Operations:

1. Vector Addition: To add two vectors, add their corresponding components.

   Example: (1, 4) plus (5, 3) equals (1 plus 5, 4 plus 3) equals (6, 7)

2. Scalar Multiplication: To multiply a vector by a number, multiply each component by that number.

   Example: 2 times (4, 7) equals (2 times 4, 2 times 7) equals (8, 14)

3. Combined Operations: We can combine addition and scalar multiplication.

   Example: 2a plus 5b where a equals (4, 7) and b equals (3, 5)

   First: 2a equals (8, 14) and 5b equals (15, 25)

   Then: 2a plus 5b equals (8 plus 15, 14 plus 25) equals (23, 39)

Scaffolding Strategies to Address Misconceptions:

- Misconception: Vectors are just points. Clarification: No, vectors represent movement or displacement, not just location.
- Misconception: The order does not matter in subtraction. Clarification: No, (5, 3) minus (1, 4) is different from (1, 4) minus (5, 3).
- Misconception: I can add the x and y components together. Clarification: No, keep x and y separate. Add x with x, and y with y.
- Misconception: Scalar multiplication changes only one component. Clarification: No, multiply both components by the scalar.

Phase 3: Practice and Application (10 minutes)

Worked Examples:

Example 1: Given a equals (2, 5) and b equals (4, negative 1), find a plus b.

Solution:

a plus b equals (2, 5) plus (4, negative 1)

equals (2 plus 4, 5 plus negative 1)

equals (6, 4)

Example 2: Given a equals (3, negative 2) and b equals (negative 1, 4), find 2a minus 3b.

Solution:

First find 2a: 2a equals 2 times (3, negative 2) equals (6, negative 4)

Then find 3b: 3b equals 3 times (negative 1, 4) equals (negative 3, 12)

Now subtract: 2a minus 3b equals (6, negative 4) minus (negative 3, 12)

equals (6 minus negative 3, negative 4 minus 12)

equals (9, negative 16)

Example 3: If a equals (2, 5), b equals (4, negative 1) and c equals (negative 7, 3), find 5a plus 7c.

Solution:

5a equals 5 times (2, 5) equals (10, 25)

7c equals 7 times (negative 7, 3) equals (negative 49, 21)

5a plus 7c equals (10, 25) plus (negative 49, 21) equals (10 plus negative 49, 25 plus 21)

equals (negative 39, 46)

Phase 4: Assessment (5 minutes)

Exit Ticket:

Students complete the following questions individually.

1. Given a equals (3, 7) and b equals (2, negative 4), find a plus b.

2. Given c equals (5, 1), find 3c.

3. If p equals (4, 6) and q equals (1, 2), find 2p minus q.

Answer Key:

1. a plus b equals (3, 7) plus (2, negative 4) equals (5, 3)

2. 3c equals 3 times (5, 1) equals (15, 3)

3. 2p equals (8, 12), so 2p minus q equals (8, 12) minus (1, 2) equals (7, 10)

Differentiation Strategies

For Struggling Learners:

- Provide pre-drawn coordinate planes with points already plotted.
- Use color coding: one color for horizontal displacement, another for vertical.
- Start with vectors from the origin (0,0) to simplify counting.
- Provide step-by-step calculation templates.
- Allow use of calculators for arithmetic.
- Pair struggling students with confident problem solvers.

For On-Level Learners:

- Encourage students to create their own vector problems.
- Ask students to explain the meaning of negative components.

- Provide mixed practice with different operations.
- Challenge students to find patterns in vector operations.

For Advanced Learners:

- Explore position vectors and how they relate to points.
- Investigate vector subtraction and its geometric meaning.
- Apply vectors to real-world navigation problems.
- Explore three-dimensional vectors with x, y, and z components.
- Challenge: If 2a plus 3b equals (11, 8) and a equals (1, 2), find b.

Extension Activity

Real-World Application: Navigation Challenge

Work in pairs or small groups

Situation: You are a pilot navigating an aircraft. Your movements can be represented as vectors.

Tasks:

12. You start at the origin (0, 0). You fly vector a equals (3, 4) representing 3 km east and 4 km north.
13. Then you fly vector b equals (2, negative 1) representing 2 km east and 1 km south.
14. Find your final position by calculating a plus b.
15. If you need to return to the origin, what vector do you need to fly?
16. Create your own navigation scenario with at least three vectors.
17. Present your scenario and solution to the class.

Real-World Applications of Vectors:

- Navigation: Ships, aircraft, and GPS systems use vectors to describe position and direction.
- Physics: Velocity, force, and acceleration are all vector quantities.
- Computer Graphics: Vectors are used to move objects on screen in video games and animations.
- Engineering: Vectors describe forces acting on structures like bridges and buildings.
- Sports: Analyzing the trajectory of a ball involves vector calculations.

Teacher Reflection Prompts

- Did students successfully plot points and draw directed lines?
- Were students able to identify horizontal and vertical displacements?
- What misconceptions emerged during the lesson, and how were they addressed?
- Did students understand the difference between vector addition and scalar multiplication?
- What adjustments would improve this lesson for future classes?