CBC Grade 10 Mathematics Lesson Plan

Adding Vectors

Strand	Measurement and Geometry
Sub-Strand	Vectors 1
Specific Learning Outcome	Add vectors graphically and algebraically to find resultant displacement in different situations
Key Inquiry Questions	How do we combine multiple displacements to find the total resultant displacement?
Learning Resources	CBC Grade 10 textbooks, graph paper, rulers, calculators
Lesson Duration	40 minutes

Lesson Structure Overview

Phase	Activity	Duration
Phase 1	Problem-Solving and Discovery (Anchor Activity)	15 minutes
Phase 2	Structured Instruction (Key Takeaways)	10 minutes
Phase 3	Practice and Application (Worked Examples)	15 minutes
Phase 4	Assessment (Exit Ticket)	5 minutes

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

Anchor Activity: Discovering Vector Addition Through Sequential Displacements

Work in Groups (2-3 students)

Materials:

- • Graph paper
- • Ruler
- • Pencil

Tasks:

1. (a) Draw the x and y axis on the graph paper.
2. (b) Draw vector AB from point A(0,0) to point B(2,2).
3. (c) Draw vector BC from point B(2,2) to point C(5,2).

4. (d) Count the number of units moved horizontally (along the x axis) from the starting point A to the final point C.
5. (e) Similarly, count the number of units moved vertically (along the y axis) from point A to point C.
6. (f) Write the resultant displacement in coordinate form (x, y), where x represents displacement along the x axis and y represents displacement along the y axis.
7. (g) Discuss and share your findings with the rest of the class.

Teacher Guidance for Anchor Activity

This anchor activity introduces vector addition through graphical representation. Students physically draw sequential displacements and discover that the resultant displacement can be found by adding the individual vector components.

Facilitation Strategy:

- • Organize students into groups of 2-3
- • Distribute graph paper, rulers, and pencils
- • Guide students to draw clear axes with labeled scales
- • Help students draw vector AB as an arrow from (0,0) to (2,2)
- • Ensure vector BC starts where AB ends, from (2,2) to (5,2)
- • Ask probing questions: "What is the total horizontal movement?" "What is the total vertical movement?"
- • Guide students to recognize: Horizontal: 5 units, Vertical: 2 units, so AC = (5,2)
- • Help students see that AC = AB + BC by adding components
- • Use student observations as bridge to formal vector addition rules

Phase 2: Structured Instruction (10 minutes)

Key Takeaways

After students have explored through the anchor activity, formalize their discoveries with these key concepts:

1. Sequential Vector Addition Concept

Consider a displacement from point P to point Q, followed by another displacement from point Q to point N. The total resultant displacement from P to N is obtained by adding the two vectors sequentially.

This can be expressed as: PN = PQ + QN

Where:

- • PQ = r represents the first displacement
- • QN = s represents the second displacement

- • Therefore, PN = r + s

2. Graphical Vector Addition (Tip-to-Tail Method)

To add vectors graphically:

8. 1. Draw the first vector from the starting point
9. 2. Place the tail of the second vector at the tip (head) of the first vector
10. 3. The resultant vector is drawn from the tail of the first vector to the tip of the last vector

This is called the "tip-to-tail" method or "head-to-tail" method.

3. Algebraic Vector Addition (Component Method)

When vectors are expressed in coordinate form (x, y), add the corresponding components:

If $a = (x_1, y_1)$ and $b = (x_2, y_2)$, then:

$a + b = (x_1 + x_2, y_1 + y_2)$

Example: If a = (2, 3) and b = (4, -1), then a + b = (2+4, 3+(-1)) = (6, 2)

4. Vector Addition with Algebraic Notation

When vectors are expressed in terms of other vectors (e.g., a, b, c), combine like terms:

If AD = AB + BC + CD = a + b + c, then AD = a + b + c

This is similar to algebraic simplification where you collect like terms.

5. Properties of Vector Addition

- • Commutative: a + b = b + a (order doesn't matter)
- • Associative: (a + b) + c = a + (b + c) (grouping doesn't matter)
- • The resultant vector represents the overall displacement

6. Real-Life Applications

Navigation: Pilots add velocity vectors (aircraft speed + wind speed) to determine actual flight path.

Engineering: Structural engineers add force vectors to determine total load on buildings.

Sports: Coaches analyze combined movements (running velocity + ball velocity) in team sports.

Scaffolding Strategies

Address common misconceptions revealed during the anchor activity:

- • Clarify that vectors must be added tip-to-tail, not tail-to-tail
- • Emphasize that the resultant goes from the starting tail to the final tip
- • Show that component addition requires adding x-components together and y-components together separately
- • Use consistent notation (arrows above letters or bold letters)
- • Connect graphical and algebraic methods as two ways to solve the same problem

Phase 3: Practice and Application (15 minutes)

Worked Examples

Example 1: Finding Resultant Vector in Terms of Given Vectors

In a diagram, find vector AD in terms of a and b, where AB = a, BC = b, and CD = c.

Solution:

AD = AB + BC + CD

AD = a + b + c

Explanation: We add the vectors sequentially from A to D by following the path A→B→C→D.

Example 2: Adding Vectors in Coordinate Form

Given the vectors a = (2, 3) and b = (4, -1), find a + b and illustrate the solution graphically.

Solution:

a + b = (2 + 4, 3 + (-1)) = (6, 2)

Graphical illustration: Draw vector a from origin to (2,3), then draw vector b starting from (2,3) to (6,2). The resultant vector goes from origin to (6,2).

Example 3: Vectors in a Square

PQNM is a square with vectors PQ and PM given as a and b respectively. Express the PN and MQ vectors in terms of a and b.

Solution:

PN = PQ + QN = a + b (diagonal from P to N)

MQ = MN + NQ = a + (-b) = a - b (from M to Q)

Explanation: In a square, opposite sides are equal and parallel. QN = PM = b, and NQ = -b.

Example 4: Algebraic Vector Expression

Given vectors u = 2p + 5q and v = p - 3q, express 3u + 2v in terms of p and q.

Solution:

3u + 2v = 3(2p + 5q) + 2(p - 3q)

= 6p + 15q + 2p - 6q

= (6p + 2p) + (15q - 6q)

= 8p + 9q

Explanation: Distribute the scalars, then combine like terms (p terms together, q terms together).

Individual Practice (Students work independently)

Provide students with similar problems to solve:

11. 1. A pentagon ABCDE with AB = m, BC = n, and CD = k. Express AC and AD in terms of m, n, and k.
12. 2. Given a = (3, 5) and b = (2, -3), find a + b.
13. 3. Simplify: 5x + 3y - z + 2(3x - z) + (8x - 6y)

Phase 4: Assessment - Exit Ticket (5 minutes)

Students complete individually to demonstrate understanding:

Question 1: On graph paper, draw vectors a = (3, 1) and b = (2, 4). Add them graphically using the tip-to-tail method and state the resultant vector.

Question 2: In triangle ABC, AB = p and BC = q. Express AC in terms of p and q.

Question 3: Given x = 3m - n and y = n + 4m, express 3x in terms of m and n.

Exit Ticket Answer Key

Question 1:

Draw vector a from origin to (3,1), then draw vector b from (3,1) to (5,5).

Resultant vector: a + b = (3+2, 1+4) = (5, 5)

The resultant goes from origin to (5,5).

Question 2:

AC = AB + BC = p + q

Explanation: Following the path from A to C through B, we add the two vectors.

Question 3:

3x = 3(3m - n) = 9m - 3n

Explanation: Distribute the scalar 3 to both terms inside the parentheses.

Differentiation Strategies

For Struggling Learners:

- • Provide pre-drawn axes on graph paper
- • Use color coding: first vector in blue, second in red, resultant in green
- • Start with simple horizontal and vertical vectors before diagonal ones
- • Provide step-by-step templates for algebraic addition
- • Use physical arrows or string to demonstrate tip-to-tail method
- • Allow calculators for component addition

For Advanced Learners:

- • Introduce vector subtraction (adding negative vectors)
- • Explore three-dimensional vector addition
- • Challenge with complex algebraic expressions involving multiple vectors
- • Connect to parallelogram law of vector addition
- • Introduce unit vectors (i, j notation)
- • Apply to physics problems (force vectors, velocity vectors)

Extension Activity

Navigation Challenge Project

Objective: Apply vector addition to plan a multi-leg journey.

Activity Description:

14. 1. Design a journey with three legs (e.g., walk 5 km east, then 3 km north, then 4 km west).
15. 2. Represent each leg as a vector in coordinate form.
16. 3. Add the vectors algebraically to find the resultant displacement.
17. 4. Draw the journey graphically showing all three legs and the resultant.
18. 5. Calculate the actual distance traveled vs. the displacement.
19. 6. Present your journey plan to the class explaining the vector addition.

Geometric Proof Activity

Students can:

- • Prove that in a parallelogram, the diagonal represents the sum of two adjacent sides
- • Explore why vector addition is commutative using diagrams
- • Investigate the triangle inequality: $|a + b| \leq |a| + |b|$

Post-Lesson Reflection for Teachers

- • Did students successfully add vectors both graphically and algebraically?
- • Were students able to use the tip-to-tail method correctly?
- • What misconceptions emerged about vector direction and magnitude?
- • How engaged were students with the graphical anchor activity?
- • Did students understand the connection between graphical and algebraic methods?
- • What adjustments are needed for future lessons on this topic?