CBC Grade 10 Mathematics Lesson Plan

Vectors in Real-Life

Strand	**Measurement and Geometry**
Sub-Strand	Vectors 1
Specific Learning Outcome	Explain the terms distance, displacement, speed, velocity and acceleration in real-life situations and determine velocity and acceleration in different situations
Key Inquiry Questions	How do we use vectors to describe motion in real-life situations?
Learning Resources	CBC Grade 10 textbooks, ruler, graph paper, 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: Analyzing Motion with Scalar and Vector Quantities

Work in Groups (2-3 students)

Materials:

- • Ruler
- • Graph paper
- • Calculator

Scenario: A student walks 4 km east and then 3 km west.

Tasks:

1. 1. Draw the movement on a straight line using your ruler and graph paper.

2. 2. Find the total distance travelled.
3. 3. Determine how far the student is from the starting point (displacement).

Now suppose the total time taken is 2 hours.

4. 4. Calculate the average speed.
5. 5. Calculate the average velocity.

Discussion Questions:

- • Which quantities depend only on size?
- • Which quantities depend on both size and direction?
- • Why are speed and velocity different even though they both measure "how fast"?

Teacher Guidance for Anchor Activity

This anchor activity introduces the distinction between scalar and vector quantities through hands-on calculation. Students discover that distance and speed (scalars) differ from displacement and velocity (vectors) because vectors include direction.

Facilitation Strategy:

- • Organize students into groups of 2-3
- • Distribute rulers, graph paper, and calculators
- • Guide students to draw a horizontal line representing east-west motion
- • Help students mark starting point, 4 km east, then 3 km back west
- • Encourage students to calculate distance (4 + 3 = 7 km) and displacement (4 - 3 = 1 km east)
- • Ask probing questions: "Is the total path the same as final position?" "Does direction matter for speed?"
- • Guide calculation of speed = 7 km / 2 hours = 3.5 km/h and velocity = 1 km east / 2 hours = 0.5 km/h east
- • Use student discoveries to introduce scalar vs. vector terminology

Phase 2: Structured Instruction (10 minutes)

Key Takeaways

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

1. Scalar vs. Vector Quantities

In daily life, we describe motion using quantities such as distance, speed and direction. Some quantities depend only on size, while others depend on both size and direction.

Scalar quantity: Has magnitude only. Examples include distance, time, and speed.

Vector quantity: Has both magnitude and direction. Examples include displacement, velocity, and acceleration.

Vectors help us describe motion accurately in transport, sports, navigation and engineering.

2. Distance and Displacement

Distance is the total path travelled. It is a scalar quantity (has only magnitude).

Displacement is the straight-line change in position together with direction. It is a vector quantity (has both magnitude and direction).

3. Speed and Velocity

Speed is the rate of change of distance.

Formula: Speed = Distance / Time

Speed is a scalar quantity (no direction).

Velocity is the rate of change of displacement.

Formula: Velocity = Displacement / Time

Velocity is a vector quantity (includes direction).

4. Acceleration

Acceleration is the rate of change of velocity.

Formula: Acceleration = Change in velocity / Time

Acceleration is also a vector quantity.

Acceleration can be positive (speeding up) or negative (slowing down, also called deceleration).

5. Real-Life Applications

Transport: GPS systems use velocity (speed with direction) to guide drivers. Traffic engineers analyze acceleration patterns for road safety.

Sports: Coaches measure athletes' velocity and acceleration to improve performance. Sprint coaches analyze acceleration in the first 10 meters.

Navigation: Ships and aircraft use velocity vectors to account for wind and currents when plotting courses.

Engineering: Vehicle designers test acceleration capabilities for safety and performance standards.

Scaffolding Strategies

Address common misconceptions revealed during the anchor activity:

- • Clarify that speed uses total distance, velocity uses displacement
- • Emphasize that vectors always include direction
- • Show that velocity can be zero even when speed is not (circular motion)
- • Use consistent units (km/h or m/s) throughout calculations
- • Connect formulas to real-world contexts (car speedometers show speed, not velocity)

Phase 3: Practice and Application (15 minutes)

Worked Examples

Example 1: Calculating Speed and Velocity

A cyclist rides 30 km east in 2 hours. Find: (a) the speed, (b) the velocity.

Solution:

(a) Speed = Distance / Time = 30 km / 2 hours = 15 km/h

(b) Velocity = Displacement / Time = 30 km east / 2 hours = 15 km/h east

Notice: The magnitudes are the same (15 km/h), but velocity includes direction (east).

Example 2: Calculating Acceleration

A vehicle increases its velocity from 8 m/s to 20 m/s in 4 seconds. Find its acceleration.

Solution:

Change in velocity = Final velocity - Initial velocity = 20 m/s - 8 m/s = 12 m/s

Acceleration = Change in velocity / Time = 12 m/s / 4 s = 3 m/s^2

The vehicle accelerates at 3 m/s^2, meaning its velocity increases by 3 m/s every second.

Example 3: Opposite Directions

A learner walks 5 km north and then 3 km south. Find: (a) the total distance, (b) the displacement.

Solution:

(a) Distance = 5 km + 3 km = 8 km

(b) Displacement = 5 km north - 3 km south = 2 km north

The learner traveled 8 km total but ended up only 2 km north of the starting point.

Example 4: Circular Motion (Zero Displacement)

A runner completes one full lap of 400 m in 50 seconds. Find: (a) the distance travelled, (b) the displacement.

Solution:

(a) Distance = 400 m (the entire lap)

(b) Displacement = 0 m (the runner returns to the starting point)

This shows that displacement can be zero even when distance is not.

Individual Practice (Students work independently)

Provide students with similar problems to solve:

6. 1. A car travels 180 km in 3 hours. Find its speed.
7. 2. A boat moves 40 km west in 2 hours. Find its velocity.
8. 3. A bus moves from rest to 25 m/s in 5 seconds. Find its acceleration.
9. 4. A delivery rider travels 6 km east and then 8 km east in a total time of 2 hours. Find the total distance and velocity.

Phase 4: Assessment - Exit Ticket (5 minutes)

Students complete individually to demonstrate understanding:

Question 1: A truck moves 50 km north in 1 hour, then returns 20 km south in 0.5 hours.

10. a) Find the total distance travelled.
11. b) Find the displacement.
12. c) Calculate the average velocity for the entire journey.

Question 2: A car changes its velocity from 15 m/s east to 5 m/s east in 2 seconds.

13. a) Find the change in velocity.
14. b) Calculate the acceleration.
15. c) Explain whether the car is speeding up or slowing down.

Question 3: Explain the difference between speed and velocity using a real-life example.

Exit Ticket Answer Key

Question 1:

a) Distance = 50 km + 20 km = 70 km

b) Displacement = 50 km north - 20 km south = 30 km north

c) Total time = 1 hour + 0.5 hours = 1.5 hours

Average velocity = 30 km north / 1.5 hours = 20 km/h north

Question 2:

a) Change in velocity = 5 m/s - 15 m/s = -10 m/s

b) Acceleration = -10 m/s / 2 s = -5 m/s^2

c) The car is slowing down (decelerating) because the acceleration is negative.

Question 3:

Speed is how fast you travel regardless of direction, while velocity includes direction. For example, if you drive at 60 km/h in a circle, your speed is constant at 60 km/h, but your velocity changes continuously because your direction changes. A car speedometer shows speed, but GPS navigation shows velocity (speed and direction).

Differentiation Strategies

For Struggling Learners:

- • Provide formula reference cards for speed, velocity, and acceleration
- • Use color coding: blue for scalars (distance, speed), red for vectors (displacement, velocity)
- • Start with one-dimensional motion (east-west only) before introducing multiple directions
- • Allow calculators for all calculations
- • Provide step-by-step worked example templates
- • Use visual diagrams extensively

For Advanced Learners:

- • Introduce two-dimensional velocity problems (north and east components)
- • Explore relative velocity (two objects moving)
- • Challenge with non-uniform acceleration problems
- • Connect to vector addition and Pythagorean theorem
- • Analyze real sports data (100m sprint acceleration profiles)
- • Introduce instantaneous vs. average velocity

Extension Activity

Real-World Motion Analysis Project

Objective: Apply vector concepts to analyze real-world motion scenarios.

Activity Description:

16. 1. Choose a real-world scenario: commute to school, sports activity, delivery route, or public transport.
17. 2. Record or estimate: total distance, displacement, time taken.
18. 3. Calculate: average speed and average velocity.
19. 4. Draw a diagram showing the path and displacement vector.
20. 5. Explain why speed and velocity differ in your scenario.

21. 6. Present findings to the class with visual aids.

Sports Performance Analysis

Students can:

- • Analyze a 100m sprint: measure acceleration in first 30m, top speed at 60m, deceleration in final 40m
- • Compare velocity profiles of different athletes
- • Discuss how understanding acceleration helps improve performance
- • Calculate average velocity vs. top speed

Post-Lesson Reflection for Teachers

- • Did students successfully distinguish between scalar and vector quantities?
- • Were students able to calculate speed, velocity, and acceleration correctly?
- • What misconceptions emerged about direction in vector quantities?
- • How engaged were students with the anchor activity?
- • Did students understand when displacement can be zero?
- • What adjustments are needed for future lessons on this topic?