CBC Grade 10 Mathematics Lesson Plan

Displacement-Time Graphs

Strand	Measurement and Geometry
Sub-Strand	Linear Motion
Specific Learning Outcome	Draw a displacement-time graph of different situations and interpret displacement-time graph in different situations
Key Inquiry Questions	How do we use displacement-time graphs in real life?
Learning Resources	CBC Grade 10 textbooks, graph paper, rulers, pencils
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: Motorist Journey from Limuru to Kisumu
Work in groups

A motorist travels from Limuru to Kisumu. The table below shows the distances covered at different times:

Time	Distance (km)
9:00 AM	0
10:00 AM	80
11:00 AM	160
11:30 AM	160
12:00 PM	210

Tasks:

1. a) Plot the graph using the data given in the table
2. b) How far was the motorist from Limuru at 10:30 AM?
3. c) What was the average speed during the first part of the journey?
4. d) What was the overall average speed?

Teacher Guidance for Anchor Activity

This anchor activity introduces displacement-time graphs through a real-world journey scenario. Students will plot data points, observe patterns, and calculate speeds from the graph slope.

Facilitation Strategy:

- • Organize students into groups of 3-4
- • Distribute graph paper and rulers
- • Guide students to label axes properly (Time on x-axis, Distance on y-axis)
- • Encourage discussion about what the flat section (11:00-11:30) represents
- • Ask probing questions: "What does a steeper line mean?" "Why is the line flat at 11:30?"
- • Help students connect slope to speed
- • Use student observations as bridge to formal concepts

Phase 2: Structured Instruction (10 minutes)

Key Takeaways

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

1. Distance vs. Displacement

Distance is the total length of the path traveled by an object, regardless of direction. It is a scalar quantity (magnitude only).

Displacement is the shortest distance from the initial to the final position of an object, represented as a vector (magnitude and direction).

2. Displacement-Time Graphs

When distance is plotted against time, a distance-time graph is obtained. A displacement-time graph shows how the displacement of an object changes over time.

Key features of displacement-time graphs:

- • The vertical axis represents displacement (in meters, kilometers, etc.)
- • The horizontal axis represents time (in seconds, minutes, hours, etc.)
- • Each point on the graph shows the object's position at a specific time

3. Interpreting the Slope

The slope of the graph at any point indicates the velocity of the object at that moment.

Velocity = Change in displacement / Change in time

- • A straight line with a constant slope represents uniform motion (constant velocity)
- • A curved line indicates acceleration or deceleration (changing velocity)
- • A steeper slope indicates higher speed
- • A horizontal line (zero slope) means the object is stationary

4. Types of Motion on Graphs

Uniform Motion: Straight line with constant slope - object moves at constant velocity with no acceleration.

Accelerated Motion: Curved line that gets steeper - object's velocity is increasing (accelerating).

Decelerated Motion: Curved line that gets less steep - object's velocity is decreasing (decelerating).

Stationary: Horizontal line - object is at rest, not moving.

5. Practical Applications

Displacement-time graphs are used to:

- • Analyze vehicle motion and traffic patterns
- • Study athletic performance in sports
- • Track delivery routes and logistics
- • Monitor elevator and escalator movement
- • Understand planetary and satellite motion

Scaffolding Strategies

Address common misconceptions revealed during the anchor activity:

- • Clarify the difference between distance and displacement
- • Emphasize that slope represents velocity, not position
- • Show that horizontal lines mean stationary, not zero displacement
- • Use visual demonstrations of motion to connect graphs to reality
- • Connect to prior knowledge of speed and velocity

Phase 3: Practice and Application (15 minutes)

Worked Examples

Example 1: Constant Velocity Motion

A car moves with a constant velocity of 5 m/s for 8 seconds. Draw the displacement-time graph and determine the displacement at t = 6s.

Solution:

Since the velocity is constant, the displacement increases linearly with time.

The relationship is: s = vt (displacement = velocity × time)

At t = 6s:

s = 5 m/s × 6 s = 30 m

Graph characteristics:

- • Straight line starting from origin
- • Slope = 5 m/s (constant velocity)
- • At t = 8s, displacement = 40 m

Answer: The displacement at t = 6s is 30 meters.

Individual Practice (Students work independently)

Provide students with similar problems to solve:

5. 1. A train moves at constant velocity of 20 m/s for 10 seconds. Draw the displacement-time graph and find displacement at t = 7s.
6. 2. Sketch a displacement-time graph for an object that: accelerates for 3 seconds, moves at constant velocity for 4 seconds, then decelerates to rest.
7. 3. From a given displacement-time graph showing a motorist's journey, calculate the velocity during different time intervals.

Phase 4: Assessment - Exit Ticket (5 minutes)

Students complete individually to demonstrate understanding:

Question 1: Study the following description of a runner's motion and sketch the corresponding displacement-time graph:

- • The runner starts from rest and accelerates uniformly for 5 seconds, covering a displacement of 25 meters.
- • The runner maintains a constant speed for the next 10 seconds, covering an additional 50 meters.
- • The runner then decelerates uniformly for 5 seconds until stopping at 100 meters.

Tasks:

8. a) Sketch the displacement-time graph based on this motion.
9. b) Determine the velocity during the constant speed phase.
10. c) Calculate the acceleration during the first 5 seconds.
11. d) Find the total time taken to complete the journey.
12. e) What is the average velocity for the entire motion?

Question 2: The displacement-time graph represents the motion of a cyclist:

- • From 0 to 4 seconds, the cyclist moves forward at a uniform velocity.
- • From 4 to 8 seconds, the cyclist is stationary.
- • From 8 to 12 seconds, the cyclist moves back towards the starting point at a uniform velocity.

Tasks:

13. a) Sketch the graph for this motion.
14. b) What is the velocity during the first 4 seconds?
15. c) What does the flat section of the graph indicate?
16. d) Find the velocity during the last 4 seconds.
17. e) Calculate the total displacement at the end of 12 seconds.

Exit Ticket Answer Key
Question 1:

b) Velocity during constant speed = 50 m / 10 s = 5 m/s

c) Acceleration = velocity / time = 5 m/s / 5 s = 1 m/s^2

d) Total time = 5 + 10 + 5 = 20 seconds

e) Average velocity = total displacement / total time = 100 m / 20 s = 5 m/s

Question 2:

b) Velocity during first 4 seconds = 4 m / 4 s = 1 m/s

c) The flat section indicates the cyclist is stationary

d) Velocity during last 4 seconds = -4 m / 4 s = -1 m/s (negative indicates backward motion)

e) Total displacement at end = 0 m (cyclist returns to starting point)

Differentiation Strategies

For Struggling Learners:
- • Provide pre-drawn graph templates with labeled axes
- • Start with simple uniform motion examples
- • Use physical demonstrations (walking across room while timing)
- • Provide step-by-step graphing guides
- • Allow use of calculators for slope calculations
- • Pair with stronger students for peer support

For Advanced Learners:
- • Introduce complex multi-phase motion scenarios
- • Challenge with non-uniform acceleration problems
- • Explore connection to velocity-time graphs
- • Investigate real-world data (GPS tracking, sports analytics)
- • Solve problems involving relative motion
- • Create their own motion scenarios and graphs

Extension Activity

Real-World Motion Analysis Project
Objective: Apply displacement-time graphs to analyze real-world motion scenarios.

Activity Description:

18. 1. Choose a real-world scenario (select one):

- • Commute to school (walking, cycling, or driving)
- • Elevator movement in a tall building
- • Marathon runner's race performance
- • Delivery vehicle route with multiple stops

19. 2. Collect or estimate time and distance data for the scenario.
20. 3. Create a displacement-time graph representing the motion.
21. 4. Identify different phases of motion (acceleration, constant velocity, rest, deceleration).
22. 5. Calculate velocities during different phases.
23. 6. Present findings to the class with explanations.

Graph Interpretation Challenge
Students work in pairs to:

- • Analyze complex displacement-time graphs with multiple motion phases
- • Write motion descriptions matching given graphs
- • Identify errors in incorrectly drawn graphs
- • Compare displacement-time graphs of two objects and determine which is faster

Post-Lesson Reflection for Teachers

- • Did students successfully plot displacement-time graphs from data?
- • Were students able to interpret slope as velocity?
- • What misconceptions emerged about distance vs. displacement?
- • How comfortable were students calculating velocity from graphs?
- • Did the anchor activity effectively introduce the concept?
- • What adjustments are needed for future lessons on this topic?