# Grade 10 Mathematics Lesson Plan

## Velocity-Time Graphs

| Strand: | Measurement and Geometry |
|---|---|
| Sub-Strand: | Linear Motion |
| Specific Learning Outcome: | Draw a velocity-time graph from given tables in different situations and interpret velocity-time graph in different situations |
| Duration: | 40 minutes |
| Key Inquiry Question: | How is Vectors 1 applied in day-to-day life? |
| Learning Resources: | CBC Grade 10 textbooks, graph paper, rulers, calculators, colored pencils |

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

#### Anchor Activity: Analyzing Train Motion

**Objective:** Students work in groups to calculate velocities at different times, determine average velocities, and discover how to represent motion graphically.

Work in groups to complete the following tasks:

Scenario: A train moving at 40 m/s along a North-South railway track passes through a station R at 5:30 PM. The train is decelerating at 4 $m/s^2$ northward.

Task 1: Find the velocity of the train at these times:

- 3 seconds after 5:30 PM
- 6 seconds after 5:30 PM
- 2 seconds after 5:30 PM

Hint: Use the formula $v = u + at$ (remember deceleration means negative acceleration)

Task 2: Determine the average velocity of the train:

- In the first 5 seconds after 5:30 PM
- In the first 10 seconds after 5:30 PM

Task 3: Draw a velocity-time graph showing the train's motion from 0 to 12 seconds. Use your calculated velocities to plot points on the graph.

Task 4: Using your graph, find the distance of the train from station R at 12 seconds past 5:30 PM.

Hint: What does the area under a velocity-time graph represent?

Discussion prompts for teachers:

- How did you calculate the velocity at different times?
- What pattern do you notice in the velocities? Are they increasing or decreasing?
- What shape does your graph have? Is it a straight line or curved?
- How can we use the graph to find distance traveled?
- What does the slope of the line tell us about the train's motion?

## Phase 2: Structured Instruction (10 minutes)

### Key Takeaways

#### *1. What is a Velocity-Time Graph?*

**Definition:** A velocity-time graph is a graph that shows how an object's velocity (speed with direction) changes over time.

#### *2. Components of a Velocity-Time Graph*

- Y-axis: Velocity (measured in m/s)
- X-axis: Time (measured in seconds)
- Slope of the line: Indicates acceleration
- Area under the graph: Represents displacement (distance)

#### *3. Interpreting Different Graph Shapes*

- Horizontal line: Constant velocity (no acceleration)
- Upward slope: Acceleration (object is speeding up)
- Downward slope: Deceleration (object is slowing down)
- Line at zero velocity: Object is stationary (not moving)

#### *4. Calculating Acceleration from the Graph*

**Formula:**

***Acceleration = Change in velocity / Corresponding change in time***

$$a = \Delta v/\Delta t = (v - u) / t$$

Where: a = acceleration ($m/s^2$), v = final velocity, u = initial velocity, t = time

#### *5. Finding Distance from the Graph*

**Key Concept:** The area under a velocity-time graph represents the distance (displacement) traveled.

- For a triangle: Area = ½ × base × height
- For a rectangle: Area = base × height
- For a trapezium: Area = ½ × (sum of parallel sides) × height

### *6. Deceleration*

Deceleration is negative acceleration. It means the object is slowing down. In a velocity-time graph, deceleration appears as a downward-sloping line.

## Phase 3: Practice and Application (15 minutes)

### Worked Examples from Textbook

Example 2.10.34: Given a table with time (0, 1, 2, 3, 4, 5, 6, 7 seconds) and velocity (0, 10, 20, 30, 40, 40, 30, 10 m/s), draw the velocity-time graph.

*Solution:*

Plot each point on graph paper with time on x-axis and velocity on y-axis. Connect the points with straight lines. The graph shows three phases: acceleration (0-4s), constant speed (4-5s), and deceleration (5-7s).

Example 2.10.36: A car starts from rest and accelerates to 40 m/s in 10 seconds. It maintains this velocity for 15 seconds before decelerating to rest, with total time of motion being 45 seconds.

*Tasks:*

a) Draw the velocity-time graph

b) Find the total distance covered

c) Determine the average velocity

d) Calculate the acceleration and deceleration

*Solution:*

- a) Graph shows trapezium shape with three sections: acceleration (0-10s), constant velocity (10-25s), deceleration (25-45s)
- b) Total distance = Area under graph:
- - Acceleration phase (triangle): ½ × 10 × 40 = 200 m
- - Constant velocity (rectangle): 15 × 40 = 600 m
- - Deceleration (triangle): ½ × 20 × 40 = 400 m
- - Total distance = 200 + 600 + 400 = 1200 m
- c) Average velocity = Total distance / Total time = 1200 / 45 = 26.67 m/s
- d) Acceleration = (40 - 0) / 10 = 4 $m/s^2$
- Deceleration = (0 - 40) / 20 = -4 $m/s^2$ (or 4 $m/s^2$ deceleration)

## Phase 4: Assessment (5 minutes)

### Exit Ticket

Given the table below with time (0, 1, 2, 3, 4, 5, 6, 7 seconds) and velocity (0, 5, 15, 30, 45, 50, 55, 60 m/s):

1. Draw the velocity-time graph to represent the data.

2. Use the graph to describe the motion of the vehicle. Is the velocity constant, increasing, or decreasing? Explain your answer.

3. Calculate the average velocity of the vehicle between t = 0s and t = 3s.

## Differentiation Strategies

### For Struggling Learners:

- Provide pre-drawn graph paper with axes already labeled.
- Give step-by-step worksheets for plotting points.
- Use color coding: one color for acceleration, another for constant velocity, another for deceleration.
- Provide formula cards with area formulas for triangles, rectangles, and trapeziums.
- Allow use of calculators for all calculations.
- Pair with peer tutors during graphing activities.
- Break down area calculations into smaller steps.

### For Advanced Students:

- Analyze graphs with multiple acceleration and deceleration phases.
- Calculate instantaneous velocity at specific points using graph slopes.
- Compare velocity-time graphs with displacement-time graphs.
- Create their own motion scenarios and draw corresponding graphs.
- Investigate real-world applications: rocket launches, car crash tests, sports performance.
- Explore how changing acceleration values affect graph shape and total distance.

## Extension Activity: Motorcycle Journey Analysis

Scenario: A motorcycle starts from rest and accelerates uniformly to a speed of 30 m/s in 8 seconds. It then continues at this speed for 12 seconds before decelerating uniformly to rest in 10 seconds.

Tasks:

1. Draw the velocity-time graph to represent the motorcycle's motion.
2. Calculate the total distance covered by the motorcycle.
3. Determine the average velocity for the entire journey.
4. Calculate the acceleration during the first 8 seconds.
5. Calculate the deceleration during the last 10 seconds.
6. Identify which phase of the journey covered the greatest distance and explain why.
7. If the motorcycle maintained its maximum speed for 20 seconds instead of 12 seconds, how would this change the total distance? Draw the new graph.