Lesson Title: Describing Velocity **Date:**_____

Subject: Forces and Motion **Topic:** Velocity

Grade: 8 or 9 **Designer:** Concord Consortium

Stage 1 - Desired Results

Lesson Overview

In this lesson, students will connect the motion of an object to the corresponding position-time and velocity-time graphs to determine the velocity traveled during different time intervals. Prior knowledge of slope meaning and measurement is recommended.

Standards Addressed

- The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph. (NSES p154, grades 5-8)
- Graphs can show a variety of possible relationships between two variables. (BSL 9B/M3, grades 6-8)
- Tables, graphs, and symbols are alternative ways of representing data and relationships that can be translated from one to another. (BSL 9B/H4, grades 9-12)
- Differentiate among translational motion, simple harmonic motion, and rotational motion in terms of position, velocity, and acceleration. (PA 3.2.P.B1)

Enduring Understanding:
An object's velocity can be determined by analyzing position-time or velocity-time data in a table or graph.

Essential Question(s): How can we measure and communicate velocity?

Students will need to know:

- **Key terms:** position, time, meters, seconds, positive, negative, forward, backward, direction, moving, stopping, velocity, constant, steady, changing, slope, interval, slow, fast, start, end
- The differences between stopping and moving, forward and backward motion, and fast and slow constant velocity on a position-time graph
- How to measure the slope of a line

Students will be able to:

- Describe an object's motion qualitatively
- Identify intervals where an object stopped, moved slow and steady, moved fast and steady, sped up, slowed down, changed direction, or moved backward (toward a reference point) on position-time and velocity-time graphs
- Determine an object's velocity in different time intervals using position-time and velocity-time data
- Compare the position-time graph to the velocity-time graph of the same motion
- Predict what a velocity-time graph looks like for constant velocity

Stage 2 - Assessment Evidence

Performance Tasks
In this activity, students:

- Analyze position-time and velocity-time data to find velocities during different motion scenarios.
- (other tasks to be filled in by teacher)

Other Evidence:

- *Describing Velocity* Check-In
- (other assessments to be filled in by teacher)

(over)

Stage 3 - Learning Plan	
Learning Procedure **Many days before:** • Review lesson plan, practice activity, secure equipment, design additional teaching instruments as desired. **Day of:** • Set up groups, computers, projector. • Introduce lesson (method tbd by teacher). • Have students complete *Describing Velocity* • Conclude lesson (method tbd by teacher).	**Required Materials:** • PC or Macintosh Computers: 1 per group • Supported Internet browser with access to SmartGraphs portal • Projection device (LCD, SmartBoard, or large monitor) preferred but not required
Possible Discussion Questions for Students:	**Sample Answers to Discussion Questions:**
What would the position-time data for forward (away from a reference point), constant velocity look like?	For forward, constant velocity, the position would increase at a steady rate with respect to time, resulting in a straight line tilting up and to the right.
What does a straight line on a position-time graph indicate?	A straight line indicates constant velocity. If it tilts up, motion is in the forward direction. If it tilts down, motion is in the backward direction. If it is horizontal, the velocity is 0, which means the object is not moving.
How can you tell how fast an object is moving by looking at its position-time graph, assuming constant velocity?	To tell how fast an object is moving, measure the slope of a position-time graph, which in this case is a line. To find the slope, divide the change in position by the change in time. Ignoring the sign, a larger slope (steeper line) indicates faster motion than a smaller slope (flatter line). If the line is horizontal, the velocity is 0, which means the object is not moving. The sign indicates direction.
How can you tell how fast an object is moving by looking at its velocity-time graph, assuming constant velocity?	Each point on a velocity-time graph corresponds to an ordered pair. The object's time is the x-coordinate and its velocity is the y-coordinate. To find an object's velocity at a certain time, find the point on the graph with the given time value and then read across to the velocity axis to find its velocity.
What does a straight line on a velocity-time graph indicate?	A straight line indicates that the change in velocity per change in time is constant. If the line is horizontal, the object's velocity is constant --- its change in velocity per change in time (acceleration) is 0. Positive velocity refers to forward motion; negative velocity refers to backward motion. If the line crosses the x axis, the object's direction changed. If the line does not cross the x axis, the object either sped up or slowed down at a constant rate.

Template adapted from Wiggins and McTighe (2004). Understanding by Design