Richmond Public Schools

Department of Curriculum and Instruction
Curriculum Pacing and Resource Guide – Unit Plan

Course Title/ Course #: Physics / 2900

Unit Title/ Marking Period # (MP): Data Analysis, Graphing and Linear Motion / MP1

Start day: 11

Meetings (Length of Unit): 3 weeks

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

PH.1a-g

PH.2 The student will investigate and understand how to analyze and interpret data. Key concepts include

a) a description of a physical problem is translated into a mathematical statement in order to find a solution;
b) relationships between physical quantities are determined using the shape of a curve passing through experimentally obtained data;
c) the slope of a linear relationship is calculated and includes appropriate units;
d) interpolated, extrapolated, and analyzed trends are used to make predictions;

PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include

a) linear motion;

Essential Understandings/ Big Ideas

The concepts developed in standard PH.2a-d include the following:

- Mathematics is a tool used to model and describe phenomena.
- Graphing and dimensional analysis are used to reveal relationships and other important features of data.
- Predictions are made from trends based on the data.
- The shape of the curve fit to experimentally obtained data is used to determine the relationship of the plotted quantities.
- All experimental data do not follow a linear relationship.

- The area under the curve of experimentally obtained data is used to determine related physical quantities.
- Physical phenomena or events can often be described in mathematical terms (as an equation or inequality).

The concepts developed in standard PH.5a include the following:

- Linear motion graphs include
  - displacement (d) vs. time (t)
  - velocity (v) vs. time (t)
  - acceleration (a) vs. time (t)
- Position, displacement, velocity, and acceleration are vector quantities.
- Motion is described in terms of position, displacement, time, velocity, and acceleration.
- Velocity is the change in displacement divided by the change in time. A straight-line, position-time graph indicates constant velocity. The slope of a displacement-time graph is the velocity.

Key Essential Skills and Knowledge

In order to meet standard PH.2a-d, it is expected that students will

- recognize linear and nonlinear relationships from graphed data.
- where appropriate, draw a straight line through a set of experimental data points and determine the slope and/or area under the curve.
- use dimensional analysis to verify appropriate units.

In order to meet standard PH.5a, it is expected that students will

- construct and analyze displacement (d) vs. time (t), velocity (v) vs. time (t), and acceleration (a) vs. time (t) graphs.
- solve problems involving displacement, velocity, acceleration, and time in one dimension (only constant acceleration).

Vocabulary

Displacement	Distance	Velocity	Speed	Elapsed time
Instantaneous Velocity	Average Velocity	Slope	Area Under Curve	Y-Intercept
X-Intercept	Coordinates	Dimensional Analysis	Unit	Position
Mathematical Model	Prediction	Trend	Linear	Nonlinear
Best-Fit Line	Acceleration			

Assessment Evidence ~ What is evidence of mastery? What did the students master & what are they missing?

Assessment/ Evidence

Use http://www.problem-attic.com/ to create a multiple choice or free response quiz or test.

Students should be able to recognize linear and nonlinear relationships from graphed data.

- Collect data (or use data from another source) that, when plotted on a coordinate plane, shows a linear relationship (e.g. mass vs. volume of a particular object) or nonlinear relationship (e.g. distance from a magnet vs. magnetic field strength) and identify each type of relationship.

Students should, where appropriate, draw a straight line through a set of experimental data points and determine the slope and/or area under the curve.

- Use manual methods (e.g. a straight edge) to estimate a best-fit line through a set of data points (generated in class or obtained from outside sources)
- Find and interpret a best-fit line through a set of data points digitally using computer software or a graphing calculator
- Identify the velocity of an object from a position-time graph (slope)
- Identify the acceleration of an object from a velocity-time graph (slope)
- Identify the displacement of an object from a velocity-time graph (area under the curve)

Student should use dimensional analysis to verify appropriate units.

- Convert fundamental and derived units from English to S.I. units (and vice versa), given initial measurements and necessary conversion factors.
- Given fundamental measurements (with units) and a "goal" derived unit (e.g. density or acceleration), identify the mathematical operations needed to calculate that derived unit using the provided fundamental measurements.
- Explain why a given equation is correct or incorrect based on unit analysis.

Students should construct and analyze displacement (d) vs. time (t), velocity (v) vs. time (t), and acceleration (a) vs. time (t) graphs.

- Given a displacement-time or velocity-time graph, students write a story that accurately reflects the motion shown in the graph. Alternatively, they may create a motion-time graph based on a provided story.
- Complete a graph-matching exercise using motion detectors and probeware, in which they must move in a certain way in order to reproduce a provided motion graph.

Students should solve problems involving displacement, velocity, acceleration, and time in one and two dimensions (only constant acceleration).

- Given a word problem involving displacement, velocity, acceleration, and/or time, students solve for a requested unknown with potentially useful equations provided.

Learning Plan ~ What are the strategies and activities you plan to use

Learning Experiences/ Best Practice

Hands on activity for generating data to find a best-fit line: Take a B.R.E.A.T.H. With Us! (Balloon Regression Experiment Analyzing Time vs. Height Activity)

Students can complete online simulations using provided simulation guides individually, in pairs, or as a whole class as the simulation is projected on a Screen or a SMART Board for the following topics:

- Dimensional analysis
- Finding slope of a graph
- Constructing and interpreting motion-time graphs

Complete "I do, we do, you do" cycles in the classroom for dimensional analysis / conversion problems and linear motion problems involving average velocity, displacement, and time elapsed.

Students complete internet scavenger hunts or guided notes to explore relevant topics in physicslab.org or www.physicsclassroom.com.

Students complete a "Graph Matching" lab (e.g. Vernier's Graph Matching) to practice analyzing a motion-time graph and translating that information into a real-life situation (or vice versa).

Students may determine and explain or justify safe driving guidelines using evidence-based kinematic relationships and concepts.

Technology Integrations

- Students may use electronic probeware, such as Vernier equipment, to make digital measurements of position and time.
- Students may use Logger Lite (free) or Logger Pro ($$) software to analyze data electronically.
- Students may use Microsoft Excel to organize and analyze data, Microsoft Word to write lab reports, and Microsoft PowerPoint to plant and present experimental plans, results, and conclusions.
- Online simulations, including Gizmos, PhET, and Concord Consortium
- Students may use scientific or graphing calculators to aid them in complex mathematical calculations during problem solving.

Resources

For online simulations:

- At least enough computers for each pair of students or a computer, projector, and screen / SMART Board
- Simulation guides (e.g. Explore Sheets)

For hands-on lab experiences

- Stopwatches
- Meter sticks or rulers
- Motion Detectors
- Graphing Calculators
- Vernier LabQuests or other probeware interfaces (calculators, computers, etc.)

Gizmos

- Unit Conversions
- Unit Conversions 2 (Sci Notation and Sig Figs)
- Slope - Activity B
- Correlation
- Distance-Time Graphs
- Distance-Time and Velocity-Time Graphs

Activities and Labs

- Motion on a Ramp
- Seeing Motion

PhET Simulations

- The Moving Man

Physics Lab Online: Introductory Mathematics (examples, lab exercises, practice problems, and worksheets)

Physics Lab Online: Kinematics – Graphs

Physics Lab Online: Kinematics - Equations

The Physics Classroom

- Habits of an Effective Problem Solver
- Tutorial: 1-D Kinematics

- Interactives: 1-D Kinematics
- Problem Set: 1-D Kinematics

Khan Academy: Displacement, Velocity, and Time

Cross Curricular Connection

- Mathematical operations and problem-solving skills are needed to solve problems involving displacement, velocity, acceleration, and time.
- Creating scatter plots to graph experimental data on a coordinate plane, then determine the appropriate best-fit curve to model that data, is primarily a mathematical skill.
- Technical and persuasive writing techniques are necessary for writing well-supported scientific conclusions.
- Linear motion has clear applications to everyday situations such as driving, sports and recreation, and many other real-world situations.