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): MP1

Start day: 1

Meetings (Length of Unit): 1 Week (and integrated into all following content units)

Desired Results ~ What will students be learning?

Standards of Learning/ Standards

PH.1 The student will plan and conduct investigations using experimental design and product design processes. Key concepts include

a) the components of a system are defined;
b) instruments are selected and used to extend observations and measurements;
c) information is recorded and presented in an organized format;
d) the limitations of the experimental apparatus and design are recognized;
e) the limitations of measured quantities are recognized through the appropriate use of significant figures or error ranges;
f) models and simulations are used to visualize and explain phenomena, to make predictions from hypotheses, and to interpret data; and
g) appropriate technology, including computers, graphing calculators, and probeware, is used for gathering and analyzing data and communicating results.

Essential Understandings/ Big Ideas

- Appropriate instruments are used to measure position, time, mass, force, volume, temperature, motion, fields, electric current, and potential.
- No measurement is complete without a statement about its uncertainty.
- Experimental records, including experimental diagrams, data, and procedures, are kept concurrently with experimentation.
- Tables, spreadsheets, and graphs are used to interpret, organize, and clarify experimental observations, possible explanations, and models for phenomena being observed.

- Accuracy is the difference between the accepted value and the measured value.
- Precision is the spread of repeated measurements.
- Results of calculations or analyses of data are reported in appropriate numbers of significant digits.
- Data are organized into tables and graphed when involving dependent and independent variables.

Key Essential Skills and Knowledge

In order to meet this standard, it is expected that students will

- measure and record position, time, mass, force, volume, temperature, motion, fields, and electric current and potential, using appropriate technology.
- determine accuracy of measurement by comparing the experimental averages and the theoretical value.
- determine precision of measurement using range or standard deviation.
- follow safe practices in all laboratory procedures.
- use simulations to model physical phenomena.
- draw conclusions and provide reasoning using supporting data.

Vocabulary

Problem	Hypothesis	Independent Variable	Dependent Variable	Control
Constant	Prediction	Standard Error	Standard Deviation	Precision
Accuracy	Significant Figure	Conclusion	Range	Graph
Mean	Scientific Model	Inference	Observation	Average
Uncertainty	Error	Experiment	Statistical Significance	Probeware

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

Assessment/ Evidence

Students should measure and record position, time, mass, force, volume, temperature, motion, fields, and electric current and potential, using appropriate technology.

- Given a scientific problem or hypothesis in a physics context, suggest appropriate technology to be used to test or investigate that problem
- Given a particular scientific tool, identify what it measures and what units the measurement should be recorded in
- Propose a science fair project experimental plan

Students should determine accuracy of measurement by comparing the experimental averages and the theoretical value.

- Calculate standard error using fictional or real data compared to theoretical, known values

Students should determine precision of measurement using range or standard deviation.

- Calculate range or standard deviation from a fictional or real data set, and explain how this calculation should be interpreted regarding the data's precision

Students should follow safe practices in all laboratory procedures.

- Complete the Flinn Safety Exam after studying the Flinn Safety Contract
- Identify and explain specific safety considerations before beginning an experimental investigation

Student should use simulations to model physical phenomena.

- Use simulations from Explore Learning (Gizmos), PhET, and others; afterwards, students should write or discuss major conclusions and key concepts that were explored or demonstrated by using the simulation

Students should draw conclusions and provide reasoning using supporting data.

- Use a claim-evidence-reasoning (CER) model to write scientific conclusions and support them with fictional or real experimental evidence
    - Edutopia article on CER
- Evaluate the validity of a conclusion based on provided data (or the conclusions of other students based on their own data)

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

Learning Experiences/ Best Practice

- Alone or in pairs, students may plan, conduct, analyze, and interpret their own independent science fair projects.
    - Entry into the METRO Richmond STEM Fair requires a written background paper and report on the project, usually due in early February. If the project makes it past the first round of cuts, interviews and a poster are then required.
    - Entry into the Richmond Public Schools STEM Extravaganza requires a poster, which is usually submitted by late March or early April.
- Students may complete real, hands-on investigations, or manipulate online simulations, within the contexts of every content unit in the course, including linear motion, non-linear motion, Newton's laws, planetary motion, gravitation, energy, waves, light, and electromagnetism.
- Students may practice recording measurements from a variety of scientific tools using appropriate significant digits based on the level of precision of each instrument; then, students should complete various calculations while appropriately applying significant figure rules when reporting a final answer.
- Students may create posters to demonstrate key lab safety practices from the Flinn Safety Contract.
- Watch an introductory video, such as Zombie College: The 5 Rules of Lab Safety, to introduce lab safety; identify key safety features of the lab, including fume hood, eye wash, shower, fire extinguisher, and nearest exit.
- Provided written or illustrated lab scenario, have students identify safety concerns.

Technology Integrations

- Students may use electronic probeware, such as Vernier equipment, to make digital measurements of position, time, mass, force, volume, temperature, motion, fields, and electric current.
- 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

Resources

- Basic non-digital scientific tools (thermometers, timers, balances, rulers/meter sticks, spring scales, graduated cylinders, etc.)
- Digital probeware (thermometers, motion detectors, force detectors, accelerometers, current and voltage meters, magnetic field sensors, light meters, etc.)
- Computers with Microsoft Office, internet access, and Logger Lite or Logger Pro installed

Gizmos

- Free Fall Tower
- Pendulum Clock

Physics Science Fair Project Ideas (Sciencebuddies.com)

Physics Science Fair Project Ideas (education.com)

Science Fair Project Guide

Cross Curricular Connection

- Mathematical statistics are needed to analyze scientific data (mean, range, standard error, standard deviation, chi-square test, t-test, p-values, statistical significance).
- Technical and persuasive writing techniques are necessary for writing well-supported scientific conclusions.
- History of the development of the scientific method connects with many philosophical/cultural topics and personalities (i.e. Aristotle, Bacon, Descartes, rationalism, ancient Greek culture, the Inquisition, the Renaissance, etc.).