

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): Scientific Reasoning and Logic / MP1

Start day: 6

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.3 The student will investigate and demonstrate an understanding of the nature of science, scientific reasoning, and logic. Key concepts include
- a) analysis of scientific sources to develop and refine research hypotheses;
 - b) analysis of how science explains and predicts relationships;
 - c) evaluation of evidence for scientific theories;
 - d) examination of how new discoveries result in modification of existing theories or establishment of new paradigms; and
 - e) construction and defense of a scientific viewpoint.

Essential Understandings/ Big Ideas

The concepts developed in this standard include the following:

- The nature of science refers to the foundational concepts that govern the way scientists formulate explanations about the natural world. The nature of science includes the following concepts
 - a) the natural world is understandable;
 - b) science is based on evidence - both observational and experimental;
 - c) science is a blend of logic and innovation;
 - d) scientific ideas are durable yet subject to change as new data are collected;
 - e) science is a complex social endeavor; and
 - f) scientists try to remain objective and engage in peer review to help avoid bias.
- Experimentation may support a hypothesis, falsify it, or lead to new discoveries.

- The hypothesis may be modified based upon data and analysis.
- A careful study of prior reported research is a basis for the formation of a research hypothesis.
- A theory is a comprehensive and effective explanation, which is well supported by experimentation and observation, of a set of phenomena.
- Science is a human endeavor relying on human qualities, such as reasoning, insight, energy, skill, and creativity as well as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

Key Essential Skills and Knowledge

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

- identify and explain the interaction between human nature and the scientific process.
- identify examples of a paradigm shift (e.g., quantum mechanics).

Vocabulary

Nature of Science	Evidence	Observation	Experiment	Logic
Innovation	Data	Hypothesis	Theory	Law
Collaboration	Objective	Subjective	Bias	Peer Review
Paradigm Shift				

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

Assessment/ Evidence

- Students may complete a research paper on a specific paradigm shift in physics, including social as well as scientific context and implications.
- Students may choose a particular physicist, historical or modern, and complete a biographical project on that person.
- Given a series of hypothetical or actual ideas or belief systems, students can be asked to identify whether each fits the “nature of science” or not. If not, students can explain what aspect(s) of the nature of science is not adhered to by that particular idea.
- Given any of the NOVA ScienceNOW videos listed below, students may write a paper or prepare a presentation why each embodies (or fails to embody) each aspect of the nature of science.

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

Learning Experiences/ Best Practice

The following NOVA ScienceNOW videos may be integrated throughout the course based on content context. Newton's Dark Secrets may be a good video to begin with because it introduces flaws in a well-known and deeply respected scientific persona.

- Students watch the [NOVA ScienceNOW: Newton's Dark Secrets](#) film (running time: 51:15) and complete the activities described in the [Newton's Dark Secrets Classroom Guide](#).
- Students watch the [NOVA ScienceNOW: Einstein's Big Idea](#) film (running time: 1:48:58) and complete the activities described in the [Einstein's Big Idea Classroom Guide](#).
- Students watch any selection of episodes from [NOVA ScienceNOW: The Elegant Universe](#) (3 full episodes, each ~50 min.) and complete the activities described in the [The Elegant Universe Classroom Guide](#).
- Students watch any selection of episodes from [NOVA ScienceNOW: The Fabric of the Cosmos](#) (4 full episodes, each ~50 min.) and complete summarizing activities such as writing summaries, filling out [Fabric of the Cosmos Worksheets](#), and/or participating in discussions or Socratic Seminars to explore the information in the videos.
- Students watch the [NOVA ScienceNOW: Big Bang Machine](#) film (running time: 53:10) and complete summarizing activities such as writing summaries and/or participating in discussions or Socratic Seminars to explore the information in the videos.

Students may summarize, analyze, and/or present current events in science related to physics using newspapers, magazines, and reputable online resources such as <http://www.livescience.com/>, <https://student.societyforscience.org/>, <http://news.sciencemag.org/>, <http://www.sciencedaily.com/>, <http://science.nasa.gov/science-news/>, <http://phys.org/>, etc.

- As an extension, organize debates over controversial scientific topics, including the financial costs of space exploration

Conduct and discuss the results of a [survey of science knowledge](#). This may serve as a good pre- and post-test of a stand-alone Nature of Science unit or a measure of progress over the course of the entire class.

Discuss with students [what science is not](#) by presenting common myths regarding science and comparing them to the accepted aspects of the nature of science as summarized in the VA Standards of Learning. Include a discussion of [what science is](#), including underlying assumptions and limitations.

While the VDOE does not include a Science Enhanced Scope and Sequence of lessons for physics, the Biology SESS includes a lesson called [Current Applications in Science](#) that may be used in a physics context (The lesson may be downloaded in Microsoft Word format and edited [here](#) by choosing on "Biology" and clicking on the "Word" link next to "Current Applications in Science."

Technology Integrations

- NOVA ScienceNOW online streaming videos listed above
- Online science news sources listed above
- Use of online bibliography generators/organizers such as www.easybib.com or www.bibme.org when writing background research papers

Resources

- For showing films and television episodes:
 - Computer with internet connection
 - Projector
 - As needed, materials required for related assessment or focus activities as outlined in classroom guides
- The Evolution and Nature of Science Institute has a wealth of resources for planning and conducting a [stand-alone unit on the Nature of Science](#) (the website is a bit antiquated and difficult to navigate at times, but the materials are high-quality)

Cross Curricular Connection

- 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.).
- Modern scientific problems almost always have economic, political, and/or cultural connections that influence research and progress.