The Virginia Instructors of Physics
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LEARNING PHYSICS TO TEACH OTHERS

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Va. SOL:

PH.3 The student will investigate and understand how to demonstrate 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 (the nature of science).

PH.4 The student will investigate and understand how applications of physics affect the world. Key concepts include
a) examples from the real world; and
b) exploration of the roles and contributions of science and technology.

Other physics SOLs depending on the topic chosen by the students

National Standards:

The unifying concepts and processes in this standard are a subset of the many unifying ideas in science and technology. Some of the criteria used in the selection and organization of this standard are

- The concepts and processes provide connections between and among traditional scientific disciplines.
- The concepts and processes are fundamental and comprehensive.
- The concepts and processes are understandable and usable by people who will implement science programs.
- The concepts and processes can be expressed and experienced in a developmentally appropriate manner during K-12 science education.

Public discussions of the explanations proposed by students is a form of peer review of investigations, and peer review is an important aspect of science. Talking with peers about science experiences helps students develop meaning and understanding. Their conversations clarify the concepts and processes of science, helping students make sense of the content of science. Teachers of science should engage students in conversations that focus on questions, such as "How do we know?" "How certain are you of those results?" "Is there a better way to do the investigation?" "If you had to explain this to someone who knew nothing about the project, how would you do it?" "Is there an alternative scientific explanation for the one we proposed?" "Should we do the

investigation over?" "Do we need more evidence?" "What are our sources of experimental error?" "How do you account for an explanation that is different from ours?"

Questions like these make it possible for students to analyze data, develop a richer knowledge base, reason using science concepts, make connections between evidence and explanations, and recognize alternative explanations. Ideas should be examined and discussed in class so that other students can benefit from the feedback. Teachers of science can use the ideas of students in their class, ideas from other classes, and ideas from texts, databases, or other sources--but scientific ideas and methods should be discussed in the fashion just described.

RECOGNIZE AND ANALYZE ALTERNATIVE EXPLANATIONS AND MODELS. This aspect of the standard emphasizes the critical abilities of analyzing an argument by reviewing current scientific understanding, weighing the evidence, and examining the logic so as to decide which explanations and models are best. In other words, although there may be several plausible explanations, they do not all have equal weight. Students should be able to use scientific criteria to find the preferred explanations.

COMMUNICATE AND DEFEND A SCIENTIFIC ARGUMENT. Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language appropriately, developing diagrams and charts, explaining statistical analysis, speaking clearly and logically, constructing a reasoned argument, and responding appropriately to critical comments. **[See Teaching Standard B in Chapter 3]**

UNDERSTANDINGS ABOUT SCIENTIFIC INQUIRY

- Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists. **[See Unifying Concepts and Processes]**
- Results of scientific inquiry--new knowledge and methods--emerge from different types of investigations and public communication among scientists. In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge. In addition, the methods and procedures that scientists used to obtain evidence must be clearly reported to enhance opportunities for further investigation.

Other specific standards based on the topic chosen by the student.

Topic/Concept

The concept of this lab/project is for students to pick a topic of interest to them, research the topic in depth and prepare to teach a group of students younger than themselves. The topics chosen are those the students may be familiar with and those that they will be learning about only briefly.

Materials

- Depends on specific plan for each student group.

Safety Considerations

None

Presentation

The students will research physics concepts in detail and plan a way to teach the material to other students. Students must be able to communicate the material in a variety of ways. Students will improve their abilities to discuss scientific concepts in common language.

Learning Physics to Teach Others

Project Description

This quarter you and your group members will have two individual projects that will build on one another. The first is a concept document in which you will document how you would present your chosen subject to a group of middle school students. The second will be actually present the material to the class as detailed in your concept document. The topics should be chosen from the following list:

- Newton's Laws of Motion, Forces and Momentum
- Light and Optics
- Quantum Physics
- Electricity and Electric Circuits
- Magnetism
- Energy – types, transfers, conservation and real world applications of energy
- Torque and Rotational Motion
- Linear Motion
- Projectile Motion (not including Potato cannons or tennis ball launchers)
- Buoyancy
- Cosmology
- Thermodynamics
- Nuclear Forces and Atomic Energy Transitions

Concept Document

This is a 2 to 3 page document that explains in detail how you would present the concept you picked last quarter. Your presentation must included a description of the concept, the date of discovery or first study as well as the first person to do the study, what they studied and how the concept impacts our lives today. Interesting facts and other historical information may be included. The concept document has the following parts:

Presentation Description	This section is where you describe how you would present the material. Here are some possible ways you can present it: Brochures Posters Video Demonstration(s) Experiment(s) Model(s) PowerPoint presentations Websites/Webquest Games Worksheets Notes pages

	Question and answer sessions Crossword puzzles/word searches Things to think about as you design your presentation: What material will be included in your presentation? What are the real world applications? What parts of the real world applications are important to your concept? Will your presentation stand-alone or will you talk about it as well? What types of other material should you have available for the audience to take away with them? The attention span of your audience is at a maximum 15 and 20 minutes per style of presentation. You need to transition from lecturing to demonstrations to hands on activities every 5 to 7 minutes. What materials will you use to help you explain the material to a junior high student? You need to communicate to visual, auditory as well as hands on learners.
Presentation Flow	How will you present the material? This should be a step-by-step discussion of how you would present the material. This should include identification of how long you would spend on each part. Presentation should include: • A statement of the presentation goals • A summary of what will be happening • A brief history of the concept • A conceptual description of the material

	• A hand out of some kind for the students to take away with them • Demonstrations or other eye catching display • Something that the students can do to help them understand the material
What materials will you need	This should be a list of what materials you will need for your presentation.
How much will it cost to develop your presentation	This is an embedded Excel spreadsheet and graph in your document.

Project Conference

A project conference will occur once during the development period. This will occur after the concept document has been turned in and graded. This conference will last no more than 10 minutes. During the conference the teams will get feedback on their presentation concept.

Project Grading

The following is the breakdown of grades for this project. Projects as a whole are worth 25 percent of your quarterly grade.

Item	Grade Percentage
Project Conference	10
Concept Document	35
Presentation	55
Total	100

Concept Document Grading

Here is how the concept document will be graded:

Item	Grade Percentage
Presentation Description	30
Presentation Flow	40
What materials will you need	10
How much will it cost to develop your presentation	20
Total	100

The first rubric is the one that will be used to evaluate the Concept Document.

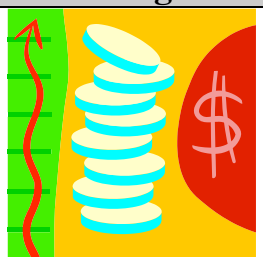
Presentation Grading

Here is how the presentation will be graded:

Item	Grade Percentage
Concept Description	20
Goals of Presentation/What audience will see	10
History of Concept	10
Real World Application discussion	15
Audience Grabber	10
Descriptive materials	15
Presenter Knowledge and Audience interest	20
Total	100

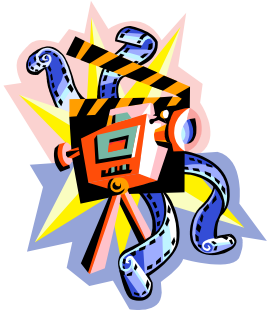
The second rubric is the one that will be used for the evaluation of the Presentation.

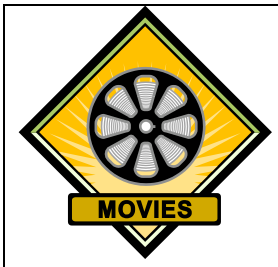
Rubric for Concept Document

Rating	Criteria
 **Profits are Looking Up**	Presentation method is clearly described in detail. Presentation Flow is clear and orderly. Most elements of presentation are included. Time requirements are identified. Presentation includes: ○ Concept Description ○ Original discoverer is identified and how he studied the concept is clearly discussed. ○ Additional contributors and their contributions are identified and fully documented. ○ How the concept impacts our lives today is defined clearly. At least 3 supporting arguments are included. Supporting arguments are supported with background material. ○ Hands on Activity and demonstration are identified and described. Materials list included and seems complete. Cost of materials is included as both a table and a pie or bar chart.
 **Meets Analyst Expectations**	Presentation method is described in detail. The minimal confusion exists Presentation Flow is clear and orderly. Most elements of presentation are included. Time requirements are identified. Presentation includes at least 4 of the following: ○ Concept Description ○ Original discoverer is identified and how he studied the concept is clearly discussed. ○ Additional contributors and their contributions are identified and fully documented. ○ How the concept impacts our lives today is defined clearly. At least 3 supporting arguments are included. Supporting arguments are supported with background material. ○ Hands on Activity and demonstration are identified and described. Materials list included and seems mostly complete. Cost of materials is included as both a table and a pie or bar chart.
 **Lower than Expected Earnings**	Presentation method is described in detail. Some confusion exists. Presentation Flow is clear and orderly. Most elements of presentation are included. Presentation includes at least 3 of the following: ○ Concept Description ○ Original discoverer is identified and how he studied the concept is clearly discussed. ○ Additional contributors and their contributions are identified and fully documented. ○ How the concept impacts our lives today is defined clearly. At least 3 supporting arguments are included. Supporting arguments

	are supported with background material. ○ Hands on Activity and demonstration are identified and described. Materials list included and seems somewhat complete. Cost of materials is included as both a table and a pie or bar chart.
 **Bargain Priced for Sale**	Presentation method is described. There are places where presentation method is not clear. Presentation Flow is included. Most elements of presentation are included. Presentation includes at least 3 of the following: ○ Concept Description ○ Original discoverer is identified and how he studied the concept is clearly discussed. ○ Additional contributors and their contributions are identified and fully documented. ○ How the concept impacts our lives today is defined clearly. At least 3 supporting arguments are included. Supporting arguments are supported with background material. ○ Hands on Activity and demonstration are identified and described. Materials list included and seems somewhat complete. Cost of materials is included as a table or as a pie or bar chart.

Rubric for Presentation

Rating	Criteria
 **Blockbuster**	Concept is discussed thoroughly in terms understandable to someone without knowledge of the material. History is discussed in detail. Real world applications are discussed and the topic's relationship are detailed. Concept Presentation method is followed. All deviations were explained to the teacher prior to the presentation. Presentation includes both printed and verbal materials. Multiple learning styles are addressed. Materials are accurate and appropriate. Demonstration(s) are appropriate, well explained and caught and kept the interest of the audience. Hands on activity was relevant and helped get the material understood. Presenters are enthusiastic and are confident of their material. Presentation is cohesive and covers the full-required length of time. Presenters spend most of their time looking at the audience and very little time looking at notes or visuals.

 **Top Box office Draw**	Concept is discussed thoroughly in terms understandable to someone with a passing knowledge of the material. History is discussed. Material is accurate Real world applications are discussed in good detail. Concept Presentation method is followed. Most deviations were explained to the teacher prior to the presentation. Presentation includes both printed and verbal materials. Multiple learning styles are addressed. Materials are accurate and appropriate. Demonstration(s) are appropriate, explained in some detail and caught and kept the interest of the audience. Hands on activity was relevant and helped get the material understood. Presenters are enthusiastic and are confident of their material. Presentation is cohesive and covers the full-required length of time. Presenters spend some of their time looking at the audience and a moderate time looking at notes or visuals.
 **Discount Theaters**	Concept is discussed is understandable by someone with knowledge of the material. History is discussed. Material was mostly correct. Real world applications are discussed in some detail. Concept Presentation method is mostly followed. Some deviations were explained prior to the presentation. Presentation includes both printed and verbal materials. Materials are accurate and appropriate. Demonstration(s) are appropriate, explained and the audience paid attention. Hands on activity was relevant and helped get the material understood. Presenters are enthusiastic and are confident of their material. Presentation is cohesive and covers the full required length of time. Presenters spend less than half of their time looking at the audience; most of the time was looking at notes or visuals.
 **Straight to Video**	Concept is discussed but a working knowledge of the material is required. History is discussed. Real world applications are discussed and the topics relationship is mentioned. Concept Presentation method was followed somewhat. Presentation materials are available. Accuracy is in question in some places. Demonstrations may or may not be completed. Hands on activity was included but not necessarily relevant to the material. Presenters are enthusiastic about their material. Presentation spans the full required length of time. Presenters spend most of their looking at notes or visuals.

Teacher Tips Regarding Lab

Teachers should question student groups about demonstrations dealing with explosions. I have had to make specific rules with regard to any type of cannon involving aerosols and fire.

Allow students to be creative. Encourage students to look on the Internet for demonstrations and hands on activities.

Sources & References