Exemplary Plans

Plunging Into Physics

Unit Summary
In this unit, students ask questions about their physical world, and design experiments to answer them. They venture out of the classroom with probeware and handheld computing devices to test a variety of physical phenomena. The study culminates in classroom presentations of their investigations. This is a final unit that follows a general physics curriculum.

Curriculum Framing Questions

- **Essential Question**
  How can we explain the things that happen around us?
- **Unit Questions**
  How can we design the right experiment to answer a science question?
  How do physicists make predictions?
- **Sample Content Questions**
  What are the rules for taking a good set of data?
  What are some sources of error?

Instructional Procedures

Setting the stage
Start the unit by discussing questions such as, “Have you ever felt your stomach drop momentarily as you descended in an elevator?” or, “What do you think the humidity is on a day like today?” Tell students they will be able to explore interesting physical phenomena like this through their own research. Encourage students to share their questions about the physical world, and record their ideas.

Introduce the basic rules of data collection and statistical analysis, and demonstrate how to use available probeware. (Probes might include those that measure temperature, gas pressure, ultraviolet radiation, magnetic fields, and acceleration.)

At A Glance

Grade Level:
10-12

Subject:
Physics

Topics:
Physical Principles
Measurement

Key Learnings:
Physical Science
Experimental Design
Data Collection and Analysis

Time Needed:
One week, 60 minutes daily

Background:
Odyssey Story from Iowa, United States

Things You Need

Standards

Resources

Print This Unit
(PDF; 9 pages)

Choosing a Question
Group students into teams of two or three, and have them outline four or five possible investigations and methods for collecting data. Suggest that groups refer to their physics texts and the Concord Probe Sight* Web site, which has “sensor suggestions” for investigations using the different types of probeware.

Meet back in the large group and have teams describe their ideas for investigations. Try to narrow the investigations to the most feasible ones, and strive for a range of experiments and data collection methods. Next, explain the steps for designing an experiment, and go over the planning guide. (If time permits, have students follow these guidelines to write a lab report.) Discuss project requirements described in the assessment rubric. Give the students the project schedule and dates for final presentations.

Have groups narrow their focus to one investigation and refine their experimental design. Meet with each team to discuss methods and safety, and plan for additional devices they may need to carry out the investigation. (For example, students wondering about the pressure at the bottom of a school swimming pool might engineer a device that would drop a length of rubber tubing to the bottom of the swimming pool while remaining connected to the pressure sensor and interfacing equipment.)

Collecting and Analyzing Data
Demonstrate data collection procedures. Show how to analyze data using software on the handheld devices, or by uploading to a spreadsheet program. Discuss methods of analysis and help students decide which processes to use. Go over expectations for recording their processes and data in a science log. Give students time to practice using their sensors before they conduct their experiment. Show students how to use digital still or video cameras to record different phases of their project.

Set aside several periods for students to complete their investigations. It is likely that they will adjust their experimental design along the way. Stress the importance of using the science log to record variables, data, and adjustments in the experimental design.

Presenting Research Findings
Give students time to create a presentation supported by multimedia. At a minimum, the presentation should cover their initial question, data collection procedures, an explanation of how their sensor works, and a conclusion. As students make presentations, assess their work using the assessment rubric.

Prerequisite Skills
Before students begin their independent projects they need to know:

- Basic principles of experimental design
- How to operate lab interfacing equipment
- Data analysis
- How to create a spreadsheet and make charts and graphs
- How to use presentation software

Differentiated Instruction

- **Resource Student**
  As students work in pairs or small groups, establish rules so all students participate.
  Provide step-by-step instructions.
- **Gifted Student**
  Encourage able students to pursue investigations that are more complicated. They may also be able to make more difficult statistical calculations.
- **English Language Learner (ELL)**
  Pair students with students who share a common language of origin but who have greater English proficiency.

Assessment Processes:
Use the assessment rubric to evaluate student's science learning, presentation skills and participation.

Credits
Shelly Nash is a high school physics teacher at Sioux City West High School in Sioux City, Iowa.

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Content Standards & Objectives

Student Objectives/Learning Outcomes:

- Design and conduct an experiment, and write a laboratory report
- Reach conclusions about the physical world
- Learn to present a research project using supporting media

Targeted State Frameworks/Content Standards/Benchmarks:
National Science Standards
Science: Investigation and Experimentation

- Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data
- Identify and communicate sources of experimental error
- dentify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions
- Formulate explanations using logic and evidence

National Educational Technology Standards (NETS):

- Collaborate with peers, experts, and others to contribute to a content-related knowledge base by using technology to compile, synthesize, produce, and disseminate information, models, and other creative works
- Routinely and efficiently use online information resources to meet needs for collaboration, research, publications, communications, and productivity
- Select and apply technology tools for research, information analysis, problem- solving, and decision-making in content learning

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Resources

Materials
Suppliers of probeware
Vernier Software & Technology: http://www.vernier.com*
Pasco Scientific: http://www.pasco.com*
ImagiWorks: http://www.imagiworks.com*

Internet Resources
Learning With Handhelds at Intel® Innovation in Education:
http://intel.com/education/handhelds
This is a good site for an overview of handhelds in education.

The Concord Consortium Probe Sight:
http://probesight.concord.org*
A resource for using probeware in science investigations.

Other Resources
Some students may find it useful to consult a local expert on their topic. For example, they may want to consult with a meteorologist if they are studying humidity or air pressure.

Technology – Hardware
Computers, lab probes, digital cameras, video equipment, presentation equipment

Technology – Software
Software for data collection, spreadsheets, electronic presentations, digital photography

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Experiment Planning Sheet

Use this guide to create your experiment framework and plan your presentation.

Before the Experiment

1. Create a title for your experiment.
2. Describe the purpose of your experiment.
3. How did you arrive at your question?
4. Use text and online resources to learn more about your topic. Keep a record of your sources.
5. Explain your experimental design including how you are going to control variables and avoid error.
6. Give a detailed account of how you will make your measurements and record your data. Use drawings and step-by-step instructions. Be prepared to edit these if you alter any steps during the actual process.
7. How did you decide on your procedure?
8. Make a list of all materials you will need to complete your project.
9. Create a data table for recording your measurements.
10. Meet with your teacher to receive approval before conducting your experiment.

After the Experiment

1. Make graphs of your data. Analyze the data. Take note of any trends or correlations in the data and explain your interpretation of the data. Discuss alternate explanations for your results, also. Make sure you note sources of error.
2. Draw conclusions about your experiment. Explain the scientific principles that were addressed.
3. Prepare to present your findings to the class. Your job is to teach the scientific concepts that underlie your research question.

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Writing a Lab Report

Title Page:
The title page provides the name of the lab experiment, the names of the lab partners, the date, and any other information your instructor requires.

Abstract:
The abstract is the report in miniature. It summarizes the whole report in one concise paragraph of 100-200 words. The abstract tells the reader what will be done and lays the groundwork, then summarizes the report itself, not the actual experiment. . You cannot write the abstract until you have completed the report. Before writing the abstract, it is often helpful to summarize each section of the report (introduction, methods and materials, procedure, results, discussion, and conclusion) in one sentence. Then try to arrange this information into a short paragraph. Remember, the abstract should be a precise and specific summary.

Introduction:
The introduction presents the subject of the report and acquaints the reader with the experiment. Typically, the introduction states the problem or the experiment, and explains its purpose and significance. It also provides background theory, previous research, or formulas the reader needs to understand and perform the experiment.

Materials:
This section can consist of a list. Be complete, accurate, and precise.

Experimental Procedure:
This section is a full descriptive narrative. Be complete, accurate, and precise, listing all steps in the correct order. State what you really did and what actually happened, not what was supposed to happen or what the textbook said.

Results:
Give your actual results, not what should have happened. Although results are usually presented quantitatively, you should always introduce each block of information verbally and provide clear and accurate verbal labels.

Discussion:
Explain, analyze, and interpret your results, being especially careful to explain any errors or problems. This is probably the single most important part of the report, since it is here that you demonstrate that you understand and can interpret what you have done.

Conclusion:
Draw conclusions from the results and discussion that answer the question, "So what?" Then go on to explain your conclusions. In this section, you may also criticize the lab experiment and make recommendations for improvement.

References:
Consult your instructor about reference forms, and check a style manual for the field.

Appendices:
Appendices may include raw data, calculations, graphs, and other quantitative materials that were part of the experiment, but not reported in any of the above sections. Refer to each appendix at the appropriate point (or points) in your report. For, at the end of your results section, you might have the note, See Appendix A: Raw Data Chart.

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Assessing Learning

Group Assessment

Student name: ___________________

Group: ____________________

Class Period: ____________________

CATEGORY	3	2	1
Experimental Design	The question is worthy and can be answered by the experiment. Plan shows effective and reliable data collection procedures.	The question is worthy. The experimental design is generally strong, but links between question and plan are unclear.	The question and experimental design do not match. Additional support is needed to plan project.
Conducting the Experiment	Sufficient and accurate data is collected. Data is well organized. Tables or charts made interpretation clear.	Data is accurate, but more data would improve interpretation. Tables and charts are appropriate.	Data may be inaccurate or limited, making interpretation difficult. Tables and charts are needed.
Analysis	Logical conclusions are based on the data and connect to the scientific principles being studied.	Data analysis may be generally accurate, but does not make strong connections to scientific principles.	Analysis is flawed or does not lead to conclusions.
Presentation	Science concepts are expressed well. Presentation is well organized and effective. Multimedia supports presentation.	Science concepts are presented, but not in depth. Presentation is generally organized and effective. Multimedia supports the presentation, but may distract from the message to a degree.	Concepts are not presented in an effective or organized manner. Multimedia does not support the message.
References	References are complete and properly cited.	References are complete, citations may need work.	References are incomplete or poorly cited.

Group Score: ________ / 15

Individual Assessment

Student name: ___________________

Class Period: ____________________

CATEGORY	5	3	1
Participation	Cooperative team member who shows leadership. Contributes significantly to group effort. Uses time and materials properly.	Cooperative team member. Contributes to group effort. Uses time and materials properly, may need reminders.	Does not contribute fully to team effort, or distracts partners. Problems with time and materials management interferes with group's progress.

Rate yourself on a scale from 1 to 5 on the level of participation in the project, with 1 being the least involved to 5 being a major contributor of ideas and effort.

1 2 3 4 5

Participation Score + Self Evaluation = Total Individual Score ___________/10

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