# *Veteran Education Transfer Plan*
# *Cover Sheet*

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| Title of ETP | Inquiring Minds What to Know: Inquiry Labs for Junior High Physical Science |
| Name of IISME Fellow | Deborah Bodony |
| Fellow's year-round email | bodony@stanford.edu |
| Sponsor Company | NASA Ames Research Center |
| Name of Mentor | Christina O'Guinn |
| National Board Certificate Area | Early Adolescence/Science |

I, the IISME **Fellow** named above, affirm that the ETP I am submitting is my own work, that I acknowledged sources where appropriate, and that I avoided including any proprietary information of the Sponsor Company. By my submission I am assigning to IISME my entire copyright in the ETP. I understand IISME is simultaneously granting me a license to use the ETP for pedagogical purposes.

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Signature Date

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| Category | *Curriculum*<br>Subject: Math <u>Science</u> Technology _____<br>Level: Elem <u>Middle</u> High Other<br>*Staff Development*<br>*Describe*_____<br>*Other*<br>*Describe*_____ |
| Objectives | **California Science Standards:**<br>• Students will plan and conduct a scientific investigation to test a hypothesis (9a).<br>• Students will distinguish between variable and controlled parameters in a test (9c).<br><br>**Early Adolescence/Science National Board Standards:**<br>• Accomplished science teachers select and adapt instructional resources, including technology, laboratory, and community resources, and create their own resources to support active student explorations of science (Standard III: Instructional Resources).<br>• Accomplished science teachers stimulate interest in science and technology and elicit their students' sustained participation in learning activities (Standard IV: Engagement).<br>• Accomplished science teachers involve students in inquiries that challenge them and help them construct an understanding of nature and technology (Standard VII: Science Inquiry). |

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| Abstract (50 words or less) | "Inquiring Minds What to Know" is a project that will include several inquiry labs focused on physical science as well as a method for writing a formal lab report. Over the course of several weeks, the students will complete an inquiry lab once a week. After completing the lab, the students will write a formal lab report on their findings from the lab. The first inquiry lab that the students complete will focus on the scientific process including gathering data, making observations, and establishing a control. The inquiry labs that will follow will focus on forces and motion. |
| **Describe how your ETP aligns with the National Board Standard stated in your proposal.** | The focus of my ETP is to stimulate student thinking through the completion of inquiry labs. Through these labs, my students will be challenged, and they will also have first hand experience with the scientific process. As a result, my ETP aligns with Standard VII: Science Inquiry.<br><br>My ETP also aligns with Standard III: Instructional Resources and Standard IV: Engagement. The labs in this ETP come from a variety of resources. I chose the labs based on the objectives that I wanted to address in this project. I then modified them to meet the needs of my junior high students and to make the focus inquiry. I also chose labs based on how engaging they would be for the students. When my students are engaged, I have found that their interest and participation increase. |
| Describe the connection between your ETP and the Summer Fellowship. | For my summer fellowship, I wrote physics and math lessons plans for NASA's PSA program. One connection between my ETP and my fellowship is that three of the four inquiry labs I developed are focused on physics. The second connection is that inquiry is an important part of the education projects developed at NASA Ames. Through my work here, I have learned the importance of using inquiry in my classroom. |
| Growth-Measurement Devices | Student growth will be measured in two ways. First, each student will complete a pre-test and post-test prior to completing the inquiry labs and after completing all of the labs. The pre-test and post-test will include questions about the scientific method and how to write a lab report<br><br>The second way that growth will be measured is that the students will write a report after each lab that will include all of the parts of the scientific method. The lab reports will be scored against a rubric. After the students complete all of the inquiry labs, I will review the data to see if the students' scores increased after the students had more experience with inquiry labs and writing lab reports. |
| Resources Needed | Each inquiry lab developed for this project has a list of materials/supplies. |

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| Evaluation/Assessment Measures Used | While students complete the lab, they will be evaluated based on their attentiveness, participation, and discussion with their lab group. After completing the lab, students will be evaluated through their individual lab reports. Class discussions will allow me to assess the understanding and progress of the class as a whole. |
| Formatting specifications | PC ____ or Mac__X__ **(Must be in Word or Text Format)**<br>Software used _Microsoft Word_____ |
| Submitted Copy | *Soft and hard copy due to peer coach by the end of the summer fellowship. Also, a copy of the cover sheet signed by a school site administrator submitted to IISME Oct.3, 2004 to receive $300 grant.* |

I, the **Mentor** named above [please select one of the following],

- ❑ have read the attached ETP, and my comments, if any, appear below.
- ❑ have read the attached ETP, and, as outlined in the IISME-Company Fellowship Agreement, have reviewed it on behalf of the Sponsor Company, and have determined that the ETP does not contain any Sponsor-proprietary information. My additional comments, if any, appear below.

Comments:

Signature Date

**Administrator**'s comments:

Signature Date

# *Inquiring Minds Want to Know: Inquiry Labs for Junior High Physical Science*

**Abstract:**
"Inquiring Minds What to Know" is a project that will include several inquiry labs focused on physical science as well as a method for writing a formal lab report. Over the course of several weeks, the students will complete an inquiry lab once a week. After completing the lab, the students will write a formal lab report on their findings from the lab. The first inquiry lab that the students complete will focus on the scientific process including gathering data, making observations, and establishing a control. The inquiry labs that will follow will focus on forces and motion.

**Standards:**

**California Science Standards:**

- Students will plan and conduct a scientific investigation to test a hypothesis (9a).
- Students will distinguish between variable and controlled parameters in a test (9c).

**Early Adolescence/Science National Board Standards:**

- Accomplished science teachers select and adapt instructional resources, including technology, laboratory, and community resources, and create their own resources to support active student explorations of science (Standard III: Instructional Resources).
- Accomplished science teachers stimulate interest in science and technology and elicit their students' sustained participation in learning activities (Standard IV: Engagement).
- Accomplished science teachers involve students in inquiries that challenge them and help them construct an understanding of nature and technology (Standard VII: Science Inquiry).

**Summary of Activities:**

Day 1:

- Introduce Inquiring Minds Unit.
- Administer Scientific Method Pre-Quiz. (Answer Key)
- Begin Scientific Method Notes.

Day 2:

- Finish Scientific Method Notes.
- Introduce the Salsa Lab and have students develop a scientific question.

Day 3:

- Have students research their question and develop a hypothesis.
- Have students write procedures for their scientific question.
- Have students develop a data table for their experiment.

Day 4:

- Have students run the experiment following their procedures.

Day 5:

- Have students edit their procedures.
- Explain the Instructions for Writing a Lab Report.
- Explain the Lab Report Evaluation to students.

**Forces and Motion Inquiry Labs**

Listed below are inquiry labs written to complement an eighth grade unit on forces and motion. Because inquiry is the basis of these labs, they can be completed by students in grades 5-8 at any point during the year in order to reinforce the scientific method, to instruct students on statistics, to prepare students for science fair, or just for the students to have fun doing real science.

- Loop Plane Proposal Form
  Forces and Motion Connection: As part of the results, the students must calculate the speed for each trial and the average speed for each plane.
- Parachute Lab Proposal Form
  Forces and Motion Connection: As part of the results, the students must calculate the velocity and acceleration for each trial, as well as the average velocity for each parachute.
- CD Glider Proposal Form
  Forces and Motion Connection: As part of the results, the students must calculate the friction force during each trial using the measured mass and the calculated acceleration.

**Scientific Method Post-Quiz** (Answer Key)

The post-quiz can be administered after the students have completed days 1 through 7. Ideally, the students would complete the three inquiry labs listed above in order to reinforce the information that they learned in days 1 through 7.

References

**Day 1:**

1. Explain overview of "Inquiring Minds Want to Know".
   - Write "Inquiring Minds Want to Know" on the board.
   - Ask students what they think of when they see this statement.
   - Have students share their ideas about this statement. Students may respond that this statement makes them think of finding an answer to a question or problem.
   - Explain to students that they are going to learn and practice the process that scientists use in order to find the answer to a question.

2. Explain the Scientific Method Pre-Quiz and have students complete the pre-quiz.
   - Explain to students that they may already have some of the skills and knowledge that it takes to be a scientist.
   - Explain to students that in order to find out what skills and information they already know they are going to complete a pre-quiz on the scientific method.
   - Have students individually complete the Scientific Method Pre-Quiz.

3. Discuss results of the pre-quiz with students.
   - Once all students have completed the pre-quiz, have each student correct his or her own paper as you read the answers.
   - Discuss with students their successes and difficulties with the pre-quiz.
   - Discuss with students what information on the pre-quiz was review.
   - Discuss with students what information on the pre-quiz was new information.

4. Discuss with students what steps they feel that a scientist would go through in order to find the answer to a question.
   - Have students share their ideas on the steps that a scientist would go through in order to find the answer to a question.
   - Write the students' ideas on the board.
   - Ask the students questions to help them brainstorm more ideas of the steps that a scientist would go through.
     Note to Teacher: If your students have already learned the steps in a previous science class, ask them to explain each of the steps in more detail. Ask them what a scientist would do during each of the steps that they name. List this information on the board.

5. Begin scientific method notes.
   - Explain to students that over the next two days they will learn the steps of the scientific method
   - Ask them to take out their notebook to record notes in.
   - Go over the scientific method notes. Tie in the ideas that students had about the steps that a scientist would go through. Help them to see that they already know some of the important things that a scientist must do when conducting an experiment.

**Day 2:**

1. Finish scientific method notes from Day 1.
   - Review with students the information that they learned on Day 1 by asking them questions about the steps that were already covered.
   - Finish notes on the steps of the scientific method.
     Note to Teacher: Go over the additional information on the scientific method with older students. These notes will explain terms such as control group, variable, and independent variable.

2. Introduce the "Salsa Lab" to students.
   - Show students the following materials:
     Hot, medium, and mild salsa
     Chips
     Thermometers
     Measuring spoons
     Timers
     Water
     Bowls
     Napkins

   - Explain to students that they are going to develop an experiment using these materials.
   - Ask students to explain the first step of the scientific method. Students should know that the first step is to think of a question.
   - Explain to students that this is exactly what they need to do. Explain that they need to develop a scientific question that they would like to answer using these materials. Emphasize that this needs to be a scientific question. For example, the question can not be, "How many chips or how much salsa can a person eat in 2 minutes?"
   - Ask students what they think is meant by a scientific question.
   - Allow students to share their ideas. Some students may respond that it is a question that a scientist would answer or a question that we can conduct an experiment to answer.
   - Explain to students that a scientific question is one that you can conduct an experiment for or follow the steps of the scientific method to determine the answer to a question.

3. Have students develop a scientific question.
   - Break students into small groups of 3 – 4 students.
   - Explain to students that they should brainstorm questions that they would like to find the answer to by conducting an experiment.
   - Circulate throughout the classroom encouraging students to think of questions that can be answered in an experiment. Make sure the question can include experimentation, measurement, and gathering of data.
   - Have each group choose one question from their list that they would like to have as their scientific question for their experiment. Encourage students to take their time choosing a question that the group is both interested in and one that a great experiment can be developed for.

- Explain to students that they will have one class period to actually conduct their experiment. If they need additional time, they can use recess time in order to complete the experiment.

4. Have each group share their final question with you for approval.
    - Discuss with each group the final question that they decide on. The questions listed below are to help make sure the group has thought through different parts of the experiment:
        - What is the variable in this experiment?
        - What is the control?
        - Are you able to control all factors of the experiment other than the variable? Explain why or why not.
        - How long will it take you to conduct this experiment?
        - Will you need additional materials in order to conduct this experiment? If so, do you have access to these materials?
    - Based on your discussion with the group, either approve the question, have the students modify their question, or have the students choose a new question.

5. Explain the inquiry lab folder.
    - Pass out an inquiry lab folder to each group.
    - Explain to students that the work they complete each day is to be placed in the inquiry lab folder.

      Note to Teacher: There are a couple of advantages to having the students keep their work in a group folder. One advantage is that you can look through each group's work to see how they are progressing. This will let you know if a particular group is lagging behind or if another group is rushing through their work and not providing detailed answers. Another advantage is that all of the group's work is in one location, and there is no chance of it getting lost.
    - Have each group place their work from day 2 in the folder.

**Day 3:**

1. Discuss how to research the questions that the students developed.
    - Explain to students that we are now ready to move on to the next steps in the scientific method.
    - Ask students to share what they must do next to complete the scientific process. Students should explain that they must research their question.
    - Explain to students that there are many ways to do research. Ask students to share how they would research their question. Students will most likely respond that they can use the internet, encyclopedias, books, and magazines.

- Explain to students that people can also be used for research. If you interview someone who is knowledgeable in the area you are working, this information can be used as research.
- Explain to students that due to our time constraints they will only complete a small amount of research. Be sure students understand that scientists spend a lot of time gathering research prior to conducting an experiment. Explain to students that when they complete their science fair projects they will also spend a lot more time researching their topic.
- Ask students why you think scientists need to research the topic for their experiment. Allow students to share their ideas.
- Explain to students that scientists need to complete research so that they are knowledgeable about their topic. One reason that scientists need to be knowledgeable is so they can develop a hypothesis. Another reason is so that they can develop the plan for their experiment.

2. Have students research their group's question.
   - Show students the resources that are available for them to use in the classroom when researching their question.
   - Explain to students that when they have completed researching their question they should have half a page of typed information.
   - Discuss with students the importance of writing all of their research in their own words (not cutting and pasting directly from the internet).
   - Explain to students the importance of citing any sources that they use. For all sources used, students should record the author, title, and year of publication (or complete data if an interview or internet resource).

     Note to Teacher: Older students should be required to use proper bibliography format when citing their sources.
   - Based on the questions that students chose, share ideas of what the students may want to research. Because salsa is being used in the lab, finding out about the ingredients in the different salsa would be a good idea for research. If students are measuring the temperature after eating the different types of salsa, then they may want to learn about the best places to take a person's temperature.
   - Remind students that one purpose of researching their question is to learn more about the topic so that they can develop a hypothesis.
   - Give students time to research their question. Because the students will be typing a formal lab report after the completion of the lab, the research at this point can be in bullet or paragraph form.

3. Have students develop a hypothesis.
    - Have students discuss the research they gathered with their group.
    - Have the students decide on a hypothesis based on their research.
    - Remind students that a hypothesis needs to be written in the form of a sentence.
4. Have students write procedures for their experiment.
    - Have students discuss in their group how they will run their experiment. Questions for students to think about are:
        - How many times will you run the experiment?
        - Will multiple people participate in your experiment? If so, who?
        - How will you keep the amount of salsa the same for each part of the experiment?
        - Will the participants drink water or milk in between the different types of salsa?
        - What data are you gathering?

    - Explain to students that procedures must be very detailed. Explain to students that they should write the procedures for a person who knows nothing about your experiment.
    - Explain to students that it is important to gather quantitative data as well as qualitative. Encourage students to think about both types of data that can be gathered in their experiment.
    - Give the students time to write the procedures for their experiment.

5. Have students develop a data table for their experiment.
    - Ask students why they think that it is important to develop a data table before actually running the experiment. Students may understand that there needs to be a place to record the data that they gather during the experiment.
    - Explain to students that a data table organizes the data gathered during the experiment. All of the data is then in one place, and this makes it easier to analyze after running the experiment.

6. Have students place all of their work in their inquiry lab folder.

7. Explain tomorrow's schedule.
    - Explain to students that tomorrow each group will conduct their experiment following the procedures they have written.
    - Explain to students that they will have one class period to run the experiment so they should come to class prepared to complete the entire experiment.

**Day 4:**

1. Have students run the salsa experiment following their procedures.
   - Provide students one class period in order to run the salsa experiment.
   - As students run the experiment, circulate throughout the classroom answering questions and helping students budget their time.
   - Remind students that the conditions for each student participating in the experiment must be the same.

2. Near the end of the class period, explain the proper clean up procedures.

**Day 5:**

1. Have students edit their procedures that they used on the previous day for the salsa lab.
   - Ask students if their procedures for the salsa lab were as detailed as they needed to be. Many students will express that their procedures were not as detailed as they needed to be.
   - Have students work in their small groups to edit their procedures. Students should add in more detail as needed.
   - Explain to students that these edited procedures will be used later in the school year for another activity.

   Note to Teacher: Prior to the students beginning their science fair projects in November, I will have the students complete this lab a second time. The students will follow the procedures (exactly) as written by another group. This will remind students of the importance of writing detailed procedures.

2. Explain how to write a lab report.
   - Give each student a copy of the worksheet Writing a Lab Report.
   - Discuss with students the importance of writing a lab report.
   - Explain that the purpose of a lab report is to organize the information from an experiment and communicate this information in a clear manner.
   - Explain to students that scientists write lab reports so that they or other scientists can repeat the experiment or test other hypotheses in new experiments.
   - Explain each instruction on the lab report.
   - Emphasize the importance of following the instructions exactly.

3. Explain the lab report evaluation.
   - Give each student a copy of the worksheet Lab Report Evaluation.
   - Explain each item on the rubric.
   - Discuss with students the importance of honestly evaluate their lab report when completing the self evaluation.

4. Provide class time for students to write their lab report or assign the lab report as homework.

# *Scientific Method Pre-Quiz*

Name_____ Class_____ Date_____

**Multiple Choice:** Write the CAPITAL letter of the best answer in the blank to the left of each question.

_____ 1. The information gained from completing an experiment is called
A. data. B. theory. C. a control. D. a publication.

_____ 2. In the scientific method, the step that follows thinking of an idea is
A. recording data. B. researching the topic.
C. forming a hypothesis. D. planning an experiment.

_____ 3. The condition that you change in an experiment is called the
A. control. B. independent variable.
C. dependent variable. D. experimental group.

_____ 4. The group that is not altered in an experiment is the
A. control group. B. experimental group.
C. dependent variable. D. independent variable.

_____ 5. At the end of an experiment, a scientist forms a(n)
A. problem. B. hypothesis. C. idea. D. conclusion.

_____ 6. The step below that is not considered a step of the scientific method is
A. thinking of an idea.
B. recording data.
C. converting all measurements to metric units.
D. forming a hypothesis.

_____ 7. During a science fair experiment, a student constructs paper airplanes out of six different types of paper. He then flies the paper airplanes and measures the distance that each one flies. The condition that he is measuring is called the
A. control group. B. hypothesis.
C. independent variable. D. dependent variable.

_____ 8. When gathering research for your experiment, you can use
A. the internet. B. an encyclopedia.
C. a knowledgeable person. D. A, B, and C are correct.

**Short Answer:** Please answer the following question in a short answer form using complete sentences.

Explain the six steps of the scientific method.

# *Scientific Method Pre-Quiz*

Name_____Answer Key_____ Class_____ Date_____

**Multiple Choice:** Write the CAPITAL letter of the best answer in the blank to the left of each question.

___A___ 1. The information gained from completing an experiment is called
A. data. B. theory. C. a control. D. a publication.

___B___ 2. In the scientific method, the step that follows thinking of an idea is
A. recording data. B. researching the topic.
C. forming a hypothesis. D. planning an experiment.

___B___ 3. The condition that you change in an experiment is called the
A. control. B. independent variable.
C. dependent variable. D. experimental group.

___A___ 4. The group that is not altered in an experiment is the
A. control group. B. experimental group.
C. dependent variable. D. independent variable.

___D___ 5. At the end of an experiment, a scientist forms a(n)
A. problem. B. hypothesis. C. idea. D. conclusion.

___C___ 6. The step below that is not considered a step of the scientific method is
A. thinking of an idea.
B. recording data.
C. converting all measurements to metric units.
D. forming a hypothesis.

___D___ 7. During a science fair experiment, a student constructs paper airplanes out of six different types of paper. He then flies the paper airplanes and measures the distance that each one flies. The condition that he is measuring is called the
A. control group. B. hypothesis.
C. independent variable. D. dependent variable.

___D___ 8. When gathering research for your experiment, you can use
A. the internet. B. an encyclopedia.
C. a knowledgeable person. D. A, B, and C are correct.

**Short Answer:** Please answer the following question in a short answer form using complete sentences.

Explain the six steps of the scientific method.

1. Think of a question.
2. Research the topic.
3. Form a hypothesis and plan the experiment.
4. Do the experiment.
5. Collect and record data.
6. Come to a conclusion.

# *Scientific Method Notes*



**Introduce the Scientific Method.**

- Write the definition of the scientific method on the board. "Scientific method: A logical way to approach a problem, any problem; problem-solving method."

- Explain to students that there are problems that they encounter on a daily basis. Have the students share a few problems that they must deal with related to school. A common problem that students may share is not enough time to complete all of their homework as well as their after school activities.

- Discuss with students ways to deal with or solve the problem that the students share. Students' solutions to the problem may be to complete work ahead of time, budget their time better by not wasting time watching television or playing on the computer, or to not participate in as many after school activities.

- Explain to students that just like they must solve problems, scientists must also solve problems. Explain that scientists use the scientific method to help them solve problems.

- Explain to students that they will learn the steps of the scientific method during this lesson.

**Explain Step 1 of the Scientific Method: Think of a Question.**

- Explain to students that there is a scientific problem that they need to solve. The problem is: How can you put out a candle without blowing on it or putting water on it?

- Say: You have just completed the first step of the scientific process and that is to think of a question that you want to answer or a problem that you want to solve.

- Write the question on the board: How can we put out a candle without blowing on it?

- Once a question has been decided on, the next step is to research the question.

- Question: Why is researching the question important?
- *Answer: (Allow students to share their ideas. Students should understand that research allows them to learn more about the topic that they are studying.)*

- Say: Depending on the question that you choose, you may already know a lot about the topic. If so, you may not need to complete as much research. When you complete your science fair project, you will be working with a topic that you do not know very much about. As a result, you will be required to complete quite a bit of research to become knowledgeable about your topic.

**Explain Step 2 of the Scientific Method: Research Your Topic.**

- Explain to students that research can include the use of books, magazines, the internet, and even people. Interviewing people who are knowledgeable about your topic is a great source for research.

- Explain to students that after they have completed their research, they should know enough information about their topic in order to develop a hypothesis.

- Question: For the question that we have chosen, how can we research this topic?
- *Answer: (Allow students to share their ideas. Students will most likely suggest searching on the internet for a way to put out a candle without blowing on it.)*

  Note to Teacher: Depending on the time and resources that you have available, you may have a few students or the entire class spend a small amount of time searching for ways to put out a candle without blowing on it. If you time or resources are limited, lead students in a discussion on what must be present for fire to burn. List the items that students mention on the board. Explain to students that they are using each other's knowledge as research for this experiment.

- Explain to students that after they research their topic, they are ready to use the information to develop a hypothesis.

- Explain to students that a hypothesis is a likely explanation to a problem.

- Explain to students that some people refer to a hypothesis as an "educated guess". Discuss with students that it is true that you become educated before making a hypothesis by completing a research. Explain to students that some scientists and teachers do not like this phrase because developing a hypothesis involves much more than guessing.

- Write on the board: "Hypothesis: A likely explanation to a problem."

**Explain Step 3 of the Scientific Method: Form a Hypothesis and Plan the Experiment.**

- Explain that a hypothesis needs to be in the form of a sentence, and it needs to answer the question that you chose for your experiment.

- Question: Based on the research that we gathered about our question, what do you think would be a likely answer to the question?
- *Answer: (Allow students to share their ideas for a hypothesis. As a class, decide which hypothesis the students would like to pursue for this experiment.)*

- Explain the importance of writing the hypothesis before beginning the actual experiment.

- Emphasize the fact that that you never change your hypothesis after you begin running your experiment, even if your experiment does not support it.

- Say: After you develop a hypothesis, then you are ready to write out the procedures for your experiment.

- Explain to students that the procedures are a step-by-step plan on how the experiment will be run.

- Emphasize the importance of these procedures being very detailed. Explain to students that they should think about writing these procedures so that another person could follow their instructions without any assistance.
  Note to Teacher: A good analogy is that writing procedures for an experiment are like writing a recipe for a favorite meal.

- Have students explain the steps that they think should be followed for this experiment.

- Write the steps on the board that students think should be followed.

- Using the ideas that the students shared, decide as a class the best procedures for this experiment.
  Note to Teacher: Two common methods for extinguishing the flame on a candle without blowing on it or using water are:
  1. To place a glass beaker over the candle. After a short period of time, the flame will extinguish due to a lack of oxygen in the beaker.
  2. Place a small amount of baking soda into a small beaker. Pour a small amount of vinegar into the beaker containing the baking soda. The baking soda and vinegar will react and form carbon dioxide gas. As soon as the reaction takes place, "pour" the carbon dioxide gas over the flame of the candle. Be sure that none of the vinegar or baking soda leaves the beaker. The carbon dioxide gas will extinguish the flame.

- Question: What information is listed at the beginning of each recipe or the beginning of each experiment?
- *Answer: (Allow students to share their ideas. Students should respond that the ingredients or materials are listed at the beginning of each recipe or experiment.)*

- Have students make a list of all of the materials needed for this experiment. Remind students that they need to include the amount of each material as well as any equipment that is needed to measure the materials.

- Explain to students that once the have planned the experiment they are ready to actually run the experiment.

**Explain Step 4 of the Scientific Method: Do the Experiment.**

- Gather the materials to complete this experiment as a class demonstration.

- Run the experiment by following the procedures that the students developed,

- After running the experiment, explain to students it is important when running an experiment to collect information about the experiment. Explain to students that this information is called data and that this is the next step of the scientific process.

**Explain Step 5 of the Scientific Method: Collect and Record Data.**

- Explain to students that in their experiments they will measure something such as time, distance, height, or amount of substance produced.

- Ask students what they could measure in the experiment that they developed.

- Allow students to share their ideas. Students will most likely suggest measuring the amount of time that it takes to extinguish the flame.

- As a class, decide what data will be collected during this experiment.

- Explain to students that it is important to have a place such as a table to record the data that is collected during an experiment. Explain that it is best to create the data table prior to beginning the experiment.

- Discuss with the students how to create a data table for the information that they will collect during this experiment.

  Note to Teacher: An example data table is shown below:

| | **Time to extinguish flame (seconds)** |
|---|---|
| **Trial 1** | |
| **Trial 2** | |
| **Trial 3** | |
| **Average** | |

- While creating the data table, discuss the importance of repeating the experiment multiple times. Explain to students that most experiments that they conduct should have multiple trials in order to verify the accuracy of the data.

- After the students have created a data table for this experiment, run the experiment at least three times as a demonstration. Have a student volunteer help to gather the data.

- Question: When you have several numbers for the same activity, such as how many hits a baseball player made in 10 games, what do we do with these numbers to understand overall what happened?
- *Answer: Students should understand that you average the numbers by adding all of the numbers up and dividing by the number of trials or games.*

- Have students calculate the average for this experiment.

- Explain to students after running the experiment multiple times that they are ready to complete the last step of the scientific process. Explain that the last step is to come to a conclusion.

**Explain Step 6 of the Scientific Method: Come to a Conclusion.**

- Explain to students that during the last step of the scientific method you come to a conclusion about the experiment.

- Explain to students that they will be writing a lab report for the experiments that they completed.

- Explain to students that for the lab reports there are two sections of information that they will write for the last step of the scientific method.

- Explain to students that the first section is called the results. Explain that for this section the students will write a small paragraph discussing their results. Significant data and trends should be discussed in this paragraph.

- Discuss with students what information from our demonstration they would include in a results paragraph.

- Write the students' ideas for the information that should be included in a results paragraph on the board. Students may explain the amount of time it took to extinguish the flame in each trial. They may explain the average amount of time that it took. They may explain data that is different. For instance, during the second trial, the flame was extinguished much faster than during the first and third trials.

- Explain to students that the second section is called the conclusion. In this section, the students should discuss if their hypothesis was correct or not. They should give possible reasons for the difference between their hypothesis and experimental results. Discuss unexpected results as well as how they could improve the experiment for further investigations.

- Discuss with students what information from our demonstration they would include in a conclusion paragraph.

- Write the students' ideas for the information that should be included in a conclusion paragraph on the board. Students should explain if their hypothesis was correct or not. They should explain why their hypothesis was correct or why it was not correct. They should explain any unexpected results. Finally, they should explain how they could improve the experiment.

## *Additional Information on the Scientific Method*

The following is additional information that can be included with the lesson on the steps of scientific method. Depending on the grade level and prior experience of the students that you are teaching, you may choose to teach all, some, or none of the information listed below. An understanding of the terms control and variable is very important for students who will be completing science fair projects.

- Draw five pots that are exactly the same on the board.

- Ask students to imagine that they are developing a science fair project about the growth of plants when watered with different liquids.

- Explain to the students that the five pots are empty. Ask them what they would do next if they were running this experiment. Students should explain that they would fill each pot with soil and place the plants in the soil.

- Question: Would you fill all of the pots to the top? Or would you just pour soil in until it looked like enough? Or would you measure out the same amount of soil for each pot?
- *Answer: (Allow students to share their ideas. Student responses will vary based on their past experiences with developing experiments.)*

- Explain to students that when running an experiment, every part of the experiment must be exactly the same except for one condition.

- Question: What is the one condition that will be changed from one pot to the next?
- *Answer: Students should understand that the type of liquid will be different from one pot to the next.*

- Explain that they could change the amount of soil or type of soil or liquid that the plants are being watered. Emphasize that only one of these may be changed in each experiment.

- Explain to students that the condition that is changed during the experiment is called the independent variable.

- Write the definition on the board: "Independent variable: Condition in an experiment that is changed."

- Question: If you were running this experiment, what liquids would you use to water the plants?
- *Answer: (Allow students to share their ideas of different liquids that they would use to water the plants. Students may respond that they will water the plants with soda, coffee, milk, or juice.)*

- Explain to students that whenever you run an experiment you must have one part of the experiment represent what normally happens. For instance, with this experiment, water is normally used to water plants. As a result, water will be one of the five liquids.

- Explain to students that the plant watered with water is called the control group. It is called this because it is the part of the experiment that is help constant or the same.

- Write the definition of control group on the board: "Control group: Conditions are held constant or kept the same."

- Write water underneath one of the pots on the board.

- Write a different liquid that the students had shared under the other four pots.

- Explain to students that the other four pots are called the experimental group or the test group. These are the pots that have all the conditions kept the same except for the single condition being tested.

- Write the definition of experimental group on the board: "Experimental group: Test group, all conditions are kept the same except for the single condition being tested."

- Ask students to imagine that over a period of eight weeks they water each plant with its specified liquid once a day. Explain to students that they use the same amount of each liquid every time they water the plants.

- Ask students what they also would need to do every day other than watering each plant. Students should respond that they would need to record data about each plant every day.

- Question: What data would you record about the plants every day?
- *Answer: (Allow students to share their ideas. Students will most likely respond that they would record the height of each plant.)*

- Explain to students that to have a great experiment they need to record quantitative as well as qualitative data.

- Explain to students that when they measure the height of each plant this is quantitative data.

- Write on the board: "Quantitative data: Numerical data".

- Explain to students that qualitative data is observations or descriptions about the plant. This data is in recorded in words.

- Write on the board: "Qualitative data: Observations or descriptions recorded in words".

- Ask students what are some examples of qualitative data that they could record for this experiment.

- Help students understand that they could record descriptions about the health of each plant and the colors of the leaves of the plant.

- Explain to students that the conditions they measure and observe are called the dependent variables. Explain that the dependent variable is the condition(s) that results from the change or the independent variable.

- Write on the board: "Dependent variable: Condition that results from the change or independent variable. This is the condition that is observed and measured."

**For extra practice:** Provide students with a sample experiment. Have them identify the following for the experiment:

- Independent variable
- Control group
- Experimental group
- Quantitative data
- Qualitative data
- Dependent variable

# *Salsa Lab Proposal Form*

Group members_____ Table #: _____

**Materials provided for this lab:**
Hot, medium, and mild salsa
Tortilla chips
Thermometers
Measuring spoons
Timer
Water
Bowls
Napkins

**Class periods to complete this lab:** 4

**Approved**

_____ **Question:**

_____ **Research:** (at least 5 facts written in bullet or paragraph form that provide information to help develop a hypothesis to the scientific question)

_____ **Sources for research correctly cited: (**author, title, and year of publication (or complete date if an interview or internet resource)

1.

2.

**_____ Hypothesis:**

**_____ Procedures:**

**Experimental plan is complete? Yes:____ No:____**

**Notes:**

**Reviewed by: _____ Date: _____**

# *Writing a Lab Report*

The purpose of a lab report is to organize the information from your experiment and communicate this information in a clear manner. Scientists write lab reports so that they or other scientists can repeat the experiment or test other hypotheses in new experiments.

**The following instructions should be followed when writing a lab report:**

1. **Complete your lab report individually.**
   You are to complete all lab reports individually unless your teacher tells you otherwise. You will work in a group to fill out the proposal form, run the experiment, and gather the data. The lab report is written after you complete these items with your group. Each person in the group will have the same: question, hypothesis, research, sources, procedures, and data. Each person in the group will develop their own graphs (if applicable) and write his/her own research summary paragraph, his/her own results paragraph, and his/her own conclusion paragraph. Each of us forms sentences and paragraphs very differently. It is obvious when information has been copied from one person to another. Any cheating/copying will result in a zero for everyone involved.

2. **Type all lab reports using an easily readable font style and size.**
   All lab reports must be typed. A normal font style such as Times, Times New Roman, or other easily readable font styles should be used. A normal font size should be used. For the two font styles mentioned, size 12 font is great. No font larger than 14 should be used when writing the text portion of your lab report.

3. **Turn in lab reports and student evaluations at the beginning of class on the second day after the experiment was completed.**
   No lab reports will be accepted late. Points will be deducted for a missing student evaluation.

**4. Use the following format and order when writing your lab report:**

Name_____ Date_____

Title of Lab: _____ Table #: _____

**Question:** (Be sure your question is specific and written as a question.)

**Research:** (For each lab, you will be asked to gather research. Summarize this research into a paragraph. Be sure to write the information in your own words. Bulleted information is not acceptable.)

**Sources Cited:** (Record the author, title, and year of publication (or complete data if an interview or internet resource) for each source used to gather research.)

**Hypothesis:** (Be sure your hypothesis is specific and written in a sentence.)

**Materials:** (Write all of the materials used during this experiment in a list. Be sure to list the amount of each material that is needed.)

**Procedures:** (Write each step that a person must follow to complete the experiment. Be sure to number each step and write in the present tense.)

**Data Table:** (Organize data in a table with a specific title. If graphs are applicable, they should be included in your lab report below the data table. Graphs also need a specific title as well as labels on the axes.

**Results:** (Summarize the significant data from your experiment in a paragraph. Focus on trends that you see in the data.)

**Conclusion:** (In paragraph format, state whether your hypothesis was correct or not. Give possible reasons for the difference between your hypothesis and experimental results. Discuss unexpected results as well as how you could improve your experiment for further investigations.)

# *Lab Report Evaluation*

| Scoring Criteria | Points | Student Evaluation | Teacher Evaluation |
|---|---|---|---|
| Specific question is stated. | 1 | | |
| Research gathered for this experiment is summarized in a paragraph. | 3 | | |
| Research sources are cited. | 2 | | |
| The hypothesis is clearly stated. | 1 | | |
| Procedures describe in detail the steps to complete the experiment. | 3 | | |
| Data is organized in a table with a specific title. | 3 | | |
| Measurements show proper units. | 1 | | |
| Results summarize the data. | 4 | | |
| The conclusion paragraph states whether the hypothesis was correct or not, what went well in the experiment, and what could be improved. | 4 | | |
| All group members acted in a safe manner throughout the entire experiment. | 4 | | |
| All group members helped to clean the lab area after completing the experiment. | 4 | | |
| Total Points | 30 | | |

**Self-Evaluation:** Students are expected to complete the self-evaluation honestly. The self-evaluation is to be turned in with your lab report. A missing self-evaluation form will result in an automatic deduction of points.

**Deadline:** Lab reports are due at the beginning of class on the second day after the experiment was completed. No late lab reports will be accepted.

# *Loop Plane Proposal Form*

Group members_____ Table #: _____

**Materials needed for one loop plane:**
1 plastic straw
1 strip of paper 1.5 cm x 9 cm
1 strip of paper2 cm x 12 cm
Scissors
Tape

**Additional materials provided:**
Plastic straws of various sizes
Paper of various thicknesses to make additional strips
Meter stick
Timer

**Instructions:**

1. Use the materials above to construct a "normal loop plane". Make a loop out of each strip of paper. Overlap the ends of each strip of paper and tape the inside and outside of the loop. Slide the straw into the pocket formed by the overlapped ends of the straw.
2. Develop an experiment that focuses on the loop plane that you developed. Additional materials are available to construct multiple loop planes.
3. Repeat the experiment at least three times.
4. Calculate the speed for each plane and for each trial. Include this information as part of your results.
5. Calculate the average speed for each plane and include this information in your results.

**Class periods to complete this lab:** 2

**Approved**

**_____ Question:**

_____ **Research:** (at least 4 facts written in bullet or paragraph form that provide information to help develop a hypothesis to the scientific question)

_____ **Sources for research correctly cited: (**author, title, and year of publication (or complete date if an interview or internet resource)

1.

2.

_____ **Hypothesis:**

_____ **Procedures:**

**Experimental plan is complete? Yes:____ No:____**

**Notes:**

**Reviewed by: _____ Date: _____**

# *Parachute Lab Proposal Form*

Group members_____ Table #: _____

**Materials provided for this lab:**
3 lightweight garbage bags
3 sandwich bags that zip
Scissors
Kite string
Clay
Eggs
Hole puncher
Permanent marker
Ruler
Triple beam balance

**Instructions:**

1. Use the materials above to create one or more parachutes. Hint: The sandwich bags can be used to hold an object at the bottom of the parachute.
2. Develop an experiment that focuses on the parachute(s) that you developed.
3. Calculate the velocity for each parachute and for each trial.
4. Calculate the average velocity for each parachute and include this information in your results.
5. Calculate the acceleration for each trial and include this information in your results.

**Class periods to complete this lab:** 2

**Approved**

_____ **Question:**

_____ **Research:** (at least 4 facts written in bullet or paragraph form that provide information to help develop a hypothesis to the scientific question)

_____ **Sources for research correctly cited: (**author, title, and year of publication (or complete date if an interview or internet resource)

1.

2.

_____ **Hypothesis:**

_____ **Procedures:**

**Experimental plan is complete? Yes:____ No:____**

**Notes:**

**Reviewed by: _____ Date: _____**

# *CD Glider Proposal Form*

Group members_____ Table #: _____

**Materials provided for this lab:**
1 CD, without any nicks or scratches
1 water bottle top with a valve (from a sports water bottle)
Hot glue gun or modeling glue
Balloons of various sizes
1 3x5 index card per group
1 small square of transparency film (1 to 2 square inches)
Tape
Straw
Constructing a CD Glider instructions

**Additional materials available for this lab:**
Variety of surfaces to place CD glider on – sandpaper, glossy paper such as transparencies
Additional CD's
Triple beam balance

**Instructions:**
1. Construct a CD glider by following the procedures on the instruction sheet.
2. Develop an experiment that focuses on the CD glider that you constructed.
3. Calculate the velocity for each trial.
4. Calculate the acceleration for each trial and include this information in your results.
5. Determine the mass of the CD Glider using a triple beam balance and include this information in your results.
6. Calculate the force during each trial. This force that you will calculate is the friction force that caused the CD glider to come to a stop. Include the calculated force in your results.

**Class periods to complete this lab:** 3

**Approved**

_____ **Question:**

_____ **Research:** (at least 4 facts written in bullet or paragraph form that provide information to help develop a hypothesis to the scientific question)

_____ **Sources for research correctly cited: (**author, title, and year of publication (or complete date if an interview or internet resource)

1.

2.

_____ **Hypothesis:**

_____ **Procedures:**

**Experimental plan is complete? Yes:____ No:____**

**Notes:**

**Reviewed by: _____ Date: _____**

# *Constructing a CD Glider*

**Directions:**

1. Plug in the glue gun.
2. Cut transparency film into a circle that fits between the bottle top and the CD. Poke a hole in the middle of the film about the size of a pencil tip. This will allow the air in the balloon to release more slowly.
3. Place the CD label side up with the shiny side facing down.
4. With the glue, draw a line around the edge of the transparency piece. Glue the transparency piece onto the label side of the CD, covering the CD hole. Make sure the transparency hole is in the middle of the CD hole. Be careful not to let the glue drip or go to the other side of the CD. This will prevent the CD from gliding properly.
5. Draw a thick line of glue around the bottom of the bottle top. Be sure to go all the way around. If you are using a glue gun, complete this step quickly.
6. Before the glue begins to set, place the bottle top on top of the transparency piece (on the label side of the CD) over the center hole of the CD and press together. The bottle top does not need to be directly in the center of the CD. If the nozzle covers the CD hole, the glider will work.
7. After letting the glue set, draw another bead around the joint between the bottle top and the CD. Let all the glue dry.
8. Cut a 3x5 index card in half lengthwise and roll it so the diameter is a similar size to the bottle top nozzle and it has a height of 1.5 inches. This will be piece of index card will serve as a collar to support the balloon so that will not fall over as it deflates.
9. Thread the balloon through the collar, inflate the balloon, and finally twist the balloon closed and attach to the bottle top.

**How to Use the CD Glider:**

1. Close the valve on the bottle top.
   Inflate a balloon and twist the bottom. Have on person hold the balloon closed while the other person places the balloon over the top of the valve. This will prevent air from escaping.
2. Carefully pull the valve up until you hear a hiss of air.
3. Place the CD Glider, shiny side down, on a flat, smooth surface
4. To launch the glider, have one student hold the balloon and release the bottle top. Have the second student blow the CD with a straw.

# *Scientific Method Post-Quiz*

Name_____ Class_____ Date_____

**Multiple Choice:** Write the CAPITAL letter of the best answer in the blank to the left of each question.

_____ 1. The information gained from completing an experiment is called
A. data. B. theory. C. a control. D. a publication.

_____ 2. In the scientific method, the step that follows thinking of an idea is
A. recording data. B. researching the topic.
C. forming a hypothesis. D. planning an experiment.

_____ 3. The condition that you change in an experiment is called the
A. control. B. independent variable.
C. dependent variable. D. experimental group.

_____ 4. The group that is not altered in an experiment is the
A. control group. B. experimental group.
C. dependent variable. D. independent variable.

_____ 5. At the end of an experiment, a scientist forms a(n)
A. problem. B. hypothesis. C. idea. D. conclusion.

_____ 6. The step below that is not considered a step of the scientific method is
A. thinking of an idea.
B. recording data.
C. converting all measurements to metric units.
D. forming a hypothesis.

_____ 7. During a science fair experiment, a student constructs paper airplanes out of six different types of paper. He then flies the paper airplanes and measures the distance that each one flies. The condition that he is measuring is called the
A. control group. B. hypothesis.
C. independent variable. D. dependent variable.

_____ 8. When gathering research for your experiment, you can use
A. the internet. B. an encyclopedia.
C. a knowledgeable person. D. A, B, and C are correct.

Short Answer: Please answer the following question in a short answer form using complete sentences.

1. Explain the six steps of the scientific method.

2. For your science fair experiment, you decide to test hamsters to determine which type of food makes the hamsters grow the quickest. You feed the two hamsters in cage one hamster pellets that you bought at the pet store. This is the normal food that the veterinarian recommended that you use. After doing some research, you find out two recipes for homemade hamster food. You follow the recipes for these foods. One is an oat-based food, and the other is a wheat-based food. You feed the oat-based food to the two hamsters in cage two, and you feed the wheat-based food to the two hamsters in cage three. You feed the hamsters twice a day, and every other day you measure their mass and length and record observations about their behavior.

   You have completed your project after two months of gathering data and two weeks of preparing your science fair board. It is the morning of your judging. You introduce yourself to the judge, and her first question for you is:
   Identify the following for your science fair experiment:
   - Independent variable
   - Control group
   - Experimental group
   - Quantitative data
   - Qualitative data
   - Dependent variable

   Answer the judge's question in the space below. Be sure to answer each part of the six parts to the question.

# *Scientific Method Post-Quiz*

Name_____Answer Key_____ Class_____ Date_____

**Multiple Choice:** Write the CAPITAL letter of the best answer in the blank to the left of each question.

___A__ 1. The information gained from completing an experiment is called
A. data. B. theory. C. a control. D. a publication.

___B__ 2. In the scientific method, the step that follows thinking of an idea is
A. recording data. B. researching the topic.
C. forming a hypothesis. D. planning an experiment.

___B__ 3. The condition that you change in an experiment is called the
A. control. B. independent variable.
C. dependent variable. D. experimental group.

___A__ 4. The group that is not altered in an experiment is the
A. control group. B. experimental group.
C. dependent variable. D. independent variable.

___D__ 5. At the end of an experiment, a scientist forms a(n)
A. problem. B. hypothesis. C. idea. D. conclusion.

___C__ 6. The step below that is not considered a step of the scientific method is
A. thinking of an idea.
B. recording data.
C. converting all measurements to metric units.
D. forming a hypothesis.

___D__ 7. During a science fair experiment, a student constructs paper airplanes out of six different types of paper. He then flies the paper airplanes and measures the distance that each one flies. The condition that he is measuring is called the
A. control group. B. hypothesis.
C. independent variable. D. dependent variable.

___D__ 8. When gathering research for your experiment, you can use
A. the internet. B. an encyclopedia.
C. a knowledgeable person. D. A, B, and C are correct.

**Short Answer: Please answer the following question in a short answer form using complete sentences.**

Explain the six steps of the scientific method.

1. Think of a question.
2. Research the topic.
3. Form a hypothesis and plan the experiment.
4. Do the experiment.
5. Collect and record data.
6. Come to a conclusion.

3. For your science fair experiment, you decide to test hamsters to determine which type of food makes the hamsters grow the quickest. You feed the two hamsters in cage one hamster pellets that you bought at the pet store. This is the normal food that the veterinarian recommended that you use. After doing some research, you find out two recipes for homemade hamster food. You follow the recipes for these foods. One is an oat-based food, and the other is a wheat-based food. You feed the oat-based food to the two hamsters in cage two, and you feed the wheat-based food to the two hamsters in cage three. You feed the hamsters twice a day, and every other day you measure their mass and length and record observations about their behavior.

   You have completed your project after two months of gathering data and two weeks of preparing your science fair board. It is the morning of your judging. You introduce yourself to the judge, and her first question for you is:
   Identify the following for your science fair experiment:
   - Independent variable
   - Control group
   - Experimental group
   - Quantitative data
   - Qualitative data
   - Dependent variable

   Answer the judge's question in the space below. Be sure to answer each part of the six parts to the question.

   a. Independent variable:
      The different types of food

   b. Control group:
      Two hamsters in cage 1 that were fed the hamster pellets

   c. Experimental group:
      Two hamsters in cage 2 and two hamsters in cage 3

   d. Quantitative data:
      Mass and length of each hamster - taken every other day

   e. Qualitative data:
      Observations about each hamster's behavior – recorded every other day

   f. Dependent variable:
      Mass, length, and behavior

# *References*

**Salsa Lab adapted from:**
An adaptation by Deborah Frazier (Monta Vista HS, Cupertino, CA) from an adaptation by Heather Pereira (Amador Valley HS, Pleasanton, CA) of Levri, E.P. and Levri M.A. (2003). Hot Salsa: A Laboratory Exercise Exploring the Scientific Method. The American Biology Teacher, 65 (5) 372-377.

**Lab Report Rubric adapted from:**
Howe High School's Science Lab Report Evaluation Rubric (Howe, OK)
http://www.howe.k12.ok.us/~jimaskew/evalab.htm

**Loop Plane Lab adapted from:**
NASA Quest Aerospace Lesson Plans: Loop Plane Activity
http://quest.arc.nasa.gov/aero/teachers/ia3.html

**Parachute Lab adapted from:**
Discovery School 6-8 Physical Science Lesson Plans Library: Forces and Motion Lesson created by Ted Latham (Watchung Hills Regional High School, Warren, NJ)
http://school.discovery.com/lessonplans/programs/forcesandmotion/

**CD Glider Lab adapted from:**
PSA (Personal Satellite Assistant) Forces and Motion Middle School Lesson Plans
http://psa.arc.nasa.gov/midd.shtml