The Scientific Method Outline

**Before Designing an experiment you:**

1. **Observe:**
   The scientific method is founded upon direct observation of the world around us. A scientist, or you, should look critically and attempt to avoid all sources of **bias** when you are observing. Use the following **physical properties** (those which have to do with appearance) to describe what you are observing or testing:

   a. **Color** – Be specific; “bright red” instead of just “red” (Use 2 words to describe color!)

   b. **Odor** - In describing odor try not compare an odor to another odor. You **would not** say, “The chalk smells like dust.” Avoid words like “gross,” or “nasty.” Words that can be used are sharp, irritating, pleasant, unpleasant, and noxious (physically harmful). Or, if you want to “guess” at the smell you can say, “It seems to smell of . . .”

   c. **Taste** – CAREFUL! Use only the four tastes that exist: sour, bitter, sweet, and salty. Again, don’t compare a taste to another taste.

   d. **Size & Shape** – These are descriptive and aren’t true physical characteristic properties. You should be as precise as you can be. The standard for measuring in science is of course the **SI system**, otherwise known as the **metric system**.

   e. **State of matter** – Solid (definite shape; has volume), Liquid (definite volume, no definite shape; takes on shape of the container), Gas (no definite shape or volume; expands equally to fill a container), Plasma (hot, ionized gas not found on earth) You shouldn’t have to use this last one!

   f. **Texture** – The surface description of an object. Can be described with words like “rough” or “smooth.” How would you describe fish skin?

   g. **Structure** – there are several ways to describe structure: element/compound/mixture, metal or non-metal, crystal, powder, granular. Not “thingy” or “stuff”

   h. **Density** – the amount of mass per unit volume. Pure substances have a specific density. Units are g/cm³ (cubed.) Water is the standard being 1g/cm³ (cubed)

   i. **Hardness, brittleness, elasticity** – Hardness is based on a scale from 1-10 with the diamond being the hardest at 10. Brittleness is, will it snap when broken? Elasticity is, will it return to its own shape?

   ****Only describe characteristics in your observations that are relevant! ****
2. Create a Question:
The second step (it can also be the first step!) in the scientific method is to pose a question. By asking a question(s), you not only can satisfy your curiosity, but you also are leading yourself into problem solving. Ex: “Why did the balloon get bigger when placed in hot water?”

3. Develop a Hypothesis:
   - This is merely an educated guess to the answer for your question. What is meant by an educated guess is that you are guessing why something happens with knowledge you have learned in the past. **Hypotheses do not always have to be correct.** Your hypothesis must be testable.
   - Your hypothesis should be in the format “If (you have some situation) . . . and (you do something to the situation, the IV) . . . then (this is what you predict will happen) . . .”
   - A hypothesis can be found to be supported, or disproven. Avoid claiming a hypothesis was “proven,” or “right.”
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**Experiment or Test**

This is the actual hands-on part of the process. Here you carry out your testing your hypothesis.

1. **Determine the Variables/Control:**
   - **Dependent Variable (DV):** This is what you will be testing.
   - **Independent Variable (IV):** This is the one thing you will purposely change.
   - **Control:** A control is something you use for comparison in which there isn’t an independent variable introduced.
   - Controlled experiments are often those in which two identical experiments are carried out with the exception of a change in one variable in one of the experiments. This is done to determine what affect the independent variable has on the outcome.

2. **Write out the procedure to test the variables.**
   - The procedure must list every step that a person performing the experiment needs to know.
   - This will contain amounts of the supplies needed.
   - This will contain explanations on how to use equipment.
   - This will allow for another person to replicate your results.

3. **Analysis**
   - How do we compare the results? As good scientists we try to repeat (replicate) our experiments to see if we come up with the same results. This is a way of accounting for errors. How will we know which results are valid? You need to decide after testing and retesting if you found evidence to support your hypothesis or, if your hypothesis was not supported.

   - **Repeated trials** – When you conduct the same experiment several times. A single person can conduct the same experiment several times, or several people can conduct the same experiment once. Either way, results of the same experiment can be concluded upon by having results from several trials to be compared.
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- If the evidence does not support your hypothesis, you might go back and revise your hypothesis, or completely reject your old hypothesis and start all over with a new idea based on new information that you gained.

What to do with your information:
If you find evidence that supports something, you need to share your information. Just think, if scientists kept information to themselves, where would we be now? This is when you, as a student or scientist, present a lab report!
THE LAB REPORT GUIDE

*Must be in the order as follows. Each section should be clearly labeled, but does not have to be on separate pages. The lab report should be word processed on a computer in “Times Roman” 12-14 font only using black ink. If you do not have access to a computer, you may neatly use black/blue ink only. Have your work edited.

**Heading:**

- Title of Lab (Use IV & DV in Title)
- Name
- Lab partners names,
- Date,
- Period

**PROBLEM QUESTION**– One variable if possible, and something that can be tested. Question must be relevant.

**HYPOTHESIS**– Must answer problem question and be testable. (“If . . . and (the IV) . . . then . .” format)

**MATERIALS**– List all materials (No specific order. Complete sentences not necessary)

**PROCEDURE**–

- **Numbered list** of the procedure followed for the experiment from start to beginning. (Not paragraph form.)
- Include specific details for each step and **do not use personal pronouns** (“I,” “He,” “She.” etc.)
- **Written in present tense.** Example: Don’t say, “She put water in the beaker.” Instead you would say, “1. Place 50 mL of distilled water in a large beaker.” **Complete sentences are not necessary.**
- Illustrations or drawings may be used for clarity.
- **Include any safety precautions at the end of this section.** It is important to have a clear procedure stated so that the test/experiment can be replicated!
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OBSERVATIONS–

- A written description of what you may have seen, heard, smelled, possibly tasted, or felt.
- Do not repeat the procedure.
- DO NOT MAKE ANY CONCLUSIONS IN THIS SECTION. Again, do not use personal pronouns. (Refer to the “OBSERVATION” section of the Scientific Method handout for physical properties.)
- Paragraph form using complete sentences.

DATA–

- Includes data tables or graphs.
- Tables should be clear, concise and easy to read.
- Titles and labels are required for tables and graphs.
- Tables or graphs should be drawn using a pencil & a ruler or, can be computer generated using Excel.

CONCLUSION– The reader should be able to understand what was being tested and what the outcome of the experiment was.

- **Recall**: What you did during this lab.

- **Expalin**: Why you did this lab, What you were trying to find out. Re-write problem question exactly from the beginning.

- **Results** of the lab. Did ut match your hypothesis or was your hypothesis not supported? And why? *Use your data to answer the question. If your data is different from the class’s, or you feel it is inaccurate, this is where you would explain what you think went wrong and how you could improve the test.

- **Uncertainty**: Errors that were in the lab that you could not control. Any problems that you came across during running this lab that you could fix for the next time you perform the lab.

- **New**: questions or new discoveries (normally you put in at least three.)