# SCIENCE & ENGINEERING PRACTICES

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# SCIENCE AND ENGINEERING PRACTICES

1. ASKING QUESTIONS (FOR SCIENCE) AND DEFINING PROBLEMS (FOR ENGINEERING)
2. DEVELOPING AND USING MODELS
3. PLANNING AND CARRYING OUT INVESTIGATIONS
4. ANALYZING AND INTERPRETING DATA
5. USING MATHEMATICS AND COMPUTATIONAL THINKING
6. CONSTRUCTING EXPLANATIONS (FOR SCIENCE) AND DESIGNING SOLUTIONS (FOR ENGINEERING)
7. ENGAGING IN ARGUMENT FROM EVIDENCE
8. OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

SCIENCE AND ENGINEERING PRACTICES

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# ASKING QUESTIONS AND DEFINING PROBLEMS

| Science asks.... | Engineering asks... |
| --- | --- |
| • What exists and what happens?<br>• Why does it happen?<br>• How do you know? | • What can be done to address a particular human need or want?<br>• How can the need be better specified?<br>• What tools and technologies are available or could be developed to address this need? |

How does someone communicate about phenomena, evidence, explanations, and design solutions?

*A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, D.C.: National Academies, 2012. Print.

ASKING QUESTIONS AND DEFINING PROBLEMS

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# IDENTIFYING QUESTIONS TO BE RESEARCHED

Scientists and engineers investigate and observe the world in order to:

1. Describe the world around them.
2. Develop and test theories and explanations of how the world works.

## Making Observations

Careful observation and description often lead to identification of features that need to be explained or questions that need to be explored.

**Qualitative observations:** descriptions of sights, sounds, smells, tastes, or textures

**Quantitative observations:** descriptions using numbers or measurements

Observations lead to identifying questions to be investigated!

## PLANNING AND CARRYING OUT INVESTIGATIONS: IDENTIFYING QUESTIONS

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# PLANNING AN INVESTIGATION

## START WITH A PROBLEM QUESTION....

- Using your observations, form a question that can be investigated using the materials available.
- A good way to form a problem question would be by using the following words:
  - How does _____ affect _____?
  - What effect does _____ have on _____?
- Your question should have the proper punctuation at the end (question mark).

## ...THEN FORM A HYPOTHESIS....

- A hypothesis is a possible explanation that predicts a specific outcome of your experiment.
- It is written using the following format;
  If (insert your independent variable) then (insert your dependent variable) because (provide a possible explanation).

## CREATING PROBLEM QUESTIONS AND FORMING A HYPOTHESIS

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# FACTORS TO CONSIDER WHEN PLANNING YOUR INVESTIGATION

In order to make sure your possible explanation is supported by the data you collect, you must make sure your experiment has the following:

| Part of Experiment | Definition |
|---|---|
| control group | the standard of comparison in the experiment; what you compare everything that happens in the experiment to |
| independent variable | the factor in the experiment that is manipulated or controlled by the person doing the experiment (the "cause" of your results) |
| dependent variable | the factor in the experiment that depends upon any changes in the independent variable; the results of the experiment (the "effect") |
| constants | factors about or around your experiment that do not change (ex. temperature of the room, size of the glassware used) |

## CONTROLLING THE EXPERIMENT: CONTROLS, VARIABLES, AND CONSTANTS

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# CARRYING OUT THE INVESTIGATION

You must decide what measurements will be taken, the level of accuracy required, and the equipment you will use in your investigation. The goal should be to measure the variable as accurately as possible and reduce sources of error.

Writing the Procedure for your Investigation

1. The procedure for your investigation should be written clearly in numbered steps.
2. There should be one direction listed per step.
3. Start each step with an action verb.

Collecting Data

1. Data should be collected in a data table.
2. Make sure to label the headings in each column of your data table.
3. Put units for any measurements in parentheses after the headings in your data table. You do not need to write the units after each number in your data table.

CARRYING OUT THE INVESTIGATION: WRITING A PROCEDURE/COLLECTING DATA

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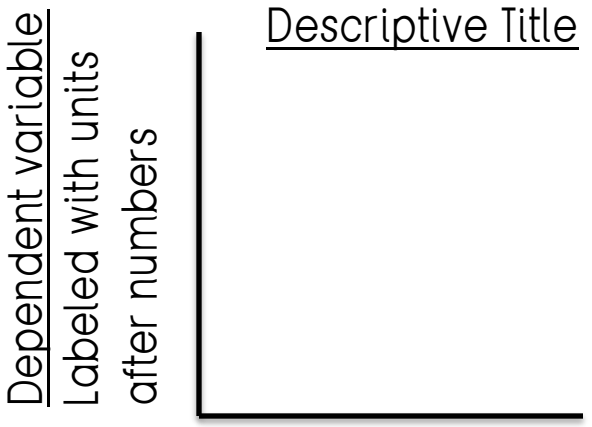
# ANALYZING AND INTERPRETING DATA

Once you collect your data, it must be presented in a clear way that shows any patterns and/or relationships. Graphs are one way to communicate your results.

Common Types of Graphs Used in Science
Bar graph: Used to show unrelated data
Line graph: Used to show continuous data

Parts of a Graph




Include a key if multiple lines or bars are needed.

Independent Variable
Labeled with units after numbers

Your graph should take up the whole page. Remember to connect the points if using a line graph.

ANALYZING AND INTERPRETING DATA

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# CONSTRUCTING EXPLANATIONS AND ENGAGING IN ARGUMENT FROM EVIDENCE

You should be able to give a scientific explanation about what happened in your investigation using the evidence you collected. Scientists must be able to argue their ideas in order for their ideas to be accepted by others. In science, we will use the claim, evidence, reasoning format to summarize our experiments.

| | |
|---|---|
| Claim | Your answer to the question, "What do you think?" |
| Evidence | Actual observations or measurements that support the claim. "What you observe." |
| Reasoning | The justification that links the evidence to the claim. It explains why the evidence supports the claim. It includes a scientific idea about what happened. "What you know." |