Name_______________________________________ Date ____________________

What Are Science and Engineering Practices and Crosscutting Concepts?

Science and Engineering Practices

Science and Engineering Practices (SEPs) are part of the Next Generation Science Standards. The SEPs describe ways scientists and engineers do their work. You will practice the SEPs at school and at home. Practicing the SEPs will teach you to think like a scientist. You will learn how to solve problems in your life. You will also be prepared for a future in science.

1. Asking Questions and Defining Problems
The first step of science is to ask a question about the world around you. You may ask, "Why can I see the moon during the day?" The next step is to think about how to investigate your question. Sometimes, scientists need to learn more about the topic they want to investigate.

Engineers think about problems to solve. An engineer may wonder how to build a better electric car. Or, how to build new homes while not harming the environment. They explain the problem that they need to solve. They also identify the criteria and constraints of the problem. They do this by naming what the solution must do and can't do.

2. Developing and Using Models

Both scientists and engineers develop and use models. Models can be drawings, three-dimensional models, or computer models. Models can help you explain concepts that are too small or too big to observe, such as the solar system. They can also help scientists make predictions or test hypotheses. For example, if you understand patterns in the solar system, you could use a model to explain why you sometimes see the moon during the day.

Engineers may use models to look for problems in their plans. They may use models that are smaller than the real product to save time and materials. Engineers use the results of their tests to improve their models and final products.

Name______________________________ Date ____________

3. Planning and Carrying Out Investigations

Scientists and engineers plan their investigations before they start. Before you begin an investigation it is important to think about:

- The question you are asking or problem you are identifying
- The variable you are testing and your controls
- Materials
- Time the investigation will need
- Data collection methods (when will you collect data and how?)
- Safety precautions

Always review an investigation plan with a teacher, parent, or other adult before you begin. The results of an investigation may or may not support your hypothesis. The results of an engineering investigation may provide you with data that shows if your design is working. The data may also show how you can improve your design.

4. Analyzing and Interpreting Data

Scientists and engineers analyze and interpret data. They analyze data they have collected and the data that others have collected. You will do the same in science class. You will collect data from your investigations. Next, you will display the data in ways so that you can analyze patterns.

Sometimes, you might create a diagram of your observations. Other times, you might use data to write an explanation or create graphs and tables. You may be asked to analyze data from other scientists and decide if their results support their hypotheses.

When looking at data, it is important to think about sources of error. If there was a problem with the investigation, you must consider how this may have affected the results.

5. Using Mathematics and Computational Thinking

Scientists and engineers use mathematics and computational thinking to produce explanations. They also use mathematics to make and test predictions.

Engineers also use mathematics to decide if the structures they design will work as needed. For example, if you design a building to withstand an earthquake, you can use math to collect data. This can help you determine how much force it would take to damage the building.

Name________________________________ Date ______________

6. Constructing Explanations and Designing Solutions

Scientists construct explanations to describe how scientific ideas are supported by data and observations they have collected. In science class, you will be asked to construct logical explanations of the ideas you observe and test. Your explanations should show that you understand how science explains a phenomenon. When writing an explanation, include as much evidence as possible to support your explanation.

Engineers design solutions in a very precise way. They consider factors such as desired functions, available technologies, cost, safety, and appearance. Engineers may develop multiple solutions to a problem. They test and refine each solution and decide which one works best. Sometimes, this involves combining the best parts of more than one solution.

7. Engaging in Argument from Evidence

Scientists often need to defend or offer more support for their explanations. They do so by carefully looking at evidence and considering comments from others. They may also work with peers to determine the best explanation. Let’s say that a scientist made the claim, “Plants get most of the nutrients they need from the air and water.” Other scientists might use data from experiments as evidence to either defend or argue this claim.

Engineers use arguments to explain if a design to a solution was effective. You might design a solution to prevent a river from flooding after a heavy rainstorm. After you test this solution, you might construct an argument to explain how well your design worked. You should use evidence to describe whether or not your design met the criteria of the problem.

8. Obtaining, Evaluating, and Communicating Information

Scientists must be able to communicate clear and accurate information to explain phenomena and ideas to other people. The first step to communicating a topic or phenomenon is to obtain information by reading different books, texts, or summarizing information from a video. It is important that you evaluate the information that you have read and summarized to make sure that the information is accurate and from a trustworthy source. When obtaining information, you might ask yourself:

- What are the important ideas found in this source?
- Is the information accurate?
- Is the source trustworthy?

Once you have summarized and evaluated information, now it is time to communicate your ideas. Scientists use many ways to communicate information. You might communicate your ideas by writing them, preparing a speech, or giving a presentation. You could also communicate in a more visual way through a chart, poster, or video.

Name____ Date ____________________

Crosscutting Concepts

Crosscutting Concepts (CCCs) are part of the Next Generation Science Standards. The CCCs are different ideas that can be found across all areas of science. The CCCs will help you discover how different topics of science are linked together. You will also learn how to view the world from a scientific perspective.

1. Patterns

Patterns can be found everywhere in our world, such as the seasons and the rise and fall of the tides. Scientists use patterns to ask and answer questions about why or how different phenomena happen in the world.

You can sort and organize ideas in science by looking for similarities and differences in patterns. Patterns are also used to make predictions about what is going to happen next. You might also use patterns as evidence to support an argument or to write an explanation.

2. Cause and Effect

Things happen naturally around us for different reasons but each event is caused by something else. After scientists have identified a pattern, they ask themselves, “What causes this to happen?” For example, you might observe that the moon seems to change shape and size and wonder, what causes this pattern?

You may identify a cause and effect relationship and test it to see if the cause always produces the effect. You may also use cause and effect to explain or predict changes in natural events, such as weather.

3. Scale, Proportion, and Quantity

Scientists and engineers use scale, proportion, and quantity to better understand systems and ideas by asking and answering questions such as:

- How big or small is the system or the parts that make it up?
- How much time or energy does it need or use?
- How does the size relate to other measurements such as time, distance, or speed?

Scientists and engineers use proportions to understand ideas in science. For example, to understand the size of an atom, you might use proportions to produce a model. You can think of the atom as the size of a whole football field and the center of an atom as the size of a green pea. You can use standard units, such as meters, to share your ideas and findings with others.

Name______________________ Date ______________

4. Systems and System Models

Systems are groups of smaller parts that work together to complete a task. A bicycle is a system made of parts like wheels, a handle, and chains. The parts of a bicycle work together to move you from one place to another.

System models are used to describe how systems work and how each part of a system helps to complete the task. Scientists and engineers use system models to describe how parts of complicated systems, such as the human body, work together.

When you look at a system, you will start by naming each of the smaller parts that make it up. You will think about the ways each part is important and how different parts work together. You might also ask yourself, what would happen to the system if one part was missing or changed?

5. Energy and Matter

One way that scientists learn more about systems is by observing and following how matter and energy move. You may do this when you study how heat energy moves between objects.

Scientists use system models to describe how energy and matter move in and out of the system. You may use models to collect evidence to support how energy and matter are conserved in nature.

6. Structure and Function

Structure and function go hand-in-hand both in the natural world and in the products that scientists and engineers produce. A particular structure of a plant or animal can tell a scientist a lot about how an animal lives. For example, birds of prey have sharp, curved talons. This shape helps these birds to grab on to and carry away small animals like mice. However, these talons would not be useful for aquatic birds that eat plants.

When scientists and engineers build a product, they must consider how the structure of the product will impact its function. Tests of the product will reveal if the structure needs to be altered in order to achieve the desired function.

7. Stability and Change

When scientists observe an environment or system, one thing that they look for is if it is stable or if it is changing. A stable system does not change or it only changes in ways that you can predict.

When you are thinking about changes in a system, it is important to think about how fast or how slow the change happens. You will observe, gather evidence, and make arguments about how small changes in a system can cause bigger changes.

Name____________________ Date ____________

Engineers use this idea to design solutions to keep big changes from happening too fast. For example, an engineer might design a solution to keep the temperature of an environment constant. This might be used to help keep living things in that system safe and alive.