NTI Day 1 Lesson
Content Standard A: Scientific Inquiry and Lab Safety and Tools
Class: Chemistry **Teacher: K. Kelly**

Scientific Evidence

Scientists ask many questions to help them understand the nature of the world. Here are some questions a scientist may ask:

Question	Example
What?	What causes weather systems to form?
When?	When did life first evolve on Earth?
Where?	Where are the edges of the universe?
Why?	Why do mitochondria resemble some species of bacteria?
How?	How do sea turtles navigate?

When a scientist asks a question, he or she comes up with a hypothesis to answer the question. A **hypothesis** is a possible answer to a question. Scientists are careful to only come up with hypotheses that can be tested. Scientists use experiments to test their hypothesis. The experiments give them evidence to support or refute their hypothesis.

After scientists find a proper hypothesis and have performed experiments, they must find evidence from those experiments. **Evidence** is data or information on which a conclusion can be based. The evidence gained in an experiment may prove that the scientist's hypothesis was correct. The evidence could also prove the hypothesis was incorrect. Either way, the scientist has learned something. Scientists often test a hypothesis by building and manipulating models.

A **model** is a representation of an object or system. When trying to learn about something, a model can help to see how the object works. Models can be used to demonstrate things that cannot be seen normally. For example, building a model of a volcano can help students to visualize what happens during an eruption without putting them in danger.

A globe is a model of the Earth.

Models are used often in everyday life. Some common models include:

- globes and maps of Earth
- toy cars
- CPR mannequins

It is important to remember that models cannot be exactly like the real thing-- otherwise they would not be models. Models can be made out of objects or ideas.

Scientific Method

Physical scientists ask many questions to help them understand matter, energy, space, and time. Here are some questions a physical scientist may ask:

What causes an electromagnetic field to form?
How do subatomic particles move?
How does Earth's gravity affect the weight of objects on Earth?

To answer these questions, physical scientists need to collect evidence through scientific investigations.

Most scientific investigations have five basic steps.

Step 1: Forming Hypotheses
The questions that physical scientists ask typically come from observations of the natural world. To begin answering their questions, physical scientists form a hypothesis. A **hypothesis** is a prediction, a possible explanation for a set of observations, or a possible answer to a scientific question. A hypothesis must be testable. This means that scientists must be able to carry out investigations and gather evidence that will either support or disprove the hypothesis. Because a hypothesis must be testable, the questions that physical scientists base their hypotheses on must also be testable.

Step 2: Testing Hypotheses
A scientist designs an experiment to test a hypothesis. All factors that can change in an experiment are called **variables**. The variable that is purposely changed to test a hypothesis is called the independent, or manipulated, variable. The factor that may change in response to the independent variable is called the dependent, or responding, variable. All of the other variables or factors, besides the manipulated and responding variables, are controlled variables. Scientists carefully control their variables so they can understand how a particular variable affects the system as a whole. This makes the data collected from an experiment meaningful.

Step 3: Data Collection

Gathering data requires observations to be made. Many observations involve the senses of sight, hearing, touch, and smell. Often, scientists use tools that increase the power of their senses or make their observations more precise. Some tools commonly used by scientists include:

Balance	a tool used to measure the mass of objects
Graduated Cylinder	a beaker marked in intervals that is used to measure volume
Microscope	a tool used to produce magnified images of small objects
Spring Scale	a tool used to measure weight and force
Thermometer	a tool used to measure temperature
Test Tube	a cylindrical tube, usually smaller than a beaker, that is open at one end and closed at the other

Step 4: Interpreting Data
When an experiment is done, a scientist analyzes the data. Scientists use tables, charts, and graphs to organize, interpret, and present data. Organizing data in tables, charts, and graphs makes it easier to see patterns. Scientists analyze and interpret data tables and graphs to determine the relationship of one variable to another and to make generalizations based on the data.

Step 5: Communicating Results
After gathering and interpreting data, a scientist draws conclusions about the hypothesis. A scientist then communicates the results of the experiment. This is an important part of any scientific investigation. Communicating results helps scientists learn from one another.

Collect & Interpret Data

Making observations and collecting information is a large part of a scientist's job. Once this information is collected it must be organized and presented in a clear and concise way. **Tables** and **graphs** are the tools that scientists use to organize and present information.

Collecting information for scientific investigations is a very important task. Collecting data can be done in many different ways, such as:

- observing
- measuring or counting
- asking questions
- performing an experiment

Once information has been collected, it should be interpreted. Most of the time, when data needs to be interpreted, it is placed into tables or graphs.

Tables allow a lot of information to be presented in a small space by **organizing data efficiently**. The information found in tables can be analyzed and interpreted to form conclusions and make predictions about the data and the topic of the investigation.

While *tables are used for organizing information*, **graphs are used to present information visually**. Different types of graphs are used for presenting information in different ways.

Circle Graphs

Circle graphs are best used to show how a whole is divided into parts (or percentages of a whole).

Circle graphs, or pie charts, are circular-shaped graphs that are broken into sections. The sections represent different parts of the whole, and all of the sections combined should add up to the total. Section sizes in the graph correspond to the percentage or amount of the whole that it represents. For example, a section that represents 50% of the total should take up half of the graph.

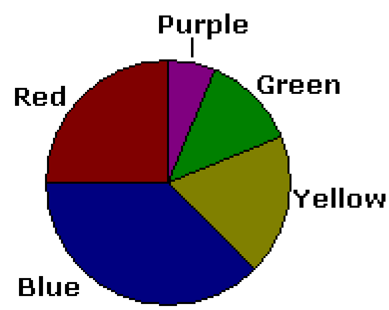
Good examples of questions that may use circle graphs include:

- percentages of students in different classes (out of students in the school)
- amount of people that resides in each continent (out of entire population)

Example 1:

Anna has a bag of one-hundred pieces of candy, which are either purple, blue, red, yellow, or green. She wants to know which color of candy she has the most of in her bag. She counts the candy and records her results. From her results, she makes the following graph.

Which color of candy does Anna have the most of?



From looking at the graph, you can tell that Anna has more pieces of **blue** candy than any other color.

Bar Graphs

Bar graphs are best used to show how a number of objects or events compare in relationship to a single property.

A bar graph uses bars to compare different objects or events to one property. Each bar represents one object or event, and there can be two or more bars present on one graph. The bar for each object is a certain length, which is determined by its amount or occurrence in relation to the other bars. Thus, the longer the bar, the greater the amount of the object or frequency of the event.

Bar graphs consist of a horizontal and a vertical scale. One scale identifies the objects to be compared and the other scale is numerical. The numerical scale must be consistent. A graph can be misleading or difficult to read depending on the scale you choose.

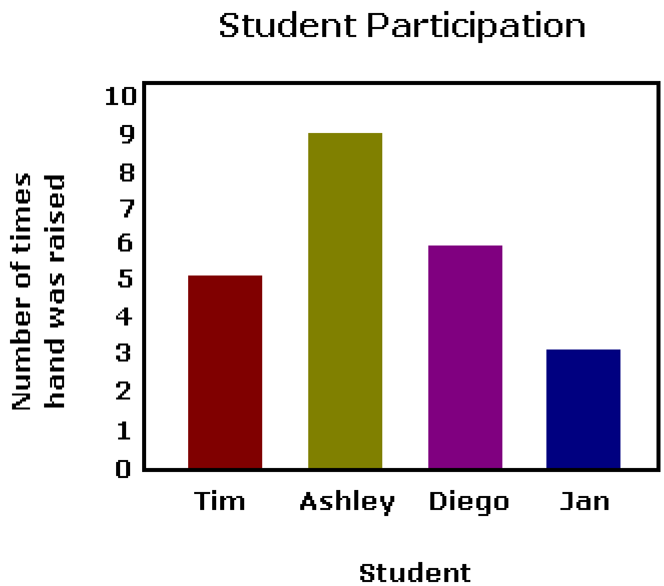
Good examples of questions that may use bar graphs include:

- the favorite color of students in a class
- number of each type of animal in an area

Example 2:

Mr. Ward wants to know how much each student in his class participates on a certain day. He decides to test this by counting the number of times that each student raises his hand during class. Mr. Ward records his results and makes the following bar graph.

Which student participated the most in class?



Using the number of times a student raised his hand in class to measure the amount of participation, **Ashley** participated most in class on that day.

Line Graphs

Line graphs are best used to show a relationship between two measured quantities, usually as a trend over time.

Line graphs are usually made up of data points on a graph, with a line that connects them or is drawn to best fit the most points. There are two axes on a line graph. The **x-axis**, or the horizontal axis, is where the independent variable (manipulated by the experimenter) is placed. The **y-axis**, or the vertical axis, is where the dependent variable (not manipulated by the experimenter) is placed. Line graphs are often used to see trends over time, with the time normally being the independent variable.

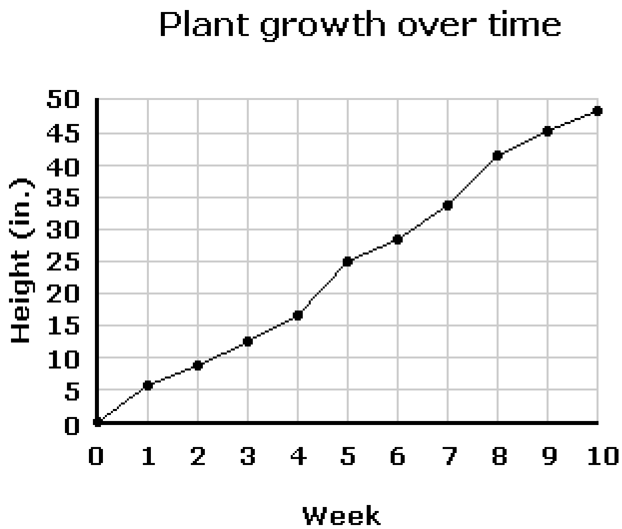
Good examples of questions that may use line graphs include:

- plotting plant growth vs. days
- plotting temperature vs. time of day
- plotting the year vs. number of animals present in an area

Example 3:

Angie is growing a plant. She measures the plant each week for ten weeks and records the height of the plant. After the ten weeks, Angie makes a line graph of the information that she collected.

How tall was Angie's plant after 5 weeks?



Angie's plant was **25 in.** tall after five weeks.