

Problem Solving in Science

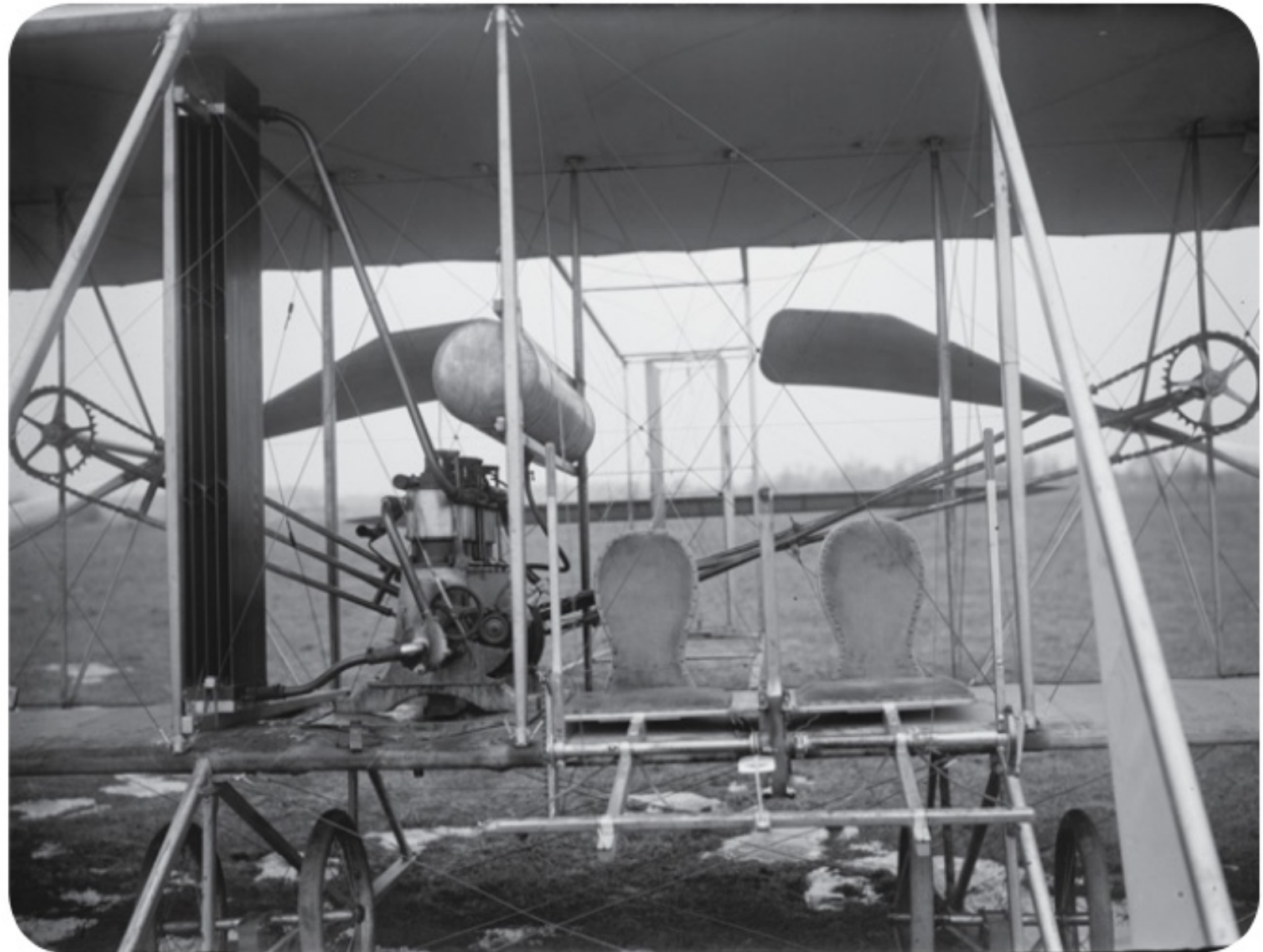
What is scientific inquiry?

Flying Machines

In the 1890s, brothers Wilbur and Orville Wright began designing and building bicycles. However, they began to focus their attention on building a new machine—one that could fly.

After experimenting for years with kites and gliders, the Wright brothers built and tested their first airplane. It flew for a few seconds at a height of about 3 m (10 ft.) above the ground.

- ❶ What parts can you identify in this early version of an airplane?
- ❷ How might the Wright brothers' experience with bicycles have helped them invent the airplane?
- ❸ How have airplanes improved in the past 100 years? Explain.



Scientific Problem Solving

Understanding Science

Science is the investigation and exploration of natural events and of the new information that results from those investigations.

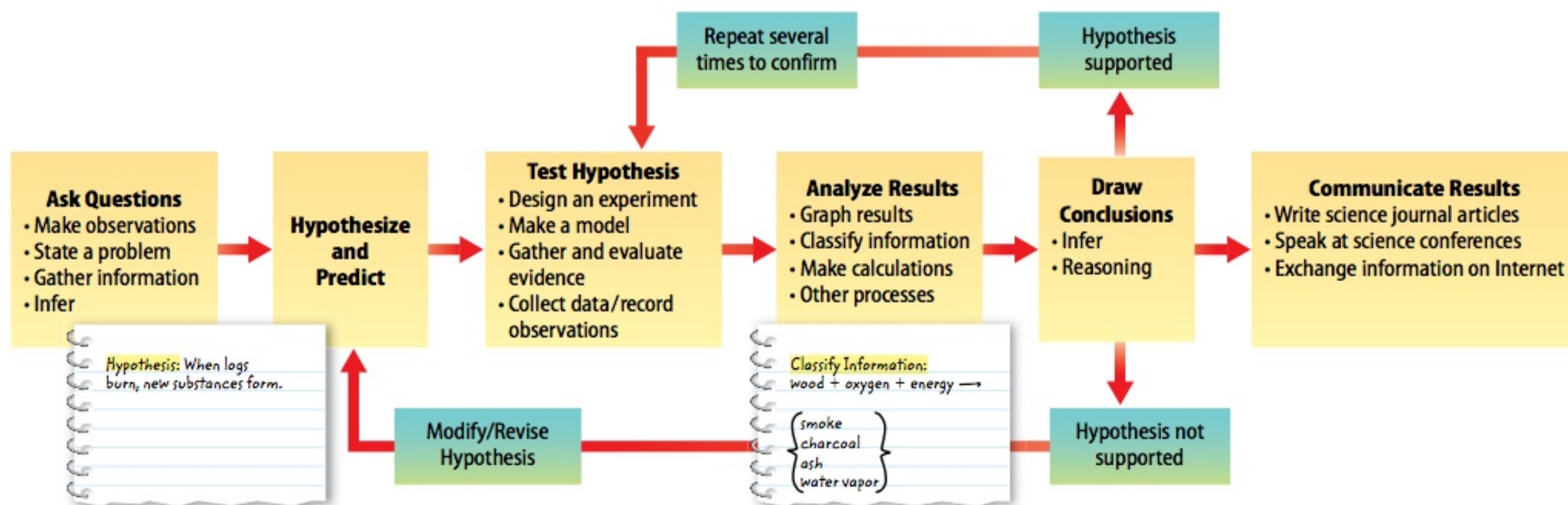
Branches of Science

Physical Science - the study of matter and energy

**Earth Science - the study of the many processes of
that occur on and deep within the Earth**

**Life Science - study of all organisms and the many
processes that occur within them**

Scientific Inquiry Process



Ask Questions

Observations - the results of using one or more of your senses to gather information and taking note of what occurs which can lead to questioning.

Inference - a logical explanation of an observation that is drawn from prior knowledge or experience

Hypothesize and Predict

Hypothesis - a possible explanation for an observation that can BE TESTED by scientific investigations

Prediction - a statement of what will happen next in a sequence of events

Test and Analyze Results

Design and carry out an experiment to generate data

OR research in RELIABLE websites or textbooks

Draw Conclusions

A conclusion is a SUMMARY of the information gained from testing a hypothesis

Experiments should be repeated to make sure the results are CONSISTENT

Communicate Results

Share your results to:

Increase the speed of scientific advances

Keep scientific information accurate

IF your hypothesis was NOT supported by your investigation
it is NOT A FAILURE! All information gained is VALUABLE!

Scientific Theory

IS an explanation of observations or events that is based on knowledge gained from MANY observations and investigations

Scientific Law

IS a rule that describes a repeatable pattern in nature

IT DOES NOT explain why or how the pattern happens
- just that it WILL happen

Results of Scientific Inquiry

Develop new materials and technology (the practical use of scientific knowledge)

New objects (in space) or events

Answers to questions - new drugs, causes of disease, new substances

Evaluating Scientific Information

Critical Thinking - is comparing what you already know with the information you are given in order to decide whether or not you agree with it

Science cannot answer all questions

Beliefs, values, personal opinions, feelings

We cannot collect scientific data on these topics

Safety in Science

Wearing protective equipment: Goggles, aprons, gloves

and to be aware of the potential hazards in any lab situation
so that you can avoid personal injury

The Shipping Business

At ocean ports, giant cranes are used to load containers on and off ships. Each container is a rectangular box of a standard size. The containers are used to carry various products.

Although you may not need cranes, you use containers to move goods. For instance, you might use a backpack or suitcase, which is like a shipping container.

- ❶ Why is it useful for shipping containers to be a standard shape and size?
- ❷ How are backpacks and suitcases similar to shipping containers?
- ❸ How do shipping companies depend on measurements?



Measurement and Scientific Tools

Description - is a spoken or written summary of observations - like measurements

Explanation is an interpretation of observations - inferences

The International System of Units (SI)

SI base units

- Meter - Length
- Gram - Mass
- Time - Second

SI Unit Prefixes

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Prefixes

Prefix	Meaning
Mega- (M)	1,000,000 or (10^6)
Kilo- (k)	1,000 or (10^3)
Hecto- (h)	100 or (10^2)
Deka- (da)	10 or (10^1)
Deci- (d)	0.1 or $\left(\frac{1}{10}\right)$ or (10^{-1})
Centi- (c)	0.01 or $\left(\frac{1}{100}\right)$ or (10^{-2})
Milli- (m)	0.001 or $\left(\frac{1}{1,000}\right)$ or (10^{-3})
Micro- (μ)	0.000001 or $\left(\frac{1}{1,000,000}\right)$ or (10^{-6})

Measurement and Uncertainty

Precision - how close repeated measurements are to EACH OTHER

Accuracy - How close a measurement is to an accepted value like density - physical property

The more lines of measurement on a tool - greater the accuracy

Scientific Notation

A method of writing or displaying very small or very large values in a short form

Percent Error

$$\text{Percent error} = \frac{\text{experimental value} - \text{accepted value}}{\text{accepted value}} \times 100\%$$

Scientific Tools

Scientific Journal

Balances

Glassware

Thermometers

Calculators

Computers

pH paper

Hot Plate

Stopwatch

Spring Scale

Over the River

You could take a boat or helicopter to visit the island of Manhattan. But most travelers use a bridge or tunnel, such as the Queensboro Bridge shown here. It has been carrying traffic across the East River since 1909.

Most cities do not sit on islands. Yet bridges are very important in cities all over the world, especially those near rivers and harbors.

- ❶ Why do you think the Queensboro Bridge was built so high above the water?
- ❷ Why must experts inspect bridges and tunnels regularly?
- ❸ How does your community rely on bridges or tunnels?



Controlled Experiments

Independent Variable - is the factor that you want to test - it is changed by the experimenter to see how it affects the DEPENDENT variable

The Dependent Variable is the factor you observe or measure during an experiment.

Constants are factors in an experiment that DO NOT change

Experimental Group has a changed independent variable (ONE)

Control group is exactly the same as the experimental group BUT without changing the independent variable

Observations, Questions, and Hypotheses

Scientists often observe and gather information about an object or an event before proposing a hypothesis. This information is recorded or filed for the investigation.

Observations:

- Recovered parts of the collapsed bridge
- A video showing the sequence of events as the bridge fails and falls into the river

Asking questions and seeking answers to these questions is a way that scientists formulate hypotheses.

- Was the original bridge design faulty?
- Were bridge maintenance and repair poor or lacking?
- Was there too much weight on the bridge at the time of the collapse?

A hypothesis is a possible explanation for an observation that can be tested by scientific investigations.