CAEC Science

Preparatory Resource Package

CAEC Testing Section:

Science

OALCF Skills Covered:

A1.3, A2.2, A2.3, C3.1, C3.2, C3.3, C4.2, C4.3 (all C level 1s for skill-building)

CAEC Science Preparatory Resource Package Overview

CAEC Science Guidelines

Students are given **90 minutes** to complete the Science section of the CAEC test. Students are required to answer **35 questions worth 1 mark each**. To complete the test, students are allowed to use a **calculator**.

The test is divided into three main areas of focus:

1. **Nature of science**

Understanding the development and scope of science as both a process and a body of knowledge based on observations of the natural world. The natural world includes all components of the physical universe that can be predicted and measured. Scientific ideas evolve with new evidence and understanding.

2. **Scientific inquiry skills**

Understanding skills, processes and methods required for scientific investigations, communicating scientific ideas and results, and making informed decisions.

3. **Science, technology, society and environment**

Understanding how society influences, reacts to, and is changed by scientific research and technologies from a variety of perspectives, including social, cultural, economic, ethical, political, safety, and environmental perspectives.

CAEC Science and OALCF Skills

The resources in this package have been chosen to cover the subject skill areas covered by the CAEC test as well as the OALCF skills required to successfully complete it. Not all skills are covered in all resources. Instead, the resources start with foundation-level skills that learners can develop and increase in difficulty and complexity as the learner progresses through the package.

Upon completing the package, the learner will have had the opportunity to practice **many** of the CAEC test and OALCF skill areas covered by the Science test.

***Please note**: *this package focuses on the building block skills required to complete the CAEC test but does not cover all contexts.*

Skills Covered by the CAEC Science Test:

Nature of science - 10% - 25%

1.1 Identify characteristics of science, such as how scientific ideas are developed through a process of ongoing inquiry.

1.2 Distinguish between observations and inferences.

1.3 Distinguish between questions that can be investigated through scientific inquiry and questions that cannot be tested through scientific inquiry, such as aesthetic, moral, and ethical judgements, and the supernatural.

1.4 Explain ways in which reliability, validity, integrity, and credibility of scientific work is maintained, including through scientific methods, placebos, double-blind studies, large sample sizes, random sampling, peer review and replicating research.

1.5 Identify factors that may introduce bias, such as preconceptions of researchers, funding of research by interest groups, and selective reporting of evidence.

Scientific inquiry skills - 60% - 85%

2.1 Formulate testable questions, for a given situation, that can be investigated through scientific inquiry.

2.2 Formulate a hypothesis or prediction based on prior knowledge or an observed pattern of events.

2.3 Determine the design elements of scientific investigations, including control groups and variables (independent, dependent, and controlled).

2.4 Identify procedures that set appropriate conditions, limit bias, and use appropriate methods for collecting data.

2.5 Identify the appropriate techniques for storing, handling, and disposing of materials according to WHMIS 2015 and consumer product symbols.

2.6 Demonstrate effective selection and use of scientific tools for data collection, such as a ruler, protractor, thermometer, or graduated cylinder.

2.7 Select appropriate units of measurement to collect and communicate data, including conversions within Système International d'unités (SI).

2.8 Visualize and communicate data in appropriate formats, such as tables, graphs, and diagrams.

2.9 Analyze patterns and trends to describe relationships among variables and data.

2.10 Estimate information from data, graphs, tables, and spreadsheets.

2.11 Evaluate scientific investigations for sources of error and formulate reasonable explanations of the results.

2.12 Evaluate the reliability, validity, and credibility of scientific investigations.

2.13 Transfer conclusions from scientific investigations to everyday life and future investigations.

Science, technology, society and environment - 5% - 15%

3.1 Identify intended and unintended consequences for humans and the environment emerging from scientific solutions and technologies.

3.2 Evaluate risks and benefits of scientific solutions and technologies.

3.3 Evaluate factors that influence scientific research.

Cognitive Domain

Low complexity (recall and reproduction) 15% - 25%

• Items require recognition of previously learned information, such as a fact, a definition, a term, a concept, a principle, or performance of a simple procedure.

Moderate complexity (skills and concepts) 50% - 80%

• Items require application of knowledge of one or more concepts and making decisions about how to approach a question or problem, how ideas relate, or what tools to use.

High complexity (strategic thinking) 5% - 15%

• Items require interpretation, analysis, generalization, abstract reasoning, judgement, or connection of information and evidence in context.

OALCF Skills used on the CAEC Science Test:

A1. Read continuous text
A1.3 Read longer texts to connect, evaluate and integrate ideas and info

A2. Interpret documents
A2.2 Interpret simple documents to locate and correct information
A2.3 Interpret somewhat complex documents to connect, evaluate and integrate info

C3. Use measures
C3.1 Measure and make simple comparisons and calculations
C3.2 Use measures to make one-step calculations
C3.3 Use measures to make multi-step calculations; use specialized measuring tools
C4.2 Make low level inferences to organize, make summary calculations, and represent data
C4.3 Find, integrate, and analyze data; identify trends in data

Overview of Resources

Resource Name	Summary	CAEC Skills	OALCF Skills
Observations and Inferences	This resource helps learners understand how observations and inferences work together in scientific inquiry.	1.2	A1.2, B2.2
Process of Ongoing Scientific Inquiry	This resource helps learners understand the steps in the process of ongoing scientific inquiry.	1.1, 2.1, 2.2, 2.13	A1.2, A1.3, B2.2
Distinguishing between questions that can and cannot be investigated through scientific inquiry	This resource helps learners distinguish between scientifically-testable and non-scientifically-testable questions, and practice formulating their own.	1.1, 1.2, 1.3, 2.1, 2.2, 2.9. 2.13	A1.2, B2.2
Formulating Hypotheses	This resource helps students understand how to formulate hypotheses in scientific investigations.	1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 2.9	A1.2, B2.2
Ways in which reliability, validity, integrity, and credibility of scientific work is maintained	This resource helps learners understand the ways in which key elements of scientific work are maintained and supported.	1.1, 1.2, 1.3, 1.4, 1.5, 2.11, 2.12, 2.13	A1.2, B2.3
Design Elements of Scientific Investigations	This resource helps learners understand the appropriate design elements of scientific investigations, including controls and limitations.	1.5, 2.4, 2.4	A1.2, A1.3, B2.3
Identifying Perspectives and Research Priorities in Science	This resource will help learners understand the how perspectives can affect research priorities.	1.1, 1.2, 1.3, 1.4, 1.5, 3.1, 3.2, 3.3	A1.2, A1.3, B2.3
Benefits and Risks of Scientific Solutions and Technologies	This resource will help learners understand intended and unintended consequences of scientific solutions and technologies.	3.1, 3.2, 3.3	A1.2, A1.3, B2.3

Understanding Graphing Using pH Levels	This resource will provide learners with an introduction to graphing using an examples of pH levels.	2.8, 2.9, 2.10, 2.11	B2.3, C4.2, C4.3
Introduction to WHMIS Consumer Product Symbols	This resource will introduce learners to the most common WHMIS consumer product symbols.	2.5	A2.2, B2.3

RESOURCE 1: Observations and Inferences

Original Authors: CLO

CAEC Science Skills Covered:

Identify the appropriate techniques for storing, handling, and disposing of materials according to WHMIS 2015 and consumer product symbols.

OALCF Skills Covered:

A1.2 Read texts to locate and connect ideas and information

B2.2 Write texts to explain and describe information and ideas

Observation and Inference

In the Science section of the CAEC test, you will be required to answers questions about key areas of scientific study. The test focuses on three main areas:

- the nature of science
- scientific inquiry skills
- science, technology, society and environment

The test will cover general scientific topics and more specific content. Some of the topics covered include:

- observation and inference
- the characteristics of science
- scientific inquiry
- reliability of research and bias
- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

- ➢ In this resource, you won’t need to use a calculator.
- ➢ After each lesson, you will have the chance to practice what you have learned.

Let's Get Started!

Observations vs. Inferences

Understanding the difference between **observations** and **inferences** is an important skill in science and daily life.

➢ **Observations** are:

- what you see, hear, feel, taste, or smell
- they are the facts you gather directly through your senses

➢ **Inferences** are:

- conclusions or interpretations
- made based on your observations and what you already know

A Closer Look

Observations

Observations are:

1. **Objective**:
   They describe things as they are without interpretation.

2. **Fact-based**:
   They rely only on the senses or tools (like a thermometer or ruler).

3. **Shared**:
   Anyone observing the same thing should agree with you.

Some Examples

Examples of Observations:

- The grass is wet.
- There are footprints in the snow.
- The soup tastes salty.
- The thermometer reads 25°C.

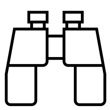
Inferences

Inferences are:

1. **Subjective**:
   They are based on your thoughts, prior experiences, or assumptions.

2. **Interpretative**:
   They explain or make sense of an observation.

3. **Variable**:
   Two people might make different inferences from the same observation.



Some Examples

Examples of Inferences:

- The grass is wet **because it rained last night**.
- There are footprints in the snow **because someone walked here recently**.
- The soup tastes salty **because too much salt was added**.
- The thermometer reads 25°C **because it's warm outside today**.

Important Notes

1. Observations are objective and can be agreed upon by others.
2. Inferences are subjective and based on prior knowledge or experiences.

Now it’s **Your** Turn

Let’s work with observations and inferences.

Activity 1: Observations and Inferences Sorting

Instructions: For each statement, decide whether it is an observation (a fact based on senses or measurement) or an inference (a conclusion based on observations and prior knowledge).

1. The bike hit a nail, causing the flat tire.
2. A soccer ball is covered in mud.
3. A bowl of soup is steaming on the table.
4. The dog is sleeping because its eyes are closed.
5. The soup must be hot because it is steaming.
6. A bike has a flat tire.
7. A soccer ball was left outside in the rain.
8. A dog is lying on the floor with its eyes closed.

Answers:

1. Inference
2. Observation
3. Observation
4. Inference
5. Inference
6. Observation
7. Inference
8. Observation

Activity 2: Observation and Inference Scenarios

Instructions: Read the short paragraph below. Write two observations and two inferences based on the text.

Scenario 1: The Bakery

You walk into a bakery and see that there are no more chocolate croissants on the shelf. A woman holding a bag of pastries is walking out the door.

1. **Write two observations:**

   ____
   ____
   ____
   ____

2. **Write two inferences:**

   ____
   ____
   ____
   ____

Answers:

Observations:

- There are no chocolate croissants on the shelf.
- A woman is holding a bag of pastries.

Inferences:

- The bakery sold out of chocolate croissants.
- The woman might have bought the last chocolate croissants.

Scenario 2: The Park

At the park, you see a kite lying on the grass. Its string is tangled in the branches of a tree, and a child is standing nearby, looking up at the kite.

1. **Write two observations:**

   ____
   ____
   ____
   ____

2. **Write two inferences:**

   ____
   ____
   ____
   ____

Answers:

Observations:

- The kite is lying on the grass.
- The string is tangled in the branches of a tree.

Inferences:

- The kite got stuck in the tree and fell to the ground.
- The child might have been flying the kite when it got tangled.

Scenario 3: The Library

You enter a library and notice a pile of books on the return desk. The librarian is scanning each book and typing on a computer.

1. **Write two observations:**

2. **Write two inferences:**

Answers:

Observations:

- There is a pile of books on the return desk.
- The librarian is scanning each book and typing on a computer.

Inferences:

- The books were just returned by library users.
- The librarian is checking the books back into the system.

Scenario 4: The Construction Site

You see a crane lifting a large metal beam into the air. Workers in yellow helmets are standing nearby, giving signals to the crane operator.

1. **Write two observations:**

2. **Write two inferences:**

Answers:

Observations:

- The crane is lifting a large metal beam.
- Workers in yellow helmets are giving signals.

Inferences:

- The beam is being moved to its place in the construction project.
- The workers are guiding the crane operator to position the beam safely.

Answers:

Observations:

- There is a broken glass on the floor.
- There is water near the sink.

Inferences:

- The cat might have knocked the glass off the counter.
- The glass broke when it hit the floor.

How Observations and Inferences Work Together

Scientists often begin with observations, then use inferences to draw conclusions or form hypotheses. Here's an example from the real world:

Scenario 1: A Cracked Windshield

- **Observation**:
  There is a long crack in the windshield of a parked car.

- **Inference**:
  A rock might have hit the windshield while the car was moving.

Scenario 2: Plants and Sunlight

- **Observation**:
  A plant placed near a sunny window grows taller than one placed in the shade.

- **Inference**:
  The plant near the window grows taller **because it gets more sunlight**, which helps it make food through photosynthesis.

➢ Observations are facts that can be directly seen or measured. Inferences require using those facts to explain what might have happened or what could happen.

➢ Observations are the foundation, and inferences build upon them.

RESOURCE 2: Process of Ongoing Inquiry

Original Authors: CLO

CAEC Science Skills Covered:

1.1 Identify characteristics of science, such as how scientific ideas are developed through a process of ongoing inquiry.
2.1 Formulate testable questions, for a given situation, that can be investigated through scientific inquiry.
2.2 Formulate a hypothesis or prediction based on prior knowledge or an observed pattern of events.
2.13 Transfer conclusions from scientific investigations to everyday life and future investigations.

OALCF Skills Covered:

A1.2 Read texts to locate and connect ideas and information

A1.3 Read longer texts to connect, evaluate and integrate ideas and information

B2.2 Write texts to explain and describe information and ideas

Process of Ongoing Inquiry

In the Science section of the CAEC test, you will be required to answers questions about key areas of scientific study. The test focuses on three main areas:

- the nature of science
- scientific inquiry skills
- science, technology, society and environment

The test will cover general scientific topics and more specific content. Some of the topics covered include:

- observation and inference
- the characteristics of science
- scientific inquiry
- reliability of research and bias
- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

➢ In this resource, you may have to do some research online.

➢ After each lesson, you will have the chance to practice what you have learned.

Let’s Get Started!

Understanding Characteristics of Science

Scientific ideas are developed through **ongoing inquiry** by exploring the process of observation, questioning, hypothesis testing, and revision.

Key Concepts

1. **Science as a Process**:
    - Science is not just a collection of facts; it is a way of learning about the world.
    - Scientific ideas can change when new evidence is found.

2. **Steps of the Scientific Process**:
    - **Observation**: Noticing something interesting in the world.
    - **Questioning**: Asking why or how something happens.
    - **Hypothesis**: Making a guess or prediction based on what you know.
    - **Experimentation**: Testing the hypothesis through experiments.
    - **Analysis**: Looking at the results of the experiments.
    - **Revision**: Changing ideas or hypotheses based on new evidence.

Some Examples

Observation

A student notices that flowers in a sunny part of the garden are blooming, while flowers in a shaded area are not.

- The **observation** is that flowers in the sunny area bloom while those in the shade do not.

Questioning

The student wonders, "Do flowers need sunlight to bloom?"

- The **question** is about the relationship between sunlight and blooming.

Hypothesis

The student predicts, "If flowers are placed in sunlight, they will bloom because sunlight helps them grow."

- The **hypothesis** is a testable statement linking sunlight to flower blooming.

Experimentation

The student plants two identical flowers, putting one in sunlight and the other in shade. They water both equally and observe them for two weeks.

- The **experiment** tests the effect of sunlight on blooming while keeping other conditions the same.

Analysis

After two weeks, the student observes that the flower in sunlight has bloomed, while the one in the shade has not.

- The student **analyzes** the data and concludes that sunlight seems necessary for flowers to bloom.

Revision

The student learns later that flowers also need a specific amount of water to bloom. They revise their hypothesis to include both sunlight and water as important factors for blooming.

- **Revision** occurs when new evidence shows the original idea was incomplete.

A Closer Look

The examples above show how science is a **step-by-step process** that builds understanding through observation, testing, and adaptation.

➢ This is called **ongoing inquiry**.

Some Examples

Examples of Ongoing Inquiry

1. **The Changing Ideas About Dinosaurs**

- **Initial Idea**: Scientists once thought dinosaurs were slow, cold-blooded reptiles.
- **New Observations**: Fossilized bones showed dinosaurs with structures like feathers.
- **Current Understanding**: Dinosaurs are now thought to be more like birds than reptiles, with evidence suggesting some were warm-blooded.

2. Understanding Disease Spread

- **Initial Idea**: In the 1800s, many people thought diseases spread through "bad air."

- **New Observations**: Scientists like Louis Pasteur observed bacteria under microscopes and linked them to infections.

- **Current Understanding**: Diseases are caused by germs, which can be treated or prevented with vaccines and medicine.

Now it's **Your** Turn

Consider the steps of the process.

Activity 1: Observation and Questioning Exercise

Scenario: A pond near a school has suddenly turned green. There used to be a large number of fish, but there aren't as many anymore.

Directions:

- Write down two observations about the pond.

- Write two questions that a scientist might ask to figure out why the pond turned green.

Answers:

Observations:

- The water in the pond is green.
- There are fewer fish visible in the pond.

Questions:

- Why did the water turn green?
- Is the green colour caused by algae?

Activity 2: Developing and Testing a Hypothesis

Scenario: A student notices that plants in the shade grow slower than plants in the sunlight.

Directions:

- Write a hypothesis to explain why this might happen.

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- Suggest an experiment to test the hypothesis.

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Answers:

Hypothesis:
Plants in the sunlight grow faster because they get more light for photosynthesis.

Experiment:
Place two identical plants in different locations—one in sunlight and one in shade—and measure their growth over two weeks.

Activity 3: Revising Scientific Ideas

Scenario: Scientists thought Pluto was a planet, but later evidence suggested it didn't meet all the criteria.

Directions:

- Write down what scientists observed about Pluto that made them change their minds.

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  ____
  ____
  ____

- Explain why it's important for scientists to revise their ideas when new evidence appears.

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  ____
  ____
  ____

Answers:

Observations:
Pluto is much smaller than other planets and does not clear its orbit of other objects.

Importance:
Revising ideas ensures that scientific understanding stays accurate and reflects the best available evidence.

Now it’s **Your** Turn

An ongoing inquiry activity.

Activity: Investigating a Mysterious Fish Decline

Scenario:

You are a scientist studying a lake where fishermen have reported catching fewer fish than usual over the past year. The lake is surrounded by farms, forests, and a small town. Recently, you noticed some dead fish floating near the shore, and the water has a slight greenish tint.

Your job is to investigate the decline in fish by following the scientific process.

Directions:

Read the scenario carefully and respond to each question below. Use your imagination and scientific reasoning to describe each step of the investigation.

1. **Observation**: Write two observations you can make based on the scenario.

2. **Questioning**: What is one key question you might ask to figure out why the fish population is declining?

3. **Hypothesis**: Based on your observations, write a hypothesis that could explain the decline in fish.

4. **Experimentation**: Describe an experiment you could design to test your hypothesis. Include details about:
    - What you would measure or observe.
    - The tools you might use.
    - The variables you would control.

5. **Analysis**: Imagine you completed your experiment. The results show that fertilizer runoff from nearby farms is causing algae blooms, which reduce oxygen in the water. How would you analyze and interpret these findings?

____

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6. **Revision**: Based on this new evidence, how would you revise your hypothesis or design a follow-up experiment?

____

____

____

____

Answers:

1. **Observation**:
    - There are fewer fish being caught in the lake.
    - The water near the shore has a greenish tint, and some fish are dead.

2. **Questioning**:
    - Could the greenish tint in the water (possibly algae) be harming the fish?

3. **Hypothesis**:
    - Fertilizer runoff from nearby farms is causing algae blooms that reduce oxygen in the lake, harming the fish.

4. **Experimentation**:
    - **What to measure**: Measure algae levels, oxygen levels in the water, and the fish population over time.
    - **Tools**: Use water sampling kits to measure oxygen and algae concentration. Use nets to estimate the fish population.
    - **Variables to control**: Keep sampling locations consistent, measure at the same time each day, and account for weather conditions.

5. **Analysis**:
    - If data shows high algae levels and low oxygen levels coincide with fish deaths, this supports the hypothesis. Correlation between fertilizer use and algae levels also strengthens the connection.

6. **Revision**:
    - Revise the hypothesis to explore whether reducing fertilizer runoff reduces algae blooms. Design a follow-up experiment where water samples are taken after implementing buffer zones around the farms to prevent runoff.

RESOURCE 3: Distinguishing between questions that can and cannot be investigated through scientific inquiry

Original Authors: CLO

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1.3 Distinguish between questions that can be investigated through scientific inquiry and questions that cannot be tested through scientific inquiry, such as aesthetic, moral, and ethical judgements, and the supernatural.
2.1 Formulate testable questions, for a given situation, that can be investigated through scientific inquiry.
2.2 Formulate a hypothesis or prediction based on prior knowledge or an observed pattern of events.
2.9 Analyze patterns and trends to describe relationships among variables and data.
2.13 Transfer conclusions from scientific investigations to everyday life and future investigations.

OALCF Skills Covered:

A1.2 Read texts to locate and connect ideas and information

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Distinguishing between questions that can and cannot be investigated through scientific inquiry

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- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

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Let's Get Started!

Distinguishing Between Testable and Non-Testable Questions

In science, some questions can be investigated through scientific inquiry. These questions are considered **testable**.

But there are also question that can't be investigated through scientific inquiry. These are considered **non-testable**, and they include questions involving:

- aesthetic judgments
- moral and ethical judgments
- the supernatural

Aesthetic: concerned with beauty or the appreciation of beauty

Morals and ethics: concerned with right and wrong or good and evil

The Supernatural: attributed to some force beyond scientific understanding or the laws of nature (like ghosts or aliens)

Key Concepts

1. **Testable Questions**:
    - Can be answered by collecting data through experiments or observations.
    - Are based on measurable facts or evidence.
    - Example: "Does the amount of sunlight affect plant growth?"

2. **Non-Testable Questions**:
    - Cannot be answered through experiments or observations.
    - Often involve personal opinions, values, or supernatural beliefs.
    - Example: "What is the most beautiful flower?"

3. **Categories of Non-Testable Questions**:

    - **Aesthetic**:
      Related to beauty or taste:

        - "Which painting is the most beautiful?"

    - **Moral/Ethical**:
      Related to values or right and wrong

        - "Is it ethical to clone animals?"

- **Supernatural**:
  Related to things beyond the natural world

    - "Do ghosts exist?"

Some Examples

Here are examples of detailed and specific testable questions, organized by different fields of science, to illustrate how they could be investigated through experiments or observations:

Biology

1. **Plants and Growth**:

   - "Does the type of soil (sand, clay, or loam) affect the growth rate of tomato plants?"

   - **How to Test:** Plant tomato seeds in different soil types, water them equally, and measure growth over time.

2. **Animal Behavior**:

   - "Do earthworms prefer moist or dry soil?"

   - **How to Test:** Place earthworms in a container with moist soil on one side and dry soil on the other and observe where they move.

3. **Health**:

    - "Does the amount of sugar in a drink affect how long it takes for bacteria to grow?"

    - **How to Test:** Prepare petri dishes with drinks containing different sugar levels and measure bacterial growth over several days.

Chemistry

4. **Chemical Reactions**:

    - "Does the temperature of water affect how quickly sugar dissolves?"

    - **How to Test:** Dissolve sugar in water at different temperatures (cold, room temperature, hot) and time how long it takes.

5. **Material Properties**:

    - "Does adding salt to ice make it melt faster?"

    - **How to Test:** Sprinkle different amounts of salt on ice cubes and measure how long they take to melt.

6. **Household Chemistry**:

    - "Which brand of dish soap produces the most bubbles?"
    - **How to Test:** Measure the bubbles produced by equal amounts of different dish soaps mixed with water.

Physics

7. **Motion and Force**:

    - "Does the angle of a ramp affect how far a toy car will travel?"
    - **How to Test:** Use ramps of different angles, release the car, and measure the distance it travels each time.

8. **Energy**:

    - "Does the colour of a surface affect how much heat it absorbs?"
    - **How to Test:** Place black, white, and coloured surfaces under sunlight and measure their temperatures after a set time.

9. **Sound**:

- "Does the size of a drum affect its pitch?"

- **How to Test:** Play drums of different sizes and measure their sound frequencies.

Earth Science

10. **Weather and Climate**:

- "Does the amount of cloud cover affect daytime temperature?"

- **How to Test:** Measure temperatures on days with different amounts of cloud cover and compare the results.

11. **Water Systems**:

- "Does the type of material in a stream bed (sand, gravel, or clay) affect how fast water flows?"

- **How to Test:** Simulate a stream bed with different materials and measure water flow rates.

Environmental Science

12. **Pollution**:

    - "Do plants grow better in soil with or without fertilizer?"
    - **How to Test:** Plant seeds in soil with and without fertilizer and compare their growth over time.

13. **Waste Management**:

    - "Does composting food waste at different temperatures produce different amounts of compost?"
    - **How to Test:** Maintain compost piles at different temperatures and measure the amount of compost produced.

Health and Human Behavior

14. **Exercise**:

    - "Does the duration of exercise affect heart rate recovery time?"
    - **How to Test:** Have participants exercise for different durations and measure how long it takes for their heart rate to return to normal.

15. **Learning and Memory**:

- "Does listening to music while studying improve memory retention?"
- **How to Test:** Have two groups of students study with and without music, then test their memory of the material.

Now it's **Your** Turn

Let's think about testable questions.

Activity: Generating Testable Questions

Scenario:

You visit a local park and notice that some of the benches are rusted, while others look new. There are also different types of trees in the park, and you observe that the ground under one type of tree is covered in fallen leaves, while the ground under another type has very few leaves. Near the park fountain, you see many bees flying around the flowers but no bees near the grassy area.

Directions:

Using the scenario above, write three questions that could be investigated through scientific inquiry. Your questions should be:

- Based on observations from the park.
- Specific and testable by collecting data or conducting experiments.

Answers: (Sample Testable Questions):

1. "Does the type of metal used in the benches affect how quickly they rust?"
2. "Do different tree species lose their leaves at different rates during the fall?"
3. "Are bees more attracted to flowers than to grass?"

Non-Testable Questions

These types of questions cannot be tested through scientific methods because they rely on personal opinions, values, or beliefs, rather than measurable evidence or observation.

Some Examples

Aesthetic (Related to Beauty or Taste)

- "Which tree in the park is the most beautiful?"
- "What is the prettiest flower to plant in a garden?"
- "Is the sound of birds chirping more pleasant than the sound of a waterfall?"

Moral or Ethical (Related to Right and Wrong)

- "Is it wrong to cut down trees to build houses?"
- "Should we stop using pesticides to protect insects?"
- "Is it ethical to keep animals in zoos?"

Supernatural (Related to Beliefs Beyond the Natural World)

- "Do ghosts exist in the forest at night?"
- "Is there a supernatural force controlling the weather?"
- "Can prayers make plants grow faster?"

Now it’s **Your** Turn

Categorizing Non-Testable Questions

Directions:

- Below are several **non-testable questions**.
- Identify which **category** each question belongs to:
    - **Aesthetic**: Related to beauty or taste.
    - **Moral/Ethical**: Related to values or right and wrong.
    - **Supernatural**: Related to beliefs beyond the natural world.

1. "Which painting in the gallery is the most beautiful?"

2. "Is it ethical to test medicine on animals?"

3. "Can spirits influence the outcome of a sporting event?"

4. "What is the most delicious type of dessert?"

5. "Is it wrong to throw away food that could be donated to the hungry?"

6. "Do ghosts live in abandoned houses?"

7. "Should people always tell the truth, no matter what?"

8. "Is the ocean more beautiful at sunset or sunrise?"

Answers:

1. Aesthetic
2. Moral/Ethical
3. Supernatural
4. Aesthetic
5. Moral/Ethical
6. Supernatural
7. Moral/Ethical
8. Aesthetic

Now it's **Your** Turn

Identify testable and non-testable questions.

Activity: Testable or Non-Testable Sorting

Directions:

- Read the list of questions below.
- Decide whether each one is testable or non-testable.
- Check the appropriate column.

Questions	Testable	Non-testable
"Does adding salt to water make it boil faster?"		
"Is it wrong to keep animals in zoos?"		
"Do different colours of light affect plant growth?"		
"Is red a prettier colour than blue?"		
"Does the number of hours you sleep affect your ability to concentrate?"		
"Is it fair for schools to have dress codes?"		

Answers:

1. Testable
2. Non-Testable
3. Testable
4. Non-Testable
5. Testable
6. Non-Testable

Activity : Testability Evaluation

Scenario:
Your town is debating whether to install wind turbines for renewable energy. Here are some questions people have raised.

Directions:

- Read the list of questions below.
- Decide whether each one is testable or non-testable.
- Check the appropriate column.

Questions	Testable	Non-testable
"How much electricity can a wind turbine produce in a year?"		
"Do wind turbines look ugly?"		
"How do wind turbines affect bird populations?"		
"Should we spend money on wind turbines instead of solar panels?"		

Answers:

1. Testable
2. Non-Testable
3. Testable
4. Non-Testable

RESOURCE 4: Formulating Hypotheses

Original Authors: CLO

CAEC Science Skills Covered:

1.1 Identify characteristics of science, such as how scientific ideas are developed through a process of ongoing inquiry.
1.2 Distinguish between observations and inferences.
1.3 Distinguish between questions that can be investigated through scientific inquiry and questions that cannot be tested through scientific inquiry, such as aesthetic, moral, and ethical judgements, and the supernatural.
1.4 Explain ways in which reliability, validity, integrity, and credibility of scientific work is maintained, including through scientific methods, placebos, double-blind studies, large sample sizes, random sampling, peer review and replicating research.
2.1 Formulate testable questions, for a given situation, that can be investigated through scientific inquiry.
2.2 Formulate a hypothesis or prediction based on prior knowledge or an observed pattern of events.
2.9 Analyze patterns and trends to describe relationships among variables and data.

OALCF Skills Covered:

A1.2 Read texts to locate and connect ideas and information

B2.2 Write texts to explain and describe information and ideas

Formulating Hypotheses

In the Science section of the CAEC test, you will be required to answers questions about key areas of scientific study. The test focuses on three main areas:

- the nature of science
- scientific inquiry skills
- science, technology, society and environment

The test will cover general scientific topics and more specific content. Some of the topics covered include:

- observation and inference
- the characteristics of science
- scientific inquiry
- reliability of research and bias
- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

- In this resource, you won't need to use a calculator.
- After each lesson, you will have the chance to practice what you have learned.

Let’s Get Started!

Formulating Hypotheses and Predictions

A **hypothesis** is a testable idea or prediction that explains what you think will happen in an experiment based on prior knowledge or observations. Scientists use hypotheses to design experiments, collect data, and determine whether their ideas are supported or need to be revised.

Key Concepts

1. What is a Hypothesis?
    - A hypothesis is a testable statement or educated guess that explains what you think will happen in an experiment.
    - It is based on observations, patterns, or prior knowledge.

2. What is a Prediction?
    - A prediction states what you expect to happen in an experiment if the hypothesis is correct.

3. How to Write a Hypothesis:

   - Use the "If...then...because..." format.

     - **If** plants are given more sunlight
     - **then** they will grow taller
     - **because** sunlight helps plants make food through photosynthesis.

Some Examples

1. Observing Patterns

   - **Observation**: You notice that your ice cream melts faster in the sun than in the shade.

   - **Hypothesis**: *If* ice cream is placed in the sun, *then* it will melt faster than ice cream in the shade, *because* the sun's heat increases the temperature around the ice cream.

   - **Prediction**: Ice cream in direct sunlight will melt completely within 5 minutes, while ice cream in the shade will take longer.

2. Using Prior Knowledge

    - **Observation**: A soccer ball bounces higher when dropped on a hard floor than on carpet.

    - **Hypothesis**: *If* a ball is dropped on a hard surface, *then* it will bounce higher than on a soft surface, *because* hard surfaces absorb less energy from the ball.

    - **Prediction**: A soccer ball will bounce twice as high on a tile floor as it does on a carpeted floor.

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3. Scenario: Investigating Temperature

    - **Observation**: Your tea cools faster when left in a larger mug than in a smaller one.

    - **Hypothesis**: *If* the surface area of a container is larger, *then* the liquid inside will cool faster, *because* more heat escapes from a larger surface area.

    - **Prediction**: Tea in a wide mug will cool to room temperature 10 minutes faster than tea in a narrow mug.

Now it's **Your** Turn

Let's look closer at hypotheses.

Activity 1: Writing Hypotheses

Directions:

- Read the scenario below.
- Think about it carefully.
- Write a hypothesis and prediction to explain the observation.

Scenario:

You observe that plants near a window grow more leaves than plants in the middle of the room.

Your hypothesis:

Your prediction:

Answers:

- **Hypothesis**: *If* plants are placed near a window, *then* they will grow more leaves, *because* they receive more sunlight, which helps them make food.

- **Prediction**: Plants placed near a window will grow 5 more leaves in a month than plants in the middle of the room.

A Closer Look

Moving from Observation to Hypothesis

A scientist is studying a lake where fish populations have been declining. During initial observations, they notice several patterns:

- The water near the shore is unusually green.
- Dead fish are found floating near areas with a lot of algae.
- The lake is surrounded by farmland, and fertilizer bags are visible near the fields.

From these observations, the scientist starts to ask questions:

- "Why is the water green?"
- "Is the algae affecting the fish population?"
- "Could the fertilizer from nearby farms be causing the algae growth?"

Using prior knowledge, the scientist knows that fertilizers often contain nutrients like nitrogen and phosphorus, which can cause algae to grow rapidly. This leads to the hypothesis:

- *If* fertilizer runoff is entering the lake, *then* it will increase algae growth, *because* the nutrients in fertilizer promote algae blooms.

➢ The scientist **designs an experiment** to test the hypothesis by measuring the amount of nitrogen and phosphorus in the lake water and comparing algae growth near areas with high fertilizer runoff to areas without it.

This example shows how the scientist moves from observing a problem to forming a hypothesis that can guide further investigation.

Activity 2: Observations to Hypotheses

Directions:

- Read the scenario below.
- Think about it carefully.
- Write a hypothesis to explain the pattern.
- Write a prediction based on your hypothesis.

Scenario:

You notice that bread gets moldy faster when stored in a plastic bag than when left on the counter.

Your hypothesis:

Your prediction:

Answers:

- **Hypothesis**: *If* bread is stored in a plastic bag, *then* it will grow mold faster than bread left on the counter, *because* moisture is trapped in the bag, creating ideal conditions for mold growth.

- **Prediction**: Bread in a plastic bag will grow visible mold in 3 days, while bread on the counter will take 5 days.

Challenges to Making Good Hypotheses

1. **Lack of Prior Knowledge**: Without a solid understanding of the subject, it can be hard to form a reasonable and testable hypothesis.

2. **Vague Observations**: If observations are unclear or incomplete, the hypothesis may be unfocused or irrelevant.

3. **Bias**: Preconceived beliefs or expectations can lead to a biased hypothesis that doesn't objectively reflect the evidence.

4. **Unclear Variables**: A good hypothesis requires clearly identifying the independent and dependent variables.

5. **Testing Limitations**: Sometimes a hypothesis is hard to test due to lack of resources, tools, or appropriate methods.

- These challenges emphasize the need for careful observation, clear reasoning, and an understanding of how to test ideas scientifically.

- We will discuss these challenges in more detail in the next couple resources.

RESOURCE 5: Ways in which reliability, validity, integrity, and credibility of scientific work is maintained

Original Authors: CLO

CAEC Science Skills Covered:

1.1 Identify characteristics of science, such as how scientific ideas are developed through a process of ongoing inquiry.
1.2 Distinguish between observations and inferences.
1.3 Distinguish between questions that can be investigated through scientific inquiry and questions that cannot be tested through scientific inquiry, such as aesthetic, moral, and ethical judgements, and the supernatural.
1.4 Explain ways in which reliability, validity, integrity, and credibility of scientific work is maintained, including through scientific methods, placebos, double-blind studies, large sample sizes, random sampling, peer review and replicating research.
1.5 Identify factors that may introduce bias, such as preconceptions of researchers, funding of research by interest groups, and selective reporting of evidence.
2.11 Evaluate scientific investigations for sources of error and formulate reasonable explanations of the results.
2.12 Evaluate the reliability, validity, and credibility of scientific investigations.
2.13 Transfer conclusions from scientific investigations to everyday life and future investigations.

OALCF Skills Covered:

A1.2 Read texts to locate and connect ideas and information

B2.3 Write longer texts to present information, ideas and opinions

Ways in which reliability, validity, integrity, and credibility of scientific work is maintained

In the Science section of the CAEC test, you will be required to answers questions about key areas of scientific study. The test focuses on three main areas:

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The test will cover general scientific topics and more specific content. Some of the topics covered include:

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- scientific inquiry
- reliability of research and bias
- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

- ➢ In this resource, you won’t need to use a calculator.
- ➢ After each lesson, you will have the chance to practice what you have learned.

Let’s Get Started!

Ensuring Reliability, Validity, Integrity, and Credibility in Science

Scientists maintain the reliability, validity, integrity, and credibility of their work using scientific methods and practices such as:

- placebos
- double-blind studies
- large sample sizes
- random sampling
- peer review
- replicating research

We will look at each of these methods and practices in more detail below. But first let’s discuss reliability, validity, integrity, and credibility.

Key Terms with Examples

Reliability:

The ability to repeat an experiment and get the same results.

- A student tests how different amounts of sunlight affect plant growth. If they repeat the experiment and get the same results, the findings are **reliable**.

Validity:

Ensuring the experiment tests what it is supposed to test.

- To test if plants grow better in sunlight, a student keeps all other conditions (water, soil, temperature) the same. This ensures the experiment measures the effect of sunlight alone.

Integrity:

Following ethical practices and accurately reporting results.

- A scientist does not change their data to match what they wanted to find. Instead, they report exactly what they observed.

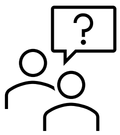
Credibility:

Building trust by using sound methods and sharing findings transparently.

- Publishing research in a **peer-reviewed** journal adds credibility because other scientists have checked the work.

Peer reviewed:

Articles are written by experts and are reviewed by several other experts in the field before the article is published in the journal in order to ensure the article's quality.

 What do **you** think?

Reliability, validity, integrity, and credibility are all very important in science. Why do you think each is important? Write your answer below.

A Closer Look

Methods to Ensure Reliable and Credible Science

It's essential to ensure reliability, validity, integrity, and credibility in scientific inquiry. Next we will discuss the methods and practices used to ensure that these aspects are maintained.

1. **Placebos:**

- Placebos are used in medical studies to compare the effects of a treatment with no active ingredient.

An Example

Imagine a study testing a new headache pill. One group of participants gets the real pill, and another group gets a sugar pill (placebo) that looks identical to the real one. If the group taking the placebo reports fewer headaches, it might mean the headaches were reduced simply because they believed they were receiving a treatment. This highlights the importance of comparing both groups to understand the real effect of the pill.

2. **Double-Blind Studies:**

- Neither the participants nor the researchers know who is receiving the treatment. This avoids bias.

An Example

In a vaccine trial, one group of participants receives the vaccine, and the other receives a placebo. The researchers and participants are both "blind" to who received which treatment. Only after the data is collected and analyzed do scientists reveal which group received the vaccine. This ensures the study results are unbiased and reliable.

3. **Large Sample Sizes:**

- Using many participants to ensure results are not due to chance.

An Example

If a scientist tests a new fertilizer on just two plants, one might grow faster simply because it’s a naturally healthier plant, not because of the fertilizer. Testing the fertilizer on 100 plants instead provides a larger set of data, making the results more reliable and generalizable to other plants.

4. Random Sampling:

- Participants are chosen randomly to ensure a fair and unbiased sample.

An Example

A researcher studying the eating habits of teenagers could randomly select participants from different schools, ensuring a mix of ages, genders, and backgrounds. If the researcher only picks participants from one school, the findings might not represent all teenagers.

5. Peer Review:

- Other scientists review research before it is published to ensure accuracy.

An Example

A scientist discovers a new drug that they claim can cure a disease. Before their study is published, other scientists review the research to confirm that the experiments were conducted properly and the data supports the claims. If there are mistakes or flaws, the reviewers suggest corrections or reject the study. This process helps maintain the quality and reliability of published research.

6. Replicating Research:

- Other scientists repeat the study to confirm the findings.

An Example

If one study shows that drinking green tea improves memory, other scientists might repeat the same experiment, using the same methods, but with different participants. If the other studies also show improved memory, this adds confidence that green tea really has this effect. If not, it might mean the original study had flaws or the results were due to chance.

Now it's **Your** Turn

Let's look at these ideas more closely.

Activity 1: Matching Methods to Examples

Directions: Match each method of ensuring reliable science to its example.

Placebo	a. A team of scientists in another lab performs the same experiment and gets similar results.
Double-blind study	b. A new medication is tested by giving one group a sugar pill and another group the actual medication.
Large sample size	c. Researchers use a computer to select participants from a database at random.
Random sampling	d. A scientific study is reviewed by experts before being published in a journal.
Peer review	e. A study includes 1,000 participants instead of 50 to reduce the impact of outliers.
Replicating research	f. Neither the doctor nor the patient knows if the treatment is real or a placebo.

Answer:

1 – b

2 – f

3 – e

4 – c

5 – d

6 – a

Activity 2: Spotting Issues in a Study

Scenario:

A scientist is testing a new fertilizer on plants. They grow plants in two different pots, giving one pot the new fertilizer and the other pot no fertilizer. However, the pot with fertilizer gets more water and sunlight than the other.

Directions:

- Identify two ways the study could be improved to ensure validity and reliability.

Answers:

- Make sure both pots get the same amount of water and sunlight so only the fertilizer is being tested.

- Use more plants to increase the sample size.

Activity 3: Explaining the Importance of Peer Review

Directions:

- Write a paragraph explaining why peer review is important in science.

Answers:

Peer review is important because it ensures that scientific research is accurate and trustworthy. Other experts check the methods, data, and conclusions to find any mistakes or biases. This process helps prevent false information from being published and makes the research more credible.

RESOURCE 6: Design Elements of Scientific Investigations

Original Authors: CLO

CAEC Science Skills Covered:

1.5 Identify factors that may introduce bias, such as preconceptions of researchers, funding of research by interest groups, and selective reporting of evidence.
2.3 Determine the design elements of scientific investigations, including control groups and variables (independent, dependent, and controlled).
2.4 Identify procedures that set appropriate conditions, limit bias, and use appropriate methods for collecting data.

OALCF Skills Covered:

A1.2 Read texts to locate and connect ideas and information

A1.3 Read longer texts to connect, evaluate and integrate ideas and information

B2.3 Write longer texts to present information, ideas and opinions

Design Elements of Scientific Investigations

In the Science section of the CAEC test, you will be required to answers questions about key areas of scientific study. The test focuses on three main areas:

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- scientific inquiry
- reliability of research and bias
- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

➢ In this resource, you won’t need to use a calculator.

➢ After each lesson, you will have the chance to practice what you have learned.

Let’s Get Started!

Part 1:

Identifying Factors That May Introduce Bias in Scientific Research

Certain factors can introduce **bias** into scientific research.

Bias: prejudice in favor of or against one thing, person, or group compared with another, usually in a way considered to be unfair.

The factors that can introduce bias into scientific research include:

- preconceptions of researchers
- funding by interest groups
- selective reporting of evidence

Key Concepts and Real-Life Examples

1. **Preconceptions of Researchers**:

    - **Definition**:

      Researchers' personal beliefs or expectations can influence how they interpret results.

  - A scientist who strongly believes that a new diet pill works may unintentionally look for data that supports their belief while overlooking data that shows no effect.

An Example

In some medical trials, researchers expecting a treatment to work may unconsciously treat participants in the treatment group differently, affecting outcomes.

2. **Funding by Interest Groups**:

- **Definition**:

  Organizations that fund research may have a vested interest in specific outcomes, potentially influencing the study's design or reporting.

➢ A study funded by a sugary beverage company might downplay links between sugar and obesity.

An Example

Tobacco companies in the past funded studies that downplayed the health risks of smoking to protect their profits.

3. **Selective Reporting of Evidence**:

- **Definition**:

  Researchers might only publish results that support their hypothesis, ignoring or hiding data that contradicts it.

➢ A drug company might only report trials where their medication was effective while ignoring trials where it had no effect.

An Example

In some cases, companies have been accused of "cherry-picking" positive results from multiple trials to make a product look better than it is.

Now it’s **Your** Turn

Let’s look closer at bias.

Activity 1: Identifying Bias in Scenarios

Directions:

- Below are three scenarios.
- For each one, identify the factor introducing bias.
- Explain why it might affect the study’s results.

1. A company selling weight-loss supplements funds a study to prove that their product works.

   Factor introducing bias:

   Why it might affect the study results:

2. A scientist who strongly believes that a new teaching method is better conducts a classroom experiment but ignores test results that show no improvement.

Factor introducing bias:

Why it might affect the study results:

3. A report claims that a new cleaning product is 95% effective but doesn't mention that it was only tested on two surfaces.

Factor introducing bias:

Why it might affect the study results:

Answers:

1. **Funding by interest groups**:
   The company funding the study may influence the results to favor their product.

2. **Preconceptions of researchers**:
   The scientist’s belief could lead to overlooking data that contradicts their expectations.

3. **Selective reporting of evidence**:
   The report hides important details about the limited scope of the testing.

Now it's **Your** Turn

How bias is introduced.

Directions:

- Read the examples below.
- Think about how bias could be introduced.
- Write your answers below.

1. A cosmetics company funds a study that concludes their skincare product reduces wrinkles.

2. A scientist known for advocating organic farming conducts a study on the benefits of organic vegetables.

3. A news article claims a new energy drink boosts performance but doesn’t include information about the number of people in the study or their results.

Answers:

1. In the first example, the company's funding may lead to biased reporting.

2. In the second, the scientist's advocacy for organic farming may affect their interpretation of data.

3. In the third, missing details about the study may mean important evidence is being withheld.

Let’s go further!

Part 2:

Designing Fair Scientific Investigations

Designing fair scientific investigations requires procedures to set appropriate conditions, limit bias, and collect data accurately. It also requires certain key design elements, including:

- control groups
- independent variables
- dependent variables
- controlled variables

Key Concepts and Real-Life Examples

1. Control Groups

Definition:

A control group is a group in an experiment that does not receive the treatment or condition being tested. It is used as a baseline to compare results and see the effects of the independent variable.

Purpose:
The control group helps scientists determine if changes in the dependent variable are due to the independent variable or other factors.

An Example

- A scientist wants to test if a new fertilizer increases plant growth.
    - **Control Group**: A group of plants that do **not** receive the fertilizer.
    - **Experimental Group**: A group of plants that **do** receive the fertilizer.
    - By comparing the growth of plants in the control group and the experimental group, the scientist can conclude if the fertilizer made a difference.

---

2. Independent Variables

Definition:
The independent variable is the factor in an experiment that is changed or manipulated to test its effects on the dependent variable.

Purpose:
It is what the scientist tests to see how it influences the outcome.

An Example

- Testing how light affects plant growth.
  - **Independent Variable**: The amount of light (e.g., full sunlight, partial sunlight, no sunlight).
  - The scientist changes the light conditions for each group of plants to observe how it impacts their growth.

---

4. Dependent Variables

Definition:
The dependent variable is the factor that is measured or observed in an experiment. It is the outcome that may change in response to the independent variable.

Purpose:
It shows the effect of the independent variable.

An Example

- Testing how different amounts of fertilizer affect crop yield.
  - **Dependent Variable**: The amount of crops produced (e.g., in kilograms).
  - The scientist measures the crop yield to determine if the amount of fertilizer impacts it.

4. Controlled Variables

Definition:
Controlled variables are factors that are kept the same in all groups of an experiment to ensure that only the independent variable is affecting the dependent variable.

Purpose:
They eliminate other variables that could interfere with the results, ensuring a fair test.

An Example

- Testing if temperature affects how quickly bread dough rises.
    - **Controlled Variables**:
        - The type of yeast used.
        - The ingredients in the dough.
        - The size of the containers.
        - The amount of time the dough is left to rise.
    - By keeping these variables constant, the scientist ensures that any changes in how fast the dough rises are due to temperature alone.

A Closer Look

Integrated Example

A student wants to test if the type of liquid (water, soda, or juice) affects plant growth.

- **Independent Variable**: Type of liquid (water, soda, or juice).

- **Dependent Variable**: Plant height (measured in centimeters).

- **Controlled Variables**:
    - Type of plant used.
    - Amount of liquid given to each plant.
    - Amount of sunlight each plant receives.
    - Temperature of the room where plants are kept.

- **Control Group**: A group of plants watered with regular water (the normal condition).

➢ By carefully setting up these elements, the student can fairly determine whether the type of liquid affects plant growth.

Now it’s **Your** Turn

Identifying Variables and Control Groups

Directions:

- Read the scenario below.
- Answer the following questions to identify the variables and control group in the experiment.

Scenario:

A scientist wants to study how different types of music affect the growth of tomato plants. They play classical music to one group of plants, rock music to a second group, and no music to a third group.

1. What is the independent variable in this experiment?

____

____

____

____

2. What is the dependent variable?

____

____

____

____

3. List two controlled variables that should remain the same for all the plants.

4. Which group is the control group? Why?

Answers:

1. Independent Variable: The type of music played (classical, rock, or none).

2. Dependent Variable: The growth of the tomato plants (measured by height or another factor).

3. Controlled Variables:
   - Amount of water each plant receives.
   - Amount of sunlight each plant gets.

4. Control Group: The group of plants with no music, because it provides a baseline for comparison to see if music affects growth.

Procedures to Limit Bias

Bias in scientific research can occur when certain factors unfairly influence the results of an experiment. To limit bias, researchers use specific procedures to ensure their findings are objective and reliable. By following these procedures, scientists can reduce the risk of bias and improve the credibility of their research.

Some procedures scientists use include:

- **Random sampling**:
  - a common method, where participants or test subjects are selected randomly to ensure the sample represents the population fairly.

- **Double-blind studies:**
  - neither the participants nor the researchers know who receives the treatment or placebo, preventing expectations from influencing outcomes.

- **Large sample sizes:**
  - help reduce the impact of outliers or unusual data points.

> **Outlier**: a person or thing differing from all other members of a particular group or set.

- Researchers also use standardized methods for data collection, such as measuring at the same time each day, to maintain consistency.

- Additionally, peer review ensures that other experts evaluate the research to identify potential errors or biases before publication.

A Closer Look

Appropriate Methods for Collecting Data

- Use tools and measurements suited to the experiment (e.g., ruler for plant growth, thermometer for temperature).

- Record data systematically, such as in a table or chart.

- Ensure measurements are taken consistently (e.g., same time of day, same conditions).

Now it's **Your** Turn

Designing a fair test.

Directions:

- Read the scenario.
- Help the student design the experiment by:
  - Writing a hypothesis.
  - Identifying the independent variable, dependent variable, and at least two controlled variables.
  - Explaining how to set up the control group.

Scenario: A student wants to test if using different types of water (tap, rain, or salt water) affects the growth of bean plants.

Write a hypothesis (prediction):

Identify the independent variable, dependent variable, and at least two controlled variables:

Explain how to set up the control group:

Answers:

1. **Hypothesis**: "Plants watered with rainwater will grow taller than those watered with tap or salt water."

2. **Independent Variable**: Type of water.
   Dependent Variable: Plant growth (height).
   Controlled Variables: Amount of water given, type of soil, type of plant.

3. **Control Group**: Plants watered with tap water, as this is the most common type of water.

Now it's **Your** Turn

Procedures to limit bias.

Directions:

- Imagine you are conducting an experiment to test if a new energy drink improves athletic performance.
- List three ways you could reduce bias in your study.

Three ways you could reduce bias in your study:

Answers:

1. Use random sampling to select participants from a diverse group of athletes.

2. Conduct a double-blind study where neither the participants nor the researchers know who is receiving the energy drink or a placebo.

3. Use a large sample size to ensure the results are reliable and not due to chance.

RESOURCE 7: Identifying Perspectives and Research Priorities in Science

Original Authors: CLO

CAEC Science Skills Covered:

1.1 Identify characteristics of science, such as how scientific ideas are developed through a process of ongoing inquiry.
1.2 Distinguish between observations and inferences.
1.3 Distinguish between questions that can be investigated through scientific inquiry and questions that cannot be tested through scientific inquiry, such as aesthetic, moral, and ethical judgements, and the supernatural.
1.4 Explain ways in which reliability, validity, integrity, and credibility of scientific work is maintained, including through scientific methods, placebos, double-blind studies, large sample sizes, random sampling, peer review and replicating research.
1.5 Identify factors that may introduce bias, such as preconceptions of researchers, funding of research by interest groups, and selective reporting of evidence.
3.1 Identify intended and unintended consequences for humans and the environment emerging from scientific solutions and technologies.
3.2 Evaluate risks and benefits of scientific solutions and technologies.
3.3 Evaluate factors that influence scientific research.

OALCF Skills Covered:

A1.2 Read texts to locate and connect ideas and information

A1.3 Read longer texts to connect, evaluate and integrate ideas and information

B2.3 Write longer texts to present information, ideas and opinions

Identifying Perspectives and Research Priorities in Science

In the Science section of the CAEC test, you will be required to answers questions about key areas of scientific study. The test focuses on three main areas:

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- the characteristics of science
- scientific inquiry
- reliability of research and bias
- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

➢ In this resource, you won't need to use a calculator.

➢ After each lesson, you will have the chance to practice what you have learned.

Let’s Get Started!

Identifying Perspectives and Research Priorities in Science

It’s important to understand how different perspectives (social, safety, economic, political) influence the research priorities of scientific organizations.

Key Concepts

1. **What are Perspectives in Research?**

    - Perspectives are **viewpoints** or **priorities** that influence how research is approached.

    - Examples include environmental, health-related, economic, and ethical perspectives.

2. **What are Research Priorities?**

    - Research priorities are **specific goals** or **focus areas** that align with a perspective.

Some Examples

Different Perspectives in Science

1. Social Perspective

Focus: How scientific research improves quality of life, fairness, and inclusion.

- **Example 1: Improving Accessibility in Education**
  Scientists develop tools like speech-to-text software to help students with disabilities access learning materials. This research focuses on making education equitable for everyone, including those with hearing impairments.

- **Example 2: Public Health Campaigns**
  Researchers study why some communities are hesitant to get vaccines. The goal is to create better communication strategies to ensure that everyone understands the benefits of vaccination and has equal access.

What do **you** think?

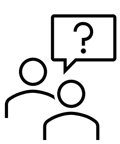
What do you think is most important about this perspective?

2. Safety Perspective

Focus: Ensuring the health and safety of individuals and communities.

- **Example 1: Food Safety Testing**
  Scientists test packaged foods for contaminants like bacteria (e.g., salmonella or E. coli). This research ensures that the food people eat is safe and meets health standards.

- **Example 2: Airbag Efficiency in Cars**
  Engineers design and test airbags to reduce injuries in car crashes. These studies save lives by improving safety standards in vehicles.



What do **you** think?

What do you think is most important about this perspective?

____

____

____

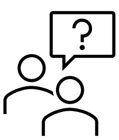
____

3. Economic Perspective

Focus: Research that promotes cost efficiency, economic growth, or profit.

- **Example 1: Renewable Energy Solutions**
  Scientists develop cheaper ways to produce solar panels. By making renewable energy more affordable, they help reduce costs for consumers while promoting economic growth.

- **Example 2: Agricultural Innovation**
  Researchers create drought-resistant crops that can grow in challenging climates. This reduces the risk of food shortages, ensures stable agricultural productivity, and boosts economies that depend on farming.



What do **you** think?

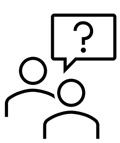
What do you think is most important about this perspective?

4. Political Perspective

Focus: Providing evidence and solutions to support policymaking.

- **Example 1: Climate Policy Research**
  Scientists collect data on rising global temperatures and predict future impacts. Their research helps governments draft policies to reduce greenhouse gas emissions and combat climate change.

- **Example 2: Public Health Laws**
  Researchers analyze the effects of smoking bans in public places. Their findings guide policymakers to create laws that reduce smoking rates and improve public health.



What do **you** think?

What do you think is most important about this perspective?

Review

Each perspective represents a unique lens through which science solves problems:

- **Social**: Focus on fairness, inclusion, and improving lives.
- **Safety**: Protect people from harm.
- **Economic**: Drive growth and cost efficiency.
- **Political**: Inform policies to manage societal challenges.

➢ These perspectives often overlap, showing how science can address multiple priorities at once. For example, researching clean energy is both an **economic** and a **political** goal.

Now it’s **Your** Turn

Let’s look closer at perspectives and research priorities.

1. Which perspective matches the research priority "Provide governments with evidence they can use to develop climate policies"?

   ____

2. Which perspective matches "Review newly developed vaccines to ensure they meet manufacturing standards and their benefits outweigh their risks"?

   ____

3. Which perspective matches "Invest in researching drugs only for treating diseases that affect a large number of people because the potential for profits is higher"?

   ____

4. Which perspective matches "Improve the quality of research by increasing the diversity of researchers to include more women, persons with disabilities, Indigenous peoples, and members of multicultural communities"?

   ____

Answers:

1. **Political**
2. **Safety**
3. **Economic**
4. **Social**

Activity: Matching Perspectives to Research Priorities

Directions:

- Below are four **new** perspectives.
- Draw a line to match each with the research priority that best fits its focus.

Perspectives:	**Research Priorities**:
Environmental	a. Developing affordable treatments for common diseases.
Health	b. Studying the effects of deforestation on wildlife.
Economic	c. Investigating fair trade practices to reduce exploitation in agriculture.
Ethical	d. Designing energy-efficient technology to reduce costs for consumers.

Answers:

1. Environmental → **b. Studying the effects of deforestation on wildlife**.
2. Health → **a. Developing affordable treatments for common diseases**.
3. Economic → **d. Designing energy-efficient technology to reduce costs for consumers**.
4. Ethical → **c. Investigating fair trade practices to reduce exploitation in agriculture**.

A Closer Look

Matching Perspectives with Research Priorities

From a **safety** perspective, consider a company developing a new type of battery for electric cars.

- Their research priority is to ensure the battery is safe for consumers.

Scientists focus on testing the battery’s performance under extreme conditions, like very high or low temperatures, to ensure it doesn’t overheat or catch fire. They also simulate car accidents to evaluate whether the battery remains stable during impacts.

By addressing these safety concerns, the research ensures the product is reliable for widespread use and protects consumers from harm.

Now it's **Your** Turn

Match perspectives and research priorities.

Directions:

- Read the scenario below.
- Write a research priority for each perspective.

Scenario:

You are part of a team researching how to improve food production in Canada.

1. **Environmental Perspective**:

   Research priority:

   ____

   ____

   ____

   ____

2. **Health Perspective**:

   Research priority:

   ____

   ____

   ____

   ____

3. **Economic Perspective**:

   Research priority:

   ____

   ____

   ____

   ____

4. **Ethical Perspective**:

   Research priority:

   ____

   ____

   ____

   ____

Answers:

1. How can farming reduce its impact on water pollution?
2. How can we make nutritious food more accessible to low-income communities?
3. How can we lower the cost of farming equipment for small farms?
4. How can we ensure fair wages for farmworkers?

RESOURCE 8: Benefits and Risks of Scientific Solutions and Technologies

Original Authors: CLO

CAEC Science Skills Covered:

3.1 Identify intended and unintended consequences for humans and the environment emerging from scientific solutions and technologies.

3.2 Evaluate risks and benefits of scientific solutions and technologies.

3.3 Evaluate factors that influence scientific research.

OALCF Skills Covered:

A1.2 Read texts to locate and connect ideas and information

A1.3 Read longer texts to connect, evaluate and integrate ideas and information

B2.3 Write longer texts to present information, ideas and opinions

Benefits and Risks of Scientific Solutions and Technologies

In the Science section of the CAEC test, you will be required to answers questions about key areas of scientific study. The test focuses on three main areas:

- the nature of science
- scientific inquiry skills
- science, technology, society and environment

The test will cover general scientific topics and more specific content. Some of the topics covered include:

- observation and inference
- the characteristics of science
- scientific inquiry
- reliability of research and bias
- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

- In this resource, you won't need to use a calculator.
- After each lesson, you will have the chance to practice what you have learned.

Let’s Get Started!

Consequences, Risks, and Benefits of Scientific Solutions and Technologies
Science and technology solve many problems in our world. But sometimes, they can cause new problems too.

In this lesson, you’ll explore how scientific solutions can have **intended consequences** (the good things they were meant to do) and **unintended consequences** (the problems that happen even though they weren’t planned).

You’ll also think about the **risks** and **benefits** of these solutions.

Key ideas:

- **Intended Consequences:**
  The planned or expected benefits.

    - Vaccines prevent disease.

- **Unintended Consequences:**
  The unexpected side effects.

    - Overuse of antibiotics can lead to resistant bacteria.

Some Examples

Let's look at some examples of intended and unintended consequences.

Example 1: Plastic

Plastic was invented to make life easier. It's used in so many things—food packaging, toys, medical equipment, even clothes.

- **Intended Consequences:**

  Plastic is cheap to make, lasts a long time, and is lightweight. It helps keep food fresh and makes medical tools sterile (clean and safe to use).

- **Unintended Consequences:**

  Have you noticed plastic waste everywhere? In oceans, it harms animals like sea turtles and birds who mistake it for food. Plastic also breaks down into tiny pieces called microplastics, which end up in the food we eat and the water we drink.

What do **you** think?

How can we reduce plastic waste while keeping its benefits?

Example 2: Fertilizers in Farming

Farmers use fertilizers to grow more crops. Fertilizers provide nutrients to plants and help feed the world’s growing population.

- **Intended Consequences:**

  By using fertilizers, farmers can grow bigger crops, faster. This helps reduce hunger and ensures there’s enough food for everyone.

- **Unintended Consequences:**

  When too much fertilizer is used, rain can wash it into rivers and lakes. This causes algae to grow out of control, which harms fish and other aquatic life. People who live near polluted water can’t drink it or use it for farming.

What do **you** think?

How can farmers use fertilizers without harming the environment?

Example 3: Vaccines

Vaccines are one of the greatest inventions in science. They protect us from serious diseases like polio, measles, and COVID-19.

- **Intended Consequences:**

  Vaccines save millions of lives by preventing diseases. They also protect communities by stopping the spread of illnesses.

- **Unintended Consequences:**

  Sometimes, people are afraid of vaccines because they hear false information. Rarely, someone might have a mild or severe reaction to a vaccine. These fears can lead to fewer people getting vaccinated, which allows diseases to spread.

What do **you** think?

How can we help more people understand the benefits of vaccines while addressing their concerns?

Now it's **Your** Turn

Let's look closer at intended and unintended consequences.

Directions:

Read the scenario below.

Answer the following questions.

Scenario:

Imagine you're a scientist. You've invented a pesticide that kills bugs on farms. It's really good at protecting crops from pests, but it also harms bees. Bees are very important because they help pollinate plants. Without them, many fruits and vegetables wouldn't grow.

1. List the Intended Consequences: Write down all the good things this pesticide does.

2. List the Unintended Consequences: Think about all the bad things that might happen because of the pesticide.

3. Find Solutions: How could you fix the unintended problems while keeping the benefits?

____
____
____
____

Answers:

1. “The pesticide protects crops, so farmers lose less food to pests.”
2. “The pesticide harms bees, which could make it harder for farmers to grow fruits and vegetables.”
3. “Scientists could design a pesticide that only harms pests, not bees.”

Risks and Benefits

Science and technology always involve **risks** (things that might go wrong) and **benefits** (things that go right). To decide if something is worth it, we need to weigh the risks against the benefits.

Some Examples

1. **Dams for Hydropower**

    - **Benefits:** Dams create clean electricity and prevent floods.
    - **Risks:** Building a dam can flood nearby areas, force animals and people to move, and harm fish habitats.
    - **Big Question:** Is clean energy worth the damage to local ecosystems?

2. **Electric Cars**

    - **Benefits:** Electric cars don't pollute as much as gas cars. They help fight climate change.
    - **Risks:** Mining for the materials in car batteries damages land and harms workers in poor conditions.
    - **Big Question:** How can we make electric cars better for people and the planet?

A Closer Look

A Scientist Weighs the Risks and Benefits of a New Technology

Dr. P is an environmental scientist working on a new type of genetically modified (GM) plant. This plant is designed to grow in very dry areas where most crops fail. The goal is to help farmers in drought-prone regions grow food and feed their communities. Before the GM plant can be widely used, Dr. P must carefully think about its risks and benefits.

Step 1: Identify the Benefits

Dr. P considers how the GM plant can help:

- Grows in dry conditions: Farmers in regions with little rainfall can still grow crops and make a living.
- Increases food security: Communities that often face hunger will have access to more food.
- Reduces water usage: These plants need less water, which is important in areas where water is scarce.

Step 2: Identify the Risks

Next, Dr. P looks at potential problems:

- Harm to local plants: The GM plant might spread and take over land used by native plants.
- Impact on wildlife: Some animals might not eat or survive on the GM plant, disrupting local ecosystems.
- Dependence on companies: Farmers might have to buy seeds from large corporations every year, which could be expensive.

Step 3: Weigh the Risks and Benefits

Dr. P carefully thinks about whether the benefits outweigh the risks. She asks questions like:

- "Will this help more people than it harms?"
- "Can we solve some of the risks, like the harm to local plants, before releasing the GM plant?"
- "How can we explain the safety of this technology to the public so they trust it?"

Step 4: Make a Decision

After gathering data and consulting other scientists, Dr. P decides the technology is worth pursuing if safety measures are put in place:

- Farmers should only grow the GM plant in specific areas to avoid spreading it to wild ecosystems.
- Scientists should continue monitoring the plant to ensure it doesn't harm wildlife.
- Educational programs should teach communities about the safety and benefits of GM foods.

Outcome

Dr. P presents her findings to a government agricultural board. With her recommendations, the GM plant is approved for use, but only with strict rules. Farmers in drought-stricken areas start planting it, and food production increases while scientists monitor the long-term effects.

- ➢ Scientists don't just focus on the benefits of new technologies—they also carefully consider the risks and find ways to minimize them.

- ➢ Science is about finding solutions, but it's also about making responsible choices!

What do **you** think?

The next time you see a new invention or hear about a new technology, ask yourself:

- What are its intended consequences?
- What are its unintended consequences?
- Do the benefits outweigh the risks?

RESOURCE 9: Understanding Graphing Using pH Levels

Original Authors: CLO

CAEC Science Skills Covered:

2.8 Visualize and communicate data in appropriate formats, such as tables, graphs, and diagrams.

2.9 Analyze patterns and trends to describe relationships among variables and data.

2.10 Estimate information from data, graphs, tables, and spreadsheets.

2.11 Evaluate scientific investigations for sources of error and formulate reasonable explanations of the results.

OALCF Skills Covered:

B2.3 Write longer texts to present information, ideas and opinions

C4.2 Make low-level inferences to organize, make summary calculations and represent data

C4.3 Find, integrate and analyze data; identify trends in data

Understanding Graphing Using pH Levels

In the Science section of the CAEC test, you will be required to answers questions about key areas of scientific study. The test focuses on three main areas:

- the nature of science
- scientific inquiry skills
- science, technology, society and environment

The test will cover general scientific topics and more specific content. Some of the topics covered include:

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- scientific inquiry
- reliability of research and bias
- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

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➢ After each lesson, you will have the chance to practice what you have learned.

Let’s Get Started!

Understanding and Using Graphs

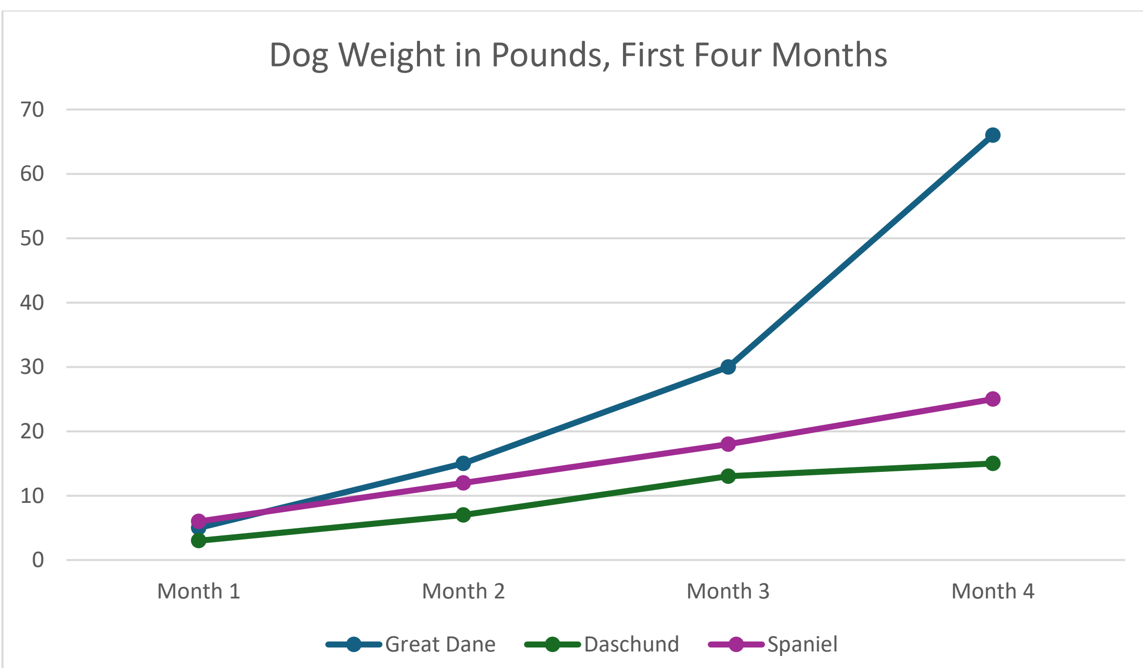
Graphs are tools that help us organize and understand information in a clear and simple way. They make it easier to see patterns, compare data, and answer questions.

By using graphs, we can quickly see what the data is telling us without having to read a lot of numbers.

Different types of graphs:

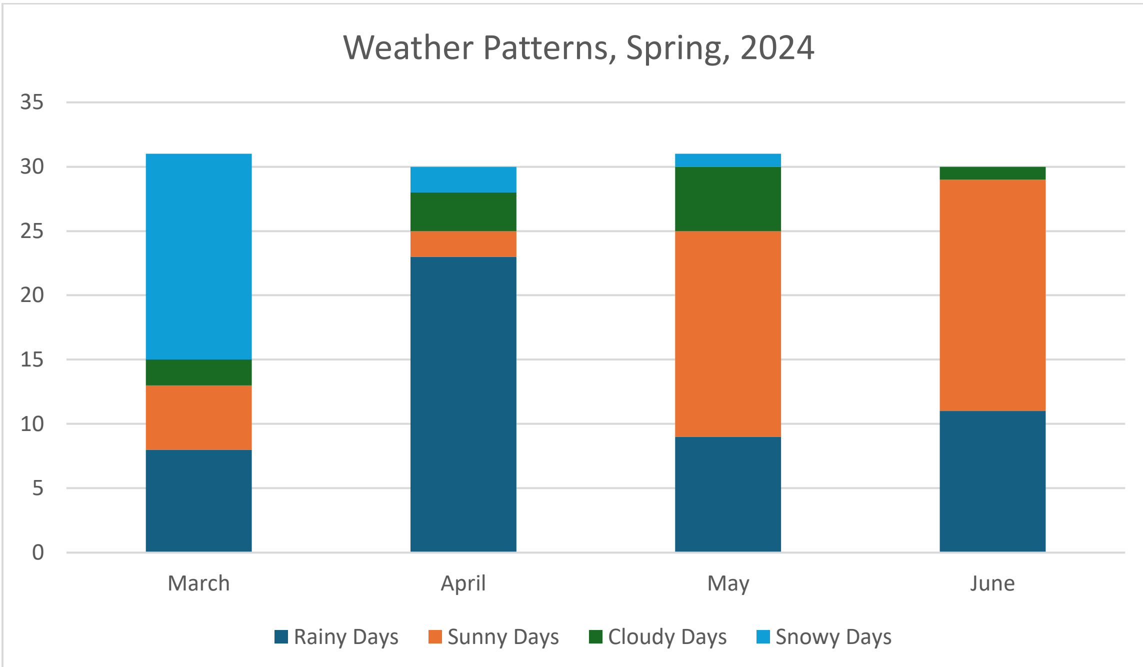
Line Graphs:

Line graphs are great for showing how something changes over time. The example below shows growth rates for three different types of dogs.



Bar Graphs:

Bar graphs are useful for comparing quantities or amounts. The example below compares the number of rainy, sunny, cloudy, and snowy days in over four months.



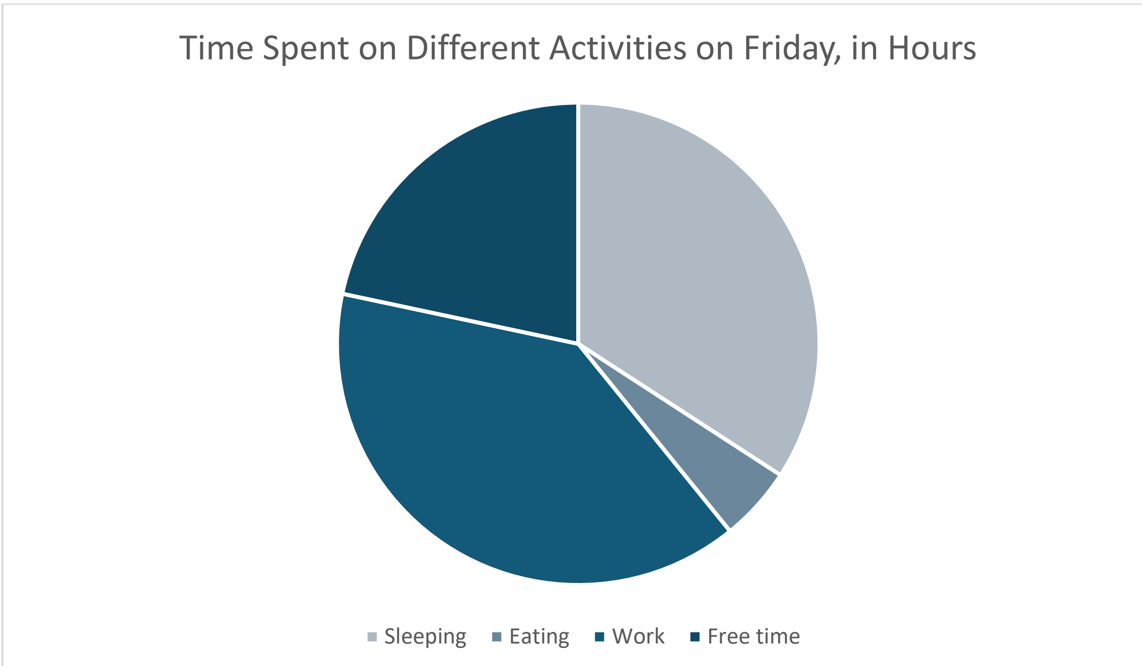
Which month has the most sunlight?

____

Which month has the most rain?

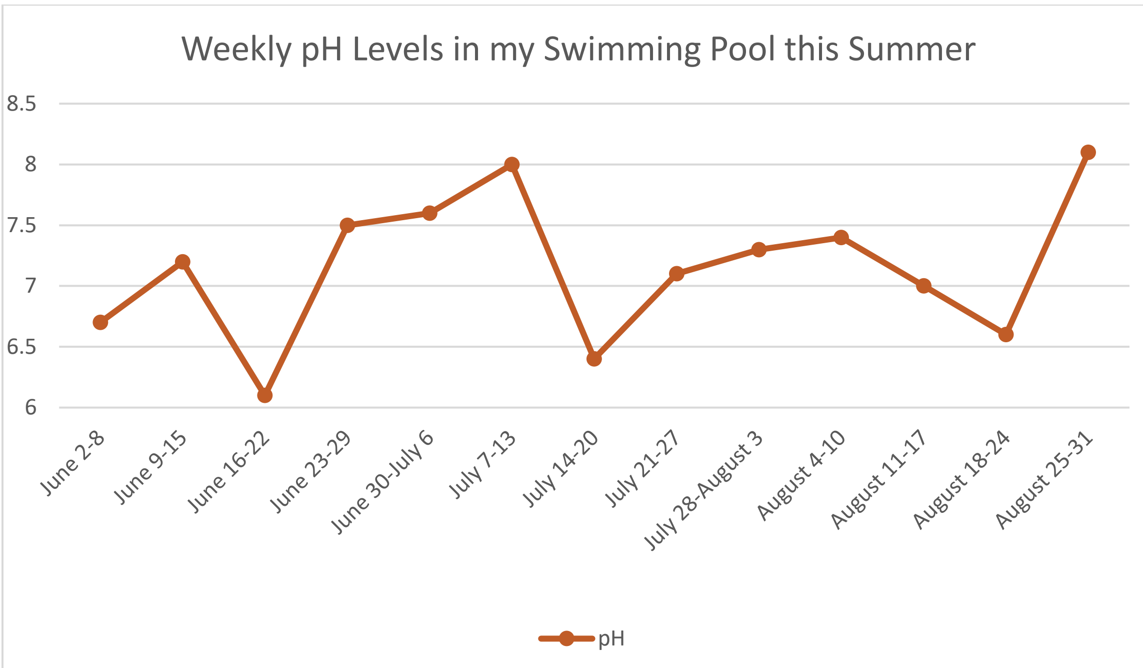
____

Pie Graphs: Pie graphs are best for showing parts of a whole as percentages. The example below shows how much of a day is spent on sleeping, eating, work, and free time.



A Closer Look

Let's look closer at how to use graphs using the example below. This line graph shows the **pH levels** in a swimming pool over the summer months.



Before working with the graph, let's have a quick overview of pH:

The pH scale measures how **acidic** or **basic** a substance is. The scale runs from 0 (very acidic) to 14 (very basic), with 7 being neutral. If the pH is too high or too low, it can irritate swimmers' skin and eyes or reduce the effectiveness of chlorine.

- For swimming pools, the ideal pH level is between 7.2 and 7.8.

Understanding the X-Y Axis

Graphs have two main axes: the **X-axis (horizontal)** and the **Y-axis (vertical)**. These axes help organize data and make it easier to understand.

1. X-axis (Horizontal):
    - In this graph, the X-axis represents time, specifically the weeks during the summer (e.g., June 2-8, June 9-15, etc.).
    - It shows when the pH measurements were taken. Reading from left to right, the X-axis allows us to see how pH levels changed over the summer.
2. Y-axis (Vertical):
    - The Y-axis shows the pH levels of the swimming pool water, ranging from 6.0 to 8.5.
    - This scale tells us the pH value for each week. The higher the point on the Y-axis, the higher the pH level of the water.

How to Use the Axes Together:

To find specific data, match a point on the graph to both axes. For example:

- The point above "July 7-13" on the X-axis aligns with 8.0 on the Y-axis. This means the pH level for that week was 8.0.
- Similarly, the point above "June 16-22" aligns with 6.5 on the Y-axis, meaning the pH level was 6.5 that week.

Now it’s **Your** Turn

Using graphs to observe patterns and trends.

Activity 1: Observing Patterns and Trends

Directions:

- Re-examine the graph titled *Weekly pH Levels in My Swimming Pool this Summer*.
- Answer the questions below.

1. What was the pH level during the week of July 7-13?

____

____

2. Which week recorded the lowest pH level?

____

____

3. Describe the overall trend in pH levels between August 4 and August 24.

____

____

4. Was the pH level ever outside the ideal range for swimming pools (7.2–7.8)? If yes, which weeks?

____

____

Answers:

1. What was the pH level during the week of July 7-13?
    - The pH level was **8.0**.

2. Which week recorded the lowest pH level?
    - The lowest pH level occurred during the week of June 16-22, with a value of **6.5.**

3. Describe the overall trend in pH levels between August 4 and August 24.
    - The pH level started around 7.5 on August 4, dropped to 6.5 by August 18-24, showing a downward trend.

4. Was the pH level ever outside the ideal range for swimming pools (7.2–7.8)? If yes, which weeks?
    - **Yes**, the pH level was outside the ideal range during these weeks:
        - Below the range: June 16-22 (6.5) and August 18-24 (6.5).
        - Above the range: July 7-13 (8.0) and August 25-31 (8.5).

Activity 2: Making Predictions and Recommendations

Directions:

- Imagine you're the pool manager.
- Re-examine the graph titled *Weekly pH Levels in My Swimming Pool this Summer*.
- Use the graph to answer the following questions:

1. If the trend from August 18-24 continues, what do you think the pH level might be in the next week?

____

____

2. What steps would you take if the pH level stays above 8.0 for multiple weeks?

____

____

3. Why is it important to regularly monitor and adjust pH levels in a swimming pool? Write one to two sentences explaining your answer.

____

____

Answers:

1. If the trend from August 18-24 continues, what do you think the pH level might be in the next week?
    - If the upward trend continues, the pH level could rise to **8.5** or higher.
2. What steps would you take if the pH level stays above 8.0 for multiple weeks?
    - Add a pH decreaser (acidic solution) to bring the pH level back to the ideal range. Regularly monitor the water chemistry to prevent high pH levels in the future.
3. Why is it important to regularly monitor and adjust pH levels in a swimming pool?
    - High or low pH levels can cause skin and eye irritation for swimmers. Additionally, an unbalanced pH reduces chlorine effectiveness, leading to unsafe water conditions.

Activity 3: Drawing Conclusions

Directions:

- Re-examine the graph titled *Weekly pH Levels in My Swimming Pool this Summer*.
- Use the graph to decide whether each statement is true or false:

True ☐ False ☐

1. The pH level was consistent throughout the summer.

Explain your choice:

____

____

True ☐ False ☐

2. The pool's pH level reached its peak in July.

Explain your choice:

____

____

True ☐ False ☐

3. The weeks of June 16-22 and August 25-31 had a similar trend.

Explain your choice:

____

____

	True	False
4. There were more weeks with a pH level below 7.0 than above 8.0.	☐	☐

Explain your choice:

____

____

Answers:

1. The pH level was consistent throughout the summer.
    - **False** – The pH levels fluctuated, ranging from 6.5 to 8.5.

2. The pool's pH level reached its peak in July.
    - **True** – The highest pH level of 8.0 occurred during the week of July 7-13.

3. The weeks of June 16-22 and August 25-31 had a similar trend.
    - **True** – Both weeks showed sharp increases in pH levels from the previous week.

4. There were more weeks with a pH level below 7.0 than above 8.0.
    - **False** – There were two weeks with pH levels below 7.0 (June 16-22, August 18-24) and two weeks with levels above 8.0 (July 7-13, August 25-31).

RESOURCE 10: Introduction to WHMIS Consumer Product Symbols

Original Authors: CLO

CAEC Science Skills Covered:

2.5 Identify the appropriate techniques for storing, handling, and disposing of materials according to WHMIS 2015 and consumer product symbols.

OALCF Skills Covered:

A2.2 Interpret simple documents to locate and connect information

B2.3 Write longer texts to present information, ideas and opinions

Introduction to WHMIS Consumer Product Symbols

In the Science section of the CAEC test, you will be required to answers questions about key areas of scientific study. The test focuses on three main areas:

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- scientific inquiry
- reliability of research and bias
- hypotheses
- the elements of scientific investigation
- patterns & relations
- consequences of technology on humans and the environment

- ➢ In this resource, you won't need to use a calculator.
- ➢ After each lesson, you will have the chance to practice what you have learned.

Let's Get Started!

Understanding Safety Symbols in Everyday Products

What is WHMIS?

WHMIS stands for **Workplace Hazardous Materials Information System**. It is a system used in Canada to help people identify and understand the dangers of chemicals and hazardous materials they might use at work.

WHMIS includes **symbols** to warn about specific hazards, such as if a material is:

- flammable
- toxic
- corrosive/irritant
- explosive

It also provides **labels** and **safety data sheets** with instructions on how to safely store, handle, and dispose of dangerous materials.

- WHMIS is important because it helps keep workers safe and prevents accidents or injuries when working with chemicals.

A Closer Look

Introduction to Safety Symbols

- Safety symbols are used to warn people about hazards associated with using certain products.
- WHMIS Symbols are for workplace products and follow Canadian safety standards.
- Household Hazard Symbols warn users about dangers in everyday household products.

1. Hazard symbol pictures

The picture tells you the type of danger:

EXPLOSIVE

The container can explode if heated or punctured. Flying pieces of metal or plastic from the container can cause serious injury, especially to your eyes.

CORROSIVE (Irritant)

The product can burn your skin or eyes. If swallowed, it can damage your throat and stomach.

FLAMMABLE

The product or its fumes will catch fire easily if it is near heat, flames, or sparks. Rags used with this product may begin to burn on their own.

POISON

If you swallow, lick, or in some cases, breathe in the chemical, you could become very sick or die.

2. Hazard symbol frames

The **shape of the frame** around the hazard symbol tells you **what part of the product is dangerous**:

If it's a **triangle**, it means the **container** is dangerous.

If it's an **octagon**, it means the **contents** are dangerous.

3. Signal words

The **signal word(s)** underneath the hazard symbol explain the **degree of risk**:

Symbol -

Signal word - DANGER EXPLOSIVE

Signal words:

- **CAUTION** means temporary injury may result. Death may occur with extreme exposure.
- **DANGER** means may cause temporary or permanent injury, or death.
- **EXTREME DANGER** means exposure to very low amounts may cause death or serious injury.

Some Examples

Here’s a list of common household products and their specific hazards:

1. **Bleach** – Corrosive, causes skin and eye irritation, and produces toxic fumes when mixed with other cleaners.
2. **Glass Cleaner** – Flammable (as a liquid or vapor) and causes mild skin and eye irritation.
3. **Oven Cleaner** – Corrosive, can cause severe burns to skin and eyes, and may release toxic fumes if heated.
4. **Aerosol Hairspray** – Flammable and may explode if exposed to high heat.
5. **Paint Thinner** – Highly flammable, can cause dizziness or nausea if inhaled, and is toxic if ingested.

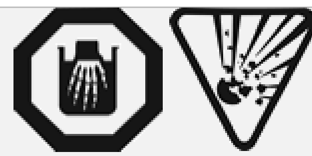
These hazards are often identified with WHMIS or household hazard symbols to help you handle these products safely.

Now it's **Your** Turn

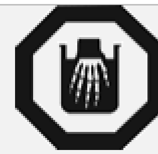
Identifying Hazards (Matching Activity)

Directions:

- Fill in the hazard description in the chart below.

Product	Hazard Description	Safety Symbol to Match
Oven Cleaner		
Glass Cleaner		
Laundry Detergent		
Spray Paint		

Answers:

Product	Hazard Description	Safety Symbol to Match
Oven Cleaner	Contains corrosive chemicals and may explode.	 
Glass Cleaner	Flammable as liquid and vapor. Causes skin/eye irritation.	 
Laundry Detergent	Causes skin irritation and may be harmful if ingested.	 
Spray Paint	Extremely flammable, releases harmful fumes.	 

Safety Tips

Here are safety tips for using products with each hazard:

1. **Bleach (Corrosive/Toxic fumes)**
   - Wear gloves and eye protection when handling.
   - Use in a well-ventilated area.
   - Never mix with ammonia or other cleaners as it produces toxic gases.

2. **Glass Cleaner (Flammable/Irritant)**
   - Keep away from open flames or heat sources.
   - Avoid inhaling vapors; use in a ventilated space.
   - Wash your hands after use to avoid skin irritation.

3. **Oven Cleaner (Corrosive/Toxic Fumes)**
   - Always wear gloves and goggles to protect your skin and eyes.
   - Open windows or use a fan to ensure good ventilation while using.
   - Avoid contact with surfaces other than the oven to prevent damage.

4. **Aerosol Hairspray (Flammable/Explosion Hazard)**
   - Keep the can away from heat, sparks, and flames.
   - Do not puncture or incinerate the can, even when empty.
   - Store in a cool, dry place away from direct sunlight.

5. **Paint Thinner (Flammable/Toxic)**
   - Wear gloves and a mask to protect your skin and avoid inhaling fumes.
   - Use outdoors or in a well-ventilated area.
   - Store in tightly sealed containers, away from heat or flames.

- By following these precautions, you can minimize the risks associated with these products.

Now it’s **Your** Turn

Real-Life Safety Practices

Directions:

- Read the scenarios below.
- Answer the following questions.

Scenario 1:

You are using an oven cleaner with corrosive and explosive hazards.

Write three safety tips to reduce the risk of injury.

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Scenario 2:

You notice the glass cleaner bottle has a flammable and irritant warning.

Write two actions to prevent accidents.

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Answers:

Scenario 1:

- Wear gloves and goggles to protect skin and eyes.
- Use the product in a well-ventilated area.
- Do not store the product near heat or open flames.

Scenario 2:

- Keep the product away from heat or sparks.
- Avoid contact with your skin or eyes.

What do **you** think?

Why is it important to recognize safety symbols on household products?

How can understanding these symbols prevent accidents?