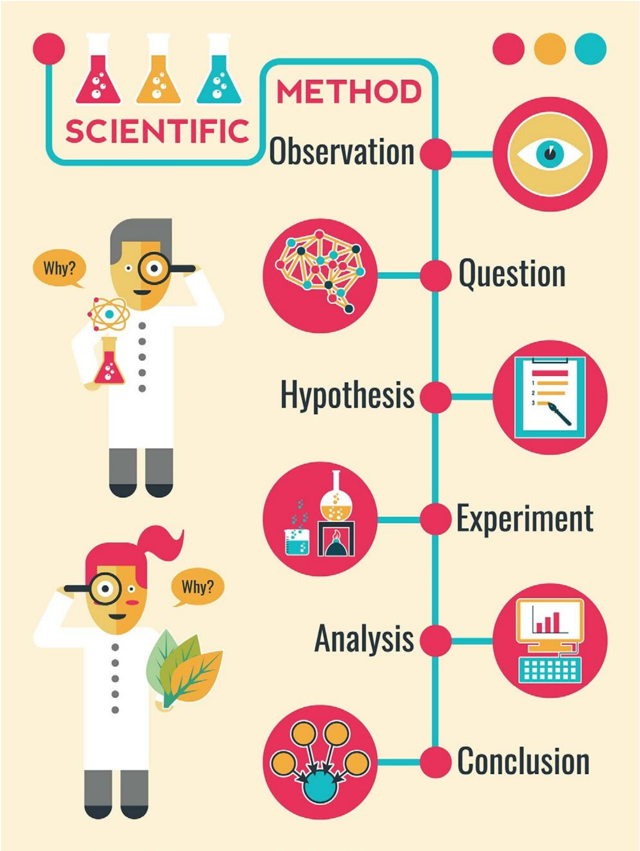
The Scientific Method

York College & University Centre

What is the scientific method?

- **Definition:**
  - A structured process used to investigate questions and solve problems.
  - Ensures results are logical, repeatable, and reliable.
- **Key Features:**
  - Step-by-step approach (observation → hypothesis → testing → conclusion).
  - Reduces bias by relying on evidence, not opinion.
  - Used in both science and engineering.
- **Why It Matters:**
  - Helps us explain natural phenomena.
  - Guides invention and problem-solving.
  - Builds knowledge that can be trusted and shared.



Why is the scientific method important?

- **Ensures Reliability**
  - Experiments can be repeated and verified.

- **Encourages Critical Thinking**
  - Decisions based on evidence, not guesswork.
  - Drives Innovation
  - Used in engineering to test designs, prototypes, and systems.

- **Real-World Impact**
  - Medicine: testing vaccines and treatments.
  - Engineering: improving safety and efficiency in machines.
  - Everyday life: solving practical problems logically.

Step 1: Observation

- **Definition:**
  - Careful noticing and recording of facts or phenomena.
  - The starting point of all scientific investigations.
- **Examples:**
  - Plants near a window grow taller than those in shade.
  - A circuit overheats after being switched on for a long time.
  - Ice melts faster on metal than on plastic.
- **Key Points:**
  - Must be accurate and unbiased.
  - Can involve the senses or tools (microscopes, sensors, measuring devices).
  - Good observations lead to meaningful questions.

Step 2: Questioning

- **Definition:**
  - Turning observations into testable questions.
  - Focused questions help guide investigations.
- **Examples:**
  - Observation: “Plants near the window grow taller.”→ Question: Does more light make plants grow faster?
  - Observation: “The circuit overheats.”→ Question: Why does the circuit heat up when current flows?
- **Key Points:**
  - Good questions are clear and specific.
  - Should lead to an experiment or test.
  - Avoid vague or untestable questions (e.g., “Why is life unfair?”).

Step 3: Hypothesis

- **Definition:**
  - An educated guess that explains your observation.
  - Based on prior knowledge or research.
  - Must be testable and falsifiable.
- **Examples:**
  - If plants near windows grow taller, then light increases plant growth.
  - If the circuit overheats, then too much current is flowing.
- **Key Points:**
  - A hypothesis is not just a guess—it's grounded in reasoning.
  - Should be written as a clear statement, not a question.
  - Leads directly to predictions that can be tested.

Step 4: Prediction

- **Definition:**
  - A logical outcome you expect if the hypothesis is correct.
  - “If … then …” statements are common.
  - In engineering, predictions can also be tested through simulation (e.g., CAD, computer models).

- **Examples:**
  - Hypothesis: Light increases plant growth.→ Prediction: If a plant is moved into more light, then it will grow taller.
  - Hypothesis: Too much current causes overheating.→ Prediction: If resistance is increased, then the circuit will stay cooler.

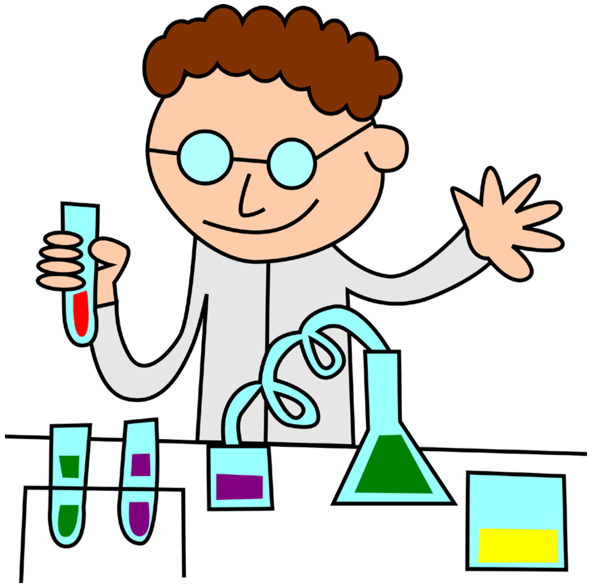
- **Key Points:**
  - Predictions connect directly to the test/experiment.
  - Simulations can save time and resources before real-world testing.

Step 5: Testing (Experiment)

- **Definition:**
  - Carrying out an investigation to collect data and check if the prediction is correct.
  - Must be fair, controlled, and repeatable.

- **Examples:**
  - Place two plants in different light conditions and measure their growth.
  - Run a circuit at different resistances and record the temperature.

- **Key Points:**
  - Control variables: keep all factors the same except the one being tested.
  - Repeat experiments to ensure reliable results.
  - Record data carefully (tables, graphs, measurements).



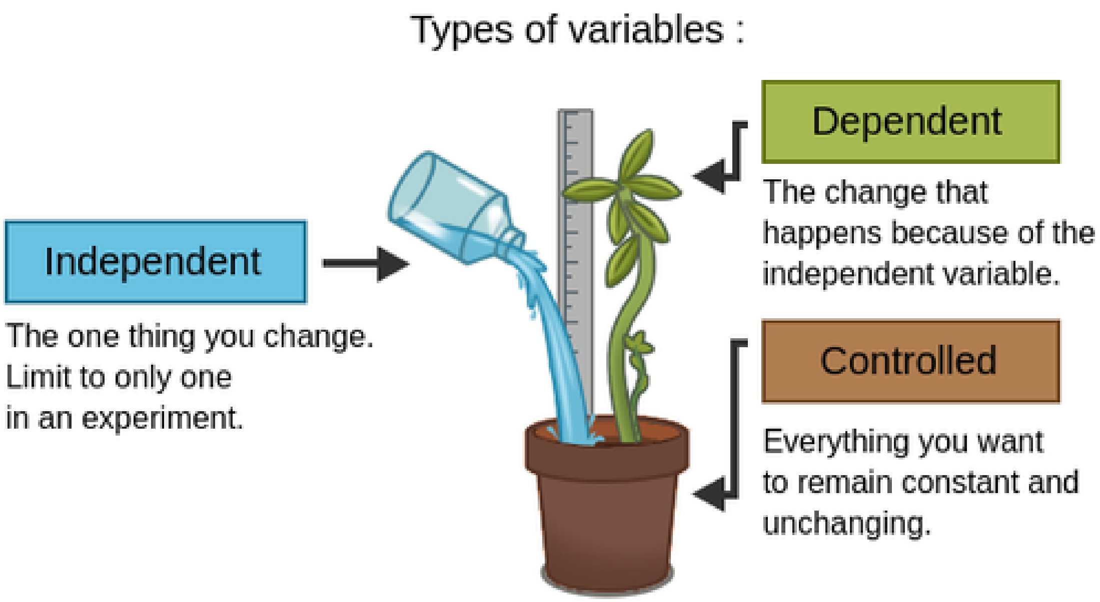
Step 5: Testing (Variables)

- **Independent Variable**
  - The factor you change in the experiment.
  - Example: Amount of light given to plants.

- **Dependent Variable**
  - The factor you measure as a result.
  - Example: Plant height.

- **Control Variables**
  - The factors you keep the same to ensure a fair test.
  - Example: Type of plant, soil, water amount, temperature.

- **Key Point:**
  - Only one variable should be changed at a time.



Step 6: Conclusion

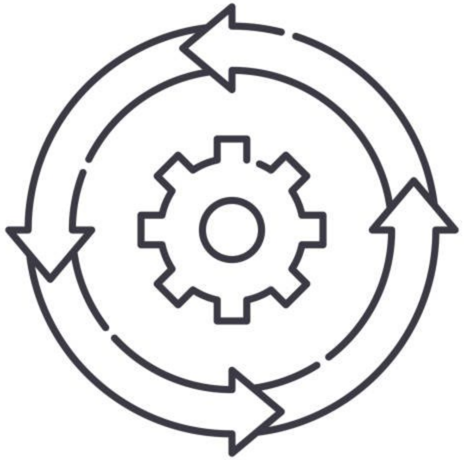
- **Definition:**
  - Explaining what the results of the experiment show.
  - Decide if the hypothesis was supported or rejected.

- **Examples:**
  - Supported: Plants in more light grew taller → light affects growth.
  - Rejected: Circuit didn't overheat at high current → another factor must be involved.

- **Key Points:**
  - A conclusion is based on evidence, not opinion.
  - Even if the hypothesis is wrong, the experiment is still valuable.
  - Results may raise new questions.

Step 7: Iteration

- **Definition:**
  - Repeating the scientific method with refined questions or new hypotheses.
  - Science and engineering rarely stop after one test.
- **Examples:**
  - If light wasn't the only factor for plant growth → test soil nutrients or water.
  - If a circuit still overheats → test different materials or cooling methods.
- **Key Points:**
  - Knowledge builds step by step.
  - Failure often provides the most useful information.
  - Iteration is how technology and science improve over time.



The 7 Key Steps

- **Observation** – Notice something.
- **Questioning** – Ask why/how.
- **Hypothesis** – Make an educated guess.
- **Prediction / Simulation** – State what should happen.
- **Testing (Experiment)** – Collect data.
- **Conclusion** – Interpret the results.
- **Iteration** – Refine and repeat.