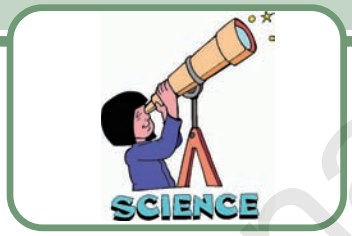
Chapter

1

What is Science?



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It is amazing to think of the facilities available today when compared to primitive era. Computers, mobile phones, internet, space shuttles, robotics, hybrid food grains, medicines, etc are all the result of ideas which originated in some human brains. They are the people who think differently to observe and understand the nature in a specific way. Let us understand how they think and what they do.

What is science?

Science is the concerted human effort to understand or to understand better, the history of the natural world and how the natural world works, with observable physical evidence as the basis of that understanding.It is done through observation of natural phenomena, and/or through experimentation that tries to simulate natural processes under controlled conditions. Science is a process of thinking.

Science is an organized study of knowledge which is based on experimentation. Science is a tool for searching truths of nature. Science is the way of exploring the world.

Questioning is the primary or fundamental step in scientific thinking. There are many phenomenon in nature around us which sprout up doubt in our minds. Ofcourse they may be problems. Let us observe the following experiences, you too can add your observations to enrich the list.

1. Why do leaves fall down from the tree after turning yellow?
2. How do ants identify sweets kept in a tin?
3. Why can't we see stars during day time?
4. Pickles do not spoil, but sambar gets spoiled soon. Why?
5. Farmers are afraid of unseasonal rains and uncontrolled pests. How to solve these problems?
6. How are diseases caused and how to prevent and cure them?

Consider some examples. An ecologist observes the behaviour of different organisms living in different habitats like crows on trees, tigers in forests, fish in water and earthworms in the soil and a

geologist studies the distribution of fossils and minerals in the Earth's crust. Both the scientists are making observations in order to find out patterns in natural phenomena. Observations and research done by these people enlighten the general public. An Astrophysicist photographs stars, planets and distant galaxies and a climatologist draws data from weather balloons. Similarly there are other scientists making observations.

The examples above are of observational science. There is also experimental science. A chemist observes the rate of one chemical reaction at different temperatures and a nuclear physicist records the results of angular momentum of a particular particle in the circular path. Both the scientists are performing experiments to discover consistent patterns. A biologist observing the reaction of a particular tissue to various stimulants is likewise experimenting to find patterns of behavior. When few scientists investigate on the causes of a disease while others may investigate on the prevention of it. So the findings of a scientist are used as a base for the other scientists. These scientists usually do their work in labs and wear impressive white lab coats.

The critical commonality is that all these people are making and recording observations of nature, or of simulations of nature, in order to learn more about how nature works in the broadest sense. We'll study below that one of their main goals is to show that old ideas (the ideas of scientists a century ago or perhaps just a year ago) are wrong and replace them with new ideas instead to explain about nature in a better way.

The word science comes from the Latin word *"scientia"*, means knowledge.

What does that really mean? Science refers to a system of acquiring knowledge. This method uses observation and experimentation to describe and explain natural phenomena. The term science also refers to the organized body of knowledge people have gained using that method. Less formally, the word science often describes any systematic field of study or the knowledge gained from it.

Why science?

The individual perspective

(Why do people conduct experiments? what are they doing?) In most of the above cases, they're collecting information to test new ideas or to disprove old ones. (Scientists become famous for discovering new things that change how we think about nature, whether the discovery is a new species of dinosaur or a new way in which atoms bond.) Many scientists find their greatest joy in a previously unknown fact (a discovery) that explains some problem previously not explained, or that overturns some previously accepted idea.

The Societal Perspective

If the above said ideas, explain individuals perspective of science and its relation to the society, one might wonder why societies and nations pay those individuals to experiment in science. Why does a society devote some of its resources to this aspect of developing new knowledge about the natural world, or what has motivated these scientists to devote their lives to develop new knowledge?

One realm of answers lies in the desire to improve the life of people. Geneticists trying to understand how certain characters are passed from generation to generation and biologists tracing the pathways by which diseases are transmitted are clearly seeking information to improve the lives of ordinary people. Earth scientists developing better models for the prediction of weather or for the prediction of earthquakes, landslides, and volcanic eruptions etc are likewise seeking knowledge that can help people to avoid the hardships that have plagued humanity for centuries. (Any society concerned about the welfare of its people, will support efforts like these for betterment of their lives.)

Another realm of answers lies in a society's desires for economic development. Many earth scientists devote their work in finding more efficient or more effective ways to discover or recover natural resources like petroleum and ores. Plant scientists seeking strains or species of high yielding fruit plants and crops are ultimately working to increase the agricultural output that nutritionally and economically enriches nations. Chemists developing new chemical substances with potential technological applications and physicists developing new phenomena like superconductivity are likewise developing knowledge that may spur economic development. In a world where nations increasingly view themselves as caught up in economic competition, can take support of such science as an investment to their economic future.

Science and Change

If scientists are constantly trying to make new discoveries (or) trying to develop new concepts and theories, then the body of knowledge produced by science should undergo constant change. Such change progress towards a better understanding of nature. It is achieved by constantly questioning whether our current ideas are correct or not

The result is that theories come and go, or atleast modified with time, as old ideas are questioned and new evidence is discovered. In the words of Karl Popper, "Science is a history of corrected mistakes", and even Albert Einstein remarked of himself "That fellow Einstein . . . every year retracts what he wrote the year before". Many scientists have remarked that they would like to return to life in a few centuries to see what new knowledge and new ideas have been developed by then - and to see which of their own century's ideas have been discarded.

Scientists observe the nature and its laws. They discover the secrets of nature. Based on these discoveries and inventions different innovations take place. Scientists follow a specific way for their innovations. The way that they follow is called *'scientific method'*. Let us find out how they follow

How scientists work - Scientific Method

Planning an investigation

How do scientists answer a question or solve a problem they have identified. They use organized ways called **scientific methods** which help them plan and conduct a study. They use scientific process skills. Which help them to gather, organize, analyze and present their information. Scientific method follows these steps.

1) Observe and ask questions
2) Form a hypothesis
3) Plan and experiment
4) Conduct the experiment
5) Draw conclusions and communicate the results

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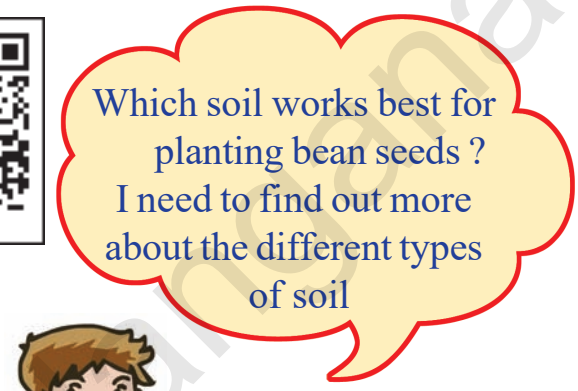


Aravind is using this scientific method for experimenting to find out an answer to his question. You can use these steps, too.

Step 1 Observe, and ask questions.

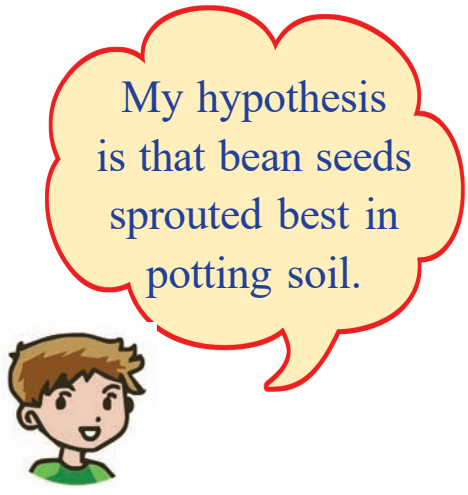
- Use your senses to make observation.
- Record **one** question that you would like to answer.
- Write down what you already know about the topic of your question.
- Decide what other information you need.
- Do research to find more information about your topic.

Step 2 Form a Hypothesis.

- Write a possible answer, or hypothesis, to your question.

  A **hypothesis** is a possible answer that can be tested.

- Write your hypothesis in a complete sentence.



Step 3 Plan an experiment.

- Decide how to conduct a fair test of your hypothesis by controlling variables.

  Variables are factors that can affect the outcome of the investigation.
- Water, light are fixed variables. Soil is the changing variable.
- Write down the steps you will follow to do your test.
- List the equipment you need.

- Decide how you will gather and record your data

I'll put identical seeds in three different kinds of soil sandy, clay, potting soils. Each flowerpot will get the same amount of water and light. So, I'll be controlling the variables of water and light.

Step 4 Conduct the experiment.

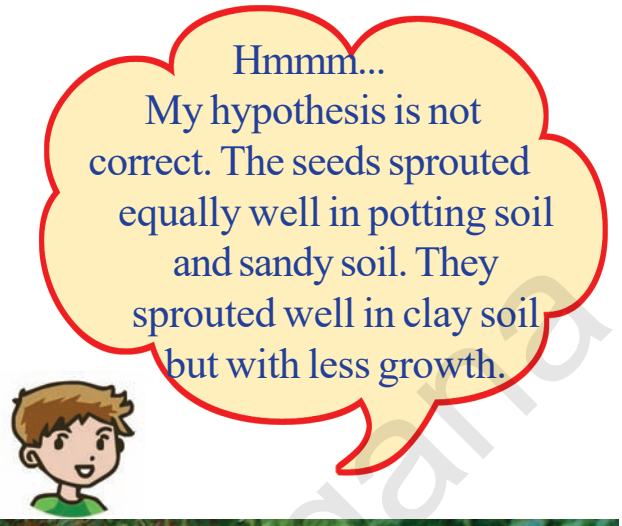
- Follow the steps you have written.
- Observe and measure carefully.
- Record everything that happens.
- Organize your data so that you can study it carefully.

I'll measure each plant every 3 days. I'll record the results in a table and then make a bar graph to show the height of each plant 21 days after I planted the seeds.

Day.	Height of the plant		
	Sandy	Clay	Potting
3	1.8 cm	1.5 cm	1.8 cm
6	2 cm	1.7 cm	2 cm
9			

Step 5 Draw conclusions and communicate results.

- Analyze the data you gathered.
- Make charts, tables, or graphs to show your data.
- Write a conclusion. Describe the evidence you used to determine whether your test supported your hypothesis.
- Decide whether your hypothesis is correct or not.



Investigate Further

If your hypothesis is correct…

You may want to pose another question about your topic that you can test.

If your hypothesis is incorrect…

You may want to form another hypothesis and do a test of a different variable.

Do you think Aravind's new hypothesis is correct? Plan and conduct a test to find it!

Using science process skills

When scientists try to find an answer to a question or do an experiment, they use thinking tools called process skills. You use many of the process skills whenever you speak, listen, read, write, or think.

Think about how these students use process skills to help them answer questions, do experiments, and investigate about the world around them.

What Saketh plans to investigate?

Saketh collects seashells on his visit to the beach. He wants to make collection of shells that are alike in some way. He looked for shells of different size and shape.

How Saketh uses process skills

He **observes** the shells and **compare** their size, shape, and colours. He **classify** the shells first into groups based on their sizes and then into groups based on their shape.

Process Skills

Observe – use the senses to learn about objects and events.

Compare – identify characteristics of things or events to find out how they are alike or different.

Classify – group or organize objects or events in categories based on specific characteristics.

What Charitha plans to investigate

Charitha is interested in learning what makes the size and shape of a rock change. She plans an experiment to find out whether sand rubbing against a rock will cause pieces of the rock to flake off and change the size or shape of the rock.

How Charitha uses process skills

She collects three rocks, **measures** their mass, and put the rocks in a jar with sand and water. She shakes the rocks every day for a week.

Then she measure and **records** the mass of the rocks, the sand, and the container. She interprets her data and concludes that rocks are broken down when sand rubs against them.

Process Skills

Measure – Compare the attributes of an object, such as mass, length, or capacity to a unit of measure, such as gram, centimetre, or litre. Gather, Record, Display, and Interpret the Data

- Gather data by making observations that will be useful for inferences or predictions.
- Record data by writing down the observations in the form of table or graph in a note-book.
- Display data by making tables, charts, or graphs.
- Interpret data by drawing conclusions about what the data shows.

What Aravind plans to investigate

Aravind wants to find out how the light switch in his bedroom works. He uses batteries, a flashlight bulb, a bulb holder, thumbtacks, and a paper clip to help him.

How Aravind uses process skills

He decides to **use a model** of the switch and the wires in the wall.

He **predicts** that the bulb , wires, and batteries have to be connected to make the bulb glow.

He **infers** that moving paper clip interrupts the flow of electricity and turns off the light. Aravind's model verifies his prediction and inference.

Process Skills

Use a Model : make a model to help you understand an idea, an object, or an event, such as how something works.

Predict : form an idea of an expected outcome, based on observations or experience.

Infer : use logical reasoning to explain events and draw conclusions based on observations.

What Swetha plans to investigate

Swetha wants to know what type of towel absorbs the most water. She plans a test to find out how much water different

types of towels will absorb. She can then suggest her father which type of towel is the best one to buy.

How Swetha uses process skills

She chooses three types of towels. She **hypothesizes** that one type will absorb more water than the others. She **plans and conducts an experiment** to test her hypothesis, with the following steps:

- Pour 1 litre of water into each of the three beakers.
- Soak a towel from all the three brands into three different beakers for 10 seconds.
- Take the towel out of the water, and let it drain back into the beaker for 5 seconds.
- Measure the amount of water left out each beaker.

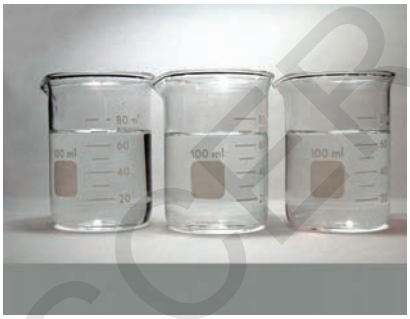
Swetha **control variables** by ensuring that each beaker contains exactly the same amount of water and by maintaining the time exactly.

Process Skills

Hypothesize – make a statement about an expected outcome.

Plan and Conduct Experiment – identify and perform the steps necessary to test a hypothesis, using appropriate tools, recording and analyzing the data collected.

Control Variables – identify and control factors that affect the outcome of an experiment so that only one variable is to be tested in an experiment.



Reading to learn

Scientists use reading, writing, and numbers in their work. They read to find out everything about a topic they are investigating. So it is important that scientists know the meaning of science vocabulary and that they understand what they read. Use the following strategies to help you become good science readers.

Before Reading

- Collect relavent information related to your topic.
- **Think:** I need to find out what are the parts of an ecosystem and how they are organized.
- Look at the **Vocabulary** words.
- Be sure that you can pronounce each word.
- Look up each word in the Glossary.
- Define each word. Use the word in a sentence to show its meaning.
- Read the title of the section.
- **Think:** I need to know what an ecosystem is. I need to read to find out what are the parts of an Ecosystem. The heading Different Ecosystem gives me a clue that an ecosystem may have both living and nonliving parts.

Let us observe the following table of endangered species

Flora and Fauna	Name of the species
Plants	Orchids species,sandalwood tree,cycas, medicinal plants, Rauvolfia serpentine etc.
Animals	Leopard, Indian Lion,Indian Wolf, Red Fox, Red Panda,Tiger, Desert Cat, Hyena etc. Gharial, Tortoise, python, Green sea turtle etc. Peacock, Great Indian bustard, Pelican, Great Indian horned bill etc. Golden monkey, Lion tailed macaque, Nilgiri Languor, Loris

Endemic Species

Observe the pictures and identify the animals. Also try to find out where these can be found?



You may find that these animals are specifically found in certain regions of the world.

You are also aware of the fact that many plants and animals are widely distributed throughout the world. But some species of plants and animals are found restricted to some areas only. Plants or animal species found restricted to a particular area of a country are called **Endemic Species.**

- Name an Endemic Species of our State?
- You may notice that kangaroo is endemic to Australia and Kiwi to New Zealand. Can you tell which among the above pictures represent an endemic species of India?

Name some other endemic species of India.

You can take help of books from your school library or internet.

During reading

Find the main idea in the first paragraph.

- Group of living things and their environment make up an ecosystem.

Find **details** in the next paragraph that support the main idea.

- Some ecosystems have only a few living organisms.
- Environment that have more space, food, and shelter have many living organisms.
- Plants and animals in an ecosystem can meet all their basic needs in their ecosystem.

Check your understanding of what you have read.

- Answer the question at the end of the section.
- If you are not sure of the answers, reread the section and look for the answer to the question.

After Reading:

Summarize what you have read.

- Think about what you have already learned about ecosystems their interaction.
- **Ask yourself:** What kind of system is an ecosystem? What interactions occur in an ecosystem?

Study the photographs and illustrations.

- Read the captions and label the parts.
- Think: What kind of ecosystem is shown in the photographs?

What are the nonliving parts of the ecosystem?

What living parts of the ecosystem are shown?

Reading about science helps you understand the conclusions you have made based on your investigation.

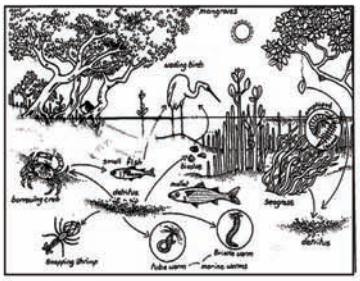
Biotic Components

Producers - magrrove, spirogyra, euglena, oscilatoria, blue green algae, ulothrix, etc.

Cosumers - shrimp, crab, hydra, protozoans, mussel, snails, turtle, daphnia, brittle Word, tube Worm, etc.

Decomposers - Detritus feeding bacteria, etc.

Abiotic components - Salt and fresh water, Air, sunlight, soil, etc.



Food web in Coringa Ecosystem

Do you know? There are over 1000 organisms living on our skin. In the chapter on microorganisms you have already seen the pictures of some of them. The biotic community consists of bacteria, fungi and small arthropods etc. The abiotic factors are dead skin cells, water, salts and oil of our sweat, air etc.

We have studied that

A living community cannot live in isolation. It lives in an environment which supplies its material and energy requirements and provides other living conditions. The living community, together with the physical environment forms an interacting system called the Ecosystem. An ecosystem can be natural or artificial, temporary or permanent.

A large grassland or a forest, a small tract in a forest or a single log, an edge of a pond, a village, an aquarium or a manned spaceship can all be regarded as ecosystem. An ecosystem can thus be defined as a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment.

(Brochure of CoP-11, Biodiversity Conference, Hyderabad, 1-19, Oct, 2012)

THE DESERT ECOSYSTEM

The desert occupy about 17% of the land and occur in the regions with an average rainfall of less than 23cms. Due to extremes of temperature, the species composition of desert ecosystem much varied and typical. The various components of a desert ecosystem.

Writing to communicate

Writing about what you are learning helps you connect the new ideas to what you already know. Scientists write about what they learn in their research and investigations to help others understand the work they have done. As you work like a scientist, you will use the following methods of writing to describe what you are learning.

In informative writing: you may

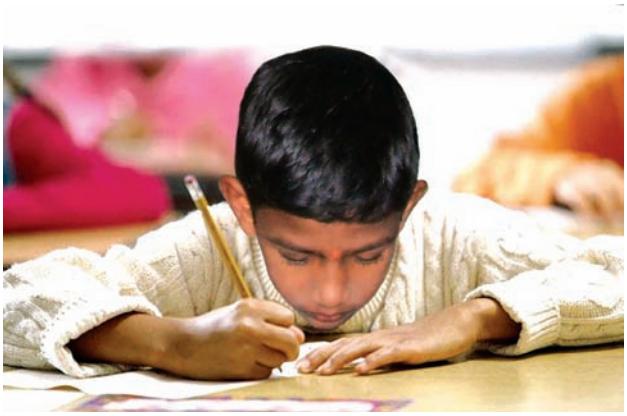
- Describe your observations, inferences, and conclusions.
- Tell how to do an experiment.

In narrative writing: you may

- Describe something, give examples, or tell a story.

In expressive writing: you may

- Write letters, poems, or songs.



In persuasive writing: you may

- Write letters about important issues in science.
- Writing about what you have learned in science helps others understand your thinking.

Measuring

Scientists make accurate measurements as they gather data. They use different measuring instruments, such as thermometer, clocks, timers, rulers, a spring balance, scale and they use beakers and other containers to measure liquids.

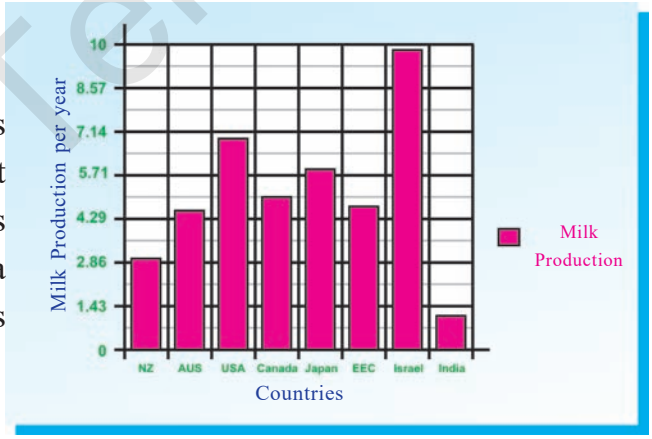
Using numbers

Scientists use numbers when they collect and display their data. Understanding numbers and using them to show the results of investigations are important skills that a scientist must have.

As you work like a scientist, you will use numbers in the following ways.

Interpreting Data

Scientists collect, organize, display, and interpret data as they do investigations. Scientists choose a way to display data that helps others understand what they have learned.



Tables, charts, and graphs are good tools to display data so that it can be interpreted by others easily.

Using Number Sense

Scientists must understand what the numbers they use represent. They compare values compute the numbers shown on graphs and record the measuring scales given on thermometers, measuring cups, beakers, and other tools.

Cows

Buffalows

Goat, Donkey, Camel

Good scientists apply their math skills to help them display and interpret the data they collect.

In your school laboratary you will have many opportunities to work like a scientist.

An exciting year of discovery lies ahead!

Safety in science

Doing investigations in science can be fun, but you need to be sure of doing them safely. Here are some rules to follow.

1. **Think ahead :** Study the steps of the investigation so you will know what to expect. If you have any questions, ask your teacher. Be sure that you understand the safety symbols that are shown.

2. **Be aware :** Keep your work area clean. If you have long hair, pull it back so that it doesn't disturb you. Roll or push up long sleeves to keep them away from your experiment.
3. **Oops! :** If you want to throw or break or cut something inform your teacher.
4. **Watch your eyes:** Wear safety goggles anytime you are directed to do so. If anything fall in your eyes, tell your teacher immediately.
5. **Yuck! :** Never eat or drink anything during a science activity unless you are permitted by your teacher.
6. **Protect yourself from shocks :** Be careful while using an electrical appliance. Be sure that electric cords are in a safe place where you can't trip over them. Don't ever pull a plug out of an outlet by pulling on the cord.
7. **Keep it clean:** Always clean up the place after finishing the work. Put everything back in their place and wipe your work area. Wash your hands.

The secret of inventions and discoveries only lies in identifying the problem. The earth revolves around the sun even before the discovery of Helio centric theory by Copernicus. In the same way the things fall down on earth even before Newton's investigations. The meaning behind that

was those people thought beyond the common man in identifying the problems. They thought and observed in unique way. We know that necessity is mother of invention, when people needed a mode to travel faster from one place to another. We discovered vehicles. In the same way to travel faster we invented supersonic jet planes and even space craft's (to learn more about the development of science go through the book History of science written by F. Cojori).

There is a sequential order in discovering things. Let us observe how your mother cooks, you also can observe how a cycle mechanic repairs a cycle, try to observe how farmer ploughs his field. You will find a systematized pattern in all these things.

Write what you observe about these patterns and discuss in groups.

How do birds and ants find their way home? Why trees shed leaves in a particular season? Likewise many more questions might sprout up in your brain. Try to answer them in your own way. For this you need to follow a sequential order, please go through the following steps.

1. Identifying problem - Let us identify any problems from your surroundings
   Ex: The bulb is not glowing in the room.
2. Making hypothesis - List out different solutions possible for the identified problem.
   Ex: De filament, fuse failure, switch problem, wire problem.
3. Collecting information- To solve the identified problem, collect required material, apparatus, Information, and persons to be consulted.
   Ex: Collect material like tester, screwdriver, wooden scale, wires, insulation tape, table and blade.
4. Data analysis - Arrange the collected data or information to conduct experiment.
5. Experimentation- Conduct experiment to prove selected hypothesis.
   Ex: Observe filament of the bulb.
6. Result analysis - Analyzing the results to find out the solution for the problem based on the results you need to select another hypothesis to prove.
   Ex: Filament of the bulb is good in condition, so we need to observe the fuse.
7. Generalisation - Based on the experiment and its results explain the solution for the problem.
   Ex: Fuse is damaged so the bulb did not glow, so we need to replace the fuse.

This is the way to find out solutions for the problems in a scientific way. You may also select such problems and, find out your own solutions.