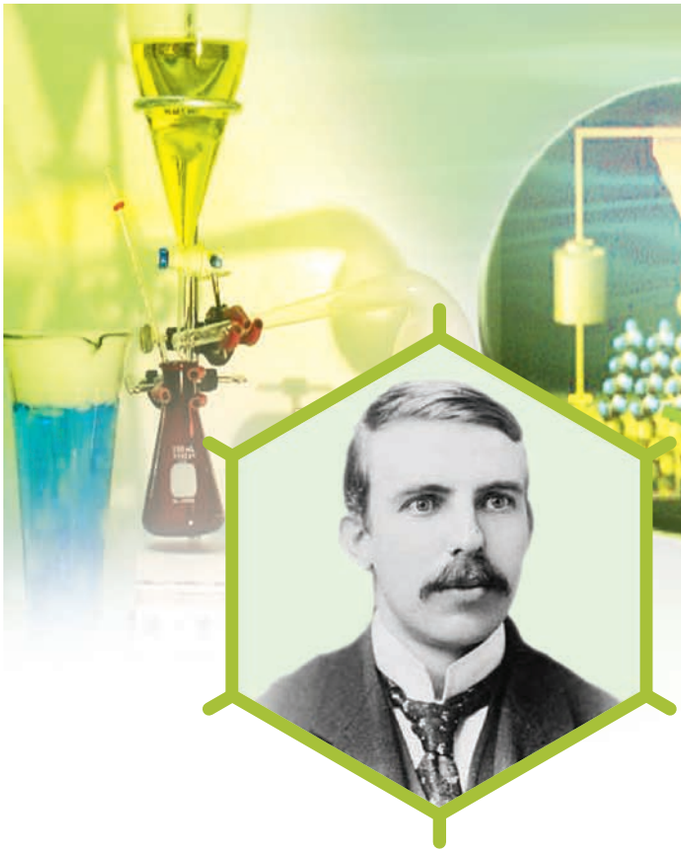


CHAPTER 7

THINGS AROUND US

with ERNEST RUTHERFORD

Ernest Rutherford (30 August 1871–19 October 1937), a physicist from Nelson, New Zealand, was known as the father of nuclear physics. Nuclear physics is the field of physics that deals with the study of structure of an atom, the smallest particles that matter is made up of. According to him, just as the planets in the solar system move around the sun, the electrons in an atom revolve around a central, sun-like nucleus. For this he was awarded the Nobel Prize in Chemistry in 1908.

I am Ernest Rutherford. The world still remembers me for the work I had done on the study of matter up to the minutest level. In this chapter, I will be introducing you to different things around you from the perspective of chemistry because as a discipline chemistry deals with the study of materials. Materials have always existed around us; it is just that we need to keenly observe the variety in them and appreciate the purposes they are used for. As a future researcher in material science engineering, you must understand the natural things around you to be able to synthesise a product that may solve the future problems of mankind such as depletion in fuel reserves, release of greenhouse gases, preservation of food, etc.

Have you ever observed the things around you? What are they made up of? Are they made of same or different materials?

What you already know...

If we look around, we see many objects such as toys, balloons, clothes, food items, plants, plastic plates, hammers, locks, pencils, stones, chalks, etc. of different shapes, sizes and colours. Some of the materials are natural and some are man-made. Some materials are living while others are non-living. Certain things exist, yet they cannot be seen with naked eyes, such as air or microscopic germs. Before we go ahead, why not do an activity to check your knowledge.

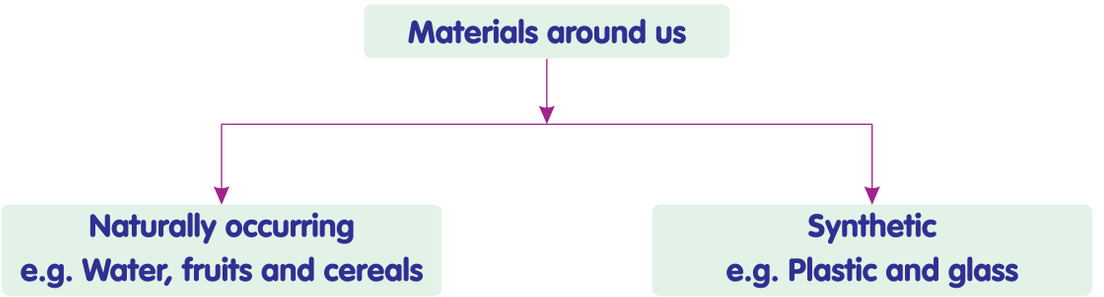
Identify and list six living and six non-living objects around you. Can you think of some other way you could classify these things. If so, group them accordingly in the follow-up journal.

What you need to know...

Things Around Us

You must have observed that different objects are made of different materials. This table is made of wood. However, you might find a table made of steel as well. Similarly, a bucket can be made of iron or plastic.

Things or objects around us are made of various materials. These materials can be naturally occurring or man-made. Cotton, fruits, all kinds of cereals and water are a few examples of natural materials. Man-made materials are also called synthetic[1] or artificial materials. Some of the man-made materials around us are plastic, glass, steel and nylon.

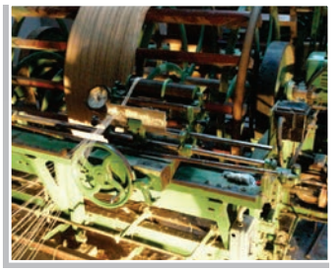


1. **synthetic** : a substance produced from artificial substances

Most of the times, we do not use a natural material as it exists. We need to process it to bring it to a usable state. Have you ever wondered how clothes are made? Clothes are made by weaving or knitting yarns into fabrics. The yarns are made up of still thinner strands called fibres. Fibres in turn could be obtained from naturally occurring materials or they may be synthesised artificially. Natural fibres are further grouped into plant fibres and animal fibres.

A good example of a natural plant fibre is cotton. The cotton used for spinning into yarn is taken from ripe and dry seeds of cotton plants. The fibres are processed by ginning, converted into threads or yarns by spinning and are woven to make cotton clothes.

Table 1. To make fabric[1] from plant fibres

Method of making fabric from cotton and jute fibres		Devices used (hand and machine)	
Ginning ↓	The matured cotton bolls burst open and the seeds are covered with white cotton fibres. Farmers pluck them and the cotton is separated from seeds. This process is called ginning.		
	In the case of jute, at the harvesting stage, the stem is cut and immersed in water to rot. Fibres are then separated and dried for further processing.		
Spinning ↓	The cotton is converted to yarns by drawing out the fibres and twisting them. This process that brings the fibres together to form yarn is called spinning. Similar process is followed in producing jute fibres as well.		
Weaving	Weaving is the process of arranging two sets of yarns together in a crisscross manner to make a fabric that is then used to make clothes.		

1. **fabric** : any cloth made from yarns or fibres by weaving or knitting

Besides cotton flowers and jute stem, plant fibres can be obtained from coconut, flax, bamboo and banana plants. Animal fibres can be obtained from the fleece of sheep and the hair of animals like goats and camels. Silk is another animal fibre obtained from the cocoons of silkworms. Synthetic fibres are man-made. They can be artificially prepared from petroleum products by various chemical processes. Some of the commonly used synthetic fibres are nylon, rayon and polyester. You will learn more about animal and synthetic fibres in higher classes.

What you need to do...

Given below is a series of pictures to show the process of making jute fibres. Prepare a write up linking and describing the process. Note it down in your follow-up journal.








What you have learnt...

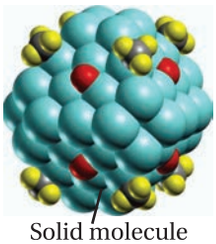
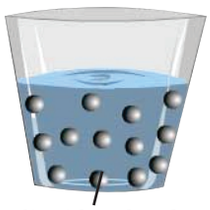
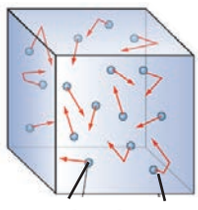
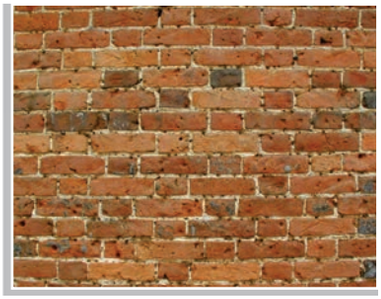
Things are made up of various materials. Materials can be natural fibres or man-made fibres. Synthetic or man-made fibres are made by processing natural fibres or other chemicals such as plastic and polyesters.

What you need to know...

Matter

You must have observed that there are basically two properties common to all materials. All of them occupy space and have some mass. Scientifically speaking, everything around us is matter. All matter is made up of tiny particles. The arrangement of these tiny particles decides the form of matter.

According to varying conditions of temperature and pressure, the matter in the universe exists in three different forms, i.e. solid, liquid and gas.

	Solid	Liquid	Gas
Properties	They are hard. They occupy a definite volume and have a definite shape.	They have a definite volume but no definite shape. They take the shape of the container they are poured in.	They do not have definite shape or volume. They move randomly and freely from one place to another.
Molecular arrangement	 Solid molecule	 liquid molecule	 gas molecule container
	They have closely packed molecules arranged regularly. The distance between two molecules of a solid is very less.	They have loosely packed molecules and are not arranged regularly. The molecules of a liquid are loosely connected to one another.	The gas molecules move randomly and freely from one place to another and are spread evenly throughout the spaces they occupy. They move in all directions.
Examples	Iron handle of a door, a gold necklace or ring, brick, ball, wood, ice	Water, orange juice, milk, oil, tea	Air, water vapour, steam, carbon dioxide, hydrogen, helium
			

The earth is made of rocks, mountains and soil. These are all solid forms of matter. The earth also has water in oceans, seas, rivers, etc. in the liquid state that helps sustain life. It also has a blanket of air around it, which is in the gaseous state. With every change in the state, the shape and volume of matter also changes.

What you need to do...

Observe the changes in the shape and volume of water as:

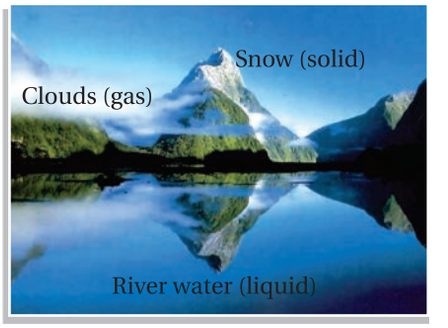
a. It freezes into an ice cube

b. It changes into vapours

Record your observations in the follow-up journal.

Interchange in the States of Matter

The states of matter are interchangeable. The solid state of water is ice that has compactly packed molecules. When ice melts on heating, it changes to its liquid state (water) that has loosely packed molecules and can acquire the shape of any vessel it is kept in. When water is heated, it changes to its gaseous state (water vapour) that has randomly moving molecules. The water vapour molecules escape in the air or move about freely within the closed vessel. On cooling, the water vapour changes back to liquid and then to solid.



Solid ⇄ Liquid ⇄ Gas

(heat: Solid → Liquid; cool: Liquid → Solid; heat: Liquid → Gas; cool: Gas → Liquid)

What you need to do...

Boil water and observe the form in which it disappears. In addition, you must have noticed that when a candle is burnt, both the wax and the wick get used up entirely. Where do they go? Record your observations in the follow-up journal.

So, you can see that in both cases, i.e. heating and cooling, although matter changes its form, it is neither created nor destroyed.

What you have learnt...

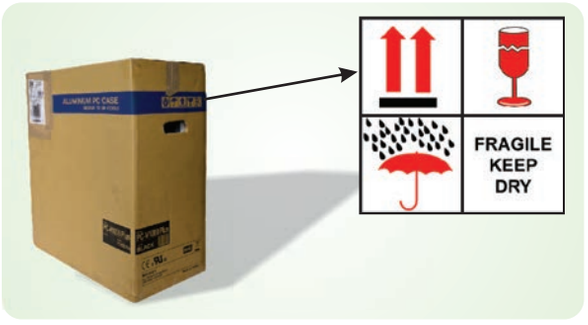
Everything around us is matter. Matter occupies space and has weight. The forms of matter are interchangeable. Matter can neither be created nor destroyed but it can change from one form to another.

What you need to know...

Properties of Materials

Just imagine what will happen if we cook rice in a wooden utensil? Before the rice gets cooked, the wooden vessel will get burnt. However, if the vessel is made of metal, it will not catch fire and the rice will get cooked. So, it is very essential to know the properties of any material well before using it for a specific purpose.

Have you ever noticed the quality tag attached to the garments you purchase? Generally, this tag tells you whether the dress should be dry cleaned or hand washed or what type of fibre it is made of. Similarly, a carton containing a breakable or fragile object such as a crystal bowl has the words 'Handle with care' written on it. The words 'Highly flammable' can be seen on an oil tanker because oil can catch fire very easily. This means that materials must be stored or handled differently depending upon their properties.



Let us learn more about the basic properties of materials.

1. Roughness and Lustre

Some materials such as wood have rough surfaces, whereas some materials such as steel have a smooth surface. All objects made of metals have the tendency to shine as their surfaces reflect light. It is because of the lustre that metals such as gold, silver and platinum are used for making ornaments.

Rusting of Iron

Metals and metal alloys[1] lose their lustre when left exposed to air. This happens due to the reaction of metal surface with oxygen that leads to the formation of a thin layer of metal oxide[2] on the surface, thus giving it a dull appearance. Rubbing this surface with sand paper will make the surface smooth and lustrous. That is why silverware needs to be frequently polished for maintaining its lustre.

2. Hardness

If you rub a stone on a surface of a wooden table, what will happen? The wooden surface will get scratched. That means stone is harder than wood. Glass is also a hard substance. Diamond is the hardest naturally occurring substance. Therefore, diamond is used for cutting and shaping glass. Cotton and rubber are soft substances. Talcum prepared from soapstone is the softest substance.

Diamond Glass Glass cutter

Metals are malleable and ductile

Generally, hard substances cannot be compressed, whereas soft substances such as wool can be compressed. If you try to compress a stone by striking it with a hammer, it will break into pieces because stone is a hard and brittle substance. On the other hand, if you hammer a piece of metallic wire, the wire will become flat at the area of impact. This shows that metals (except mercury) are hard but malleable[3]. They can be expanded and moulded into various shapes. They are also ductile, i.e. they can be easily drawn into wires.

Hard and brittle stone

If you were to choose a material for making locks, which material will you choose from the following: stone, rubber, plastic, wood or metal?

Obviously, to protect your house, you need a lock that is strong enough to withstand any kind of force, and cannot be burnt or dissolved in water. So, now you know why the knowledge of properties of materials is essential.

1. **alloy** : substances formed by mixing two or more metals
2. **metal oxide** : metals when in contact with oxygen form metal oxides
3. **malleable** : easy to shape or bend

3. Solubility

The capacity of a substance to dissolve in a liquid is known as its solubility. For example, solids like stone and metals are insoluble in water, whereas salt, baking powder and detergents dissolve in water easily.

When a liquid is completely soluble in water or any other liquid, they are called miscible liquids. Liquids such as water, alcohol and vinegar are miscible. The liquids that do not mix with each other are called immiscible liquids. Oil is immiscible with water. In spite of mixing them well together, oil floats as a separate layer on the surface of water. However, liquids that are immiscible with water may be miscible with other liquids. For example, coconut oil, kerosene oil and petrol are immiscible in water but are miscible in one another.

Immiscible liquids

Most of the gases such as hydrogen and nitrogen are insoluble in water, whereas oxygen and carbon dioxide are slightly soluble in water. Have you ever wondered how plants and animals survive in water? It is because they use the gases dissolved in water for breathing and making their food.

What you need to do...

Step 1: Place a few rock sugar candies in a beaker filled with water. Do not stir. Record the time it takes for the candies to completely dissolve in water.

Step 2: Place a few rock sugar candies in the second beaker filled with water. Stir it till the candy lumps dissolve completely. Record the time taken to dissolve these candies.

Step 3: Take a few candy lumps and crush them into powder. Put this powder in the third beaker. Stir it once. Record the time taken for the candy powder to dissolve.

Which one is the fastest way to dissolve rock sugar candies?

You could repeat this experiment by placing sugar candies in your mouth one by one. Observe the time taken by the first candy to dissolve in your mouth without moving the candy back and forth with your tongue. Record the time taken by the second candy to dissolve by moving the candy back and forth with your tongue but strictly not chewing it. Record the time taken by the third candy to dissolve by moving it around and chewing it.

The candy quickly dissolves when it is crushed, chewed or moved back and forth.


Rock sugar candies

4. Transparency

We can see through some objects clearly. Such objects are transparent because they allow light to pass through them. For example, glass and diamond are transparent. Air and water are also transparent.

Objects through which we can see partially are called translucent objects. The translucent objects are those that allow light to pass through them partially. Frosted glass and butter paper are few examples of translucent objects.

Objects through which we cannot see are called opaque objects. These objects do not allow light to pass through them. Metals and wood are opaque in nature.

5. Conductivity

The ability of a substance to allow heat and electricity to flow through it is called conductivity.

a. Conductivity of Heat

The tendency of certain materials to permit the flow of heat through them is called thermal[1] conductivity because it leads to the change in the temperature of a substance. This property varies from material to material.

Conductivity of heat

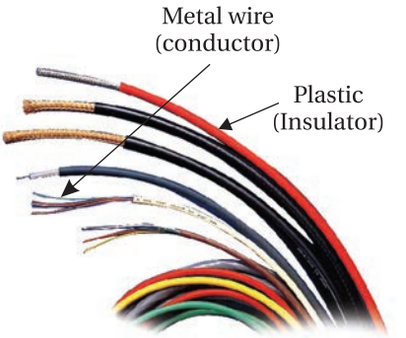
A pressure cooker is made of aluminium but the handle is made of plastic. Aluminium is a good conductor of heat, whereas the plastic handle is a bad conductor of heat. Due to this property, you are able to remove the pressure cooker from fire by holding the handle.

All metals are good conductors of heat, whereas materials such as wood, rubber, plastic and asbestos are bad conductors of heat. Except mercury, all liquids are poor conductors of heat. Compared to a solid, air conducts heat more slowly. This property of air is a blessing for us as when air gets trapped in the fibres of our woollen clothes, it does not allow our body heat to escape easily and thus keeps us warm.

b. Conductivity of Electricity

Some materials are used in electrical appliances due to their property of electrical conductivity. Passing of electric current from one end of an object to another end is called conduction of electricity. Substances that allow electric current to pass through them are called conductors, whereas substances that do not allow electric current to pass through them are called insulators.

All metals are good conductors of electricity. Wood, plastic and rubber are examples of insulators. Copper or aluminium wires have a plastic or rubber coating on them so that a person does not suffer from an electric shock on touching them.



Conductivity of electricity

1. **thermal** : ability of a substance to carry heat

Have you ever heard of optical fibers? It is glass moulded into a thin wire-like structure. It is transparent and uses reflection of light to convert electrical signals for communication. Can you gather more information on this material based on its properties?

Optical fiber

What you need to do…

While playing in the park, you spotted something strange in the sky. It was an unidentified flying object (UFO). As it came closer for landing, its two doors opened and something fell down. And the next moment the UFO vanished into air. You ran to the spot to see what had been dropped. It was a lump of jelly-like substance of the size of a football. It was non-sticky and ductile, fluorescent and a non-conductor of heat but a good conductor of electricity. What all purposes will you use this substance for?

Discuss in groups of four and note down the uses in your follow-up journal.

6. Magnetism

Certain materials that get attracted to magnets are called magnetic materials. Iron, steel, nickel and cobalt are magnetic in nature. Materials such as wood and cotton do not get attracted to a magnet and are non-magnetic. Magnetic material are used in telephones, televisions, toys, etc.

7. Combustibility

The property of certain materials to burn when heated in the presence of air is called combustibility. Solid substances such as dry wood and charcoal are combustible in nature. Water and various fruit juices are incombustible. However, petrol, kerosene and alcohol are combustible liquids. Such substances are generally used as fuels for various purposes such as cooking, heating, etc.

Forest fire

Among gases, hydrogen is the lightest and the most combustible gas. LPG[1] is a gas used for cooking purposes, whereas CNG[2] is used for running automobiles such as buses, cars, etc. Nitrogen and carbon dioxide are incombustible gases. Oxygen is also an incombustible gas, but it helps in combustion. All combustible substances burn only in the presence of oxygen.

LPG cylinder

What you need to do…

Take four diyas. In one diya, place some cotton balls. In another diya, place a cotton ball dipped in oil and in the third, place a wet cotton ball. In the fourth diya, place cotton in wax. Light all the diyas and find out whether oil, water, cotton and wax are combustible. Record your findings in the follow-up journal.

1. **LPG** : liquified petroleum gas used in homes for cooking
2. **CNG** : compressed natural gas is a very cheap fuel for automobiles and causes less pollution

What you have learnt…

The things around us could be made from one or more materials. Different materials have different properties. The materials can differ in their appearance, solubility in water, transparency, conductivity, combustibility, etc. The use of these materials depends on their properties.

What you need to know…

Changes Around Us

Materials may undergo changes in their physical or chemical forms due to difference in temperature or pressure leading to new properties. Material can also react with other materials resulting in an absolutely new product.

On heating, wax changes into liquid, but on removing the source of heat, the wax slowly regains its solid state. This is a reversible change.

Now just think what happens when a spoonful of curd is added to milk. After a few hours, the milk also changes to curd, which is semi-solid and sour to taste. But, the curd cannot be changed back into milk. This is an irreversible change.

In other words, things around us are subjected to change due to various reasons. The changes such as heating, cooling, application of force or a reaction lead to the formation of new products. These changes may be temporary or permanent in nature. Some changes may be fast and some may be slow.

Look at the table below and understand the effect of changes on different substances.

CHANGE	CAUSE	EFFECT	NATURE OF CHANGE
Burning of cooking gas	heat or spark	fire	fast and irreversible
Sprouting of a seed	favourable conditions	germination	slow and irreversible
Rusting of iron	reaction with damp air	rusting of iron	slow and irreversible
Lighting of bulb	electric current	glowing of bulb	fast and reversible
Burning of paper	fire	turning into ash	fast and irreversible
Mixing salt in water	solubility	formation of salt solution	reversible and can be made faster
Cooking of egg	heat	cooked egg	fast and irreversible
Fermentation of juice	action of bacteria	fermented juice	slow and irreversible
Freezing of water	cooling	ice	slow and reversible
Change of seasons	revolution of sun	new season	slow and periodic

So, now you know that some changes may lead to the formation of a new product. Sometimes, it may or may not be possible to obtain the original material again. Based on this observation, we can distinguish the changes as physical or chemical changes.

In a physical change, the characteristic properties of a substance remain unchanged. No new substance is formed. It is reversible and temporary in nature.

When a new substance is formed with absolutely different characteristic properties from those of the original substance, it is a chemical change. It is irreversible and permanent in nature as it leads to the formation of a new substance with different molecular structure. A few physical and chemical changes are mentioned below:

PHYSICAL CHANGE	CHEMICAL CHANGE
Dissolution of sugar in water	Milk processed into cottage cheese
Stretching of a rubber band	Growth of a child to adult
Moulding of clay	Curdling of milk
Knitting	Burning of paper producing ash
Cooling of milk	Plants carrying out photosynthesis
Evaporation of water	Burning of wax in air producing carbon dioxide
Blowing up a balloon	Addition of washing soda and lemon juice to water releasing carbon dioxide and other residues
Crumbling a piece of paper	Decomposition of fallen leaves into compost
Change of wood to a baseball bat	Passing of electricity through water releasing hydrogen and oxygen gases
Expansion of iron on heating	
Soaking of dry soil	

What you need to do…

Read the story given below. Identify the physical and chemical changes concealed in the story and note down in the form of a table in your follow-up journal.

Today is Ridhima's birthday. She has invited many friends to her house. She wants to help her mother in making arrangements for the party. Ridhima cuts the vegetables, shreds the cheese for the salad and boils eggs for slicing.

Mother has decided to cook some macaroni. Ridhima mixes the ingredients for the macaroni, while her mother cuts the potatoes and places them in a pan to fry. Earlier, mother had made custard and kept it aside for cooling. Ridhima put the custard in the refrigerator so that it could cool and set. In the meantime, her mother put the cake mix and other ingredients into a bowl, beat it until fluffy, placed it in a pan and put it in the oven for baking.

When the macaroni was cooked right through, the French fries were golden brown and the cake was baked just right, her friends dropped in. After everyone enjoyed the evening, it was time for them to have a hot chocolate drink. Ridhima boiled some water and poured it into mugs. Instant cocoa powder, cream and sugar were added to the mugs. Later, her mother and Ridhima cleaned up the scraps and placed them in the garbage can. They washed the dishes in steaming hot water and dried them.

It was time for Ridhima to iron her clothes for going to school the next day. While searching for an iron, she broke a crystal bowl in which mother had poured milk to set curd. She felt sorry about it, but her mother did not say anything as it was her birthday.

What you have learnt…

Things around us keep changing all the time. Some changes are fast and some are slow.

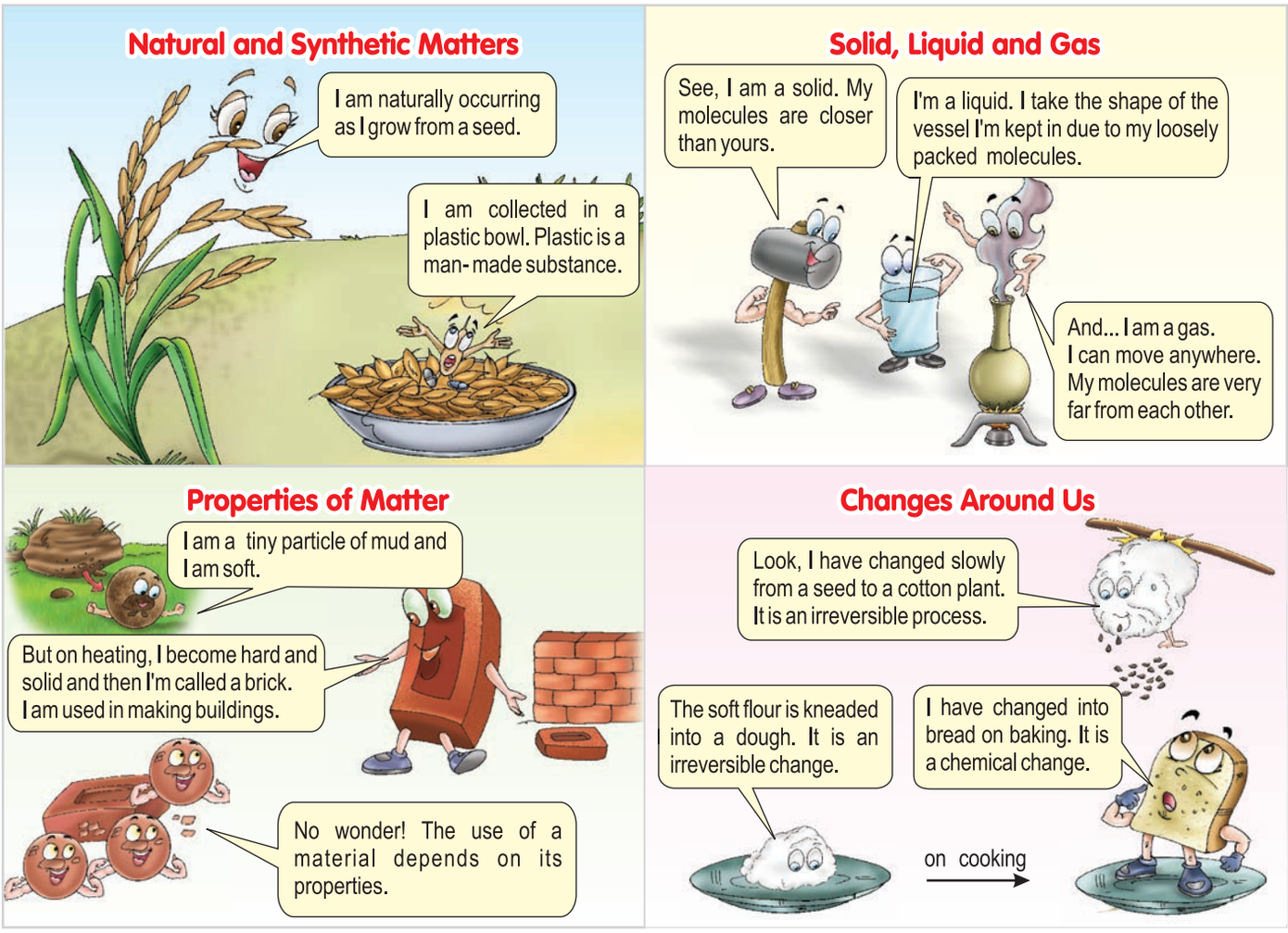
The changes occur due to the action of heat, force or reaction with other substances.

They may be reversible or irreversible. Most of the physical changes are reversible.

Most of the chemical changes lead to the formation of a new product that differs from the original substance in composition.

Are you wonderstruck by the knowledge of different materials around us? Knowing their properties may help you to research and develop new kinds of materials. The existing man-made materials such as plastic are non-biodegradable.
When you make a new material, ensure that it is eco-friendly, non-toxic and extremely useful for well-thought-of purposes. Till then, bye...!

What you need to remember...



Time to work out...

1. What are natural and synthetic materials? Give a few examples.
2. What do you mean by solubility of a substance?
3. What do you mean by ginning?
4. Distinguish between a chemical change and a physical change.
5. Compare the solid and liquid states of a substance.
6. Rusting of iron is an irreversible and slow process. Explain.
7. "Matter can neither be created nor destroyed." Comment.
8. "Diamond can cut glass." Give reason.

9. Classify the following as reversible and irreversible changes:
   a. Melting of ice
   b. Growth of a plant
   c. Baking of a cake
   d. Melting of chocolate
   e. Dissolving of salt in water
10. Why is it necessary to know the properties of different materials?

For the apprentice...

You are provided with natural and synthetic materials such as coins, clay, rocksalt, cotton, nylon and turmeric powder.

Study these materials and write their properties. The materials could be examined for their hardness or softness, lustre, conductivity to heat, transparency and solubility.

You will observe that the properties change across materials. This will help you gain knowledge about materials and how to use them carefully in everyday life.

(CAUTION: This activity should be performed in the presence of a teacher or a supervisor.)

Happy Surfing……Click…..Click…

Know more about Ernest Rutherford at:
http://nobelprize.org/nobel_prizes/chemistry/laureates/1908/
http://www.pbs.org/wgbh/aso/databank/entries/bpruth.html

Know more about atoms and molecules at:
http://ull.chemistry.uakron.edu/genobc/Chapter_02/
http://www.chem4kids.com/files/atom_intro.html
http://www.chemistry.mcmaster.ca/aim/aim_0.html

Tool Kit ..... Cotton wool, silk thread, wool thread, nylon thread, watch glass, slides, slide covers, shape blade