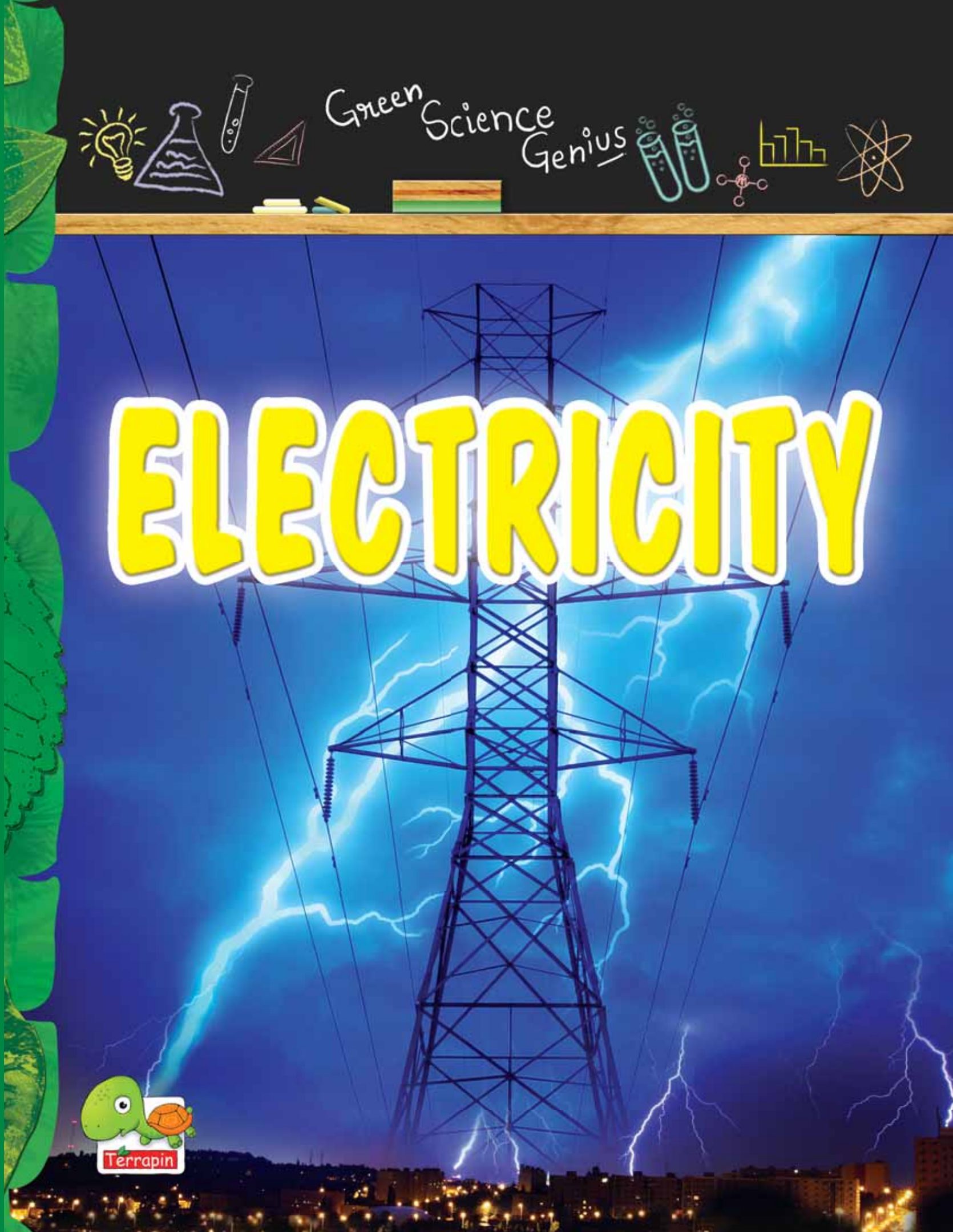
Green Science Genius

ELECTRICITY



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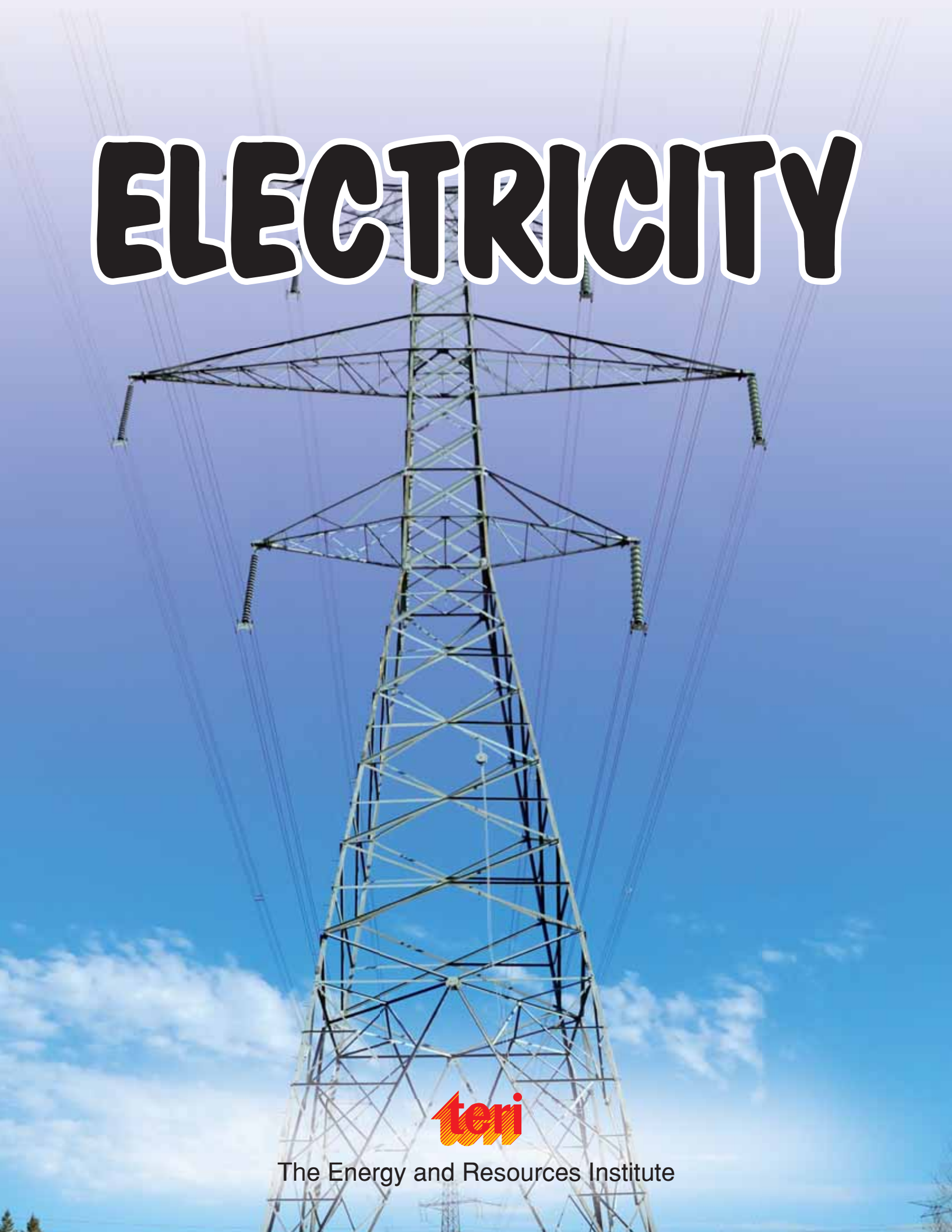

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The Energy and Resources Institute

A note from Dr R K Pachauri

Human society has made remarkable progress in the field of science and technology during the past century. We have crossed boundaries in space exploration and genetics, and have also made enormous strides in the development of technologies. However, some of these changes have brought with them problems that affect our natural resources. We have endangered our flora and fauna, polluted our water resources and contaminated the air we breathe. In order to reverse the damage to our environment, we must ensure that future developments in science are in harmony with nature.

This series explores the fundamental scientific concepts of light, sound, energy, and electricity. For example, is light made up of waves or particles? How does noise pollution affect us? What are the different sources of electricity, and how is the power in our homes generated? These concepts acquire greater meaning in today's world, where science and technology offer us ideal solutions to problems that have put our planet's future at risk.

I hope that those who read these books will not only enjoy them, but will also feel inspired to protect the beautiful world of science brought alive on these pages. Children, being the future custodians of Planet Earth, are in a unique position to create a beautiful, peaceful, and healthy future for the human race.

R K Pachauri
Director-General, TERI
Chairman, Intergovernmental Panel on Climate Change

contents

What is electricity?

Around 600 BC, a Greek mathematician named Thales noticed that when amber (a substance obtained from trees) was rubbed against fur, it attracted small objects like hair. The Greeks called amber 'elektron', from which electricity got its name.

Hair dryer

Powering the world

Flick a switch and the lights come on in a room. Press the remote and an air conditioner starts. Push a button and a computer comes to life. Each of these things happens because of electricity.

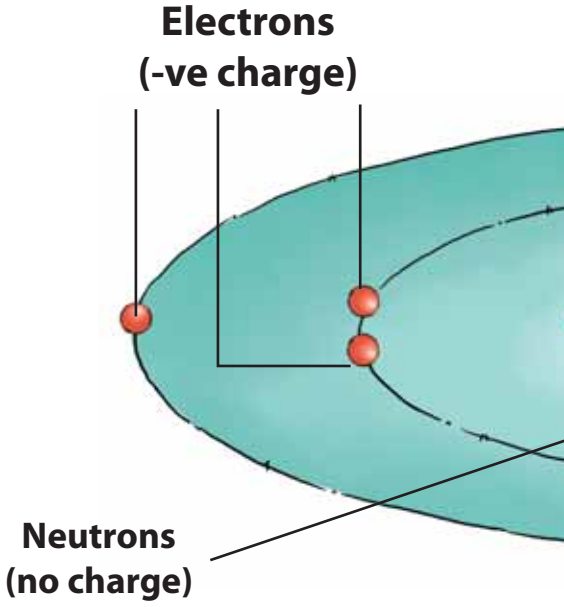
Every day, we use electricity in hundreds of ways. To get a rough idea, just think of the appliances around you that have a wire attached to a plug, and devices that operate on batteries. But what is electricity? How is it produced? And how does it work for us?

Toaster

Iron

Electronic oven

Vacuum cleaner



Charged up

To understand electricity, we first need to learn about **atoms**. Atoms are small particles we cannot see. But they are part of everything around us. The tiny atom is made up of even smaller particles called **electrons**, **protons**, and **neutrons**.

Electrons and protons contain energy called electrical charge. There are two types of charges—positive **(+)** and negative **(-)**. Protons carry positive charge, electrons carry negative charge, while neutrons do not have any charge. Electricity is defined as the presence of electrical charge, as well as the movement of these charges.

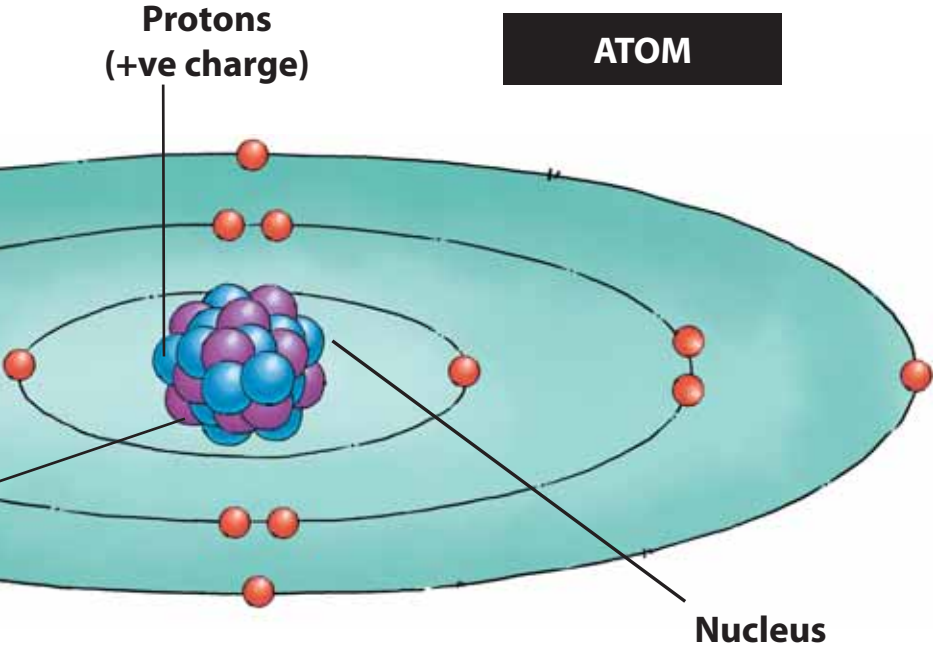
Opposites attract

As long as an atom has an equal number of protons and electrons, we call the atom balanced. In other words, it is neither positively charged nor negatively charged.

However, electrons can jump from one atom to another. When this happens, the atom that loses electrons becomes **positively charged**, while the atom that gains electrons becomes **negatively charged**. A positively charged atom and a negatively charged atom attract each other.

FACT SWITCH

Electricity needs to be converted into other forms of energy to be useful to us. For example, it gets converted into light energy in a light bulb, mechanical energy in a fan, and sound energy in a speaker.



SPARK OF KNOWLEDGE

In 1791, Luigi Galvani, while dissecting a frog, found out that nerve cells use electricity to send information to muscles. This form of electricity is called bioelectricity.

Static electricity

When we rub a balloon against a shirt sleeve and then hold it close to the shirt, the balloon sticks to the fabric. In fact, the balloon will stick to hair, and even to a wall! This happens because of attraction between positive and negative electric charges.

Sticking and shocking

When the balloon was rubbed against the sleeve, some electrons jumped from the shirt to the balloon. Thus, the sleeve became positively charged; while the balloon became negatively charged by gaining electrons. These bodies with opposite charges attracted each other, causing them to stick to one another. A charged object will also attract a neutral body.

Like the balloon, many other objects get charged or electrified, when rubbed against another object. The electric charge is stored on the surface of the object. The presence of such charge is known as **static electricity** or electricity at rest.

Sometimes, we feel a slight electric shock on touching a metal doorknob. This is also static electricity in action. When we touch the knob, electrons from our fingers leap into the doorknob, making it negatively charged. However, the finger is positively charged. The mild shock is a result of the quick movement of these electrons.

The stingy and the sharers

Atoms of materials such as ceramic, plastic, rubber, and glass are made up of electrons that are tightly bound and do not move around freely. That is why they do not share their electrons easily. Such materials are called **insulators** because they do not allow electricity to pass through them.

A balloon gets charged by rubbing it against a sweater, as it picks up extra electrons and acquires a negative charge. It will also attract objects that are neutral such as hair or paper.

Plastic is a good insulator of electricity for low to moderate voltages. It is used to manufacture miniature circuit breakers (MCBs) that protect an electric circuit from damage caused by overload or a short circuit.

On the other hand, **conductors** are materials that allow electric current to pass through easily. These have plenty of free electrons that travel together through the material forming an electron flow, or current. Metals such as copper, aluminium, and silver, and non-metals such as carbon are good conductors.

Besides conductors and insulators, there are semiconductors—materials like silicon and germanium that have electrical properties somewhere in between those of a conductor and an insulator. These have very few free electrons, as their atoms are closely grouped together in a crystalline pattern. However, the electrical conductivity of semiconductors can be greatly improved by adding certain 'impurities' to the crystalline structure, which lead to more free electrons.

Be shockproof

Synthetic materials like polyester pick up a lot of static charge. But clothes made of natural fibres like cotton protect us from static shocks. Also, dry skin is more prone to such shocks. So, using a hand lotion helps.

FACT SWITCH

In the 1900s, Christmas lights were so expensive that having a Christmas tree with electric lights was considered a status symbol.

SPARK OF KNOWLEDGE

Lightning is caused when electrons move between a cloud and the ground or between two clouds. The electrons bump into air molecules, heating them up, resulting in a bolt of lightning.

Green Science Genius : Electricity

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