



Gurukul Technicals Institute

Computer education · Robotics · Science projects · Delhi

FREE EBOOK

SCIENCE PROJECTS AND KITS

Science Projects for Class 9 and 10

Models and experiments for high-school physics, chemistry and biology

INSIDE THIS BOOK

- Choosing a project that fits your syllabus
- Force, motion and sound
- Electricity and magnetic effects
- Light
- ...and 4 more chapters, practice questions and a glossary

Intermediate

Students of class 9 and 10

engineergurukul.com

+91 97116 99511

Science Projects for Class 9 and 10

Eighteen science projects matched to class 9 and 10 topics, from Newton's laws and Ohm's law to electrolysis, photosynthesis and heredity. Each project gives the principle, the materials, safe numbered steps, what you should observe and the viva questions examiners ask, so you can build it, explain it and record it well.

WHO IT IS FOR	Students of class 9 and 10
LEVEL	Intermediate
SUBJECT AREA	Science projects and kits
WHAT IS INSIDE	8 chapters, practice questions with answers, and a glossary

HOW TO USE IT

Read one chapter at a time and try the examples as you go: on a computer, at your workbench or in your notebook. The boxes give tips, safety points and short activities. When you finish, test yourself with the practice questions and check your answers at the end. Words you may not know are explained in the glossary.



Gurukul Technicals Institute

A-10, Chief Commissioner Colony, opposite Rana Pratap Bagh, Delhi 110007
Phone 011 2721 1512 · Mobile and WhatsApp +91 97116 99511
engineergurukul@yahoo.co.in · engineergurukul.com

Free ebook. You may read, print and share this ebook for learning. It may not be sold or changed.

© 2026 Gurukul Technicals Institute. First edition, October 2026. The information was checked when it was written; software, prices and rules change, so for anything official always check the latest source.

What you will find inside

1	Choosing a project that fits your syllabus	4
2	Force, motion and sound	5
3	Electricity and magnetic effects	7
4	Light	11
5	Chemical reactions	14
6	Life processes and control	17
7	Heredity and the environment	19
8	Recording observations and facing the viva	22
	Practice questions	23
	Answers	24
	Glossary	25

Choosing a project that fits your syllabus

A good project shows one science idea clearly and helps you understand a chapter you will be tested on. So start from your textbook, not from a photo you saw somewhere.

Linking projects to topics

Syllabuses change from time to time, so check your current textbook, and ask your teacher which chapter a topic belongs to.

Topic	Usually studied in	Projects in this book
Force and laws of motion	Class 9	Newton's laws demo kit
Sound	Class 9	Sound wave model
Electricity	Class 10	Verifying Ohm's law
Magnetic effects of current	Class 10	Solenoid, electric motor, generator
Light	Class 10	Glass slab, human eye model, lens power
Chemical reactions, acids, metals	Class 10	pH testing, reactivity series, electrolysis
Life processes	Class 10	Photosynthesis, respiration
Control and coordination	Class 10	Reflex arc model
Heredity	Class 10	Heredity bead model
Our environment	Class 10	Ozone layer model, waste management model

How each project is set out

Every project gives the **principle** (the science idea), what **you need**, numbered **steps**, the **observation** you should make, and **viva** questions with short answers. A **viva** is a short spoken test about your own work.

Safety rules for every project

1. Use only cells and batteries, up to 12 V. Never connect anything to a wall socket.
2. An adult must handle chemicals, flames, boiling water, sharp cutters, soldering irons and hot glue guns.
3. Never taste a chemical. Wear gloves and goggles for chemicals, and wash your hands afterwards.
4. A wire joined straight across a cell is a **short circuit**: it gets hot and drains the cell. Disconnect circuits when you are not testing them.

Picking your project

Ask four questions. Does it interest me? Can I get the materials? Can I finish in time? Can I explain it in my own words? Choose a project with four "yes" answers.

EXAMPLE

Kabir from Pune had two weeks for a physics project and chose Ohm's law. He borrowed a multimeter from the school lab and bought four cells (! 80), four single-cell holders (! 60) and a resistor (! 2). His project cost ! 142.

CHAPTER 2

Force, motion and sound

These two class 9 projects use things you can find at home.

Project 1: Newton's laws demo kit

Principle: First law: a body stays at rest, or keeps moving in a straight line, unless a force acts on it. This tendency is called **inertia**. Second law: force equals mass times acceleration ($F = ma$). **Acceleration** is how fast the speed changes. Third law: every action has an equal and opposite reaction.

You need: a glass tumbler, a postcard, a ! 5 coin, two identical toy cars, clay to load one car, a rubber band, two nails in a plank, 4 metres of string, a straw, a balloon and tape.

Steps:

1. **First law.** Put the postcard on the tumbler and the coin in the middle of the card. Flick the card away sideways, sharply.
2. **Second law.** Stretch the rubber band between the nails. Pull the empty car back against it to a pencil mark, let go and measure how far it rolls. Load the other car to about twice the weight and launch it from the same mark.
3. **Third law.** Thread the string through the straw and tie it tightly between two chairs. Blow up the balloon, hold its neck shut, tape it under the straw and let go.

Observation: The coin drops into the glass. The loaded car moves off more slowly and stops sooner. The balloon shoots along the string as air rushes out backwards.

Viva:

- Why does the coin fall into the glass? The force acts on the card only for a moment. Inertia keeps the coin in place, and gravity pulls it down.
- Do action and reaction act on the same body? No. The balloon pushes the air backwards, and the air pushes the balloon forwards.

EXAMPLE

A force of 2 newtons on a 0.5 kg trolley gives an acceleration $a = F \div m = 2 \div 0.5 = 4 \text{ m/s}^2$. On a 1 kg trolley, the same force gives only 2 m/s^2 .

Project 2: Sound wave model

Principle: Sound is a **longitudinal wave**: the particles of the medium move back and forth along the direction the wave travels. This makes **compressions** (crowded regions) and **rarefactions** (spread-out regions). Sound needs a **medium** (air, water or a solid) and cannot cross empty space.

You need: a plastic slinky spring, a long table, two paper cups, 8 metres of strong thread, two buttons, chart paper and sketch pens.

Steps:

1. Stretch the slinky along the table, with a friend holding the far end.
2. Push your end forward and back once, sharply. Watch the crowded region travel.
3. Now move your end from side to side. This makes a **transverse wave**, in which the coils move across the direction of travel.

4. Pass the thread through a small hole in the bottom of each cup and tie a button inside.
5. Pull the thread tight and speak softly into one cup while your friend listens. Then let the thread go slack and try again.
6. Draw compressions and rarefactions on chart paper. Mark one **wavelength**, the distance between the centres of two neighbouring compressions.

Observation: The pulse travels along, but each coil only moves back and forth. A tight thread carries your voice; a slack one does not.

Viva:

- Why is sound called a mechanical wave? It needs a medium to travel through.
- Where does sound travel fastest: air, water or steel? Steel. Sound is fastest in solids and slowest in gases.

DID YOU KNOW

Sound travels at roughly 340 metres per second in air at room temperature. Light is far faster, so you see lightning before you hear the thunder.

CHAPTER 3

Electricity and magnetic effects

Your textbook may cover the electric motor and generator briefly or not at all. They still make excellent projects, because they show how electricity and magnetism are linked.

Project 3: Verifying Ohm's law

Principle: At a constant temperature, the current (I) through a conductor is directly proportional to the **potential difference** (V), or voltage, across it. So $V \div I$ is constant: this is the **resistance**, R , measured in ohms (Ω). We write $V = IR$.

You need: four 1.5 V cells in single-cell holders, a 1 k Ω resistor, a switch, wires with crocodile clips, and an ammeter and a voltmeter (or one digital multimeter).

Steps:

1. Connect one cell, the switch, the resistor and the ammeter in a single loop. This is a **series** connection. On a multimeter, choose the 20 mA DC current range.
2. Connect the voltmeter across the resistor. This is a **parallel** connection. With one multimeter, measure the current, then move the meter across the resistor on its 20 V DC range.
3. Close the switch, note V and I, and open it again.
4. Repeat with two, three and four cells in series.
5. Work out $V \div I$ each time. Plot a graph with I on the x-axis and V on the y-axis.

Observation: Kabir's readings:

Cells	V (volts)	I (mA)	$V \div I (\Omega)$
1	1.55	1.56	994
2	3.08	3.10	994
3	4.61	4.62	998
4	6.12	6.15	995

$V \div I$ is nearly constant, and the graph is a straight line through the origin. Remember that 1 mA is 0.001 A, so $1.55 \div 0.00156 = 994 \Omega$.

Viva:

- Why open the switch between readings? A current heats the resistor, and resistance changes with temperature.
- What does the slope of the graph give? The resistance.

TIP

Resistors have a **tolerance**, often $\pm 5\%$. A "1 k Ω " resistor may be anywhere from 950 Ω to 1,050 Ω , so 995 Ω is a good result.

Project 4: Magnetic field of a solenoid

Principle: A **solenoid** is a long coil of many turns. A current through it makes a magnetic field like a bar magnet's. Look at one end: if the current flows anticlockwise, that end is a north pole; if clockwise, a south pole.

You need: 3 metres of thin enamelled copper wire, a straw, a large iron nail, a 1.5 V cell in a holder, a push switch, a compass, iron filings, a card, steel pins and sandpaper.

Steps:

1. Wind about 80 turns closely along the straw. Sand the coating off the last 2 cm of each end.
2. Connect the coil, the switch and the cell in series.
3. Lay the card over the coil and sprinkle filings on it. Press the switch and tap the card gently.
4. With the switch pressed, bring the compass near each end. Note the poles. Turn the cell round and test again.
5. Slide the nail into the straw, press the switch and pick up some pins. Release the switch.

Observation: The filings form a bar magnet's pattern, with straight lines inside the coil. The poles swap when the current is reversed. With the nail inside, the coil lifts pins and drops them when the current stops: it is an **electromagnet**.

Viva:

- How can you make the field stronger? Use more turns, more current, or a soft iron core.
- Why soft iron? It becomes strongly magnetic and loses its magnetism when the current stops.

SAFETY

The coil is nearly a short circuit across the cell, so the wire and the cell get warm. Press the switch for a few seconds at a time only.

Project 5: Simple electric motor

Principle: A wire carrying a current in a magnetic field feels a force. **Fleming's left-hand rule** gives its direction: hold the thumb, first and middle fingers of your left hand at right angles. The first finger points along the field, the middle finger along the current, and the thumb shows the motion.

You need: 1 metre of enamelled copper wire, a 1.5 V D cell, two large safety pins, a thick rubber band, a strong ring magnet, sandpaper and a marker pen.

Steps:

1. Wind the wire 20 times around the marker. Slide the coil off and wrap each free end twice round it to hold it, leaving 3 cm of straight wire on opposite sides.
2. Sand all the coating off one straight end. Hold the coil upright and sand only the top half of the other end.
3. Hold a safety pin against each end of the cell with the rubber band, eyes at the top.
4. Put the magnet on the cell, rest the coil in the eyes and give it a gentle spin.

Observation: The coil keeps spinning. Turning the magnet over makes it spin the other way.

Viva:

- What energy change takes place? Electrical energy becomes energy of motion.
- Why sand only half of one end? The current flows for half of each turn, so the coil is never pushed backwards. A real motor does this job with a **split-ring commutator**.

Project 6: Electric generator

Principle: When the magnetic field through a coil changes, a current is produced in it. This is **electromagnetic induction**. **Fleming's right-hand rule** gives the direction: thumb along the motion, first finger along the field, and middle finger along the induced current.

You need: a small DC motor from an old toy car, a red LED, two wires and thread. In the lab: a coil of many turns, a bar magnet and a **galvanometer**, a meter that detects small currents.

Steps:

1. Connect the LED's legs to the motor's terminals.
2. Wind thread round the shaft and pull it off sharply, so the shaft spins fast. If the LED does not glow, wind the thread the other way.
3. In the lab, connect the coil to the galvanometer. Push the magnet in, hold it still, then pull it out.

Observation: The LED flashes when the shaft spins fast in one direction. The galvanometer needle moves one way as the magnet goes in, the other way as it comes out, and stays at zero while the magnet is still.

Viva:

- Why is there no current when the magnet is still? The magnetic field through the coil is not changing.
- Why does the LED light for one direction of spin only? An LED passes current one way only, and this motor gives direct current.

CHAPTER 4

Light

Borrow a glass slab and lenses from the school lab for these projects.

Project 7: Refraction through a glass slab

Principle: Light bends when it passes from one medium into another. This is **refraction**. Through a slab with parallel faces, the ray that comes out is parallel to the ray that went in, but shifted sideways: the **lateral displacement**. For two given media, $\sin i \div \sin r$ is constant (Snell's law). This constant is the **refractive index**.

You need: a rectangular glass slab, a drawing board, white paper, four board pins, a protractor, a scale and a sharp pencil.

Steps:

1. Pin the paper to the board, trace round the slab, and remove it.
2. Mark a point E on the long top edge. Draw the **normal** there, a line at 90° to the edge, and a ray meeting E at 45° to it.
3. Put the slab back. Fix pins P and Q on the ray, about 5 cm apart.
4. Look through the opposite face. Fix pins R and S so they look in line with the images of P and Q.
5. Remove the slab and pins. Join R and S to meet the bottom edge at F. Join E to F.
6. Measure the angle of refraction r at E and the angle of emergence e at F. Repeat for 30° and 60° .

Observation:

i	r	e	$\sin i \div \sin r$
30°	19°	30°	1.54
45°	28°	45°	1.51
60°	35°	59°	1.51

The angle of emergence equals the angle of incidence, within a degree. Glass has a refractive index of about 1.5.

Viva:

- Why does the ray bend towards the normal as it enters glass? Light travels more slowly in glass than in air.
- What increases the lateral displacement? A thicker slab and a larger angle of incidence.

TIP

Keep the pins far apart and line up their feet, not their heads, for a more accurate line.

Project 8: Human eye defects model

Principle: The eye lens forms a sharp image on the **retina**, the light-sensitive layer at the back of the eye. In **myopia** (near-sightedness), the image of a distant object forms in front of the retina; a concave lens corrects it. In **hypermetropia** (far-sightedness), the image of a near object forms behind the retina; a convex lens corrects it.

You need: a convex lens of focal length about 10 cm, a weak concave and a weak convex lens, a white card (the screen), a metre scale, clay, chart paper, and a torch with a black paper arrow taped over its glass.

Steps:

1. Place the torch about 2 metres from the convex lens. Move the screen until a sharp image of the arrow appears. Mark this as the "normal eye".
2. Move the screen 2 to 3 cm farther away, like an eyeball that is too long. The image blurs. Hold the concave lens just in front of the convex lens and adjust until the image is sharp again.

3. Move the screen 2 to 3 cm closer than the mark, like an eyeball that is too short. Correct the blur with the convex lens.
4. Draw a large labelled eye on chart paper behind the model: cornea, iris, pupil, lens, retina, optic nerve.

Observation: Each "defect" blurs the image, and the correct extra lens sharpens it again.

Viva:

- What are the near point and far point of a normal eye? About 25 cm, and infinity.
- What causes myopia? An eyeball that is too long, or an eye lens that is too strongly curved.

REMEMBER

A real eye lens changes shape to focus, using the **ciliary muscles**. This is **accommodation**. The model's glass lens cannot, so the model shows the idea simply.

Project 9: Power of a lens

Principle: The **power** of a lens tells how strongly it bends light. $P = 1 \div f$, with the focal length f in metres. The unit is the **diopetre** (D). A convex lens has positive power and a concave lens negative power. For lenses in contact, the powers add: $P = P_1 + P_2$.

You need: a convex lens, a white card, a metre scale and a window with a view of distant trees or buildings.

Steps:

1. Hold the card against a wall that faces the window. Hold the lens between the window and the card so it forms an image of the distant scene.
2. Move the lens until the image is sharp. The distance from lens to card is roughly the focal length.
3. Repeat three times and take the average.
4. Change the focal length to metres and work out the power.

Observation: Meera's readings were 19.8 cm, 20.4 cm and 19.8 cm: an average of 20.0 cm, or 0.20 m. So $P = 1 \div 0.20 = +5$ D. With a concave lens held against it, the pair had a focal length of 40 cm, a power of +2.5 D. So the concave lens had a power of $2.5 - 5 = -2.5$ D.

Viva:

- What does -2 D on a spectacle prescription mean? A concave lens of focal length 50 cm , used to correct myopia.
- Which is more powerful, $f = 10\text{ cm}$ or $f = 50\text{ cm}$? The 10 cm lens ($+10\text{ D}$ against $+2\text{ D}$).

SAFETY

Never look at the Sun through a lens, and never focus sunlight on skin, paper or anything that can burn.

CHAPTER 5

Chemical reactions

Do these projects in the school lab, with your teacher present.

Project 10: Testing pH with indicators

Principle: The **pH scale** runs from 0 to 14. A pH below 7 is acidic, 7 is neutral and above 7 is basic. An **indicator** is a substance that changes colour with pH.

You need: half a red cabbage, hot water, a strainer, clear cups, pH paper, turmeric, filter paper, and samples: lemon juice, vinegar, milk, tap water, and solutions of baking soda, soap and washing soda.

Steps:

1. An adult chops the cabbage, covers it with hot water and strains it after 20 minutes. The purple liquid is your indicator.
2. Put two spoons of each sample into its own labelled cup.
3. Add a spoon of cabbage indicator to each and note the colour.
4. Touch a strip of pH paper to each sample and compare it with the colour chart.
5. Brush turmeric paste on filter paper, let it dry, and touch each sample to it.

Observation: Typical results:

Sample	Cabbage colour	pH (about)
Lemon juice	Red-pink	2

Sample	Cabbage colour	pH (about)
Vinegar	Pink	3
Milk	Purple	6 to 7
Tap water	Purple	7
Baking soda	Blue	8 to 9
Soap solution	Blue-green	9 to 10
Washing soda	Green	11

Turmeric stays yellow in acids and turns reddish-brown in bases.

Viva:

- Why can turmeric not tell an acid from water? It stays yellow in both.
- Why does an antacid ease acidity? It is a mild base that neutralises extra stomach acid.

Project 11: Reactivity series by displacement

Principle: A more reactive metal pushes a less reactive metal out of its salt solution. This is a **displacement reaction**. For iron: $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$.

You need: copper sulphate and ferrous sulphate solutions, two iron nails, a copper wire, a zinc granule, sandpaper, thread, three test tubes, a stand, gloves and goggles.

Steps:

1. Rub the nails and the copper wire with sandpaper until they shine.
2. Tube A: copper sulphate with an iron nail tied on thread, half dipped in.
3. Tube B: ferrous sulphate with the copper wire.
4. Tube C: copper sulphate with the zinc granule.
5. Leave for 20 to 30 minutes, then compare.

Observation: In A, the dipped part of the nail turns reddish-brown and the blue solution fades to pale green. In B, nothing happens. In C, the zinc gets a reddish-brown coat and the blue fades. So zinc is more reactive than iron, and iron more than copper.

Viva:

- Why does copper not react with ferrous sulphate? Copper is less reactive than iron.
- Why sandpaper the nail? To remove rust and dirt so the metal touches the solution.

SAFETY

Copper sulphate is harmful if swallowed and irritates the eyes. Wear gloves and goggles, wash your hands, and dispose of the solutions as your teacher says.

Project 12: Electrolysis of water

Principle: An electric current can split water into hydrogen and oxygen: $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$. This is a **decomposition reaction**. An **electrode** is a conductor that carries current into or out of the liquid. Hydrogen collects at the **cathode** (negative electrode) and oxygen at the **anode** (positive), twice as much hydrogen by volume.

You need: a plastic cup, two pencils sharpened at both ends, clay or glue, a teaspoon of washing soda, two small test tubes, a 9 V battery and clip, and two wires with crocodile clips.

Steps:

1. An adult makes two holes in the bottom of the cup. Push a pencil through each so the tips stand inside, and seal round them with clay or glue.
2. Fill the cup with water and stir in the washing soda.
3. Fill each test tube with the solution, close it with your thumb, turn it over in the cup and place it over a pencil tip.
4. Connect the outside ends of the pencils to the battery, noting which is positive.
5. After 20 to 30 minutes, mark the gas level in each tube.

Observation: Bubbles rise from both tips. The tube over the negative electrode collects about twice as much gas.

Viva:

- Why add washing soda? Pure water conducts electricity poorly.
- How are the gases tested? Oxygen relights a glowing splint. Hydrogen burns with a pop. Your teacher does these tests.

SAFETY

Do not use common salt. It produces chlorine, a poisonous gas.

DID YOU KNOW

The measured ratio is often a little more than 2 : 1, because some oxygen dissolves in the water and some reacts with the graphite.

CHAPTER 6

Life processes and control

These projects show how plants make food, how living things get energy, and how the body reacts fast.

Project 13: Photosynthesis needs light and chlorophyll

Principle: Green leaves make food by **photosynthesis**: carbon dioxide + water → glucose + oxygen, using sunlight and **chlorophyll**, the green pigment. Leaves store the glucose as starch, which iodine turns blue-black.

You need: a potted plant with variegated leaves (green with white or yellow patches, such as croton), a potted green plant, black paper strips, clips, alcohol, a beaker, a test tube, dilute iodine solution and a white saucer.

Steps:

1. Keep both plants in a dark place for about three days. This **destarching** uses up the starch already in the leaves.
2. Clip a black paper strip across both sides of one green leaf. Keep the plants in bright sunlight for about six hours.
3. Pick the covered leaf and a variegated leaf, and sketch the variegated pattern.
4. Your teacher boils the leaves in water for two minutes, then puts them in a test tube of alcohol standing in a beaker of hot water until they turn pale.
5. Rinse the leaves, spread them on the saucer and add iodine.

Observation: The parts that had light and chlorophyll turn blue-black. The covered strip and the white patches stay brownish.

Viva:

- Why destarch the plant first? So any starch found must have been made during the experiment.
- Why is the alcohol heated in a water bath? Alcohol catches fire easily, so it is never heated over a flame directly.

TRY THIS

Put a sprig of the water plant Hydrilla in a glass of water. Count the bubbles of oxygen rising in one minute in sunlight, and again in shade.

Project 14: Respiration releases carbon dioxide

Principle: **Respiration** breaks down food to release energy. With oxygen (**aerobic** respiration), glucose gives carbon dioxide, water and energy. Without oxygen (**anaerobic**), yeast turns glucose into alcohol and carbon dioxide. Carbon dioxide turns limewater milky.

You need: dry yeast, sugar, warm water, two plastic bottles, two balloons, limewater, two test tubes, a straw and a syringe.

Steps:

1. Put a cup of warm (not hot) water, two teaspoons of sugar and a teaspoon of yeast in one bottle, swirl, and stretch a balloon over the neck.
2. Set up the second bottle the same way without yeast. This is the **control**.
3. Check the balloons every 15 minutes for an hour.
4. Pour limewater into two test tubes. Blow out gently through the straw into tube A. Never suck.
5. Pump room air into tube B with the syringe for the same time.

Observation: The balloon on the yeast bottle swells; the control stays flat. Tube A turns milky quickly; tube B stays clear much longer.

Viva:

- Why have a control? To show that the yeast makes the gas.
- What makes the limewater milky? Carbon dioxide reacts with it to form calcium carbonate.

Project 15: Reflex arc model

Principle: A **reflex** is a quick, automatic response, such as pulling your hand away from a hot pan. The message travels along a **reflex arc**: receptor → sensory neuron → relay neuron in the spinal cord → motor neuron → muscle. A **neuron** is a nerve cell.

You need: a thermocol sheet, sketch pens, a 9 V battery and clip, a push switch, three red and three green LEDs, six 1 k Ω resistors, a small 9 V buzzer, wire and insulation tape.

Steps:

1. Draw and label an arm with its hand touching a pan, the spinal cord, a sensory nerve and a motor nerve.
2. Fix the push switch at the fingertip as the receptor.
3. Fix the red LEDs along the sensory nerve, the green LEDs along the motor nerve, and the buzzer at the arm muscle.
4. Connect each LED in series with its own resistor, long leg towards positive.
5. Connect all six LED pairs and the buzzer in parallel, with the switch between them and the battery's positive terminal. Press the switch.

Observation: The lights show the message's path, and the buzzer stands for the muscle contracting.

Viva:

- Why does a reflex not wait for the brain? The spinal cord responds directly, which saves time; the brain is told afterwards.
- Which neuron carries the message to the muscle? The motor neuron.

SAFETY

An adult should do any soldering. Disconnect the battery when you finish.

CHAPTER 7

Heredity and the environment

These three projects link biology with the world around you.

Project 16: Heredity bead model

Principle: Each parent passes on one of its two factors (genes) for a trait. In pea plants, tall (T) is **dominant** over dwarf (t), which is **recessive**. Crossing two Tt plants gives TT, Tt and tt in a 1 : 2 : 1 ratio, and tall to dwarf plants in a 3 : 1 ratio.

You need: two cloth bags, 50 red beads and 50 white beads for each bag, a notebook and chart paper.

Steps:

1. Each bag is one Tt parent. A red bead is T and a white bead is t.
2. Without looking, take one bead from each bag and write down the pair. Put both beads back.
3. Repeat 100 times.
4. Count the TT, Tt and tt pairs.
5. Draw a **Punnett square**, a grid of all possible pairs, on the chart.

Observation: Aarti got 27 TT, 48 Tt and 25 tt. That is 75 tall to 25 dwarf, or 3 : 1.

Viva:

- What is the difference between genotype and phenotype? The **genotype** is the set of factors (Tt); the **phenotype** is what you see (tall).
- Why put the beads back? To keep the chances the same for every draw.

TRY THIS

Fill one bag with X beads only (the mother) and the other with equal X and Y beads (the father). About half your draws are XX (girl) and half XY (boy). The father's chromosome decides the child's sex.

Project 17: Ozone layer model

Principle: **Ozone** (O₃) is a form of oxygen with three atoms in each molecule. A layer of it high in the atmosphere absorbs most of the Sun's harmful **ultraviolet (UV) radiation**. **CFCs** (chlorofluorocarbons), gases once common in refrigerators and sprays, damage it.

You need: a thermocol base, half a thermocol ball (the Earth), chart paper, blue cellophane, paper arrows and a cut-out Sun.

Steps:

1. Fix the half ball on the base.
2. Cut paper arcs for the layers of the atmosphere. Label the lowest layer (about 8 to 18 km thick, depending on the place) and the one above it, the **stratosphere**.
3. Glue a band of blue cellophane inside the stratosphere arc, labelled "ozone layer, about 15 to 35 km up".
4. Leave the cellophane thin over the South Pole to show the ozone hole.
5. Fix arrows from the Sun. Most stop at the ozone band; one passes through the thin patch.
6. Label CFC sources and the effects of extra UV, such as skin cancer and eye damage.

Observation: The model shows how the ozone layer stops most UV, and how a thin patch lets more through.

Viva:

- How is ozone formed? UV radiation splits oxygen molecules into atoms, which join other oxygen molecules to form ozone.
- What did countries agree in 1987? The Montreal Protocol, to cut the use of CFCs. The layer is now slowly recovering.

REMEMBER

Ozone high up protects us, but ozone near the ground is a harmful pollutant.

Project 18: Waste management model

Principle: **Biodegradable** waste, such as peels and leaves, is broken down by microbes.

Non-biodegradable waste, such as plastic and glass, is not. Separating waste at home lets wet waste become **compost** (natural fertiliser) and dry waste be recycled.

You need: a cardboard base, three small boxes, a 2-litre bottle, dry leaves, vegetable peels, soil, four small pots, and pieces of banana peel, newspaper, plastic bag and aluminium foil.

Steps:

1. Paint one box green for wet waste and one blue for dry waste. Mark the third for household hazardous waste, such as used batteries.

2. An adult cuts the bottle in half. Fill the bottom half with layers of dry leaves, peels and soil, keep it damp, and make small air holes: this is your compost bin.
3. Bury one test piece in each pot, water lightly, and dig them up after three weeks.
4. Draw arrows on the base: home → separated bins → compost bin, recycling centre or landfill.

Observation: The peel has mostly broken down and the newspaper is soft and torn. The plastic and foil are unchanged.

Viva:

- Why separate waste at home? Mixed waste is hard to compost or recycle, so it ends up in a landfill.
- Which of the three Rs (reduce, reuse, recycle) is best? Reduce, because waste never made needs no handling.

CHAPTER 8

Recording observations and facing the viva

A project is marked on how well you record and explain it, as well as on how well it works.

Your project file

Set out your file in this order: title and aim; principle; materials and a neat, labelled pencil diagram; procedure, in numbered steps in the past tense ("The slab was placed..."); observations, in a table with units in the column headings; calculations and result; precautions and sources of error; conclusion and the books you used.

Taking good readings

- Repeat each reading at least three times and take the average.
- Write units with every number, and label both axes of a graph.
- A **source of error** limits accuracy even when you work carefully, such as the thickness of a pin or a cell running down. A careless slip is a mistake, not a source of error.

EXAMPLE

Rohan measured the refractive index three times and got 1.52, 1.51 and 1.50. His average was $(1.52 + 1.51 + 1.50) \div 3 = 1.51$.

Facing the viva

1. Practise explaining your project in one minute, to a friend or a mirror.
2. Know the principle well enough to say it in your own words.
3. Know every material and why you used it.
4. If you do not know an answer, say so honestly, then say what you think and why.

TIP

Examiners often ask "What would happen if...?" Before your viva, change one thing, such as the number of cells, and see what happens.

CHECK YOURSELF

Practice questions

1. State Newton's first law of motion and name the property it describes.
2. A force of 3 N acts on a mass of 1.5 kg. What is the acceleration?
3. What are compressions and rarefactions?
4. State Ohm's law.
5. A resistor has 4.5 V across it and 3 mA through it. What is its resistance?
6. How are an ammeter and a voltmeter connected in a circuit?
7. Give two ways to make a solenoid's magnetic field stronger.
8. In Fleming's left-hand rule, what do the first finger, middle finger and thumb show?
9. What is electromagnetic induction?
10. Through a glass slab, how is the emergent ray related to the incident ray?
11. Light enters glass at 45° and is refracted at 28° . Find the refractive index. ($\sin 45^\circ = 0.707$, $\sin 28^\circ = 0.469$)

12. Which lens corrects myopia, and why?
13. Find the power of a convex lens of focal length 25 cm.
14. What colour does red cabbage indicator turn in lemon juice and in washing soda solution?
15. Why does an iron nail turn brown in copper sulphate solution?
16. Why must common salt not be used in the electrolysis project?
17. Why are leaves heated in alcohol before the starch test, and why is a water bath used?
18. Write the path of a message in a reflex arc.
19. In the bead model, what ratio of tall to dwarf plants do you expect, and why?
20. Why is ozone in the upper atmosphere useful, but ozone near the ground harmful?
21. Name one biodegradable and one non-biodegradable item from the waste project.

ANSWER KEY

Answers

1. A body stays at rest or keeps moving in a straight line unless a force acts on it. The property is inertia.
2. $a = F \div m = 3 \div 1.5 = 2 \text{ m/s}^2$.
3. Compressions are regions where the particles are crowded together; rarefactions are regions where they are spread out.
4. At constant temperature, the current through a conductor is directly proportional to the potential difference across it ($V = IR$).
5. $R = V \div I = 4.5 \div 0.003 = 1,500 \Omega$, or $1.5 \text{ k}\Omega$.
6. An ammeter in series; a voltmeter in parallel, across the part being measured.
7. Any two: more turns, more current, or a soft iron core inside the coil.
8. The first finger shows the field, the middle finger the current, and the thumb the motion (force).
9. Producing a current in a coil by changing the magnetic field through it.
10. The emergent ray is parallel to the incident ray but shifted sideways (lateral displacement).
11. $n = 0.707 \div 0.469 = 1.51$.

12. A concave lens. It spreads the light out a little, so the image moves back onto the retina.
13. $f = 0.25 \text{ m}$, so $P = 1 \div 0.25 = +4 \text{ D}$.
14. Red or pink in lemon juice; green in washing soda solution.
15. Iron is more reactive than copper, so it displaces the copper, which coats the nail.
16. It produces chlorine, a poisonous gas, at the positive electrode.
17. Alcohol removes the chlorophyll so the iodine colour shows clearly. It catches fire easily, so it is never heated over a flame.
18. Receptor $\rightarrow$ sensory neuron $\rightarrow$ relay neuron in the spinal cord $\rightarrow$ motor neuron $\rightarrow$ muscle (effector).
19. About 3 : 1. Tall (T) is dominant, so TT and Tt plants look tall; only tt plants are dwarf.
20. High up, it absorbs harmful UV radiation from the Sun. Near the ground, it is a pollutant that harms health.
21. Banana peel or newspaper is biodegradable; a plastic bag or aluminium foil is non-biodegradable.

WORD LIST

Glossary

Inertia

the tendency of a body to stay at rest or keep moving in a straight line.

Longitudinal wave

a wave in which particles move back and forth along the direction of travel, as in sound.

Resistance

how strongly a conductor opposes current, measured in ohms (Ω).

Solenoid

a long coil of wire that acts like a bar magnet when current flows.

Electromagnetic induction

producing a current in a coil by changing the magnetic field through it.

Refraction

the bending of light as it passes from one medium into another.

Refractive index

the ratio $\sin i \div \sin r$, which shows how much a medium bends light.

Dioptre

the unit of lens power, equal to $1 \div$ focal length in metres.

Myopia

near-sightedness, in which distant objects look blurred.

Hypermetropia

far-sightedness, in which near objects look blurred.

Indicator

a substance that changes colour in acids and bases.

Displacement reaction

a reaction in which a more reactive metal pushes a less reactive one out of its compound.

Electrolysis

breaking down a substance by passing an electric current through it.

Anaerobic respiration

releasing energy from food without oxygen.

Reflex arc

the path a nerve message takes in a quick, automatic response.

Dominant

a factor (gene) that shows its effect even when only one copy is present.

Phenotype

the trait you can see, such as tall or dwarf.

Ozone layer

a layer of ozone gas high in the atmosphere that absorbs most UV radiation.

Biodegradable

able to be broken down by microbes.



Gurukul Technicals Institute

Computer education institute in Delhi, with authorised member centres, robotics classes and science projects, working models and DIY kits.

COURSES

Computer & Office Skills · Accounting & Business Software · Programming & Web Development · Design & Digital Skills · Hardware & Networking · Robotics & Coding · Other Programmes

PROJECTS AND KITS

Ready-made school projects · DIY and STEM kits · Robotics and coding · Components and spares · Engineering projects

CONTACT

Head office: A-10, Chief Commissioner Colony, opposite Rana Pratap Bagh, Delhi 110007

Phone: 011 2721 1512 · **Mobile and WhatsApp:** +91 97116 99511

Email: engineergurukul@yahoo.co.in

Website: engineergurukul.com · **Instagram:** [@science_projects_club](https://www.instagram.com/science_projects_club)

More free ebooks for computer courses, robotics and science projects: engineergurukul.com/resources/ebooks/

Free to read, print and share. Not for sale.