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FREE EBOOK

SCIENCE PROJECTS AND KITS

Best Out of Waste Science Projects

Working models from bottles, cardboard, CDs and old parts

INSIDE THIS BOOK

- Why reuse?
- Collecting and cleaning materials safely
- Air in motion
- The power of pressure
- Saving water
- ...and 5 more chapters, practice questions and a glossary

Beginner

Students of class 3 to 10, parents and teachers

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Best Out of Waste Science Projects

Fifteen working science models made from bottles, cartons, CDs, newspaper and other things people throw away, from a bottle windmill and a CD hovercraft to a syringe hydraulic arm, a solar oven, a rain gauge and an air-powered bottle rocket. Each project gives the materials, safe numbered steps and the science behind it, with tips on collecting materials safely and presenting the waste-management message.

WHO IT IS FOR	Students of class 3 to 10, parents and teachers
LEVEL	Beginner
SUBJECT AREA	Science projects and kits
WHAT IS INSIDE	10 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.



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Why reuse?

Every day, homes, schools and shops throw away bottles, boxes, cartons, cans and paper. Much of it ends up in dumps, drains and rivers. Many plastics take hundreds of years to break down, so the bottle thrown away today may still be lying somewhere when your great-grandchildren are born.

You have probably heard of the **three Rs**:

1. **Reduce:** use less in the first place. Carry a cloth bag and a steel water bottle.
2. **Reuse:** use something again, for the same job or a new one. A jam jar becomes a pen stand.
3. **Recycle:** send material to a factory that breaks it down and makes something new from it.

Reuse comes before recycling because it needs no factory, no transport and no extra energy. Every project in this book is reuse: a bottle becomes a windmill, a carton becomes a periscope.

Sorting waste at home

Type of waste	Examples	What to do
Wet waste	Vegetable peels, tea leaves, garden leaves	Compost it
Dry waste	Paper, cardboard, plastic, metal, glass	Reuse, then give for recycling
Hazardous waste	Batteries, medicines, bulbs, old electronics	Keep separate and hand over to proper collectors

Many cities ask homes to put wet waste in a green bin and dry waste in a blue bin. Sorting at home is called **segregation**, and it makes recycling much easier.

DID YOU KNOW

India's Swachh Bharat Mission, started in 2014, made cleanliness and the sorting of household waste a national campaign.

EXAMPLE

Tanvi's class in Bengaluru set up a collection box for one week. They collected 46 plastic bottles, 18 juice cartons, 9 old CDs and a stack of newspapers. That was enough for every group in the class to build two models from this book.

REMEMBER

A best-out-of-waste model teaches two lessons at once: the science of how it works, and the value of what we throw away. Be ready to explain both.

CHAPTER 2

Collecting and cleaning materials safely

What to collect

Material	Good for
Plastic bottles (1 litre and 2 litre)	Windmill, rocket, filter, planter, rain gauge, bird feeder
Cardboard boxes and shoeboxes	Solar oven, hydraulic arm, car bodies
Juice and milk cartons	Periscope
Old CDs	Hovercraft
Bottle caps	Wheels, knobs
Newspapers	Bridge, insulation
Tins with smooth rims	Telephone

Material	Good for
Ice-cream sticks, straws, skewers	Frames, axles

What never to collect

- Broken glass, or tins with jagged edges.
- Medicine bottles and strips, used syringes and any needle.
- Containers that held pesticides, cleaners, kerosene, petrol or paint thinner. Traces stay inside even after washing.
- Old batteries, especially leaking or swollen ones, and broken tubelights or CFL bulbs.
- The insides of old electronics.

Cleaning

1. Rinse bottles and cartons with soapy water. Cut cartons open to clean them properly.
2. Soak bottles in warm water to peel off labels.
3. Dry everything fully in the sun. Damp materials grow mould and smell.
4. Sort your materials into a labelled "project box".

Cutting and joining safely

- An adult makes the first cut in a plastic bottle with a cutter. You can then continue with scissors.
- Cover every cut plastic edge with tape. Cut bottles are sharper than they look.
- Holes in caps and bottles are made by an adult, using a hand drill or a nail heated over a flame, near an open window because melting plastic gives off fumes.
- An adult uses the hot glue gun. The glue stays hot enough to burn for some time after it comes out.

SAFETY

Younger students should always work with an adult beside them when anything is cut, punched, heated or glued with hot glue. Wash your hands after handling collected waste.

TIP

Keep a basic kit ready: scissors, cello tape, insulation tape, white glue, a ruler, a marker, string, rubber bands and a few split pins. Most projects need nothing else besides the waste itself.

CHAPTER 3

Air in motion

Project 1: bottle windmill

The science: Moving air has energy. The angled blades turn the push of the wind into a spin, and the spin can do work, such as lifting a load.

You need: two 1-litre bottles, a wooden skewer, a straw, thread, a paper clip, a little sand and glue.

1. An adult cuts the top part off one bottle, about 8 cm below the cap.
2. Cut this piece from the open edge up to the shoulder to make six equal strips. Bend each strip outwards and give it a slight twist, all in the same direction. These are the blades.
3. An adult makes a hole in the centre of the cap. Push the skewer through and glue it, so the blades and skewer turn together.
4. For the tower, put some sand in the second bottle so it does not fall over. An adult makes two holes opposite each other near its top.
5. Push the straw through both holes and slide the skewer through the straw. The straw is a **bearing**: it lets the skewer turn smoothly.
6. Tie the thread to the back end of the skewer and hang the paper clip from it.

7. Place the windmill in front of a table fan or outside in the wind.

The blades spin, the skewer winds up the thread, and the paper clip rises.

DID YOU KNOW

Wind farms in states such as Tamil Nadu and Gujarat use giant turbines that work on the same idea. Instead of lifting a paper clip, the spin turns a generator that makes electricity.

Project 2: CD hovercraft

The science: Air escaping under the CD forms a thin cushion that lifts it slightly off the table. With almost no surface touching, there is very little **friction**, the force that resists sliding. So the CD glides with the smallest push.

You need: an old CD, a balloon and the push-pull cap from a sports water bottle.

1. Glue the cap over the hole in the centre of the CD. An adult can use hot glue. Seal all the way round so no air leaks, and let it set.
2. Close the cap. Blow up the balloon, twist its neck and stretch its mouth over the cap.
3. Put the CD on a smooth table and pull the cap open.

The hovercraft drifts across the table until the balloon is empty.

SAFETY

Never bend a CD. It can crack into sharp pieces.

Project 3: balloon car

The science: Air rushes backwards out of the balloon, and the car is pushed forwards. Every push has an equal push in the opposite direction. This is Newton's third law of motion.

You need: a piece of stiff cardboard about 15 cm by 8 cm, four bottle caps, two skewers, three straws, a balloon, a rubber band and tape.

1. Tape two straws across the underside of the cardboard, one near the front and one near the back.
2. An adult makes a hole in the centre of each cap.
3. Slide a skewer through each straw and fix a cap on each end as a wheel. Trim the skewer ends and cover them with tape.
4. Fix the balloon's mouth over one end of the third straw with the rubber band, so it is airtight.
5. Tape this straw on top of the car, with the balloon at the front and the straw sticking out at the back.
6. Blow up the balloon through the straw, pinch it, put the car on the floor and let go.

REMEMBER

The wheels must spin freely. If a wheel rubs against the cardboard, friction wastes the balloon's push and the car stops short.

CHAPTER 4

The power of pressure

Project 4: syringe hydraulic arm

The science: Liquids can hardly be squeezed at all. So when you push water in a closed system of syringes and tubes, the pressure passes through it to the other end. This is **Pascal's law**. Earthmovers, car brakes and the jacks used to lift cars all work this way.

You need: six new plastic syringes with no needles (10 mL or 20 mL), about 1.5 m of thin plastic tubing that fits the syringe nozzles tightly (aquarium air tubing works), thick cardboard, ice-cream sticks, split pins, tape and water with a drop of food colour.

1. Cut cardboard pieces for a base, an upright post, an arm in two parts and a two-finger gripper.
2. Join the pieces at their pivot points with split pins, so each joint swings freely.
3. Fill one syringe with coloured water. Fix a length of tube to it and push until water comes out of the far end of the tube.
4. Push the plunger of a second syringe fully in and fix it to the free end of the tube. You now have a pair.
5. Make three pairs. Tape one syringe of each pair to the base as a control. Tape the other to the arm so that its plunger lifts the arm, bends the elbow or closes the gripper.
6. Push and pull each control plunger to move the arm.

SAFETY

Use only new syringes, bought without a needle from a chemist. Never use a syringe that has been used for an injection, or any syringe you find.

TIP

Bubbles of air make the arm feel spongy, because air can be squeezed. That is the best way to explain why hydraulic machines use liquids.

Project 5: air-powered bottle rocket

The science: When you stamp on an empty bottle, you squeeze the air inside into a smaller space, so its **pressure** rises. The air rushes out through the pipe and blasts the paper rocket off the end.

You need: an empty 2-litre soft-drink bottle, about 1.5 m of garden hose that fits tightly over the bottle's neck, a 30 cm piece of plastic pipe that fits tightly inside the hose, insulation tape, A4 paper, cello tape, card and two bricks.

1. Push the hose onto the bottle's neck and seal it with insulation tape.
2. Push the plastic pipe into the other end of the hose and tape it. This is the **launch tube**.
3. Rest the launch tube on the bricks, pointing up at an angle, away from people and buildings.
4. To make the rocket, roll a sheet of paper loosely round the launch tube and tape the seam, so the tube slides in and out easily.
5. Slide it off, and fold and tape the top end into a closed, airtight cone.
6. Tape three card fins near the bottom. Round off their corners.
7. Slide the rocket over the launch tube. Everyone stands behind the launcher. Count down and stamp hard on the bottle.
8. Take the rocket off and blow into the launch tube to pop the bottle back into shape.

SAFETY

This rocket uses air pressure only. Never add vinegar and baking soda, any fuel, fire or chemical. Launch only outdoors, on open ground, with an adult in charge. Never aim at people, animals, windows or overhead wires, never stand in front of the launch tube, and wear safety glasses. Do not use a pump: pumping air into a bottle can make it burst.

TRY THIS

Launch at different angles and measure how far the rocket lands each time. An angle of about 45° usually sends it farthest.

Saving water

Project 6: drip irrigation from bottles

The science: Drip irrigation lets water fall a drop at a time, right at the roots of a plant. Little is lost to evaporation or runs off the surface, so the plant gets more of the water. Gravity pulls the water down, and the size of the hole controls how fast it drips. Many Indian farmers use drip systems with pipes to save water.

You need: a 1-litre bottle with its cap, a thumb pin, a stick and string.

1. An adult cuts off the bottom of the bottle so it can be filled from the top.
2. An adult makes one or two tiny holes in the cap with the thumb pin.
3. Tie the bottle upside down to a stick pushed into the soil, with the cap just above the base of the plant.
4. Fill the bottle with water and count the drops in one minute.

To slow the flow, use one hole. To speed it up, make the hole slightly bigger.

EXAMPLE

Rohit in Jodhpur counted 30 drops a minute from his bottle. One litre lasted about 11 hours, slowly watering his tulsi plant all through a hot day, while the soil around it stayed moist.

Project 7: bottle water filter

The science: Muddy water passes through layers that trap smaller and smaller particles. This is **filtration**. Charcoal also takes up some colour and smell.

You need: a 2-litre bottle, cotton wool, washed charcoal pieces (activated charcoal from an aquarium shop works best), fine sand, coarse sand, small pebbles, larger pebbles, a jar and muddy water.

1. An adult cuts off the bottom of the bottle. Remove the cap.

2. Turn the bottle upside down over the jar and push a plug of cotton wool into the neck.
3. Add layers in this order: charcoal, fine sand, coarse sand, small pebbles and larger pebbles on top.
4. Pour clean water through first to rinse the layers, and throw that water away.
5. Pour muddy water in slowly and watch what comes out.

The water that drips out is much clearer than what went in.

SAFETY

Do not drink the filtered water. It looks clean, but it can still carry germs and dissolved chemicals. Drinking water must be properly purified or boiled. Real treatment plants use sand filters too, but they also kill germs, usually with chlorine.

Project 8: self-watering planter

The science: Water climbs up through the narrow gaps between cotton fibres, even against gravity. This is **capillary action**. A cotton wick carries water from a store below up into the soil as the soil dries.

You need: a 2-litre bottle, a strip of old cotton cloth about 25 cm long, soil and a few seeds of methi or coriander.

1. An adult cuts the bottle in two, about one-third of the way up from the bottom.
2. An adult makes a hole in the cap. Thread the cloth strip through it so that half hangs on each side.
3. Turn the top part upside down and fit it, neck first, into the bottom part.
4. Fill the top part with soil, keeping the upper half of the wick buried in the soil.
5. Pour water into the bottom part so the lower end of the wick sits in it. Sow the seeds and water the soil once.

SAFETY

Mosquitoes breed in standing water. Change the water in the bottom part at least once a week and keep the gap between the two parts covered with tape.

CHAPTER 6

Strong shapes: the newspaper bridge

Project 9: newspaper truss bridge

The science: A load on a bridge squashes some parts, which is called **compression**, and stretches others, which is called **tension**. A flat sheet of paper bends under almost nothing, but the same sheet rolled into a tight tube is surprisingly stiff.

Shape matters too. Push the corners of a square frame and it leans over into a diamond. A triangle cannot change shape unless one of its sides changes length, so it stays rigid. A framework built from triangles is called a **truss**.

You need: about ten old newspapers, a pencil, cello tape or masking tape, a piece of card for the deck, two desks, and a cloth bag with 500 mL water bottles for the load.

1. Lay a double sheet of newspaper flat. Starting at one corner, roll it tightly round the pencil towards the opposite corner. Tape the end and slide the pencil out.
2. Make about 30 tubes.
3. Build two side frames. Each has a long top tube and a long bottom tube, joined by short tubes in a zigzag so that the spaces between them are triangles.
4. Stand the two frames up side by side and join them with cross tubes at the top and bottom. Add diagonal cross tubes too, so the bridge cannot twist.
5. Tape a card deck along the bottom.

6. Place the bridge across a 30 cm gap between two desks.
7. Hang the bag from the middle and add bottles one at a time. Record the load the bridge holds before it sags badly or fails.

EXAMPLE

A class 7 team in Chennai built a bridge that weighed 250 g and held 5 kg before it buckled. Their **strength-to-weight ratio** was $5,000 \text{ g} \div 250 \text{ g} = 20$. Judges often score bridges this way, because a heavy bridge can be strong simply by using more paper.

SAFETY

Hang the load only a few centimetres above the floor, and keep your feet out of the way when testing to failure.

DID YOU KNOW

Howrah Bridge in Kolkata is built from steel triangles. Look at a photo of it and count how many you can find.

CHAPTER 7

Sun and rain

Project 10: solar oven

The science: Shiny foil **reflects** sunlight into the box. Black paper **absorbs** light, which means it takes it in, and turns it into heat. The clear window lets sunlight in but stops the warm air from escaping. This trapping of heat is called the **greenhouse effect**. Newspaper around the sides keeps the heat in.

You need: a pizza box or a shoebox with a lid, aluminium foil, black chart paper, clear plastic sheet or cling film, newspaper, tape and a stick.

1. On the lid, draw a square flap 3 cm in from the edges. An adult cuts along three sides of it, so it can fold up along the fourth.

2. Cover the inside of the flap with smooth foil, shiny side out.
3. Tape clear plastic tightly over the opening the flap leaves in the lid.
4. Line the floor of the box with black paper, and pack rolled newspaper round the sides.
5. Around midday, set the oven in full sun. Prop the flap with the stick so it reflects sunlight through the window onto the black floor.
6. Put a piece of chocolate, or a slice of bread with cheese, on a dark plate inside the oven. Check it after 30 minutes.

SAFETY

The inside of the oven and the plate get hot, so use a cloth to take them out. Do not look straight at the bright reflection on the foil. Use the oven only to warm or melt food, not to cook raw eggs, meat or rice.

Project 11: rain gauge

The science: Rainfall is measured as the depth of water, in millimetres, that would collect on flat ground. A container with straight sides collects the same depth of water whatever its width, so a bottle with straight sides can measure rain.

You need: a 2-litre bottle with straight sides, a few pebbles, a strip of paper marked in millimetres, clear tape and a marker.

1. An adult cuts off the top third of the bottle.
2. Put the pebbles in the bottom to stop it blowing over. Add water until it just covers the pebbles and the bumpy base. Mark this level as zero.
3. Stick the millimetre strip on the side, starting at the zero mark, and cover it with clear tape.
4. Turn the cut-off top upside down and fit it into the bottle as a funnel. It keeps leaves out and slows evaporation. Its rim must be the same width as the bottle.
5. Stand the gauge in an open place, away from trees and roofs.

6. Read the level at the same time every day, and write it in a table. Then pour water out until the level is back at zero. Every few days, empty the gauge completely and refill it to zero, so mosquitoes cannot breed in it.

REMEMBER

If the funnel is wider than the bottle, it catches extra rain and your readings are too high. The collecting area must match the measuring area.

DID YOU KNOW

Mawsynram and Sohra (Cherrapunji) in Meghalaya are among the wettest places on Earth. The India Meteorological Department measures rainfall at stations across the country.

CHAPTER 8

Light and sound

Project 12: periscope from juice cartons

The science: Light travels in straight lines and bounces off a mirror at the same angle at which it arrives. This is the **law of reflection**. Two mirrors, each set at 45° , turn the light down and then out again, so you can see over a wall or round a corner.

You need: two clean 1-litre juice or milk cartons, two small mirrors that fit across the inside of a carton (acrylic mirror sheet is safest), tape and scissors.

1. Cut the tops off both cartons and tape them together, end to end, into one tall tube.
2. Near the top of the tube, cut a square window in the front face. Near the bottom, cut a window of the same size in the back face.
3. Fix the top mirror inside, behind the top window, sloping at 45° so it faces both the window and the bottom of the tube.

4. Fix the bottom mirror behind the bottom window, sloping at 45° so it faces the window and the top mirror. The two mirrors are parallel.
5. Hold the periscope upright, look into the bottom window, and adjust the mirrors until you see clearly over a table or wall.

The image is the right way up, because the second mirror reverses the first.

SAFETY

If you use glass mirrors, an adult should cover all their edges with tape. Never look at the sun through a periscope.

Project 13: tin-can telephone

The science: Sound is a **vibration**. Your voice makes the base of the can vibrate. The tight string carries the vibrations to the other can, whose base vibrates and makes the air near your friend's ear vibrate too. Solids carry vibrations much better than air does.

You need: two clean tins with smooth rims, or two paper cups for younger children, about 10 m of strong cotton or nylon string, two matchsticks, and a nail and hammer for the adult.

1. Cover the rims of the tins with tape.
2. An adult punches a small hole in the centre of each base.
3. Push one end of the string through the hole from outside and tie it to a matchstick inside, so it cannot pull out. Do the same at the other end.
4. Walk apart until the string is tight. One person talks into a can while the other listens.

SAFETY

Never use kite string coated with glass powder (manjha). It cuts skin easily.

TRY THIS

Let the string go slack, then pinch it with your fingers while your friend talks. Both stop the sound. Then try making a three-way telephone by tying a third string to the middle of the first.

CHAPTER 9

Helping nature

Project 14: bottle bird feeder

Why make it: Birds in towns and cities can struggle to find food and water. A feeder helps them, and it lets you watch them closely and keep a record, which is real science.

You need: a 2-litre bottle with its cap, two wooden spoons, string, and grain such as bajra, broken rice or other millets.

1. An adult makes two holes opposite each other about 8 cm from the bottom, slightly smaller than the handle of a spoon.
2. Push a spoon through so its bowl sticks out of one hole and the handle out of the other. Make the hole on the bowl side a little larger, so grain trickles out onto the bowl.
3. Fix the second spoon the same way, about 8 cm higher and at right angles to the first.
4. An adult makes a few small holes in the bottom so rainwater can drain out.
5. Fill the bottle with grain, close the cap, and hang the feeder from a branch about 2 m high, in the shade and out of reach of cats.
6. Every day, note which birds visit, how many and at what time.

TIP

In summer, keep a shallow bowl of clean water near the feeder and change it every day. Never put out salty, spicy, sweet or fried snacks, or leftover cooked food. Clean the feeder every week and throw away any wet or mouldy grain.

DID YOU KNOW

World Sparrow Day is celebrated on 20 March each year to draw attention to the house sparrow.

Project 15: compost bin

The science: Decomposers, such as bacteria, fungi and earthworms, break down plant waste into

compost: a dark, crumbly material that makes soil richer. They need air, moisture and a mix of two kinds of waste. **Greens**, such as vegetable peels and fresh leaves, are wet and rich in nitrogen. **Browns**, such as dry leaves, paper and cardboard, are dry and rich in carbon.

You need: a large old bucket with a lid, washed, a tray to stand it on, dry leaves, kitchen peels and a little garden soil.

1. An adult makes small holes in the sides and bottom of the bucket for air and drainage.
2. Put a layer of dry leaves at the bottom.
3. Add a layer of peels, then a thin layer of soil, which brings in decomposers. Repeat the layers as you collect more waste.
4. Keep the mix as damp as a squeezed-out sponge, and stir it once a week with a stick.
5. Keep the lid on. In about two to three months, the bottom layer turns dark and crumbly and smells like earth.

Do not add meat, fish, dairy, oil or cooked food, which smell and attract pests. Plastic, glass and metal never rot.

TIP

If the bin smells bad, it is too wet. Mix in more dry leaves or torn paper. Always wear gloves, and wash your hands afterwards.

TRY THIS

Make a mini compost column in a clear bottle. Mark the height of the layers each week and watch them sink and darken.

CHAPTER 10

Presenting the waste-management theme

A best-out-of-waste project is judged on two things: the science, and how well it shows the value of reuse. Plan your display to tell that story.

Show where it came from

- Put a few of the original waste items beside your model: a crushed bottle, a flattened carton, an old CD.
- Label each part of the model with the waste it came from, such as "Blades: one 1-litre bottle".
- Count your materials. "This project reused 6 bottles, 2 cartons and 1 CD" is a strong, honest message.

Make a simple chart

1. The three Rs, with one example of each from your own project.
2. How your family sorts its waste: wet, dry and hazardous.
3. The science of your model, in a numbered sequence or a flow of arrows.
4. What you would improve next time.

Keep the message honest

Use only facts you can check. If you quote a number about waste, write where it came from. A small, true fact you measured yourself, such as the weight of dry waste your family threw away in one week, is better than a big figure you cannot explain.

EXAMPLE

Arnav from Pune practised this 30-second explanation for his solar oven: "This oven is made from a pizza box, foil from a sweet box and old newspaper. The foil reflects sunlight in, the black paper turns it into heat, and the plastic window traps the warm air. It melted chocolate in 20 minutes. It cost nothing, and none of these things went to the dump."

TIP

After the exhibition, take your model apart and reuse the materials, or give them for recycling. A waste project that ends up in the bin misses its own point.

CHECK YOURSELF

Practice questions

1. What are the three Rs?
2. Why does reuse come before recycling?
3. Name the three types of household waste and give one example of each.
4. Name two things you should never collect for a project, and say why.
5. Why must collected bottles and cartons be dried fully before use?
6. In the bottle windmill, what job does the straw do?
7. Why does the CD hovercraft glide so easily?

- 8.** Which law of motion explains the balloon car?
- 9.** What is Pascal's law, and where is it used?
- 10.** Why do air bubbles make a hydraulic arm feel spongy?
- 11.** Why must only new syringes without needles be used?
- 12.** Why does stamping on the bottle launch the rocket?
- 13.** Give three safety rules for the bottle rocket.
- 14.** Why does drip irrigation save water?
- 15.** Why must water from the bottle filter not be drunk?
- 16.** What is capillary action, and which project uses it?
- 17.** Why is a triangle used in bridge frames instead of a square?
- 18.** A paper bridge weighs 200 g and holds 3 kg. What is its strength-to-weight ratio?
- 19.** Why is the floor of the solar oven black?
- 20.** Why must the funnel of a rain gauge be the same width as the bottle?
- 21.** How do the two mirrors in a periscope let you see over a wall?
- 22.** Why does the tin-can telephone stop working when the string is slack?
- 23.** Name two foods you should never put in a bird feeder.
- 24.** What are greens and browns in a compost bin?
- 25.** How can you show the waste-management theme in your display?

Answers

1. Reduce, reuse and recycle.
2. Reuse needs no factory, no transport and no extra energy, so it saves more than recycling.
3. Wet waste, such as vegetable peels; dry waste, such as paper or plastic; and hazardous waste, such as batteries or medicines.
4. Any two: broken glass and jagged tins (they cut); used syringes and needles (infection); chemical containers (harmful traces stay inside); old batteries and broken tubelights (harmful substances).
5. Damp materials grow mould and start to smell.
6. It acts as a bearing, letting the skewer turn smoothly with little friction.
7. Air escaping under the CD forms a cushion that lifts it, so there is almost no friction with the table.
8. Newton's third law: every push has an equal push in the opposite direction. Air pushed backwards pushes the car forwards.
9. Pressure applied to a liquid in a closed system passes through it to every part. It is used in earthmovers, car brakes and car jacks.
10. Air can be squeezed, so some of the push compresses the bubble instead of moving the other plunger.
11. A used syringe can spread infection, and needles can cause injury.
12. Squeezing the air into a smaller space raises its pressure, and the air rushes out through the pipe, pushing the rocket off.
13. Any three: air pressure only, with no chemicals, fuel or fire; launch outdoors with an adult; never aim at people or animals; stand behind the launcher; wear safety glasses; never use a pump.
14. Water goes straight to the roots a drop at a time, so less is lost to evaporation and runoff.
15. It can still contain germs and dissolved chemicals. Filtering removes only particles.
16. The rising of water through narrow gaps, such as between cotton fibres. The self-watering planter uses it.

17. A triangle cannot change shape unless a side changes length, so it stays rigid. A square can be pushed into a diamond shape.
18. $3,000 \text{ g} \div 200 \text{ g} = 15$.
19. Black absorbs light and turns it into heat.
20. A wider funnel would catch extra rain and give readings that are too high.
21. The top mirror turns light from the object down the tube, and the bottom mirror turns it out to your eye. Each is set at 45° .
22. Vibrations travel along the string only when it is tight. A slack string does not carry them.
23. Any two: salty, spicy, sweet or fried snacks, and leftover cooked food.
24. Greens are wet, nitrogen-rich wastes such as peels and fresh leaves. Browns are dry, carbon-rich wastes such as dry leaves and paper.
25. Show the original waste items, label each part with what it came from, count the materials reused, and explain the three Rs with honest facts.

WORD LIST

Glossary

Bearing

a part that lets another part turn smoothly with little friction.

Capillary action

the rising of water through narrow gaps, such as between fibres.

Compost

dark, crumbly material made when plant waste rots, used to enrich soil.

Compression

a force that squashes something.

Decomposer

a living thing, such as a bacterium or fungus, that breaks down dead material.

Drip irrigation

watering plants a drop at a time, straight at the roots.

Filtration

separating solid particles from a liquid by passing it through a filter.

Friction

the force that resists one surface sliding over another.

Greenhouse effect

the trapping of heat behind a clear covering that lets sunlight in.

Law of reflection

light bounces off a mirror at the same angle at which it arrives.

Pascal's law

pressure applied to a liquid in a closed system passes through to every part of it.

Pressure

how hard a force pushes on a given area.

Recycle

to break down used material in a factory and make something new from it.

Reuse

to use something again, for the same job or a new one.

Segregation

sorting waste into types, such as wet, dry and hazardous.

Strength-to-weight ratio

the load a structure holds divided by its own weight.

Tension

a force that stretches something.

Truss

a framework made of triangles.

Vibration

a quick back-and-forth movement; sound is made of vibrations.



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