EXPERIMENT MANUAL

FUN STEM PROJECTS AND EXPERIMENTS

Pepper Mint

IN

THE FANTASTIC Underwater Science VOYAGE

THAMES & KOSMOS

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Pepper Mint — Safety Information

WARNING! Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled. Strangulation hazard — long tubes and cords may become wrapped around the neck.

WARNING! Only for use by children aged 8 years and older. Instructions for parents or other supervising adults are included and have to be observed. Keep the packaging and instructions as they contain important information.

SAFETY ADVICE FOR BATTERIES

- Two AA batteries (1.5 volt, type LR6) are required for operation. These are not included in the kit because of their limited shelf life.
- Avoid short-circuiting the batteries. A short circuit can cause the wires to overheat and the batteries to explode.
- The supply terminals are not to be short-circuited.
- Different types of batteries (e.g., rechargeable and standard) or new and used batteries are not to be mixed.
- Do not mix old and new batteries.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Batteries are to be inserted with the correct polarity and pressed gently into the battery compartment. Instructions for inserting and changing batteries are on page 29.
- Non-rechargeable batteries are not to be recharged. They could explode!
- Rechargeable batteries are only to be charged under adult supervision.
- Rechargeable batteries are to be removed from the toy before being charged.
- Exhausted batteries are to be removed from the toy.
- Wires must never be inserted into a power socket.
- Warning! Do not manipulate the protective device in the battery compartment (PTC). This could cause overheating of wires, eruption of batteries and excessive heating.
- Dispose of used batteries in accordance with environmental provisions, not in the household trash.
- Avoid deforming the batteries.

Notes on disposal of electrical and electronic components

The electronic components of this product are recyclable. For the sake of the environment, do not throw them into the household trash at the end of their lifespan. They must be delivered to a collection location for electronic waste, as indicated by the following symbol:

Please contact your local authorities for the appropriate disposal location.

ALESSANDRO GRAF VOLTA

- Once said: "You must be ready to give up even the most attractive ideas when experiments show them to be wrong."
- Also from Italy, Volta was born in 1745.
- He did not speak until he was 4 years old.
- He invented the first battery (= "voltaic pile").

ELECTROLYSIS OF WATER

Using a voltaic pile – the world's first working battery – Volta performed electrolysis on water for the very first time in 1800. The electrolysis of water involves breaking down water molecules into their individual parts. This produces oxygen and hydrogen gas. This technique is used to split chemical compounds into their component parts.

AGNES POCKELS

- Once said: "Only someone who is compassionate toward herself can show compassion toward others."
- She was a German chemist born in Venice in 1862.
- She chose not to pursue formal education so she could look after her parents, and she educated herself.
- She investigated surface tension.

As we saw on page 16!

- Her findings were initially ignored by German scientists and it was only with the help of an English physicist that they eventually became known to the wider world.

Did you know?

Have you ever wondered why so many famous physicists of the past were men, and only a few were women? It was because of the strict rules of society back then. Agnes Pockels was unable to publish her research findings because the scientific journals of the time refused to publish anything that was written by a woman. Fortunately, things have changed over the last 150 years. Today, women can choose to become whatever they want to be ...

Believe in yourself!

Dear Parents and Adult Supervisors

This STEM experiment kit gives your child a fun way to discover the basic principles of physics. The kit includes everything needed for the experiments, except batteries and a few other common household items.

The step-by-step instructions feature a story that unfolds throughout each chapter. The heroine of the story is Pepper Mint — an eleven-year-old girl whose creativity and cleverness help her find her way through a series of adventures and overcome various challenges. The kit includes a figurine of Pepper Mint herself as well as the research vessel, so that your child can play along with the story. This kit offers a total of nine exciting experiments. Each experiment adds another element to the research vessel and the underwater station: a hydraulic crane, a snapping mechanism, a ship's propeller, and much more. When your child reaches the end of the instructions, he or she will find out how to use all of the projects together.

Every construction project provides a fun introduction to the physics behind it. Along the way, your child learns why water can be used to transmit force, what water is actually made of, and how to safely build an electric circuit.

Children in this age group are at different stages of development, so you can decide in advance which experiments your child can do alone, and where your help will be needed. Please make sure you're on hand to provide advice and practical help, and to check the finished product after each experiment.

Together with your child, decide on a suitable place for conducting the experiments. Small amounts of water (15 ml) may spill from time to time, so it's best to find a surface that won't be damaged by water.

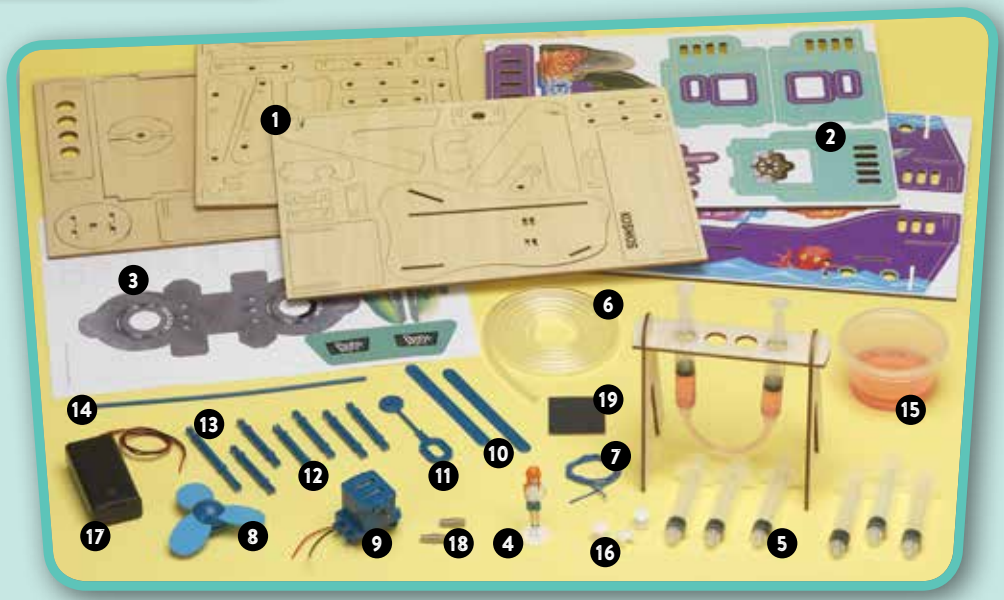
As it contains electronics experiments, this experiment kit is not suitable for children under the age of eight. Please keep small children and pets away from the experiment equipment, and take time to read through the safety information with your child. Keep the instructions handy for reference at all times.

Have fun experimenting and playing!

Here's what to do:

1. Read the story or get someone to read it aloud
2. Carry out the experiment
3. Learn through playing

Pepper Mint Kit Contents



Make sure you have all of the components of your kit and check them off:

✔	No.	Description	Qty.	Item No.
❍	1	Wood sheet, plain	3	720575
❍	2	Wood sheet with printed illustrations	2	720575
❍	3	Cardboard sheet	1	720571
❍	4	Pepper Mint figure	1	720566
❍	5	Syringe	8	720740
❍	6	Tube, 150 cm	1	720741
❍	7	String, 40 cm	1	720742
❍	8	Propeller	1	720744
❍	9	Motor	1	720745
❍	10	Stirrer	2	720724

✔	No.	Description	Qty.	Item No.
❍	11	Bubble wand	1	720725
❍	12	Axle, short	6	720726
❍	13	Axle, long	1	720727
❍	14	Stick	1	720728
❍	15	Tub with cover	1	720572
❍	16	Screw, two-piece	3	720723
❍	17	Battery compartment with cables	1	720743
❍	18	Spring	2	713882
❍	19	Sandpaper	1	720574

You will also need:

ruler, scissors, craft glue, tap water, paper, adhesive tape, watercolor paint, 2 x AA batteries (1.5-volt, type LR6/ mignon), tablespoon, sugar, soap, dish towel, dishwashing liquid or bubble-blowing solution, flat-head screwdriver, paper clips, coins, pencil

Tip! If you are missing any parts, please contact Thames & Kosmos customer service.

US: techsupport@thamesandkosmos.com

UK: techsupport@thamesandkosmos.co.uk

Table of Contents

Tip! On pages 16–17 and 31 you'll find exciting experiments all about water and blowing bubbles. For even more background knowledge, go to the last double-page spread.


Pepper
Mint

The Expedition Begins

Pepper headed into the local aquarium and walked straight over to the new saltwater tank. A tall man with unruly hair and a clipboard was standing in front of the empty tank. His name was Mr. Eisenbart, and he was the director of the aquarium. He greeted Pepper enthusiastically.

"Hi Pepper, have you packed all your things for the next three weeks?" Mr. Eisenbart looked skeptically at the small bag that Pepper had slung over her shoulder.

"I've got my diving gear and my tools. I'm all set!" said Pepper, beaming. She was very excited about their expedition to the Bermuda Triangle, which Mr. Eisenbart had spent the last few weeks preparing for. And Pepper, who had volunteered to spend the past year cleaning every single pane of glass in the aquarium, had been allowed to come along!

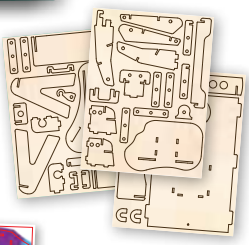
The empty tank in the aquarium had been prepared for the rare species of fish that Mr. Eisenbart planned to catch on their expedition and then investigate in the city aquarium.

"How about we take a look at the research vessel?" asked Mr. Eisenbart. Pepper nodded. Together, they walked down to the pier next to the aquarium, where a small team was busy loading the *Kosmos*. The biggest ship that Pepper had ever been allowed to set foot on was her friend Andy's canoe. With a slightly queasy sensation, Pepper stepped on board the enormous ship, feeling a little like an adventurous pirate.

Pepper Mint AND THE Research Vessel

YOU NEED ...

2 x wood sheets with illustrations



3 x plain wood sheets

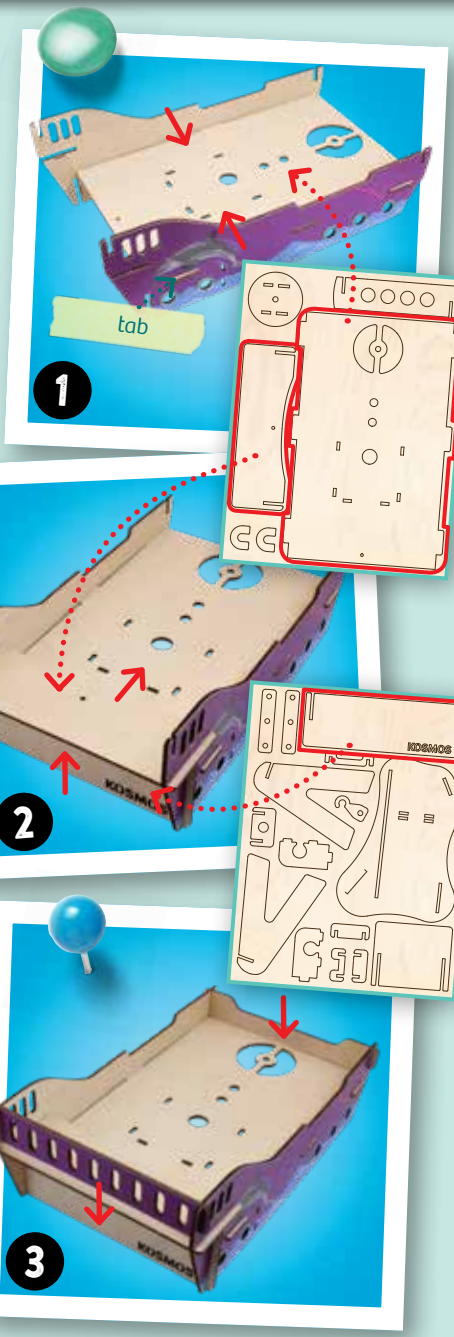
HERE'S HOW!

1. Push the purple-colored side panels onto the base panel of the ship from the right and left. You'll need to push the tabs sticking out from the sides of the base panel into the notches in the side panels.

2. Pushing up from below, slide the wooden panel with "KOSMOS" written on it onto the front of the ship (the shorter side). The side panels have slots in them for this purpose. Next, take the upper deck panel, which has a small hole in it, and fit it over the base panel of the ship by sliding it in from the front.

Tip! If the pieces snag instead of sliding together smoothly, you can use your sandpaper to make the slots a little wider or the tabs a little narrower. Don't force the pieces together — ask your parents for help if you need it.

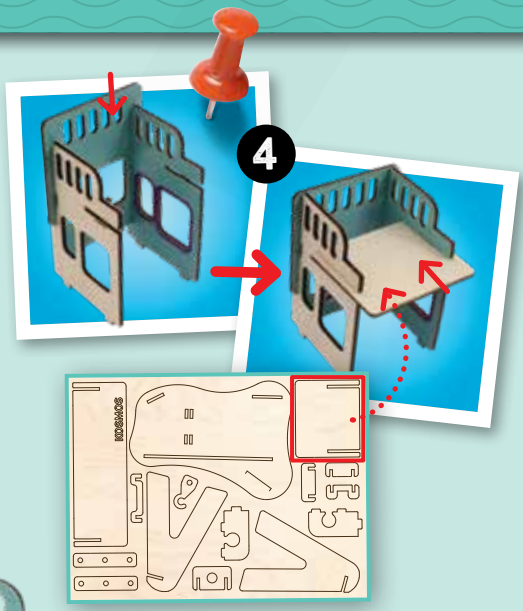
3. Now complete the front of the ship (the shorter side) by adding the purple-colored railing, which you can slide into the corresponding slots from above. Finally, attach the back panel across the back of the ship.

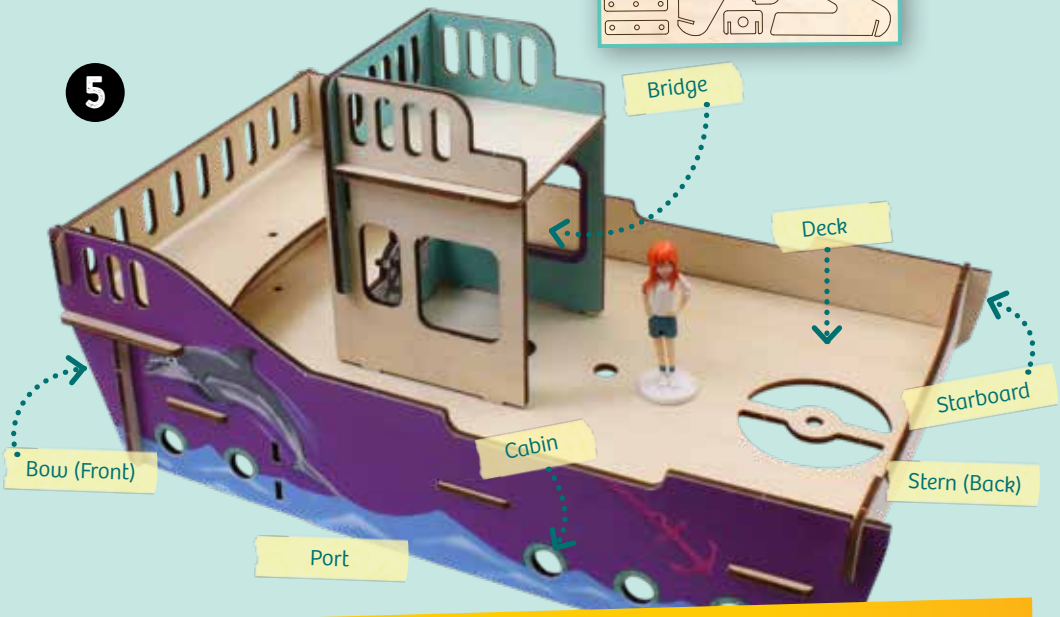


4. To build the little cabin, assemble the three teal-colored wooden pieces by sliding the middle section down onto the two side walls. The colored sides of the panels should be facing inward. Next, slide the top horizontal panel into the horizontal slots and push it in fully.

5. You're almost finished. Push the cabin down into the corresponding slots in the base panel of the ship. Hold your hand against the underside of the base panel as you do so.

Your research vessel is now ready for you and Pepper Mint to set sail on your expedition!





To make sure you can conduct the following water-based experiments without worrying about making a mess, you and your parents should find a suitable place for experimenting, ideally somewhere with a surface that won't be damaged by water. Even though you'll only be using small amounts of water (6 ml in each syringe), you should always have a towel or some paper towels nearby to mop up any spills. If the wood gets wet, you can blot the wet parts with a towel and let the wood dry overnight.

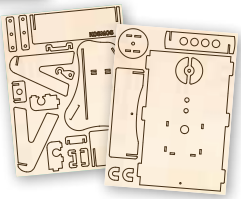
The Wonder of Water

Pepper stood wide-eyed on the deck, staring at Mr. Eisenbart's pale, hairy legs. The team had barely finished loading the ship with their provisions for the next few weeks and moving into their cabins below deck when the aquarium director had swapped his dusty suit for a pair of colorful shorts and a light shirt.

A deep droning sound distracted Pepper from this unusual sight and, after a little lurch, the ship began to move away from the pier. The others were all bustling about around her, doing a hundred different jobs at lightning speed. The anchor was pulled in, the flag was raised, and the last few objects on deck were secured. The expedition could finally begin! The ship rocked lightly up and down on the waves, and after a while, Pepper managed to ignore the queasy feeling in her stomach and went out to explore the ship.

The cabins that the expedition team would be sleeping in were located below deck. Pepper was lucky enough to have been assigned a cabin with a porthole. Under the cabins was the ship's hold, and behind that was the engine room containing the ship's propeller, which was emitting a steady drone. Back on the deck of the ship, Pepper spent the next hour watching the coast behind her growing smaller and smaller, and she couldn't help but be amazed that an object as big and heavy as the research vessel that she was standing on didn't simply sink. How was it even possible that a ship could float?

YOU NEED ...



2 x plain wood sheets

2 x syringes

10-cm tube

You will also need: tap water, ruler, scissors, watercolor paint (or dye)

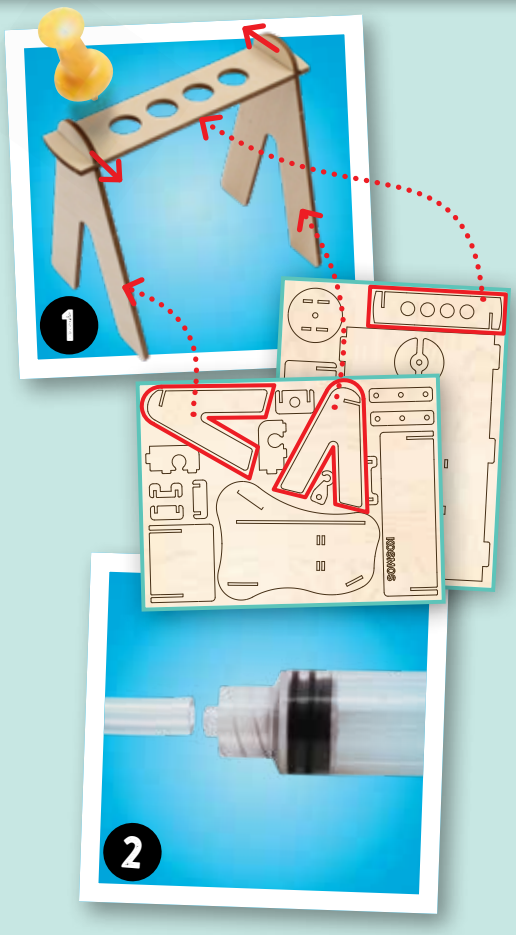
Tub

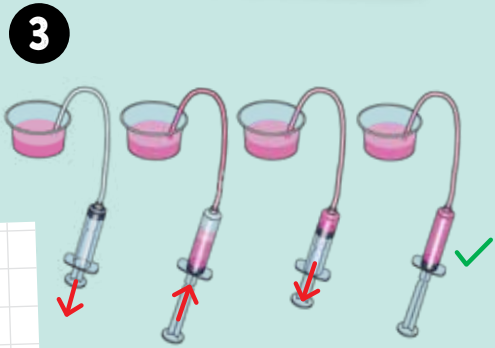
HERE'S HOW!

1. Assemble the syringe holder by sliding the two legs into the holder, one from the front and the other from behind.

2. With the scissors, cut off a 10-cm piece of tube. Make sure that you cut the end of the tube in a straight line. Connect one end of the tube to the opening at the bottom of one of the syringes. To do this, position the end of the tube over the nozzle, then push the tube onto the nozzle until it can't go any further. If it's too tricky, ask your parents for help.

3. Fill the syringe with tap water, as shown in the drawing below. Fill the tub halfway with water. Hang the end of the tube over the side of the tub and pull out the plunger. The syringe is now filled half with air, half with water. Hold the syringe upright and push all the air out (and out of the tube too). Finally, pull the plunger out fully.





Tip! If you like, you can also add color to the water using some watercolor paint or dye. This will make it easier to see what's going on in the syringes and tubes. If you're using colored water, make sure you stay away from carpets, curtains, or other fabrics, and remember to wear old clothes.

4 Place the full syringe, with the plunger pulled out, into the syringe holder. To do this, carefully thread the tube through one of the holes, pulling it down gently from above, until the syringe is suspended from the holder. Place an empty syringe, with the plunger fully pushed in, into a hole at the other side of the holder and connect the free end of the tube that's filled with water to the empty syringe.

WHAT IS WATER?

Like everything in the world, water is made up of tiny particles that can't be seen with the naked eye. We call these building blocks "atoms." The most basic building blocks are known as "elements" and these can be combined into larger groups called "molecules" as a result of chemical reactions. Water is made up of many tiny water molecules, which in turn are made up of the elements "oxygen" and "hydrogen." Each water molecule consists of two hydrogen atoms attached to one oxygen atom.

WHAT'S HAPPENING?

When you carefully press the protruding plunger down, water flows into the empty syringe at the other end of the tube and pushes the plunger up on the other side. The initial movement you made is transmitted by the water. What happens if you hold the plunger of the empty syringe down, while also carefully pressing the plunger of the full syringe down? Can the water be compressed?

Empty the two syringes and the tube into a sink and try the same experiment using air instead of water this time. Can the air be compressed?

WHY DO SHIPS FLOAT?

When an object enters a body of water, it pushes water molecules aside as it enters the water. A ship will float if the water that it displaces weighs more than the vessel itself. Even though ships can weigh many thousands of tons, their shapes are cleverly designed to allow them to displace enough water to allow them to float.

Try out this experiment: Fill your tub with water, then take some modeling clay and shape some of it into a ball and some of it into a small boat. The ball will sink, while the boat will float on top of the water. The boat displaces more water than the ball.

GOOD TO KNOW

Water can transmit forces because it can't be compressed — unlike air, which can be compressed up to a certain point. Water, and liquids in general, aren't compressible because the molecules are packed closer together in a liquid than in a gas. The branch of physics that studies this phenomenon is known as "hydraulics."

Pepper Mint AND THE Flag

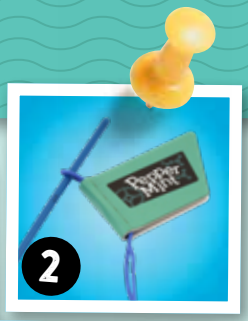
YOU NEED ...

Flag from cardboard sheet

Mast

20-cm string

You will also need: Ruler, scissors, and craft glue



HERE'S HOW!

1. Remove the Pepper Mint flag from the cardboard sheet and lay it down with the back side facing up. Fold the 20-cm piece of string in half, so that each end is of equal length, then place the string down the center line of the flag, with the loop at the top.
2. Fold the flag along the center line and glue the two identical sides together. Make sure that the loop is still sticking out at the top. Insert the mast through the loop and slide the flag to the middle of the mast.
3. A knot directly below the flag will prevent it from slipping: tie both ends of the string in a pretzel-shape around the mast and tighten the knot.
4. Take the mast with the flag attached and insert it through the precut hole in the upper deck at the front end of the ship, then hoist the Pepper Mint flag!

WHAT'S HAPPENING?

Thanks to the adjustable knot, you can move the flag up and down the mast. At sea, flags have a special meaning. Sailors use patterns and colors of different flags to send each other messages across long distances. If someone goes overboard — that is, accidentally ends up in the water — sailors hoist an emergency flag that signals to everybody that there is a "man overboard!"

Storm on the Horizon

Having quickly tired of watching the rolling waves and unchanging horizon, Pepper turned her gaze to the bridge. Now that she understood why the ship wasn't going to sink, she wondered how it was going to be able to find its way to the Bermuda Triangle. It obviously couldn't read a map, and the open ocean all looked the same. Maybe she should pay the captain a visit on the bridge, and take a closer look at all those buttons and gadgets ...

Without hesitation, Pepper climbed the steps to the bridge deck, knocked briefly on the door to the control room and opened it. A tall woman with an eye patch and a parrot on her shoulder turned to look at Pepper, who, at this unexpected sight, completely forgot what she had wanted to ask. After a long silence, Pepper finally announced: "Hello, I'm Pepper Mint."

She didn't get to hear the name of the captain, as some buttons suddenly began to flash red and a loud beeping noise attracted the captain's attention. The woman shooed Pepper out with a wave, as her parrot cawed "Pepperrrrr Mint" over and over. When Pepper looked up, she saw that the horizon had changed, and that the ship had begun to rock up and down more intensely. The *Kosmos* was heading straight toward a bank of storm clouds!

YOU NEED ...

30-cm tube

2 x syringes

Tub

You will also need: ruler, scissors, tap water, adhesive tape, paper towels

HERE'S HOW!

1. Remove the mast and the cabin. Turn your ship upside-down.

   Use the scissors to cut a 30-cm length of tube, with a straight edge at the end, and then connect this tube to a syringe. Completely fill the tube and syringe with tap water, as described on page 9.

   Insert the tube full of water through one of the portholes in the side panel, then insert it down again through the hole in the base panel of the ship, as shown. Have a towel ready in case the tube leaks.

2. Slide an empty syringe (the plunger should be pushed all the way down) into the big hole in the base panel of the ship. The handles on either side of the syringe should be touching the underside of the base panel, while the barrel of the syringe should be pushed down through to the other side.

3. Turn the ship the right way up again. Connect the open end of the tube to the empty syringe.

Tip!

You can seal the open end of the tube with a piece of adhesive tape, so that it doesn't drip during assembly.

4. Insert the cabin into the base panel, and position the tube firmly between the syringe and the top of the cabin so that it can't move. Make sure that there are no kinks in the tube. Slowly push the plunger of the full syringe inward.

WHAT'S HAPPENING?

Your entire ship will rise and fall, as though it were sailing over a series of waves. If you push one plunger inward, the water will pass through the tube into the other syringe, pushing its plunger the same distance outward. The plunger presses against the tabletop and lifts the entire ship upward.

If you leave your ship set up like this for a long while, the water might evaporate and air bubbles might appear in the tube. If that happens, you'll need to push the plunger very carefully inward, otherwise the tube may burst. Make sure to change the water from time to time, or conduct some air-based experiments!

WHAT ARE HYDRAULICS?

The word hydraulics comes from Greek and means water ("hydro") and pipe ("aulos"). In science, hydraulics is the study of the flow behavior of liquids. That sounds pretty complicated, but you've actually already explored what it means using your model, i.e. how a liquid is used to transfer a force. The pressure that is exerted on a pump is transmitted to the water, and the water then passes this pressure to a piston, which performs some kind of work. This is a hydraulic transmission system.

WHERE ARE HYDRAULICS USED?

Today, hydraulics are used for transferring forces in very big machines. For example, they are used in agriculture and construction for forklifts, cranes, and diggers. Have you ever noticed the tubes on your bike that run from the handlebars right to the brakes? Even there, you're using a hydraulic system with brake fluid. Instead of water, special oil is often used as it doesn't evaporate when it gets warm, or freeze when it gets cold.

In the Bermuda Triangle

Pepper spent the next few hours below deck, clinging to the frame of her bunk bed as tightly as she could. Maybe now would be a good time to call her mother and confess that she had been the one responsible for the explosion in their cellar because her test tube stand had fallen over. Or maybe she should tell her father that the reason all the saw blades in the shed were dull was that she wanted to build a soapbox cart for the race that fall. But when Pepper glanced at her phone, she noticed that it had stopped working. "Peculiar," thought Pepper, as it suddenly occurred to her that the deep drone from the engine room had also stopped. All she could hear was the sea outside and the various members of the expedition party calling out every now and then. She pressed the light switch but her cabin remained in darkness.

Struggling to remain upright, Pepper made her way down the swaying corridor to Mr. Eisenbart's cabin. If anyone understood what was going on here, it was Mr. Eisenbart, the old deep-sea researcher! He was sitting at a folding table with a marine chart spread out in front of him as Pepper entered the cabin.

"Hello Pepper," he said. "I hope our little adventure isn't upsetting you. Countless sailors have recounted strange stories about the Bermuda Triangle, stories about machines and devices that have stopped working, bubbles of gas that have risen up from the bottom of the ocean, or impenetrable fog descending and causing sailors to lose their way ..."

YOU NEED ...

Tub

You will also need: tap water, paper clips, soap or dishwashing liquid, coins

HERE'S HOW!

1. Fill two thirds of your tub with tap water. Carefully place a paper clip or pin onto the surface of the water.
2. Drop a little dishwashing liquid into the water.

WHAT'S HAPPENING?

The paper clip floats on the surface — until you add soap and disturb the "surface tension" of the water. Then it sinks to the bottom. Water consists of a great number of molecules that attract and repel each other. If a molecule is surrounded by other water molecules, these interactions balance each other out. If a water molecule comes in contact with air, because it's at the surface, the forces of attraction can no longer be balanced out, and the molecule is drawn inward into the liquid. Water tries to form the smallest possible surface area in relation to the substance that borders it. This is why water forms round droplets, and why it has a surface tension that allows small creatures, like water striders for example, to walk on it. The soap is made up of molecules that push between water molecules on the surface, disturbing the water's surface tension.

WHY CAN'T WATER BE COMPRESSED?

You've almost certainly noticed before that very cold water below 0° Celsius freezes and turns to ice, or that if you boil water (over 100° Celsius), it evaporates and disappears. This is referred to as "states of matter." Heat plays a very special part in these changes from solid to liquid to gas. The warmer water gets, the more its molecules bounce around because they have more energy. With ice, the molecules are frozen into a grid-like lattice structure. In water, this rigid structure comes apart, and the molecules start moving about. In steam, they shoot around all over the place, so much so that they're barely even connected to each other any more. When water is in liquid form, the molecules move about, however because of the forces of attraction and repulsion that exist between the individual molecules, they stay at a set distance from each other. This is why you can't compress the water in your syringe.

3. Fill up your tub to the brim with clean tap water.

4. Drop small coins into the tub one by one, until the water overflows.

WHAT'S HAPPENING?

The coins displace the water and raise the water's surface so that it spills out over the edge of the tub. You can see how the surface of the water arches upward until the surface tension breaks down and the water flows out over the edge of the tub.

THE BERMUDA TRIANGLE

Very little exploring has been done in this coastal area off the southeastern coast of the US. For many years, it has been a place of wild speculation and eerie legends about ships being swallowed up by the sea, and planes suddenly crashing or vanishing without a trace. There have even been tales of sea monsters and aliens, accompanied by claims that they're the ones responsible for the many mysterious occurrences in the Bermuda Triangle. The most impressive case dates back to 1945, when five aircraft from the US Air Force disappeared from the radar without a trace. The search and rescue aircraft that was sent out to find them also failed to return.

In the meantime, calculations have shown that accidents are no more common in the Bermuda Triangle than anywhere else in the world, but the legends refuse to die. Now at last scientists are onto a possible reason that would explain why ships sink in the Bermuda Triangle: The ocean floor stores enormous amounts of methane gas. These bubbles of gas can burst and because gas has a lower density than water — meaning that it's lighter — this results in a massive quantity of gas suddenly rising to the surface, and the sea level dropping for a moment. Large craters on the sea floor of the Bermuda Triangle suggest that these theories could indeed be correct.

Save the Expedition!

The storm brought the research ship into exactly the area that Mr. Eisenbart had marked with a red "X" on his marine chart. Somewhere in the vast expanse of water around them swam a specimen of strange fish that they would hopefully take home with them to study at the city aquarium.

As Pepper stepped out onto the deck several hours later, the team was standing around the ship's crane, soaked to the skin and completely bewildered. "Did we run out of dessert or something? Why do you all look so disappointed?"

"Well, you see," began Mr. Eisenbart, "We can't go on a dive to find the fish. The crane that was to lower the diving chamber into the sea and lift it out again has stopped working. Just like every other electronic device on board."

"Even our radio is dead," added the captain.

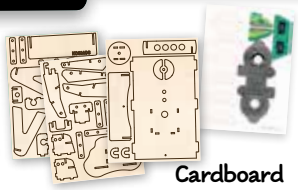
"Radiooooo deaaaad," cawed the parrot on her shoulder in agreement.

Pepper didn't want to let the bad news spoil her mood. She had spent a whole year scraping muck off panes of glass at the aquarium so that she could come on this expedition.

She looked more closely at the crane, examining the joints and wrinkling her forehead. No electronics? Well, so what ... Surely there are other ways to move the crane!

Pepper Mint AND THE Ship's Crane

YOU NEED ...



3 x plain wooden sheets

Cardboard sheet

1 x 30-cm tube, 1 x 20-cm tube

4 x syringes

Tub

10-cm string

3 x 2-piece screws

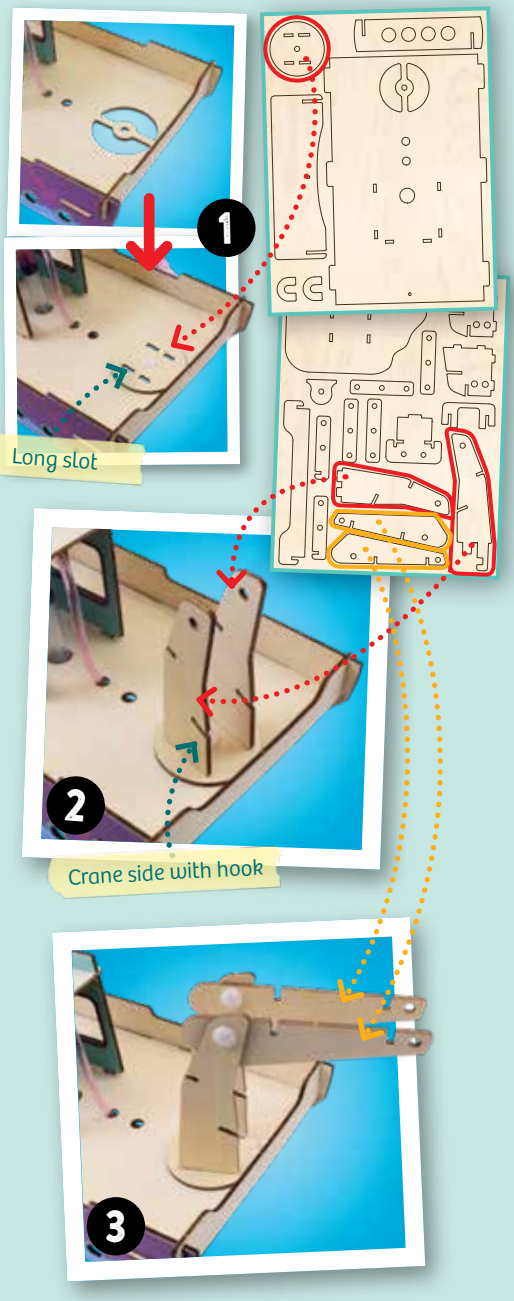
You will also need: ruler, scissors, adhesive tape, tap water, large flat-head screwdriver

HERE'S HOW!

1. Use one of the screws to attach the base of the crane to the precut opening in the base panel of the ship. The screw is made up of two pieces that can be separated by turning them counterclockwise and then screwed into each other by turning them clockwise. Take one of the screw pieces, and from above, insert it down through the middle hole in the crane base, and then down through the base panel of the ship. From beneath, twist the other screw piece up into the screw piece above. Tighten the screw firmly using a flat-head screwdriver if necessary. **Warning: Make sure that the longer slots in the crane base point toward the front of the ship.**

2. Now, with their tabs pointing downward, insert the two sides of the crane into the crane base. **The crane side with the hook on its lower end must be inserted into the left-hand slot.**

3. With the remaining two screws, attach the crane jib pieces to the inner sides of the crane. Use a flat-head screwdriver if necessary.



4. The crane will be operated using two hydraulic syringes. You can see in the pictures how to set up the syringes using the connector piece from the cardboard sheet.

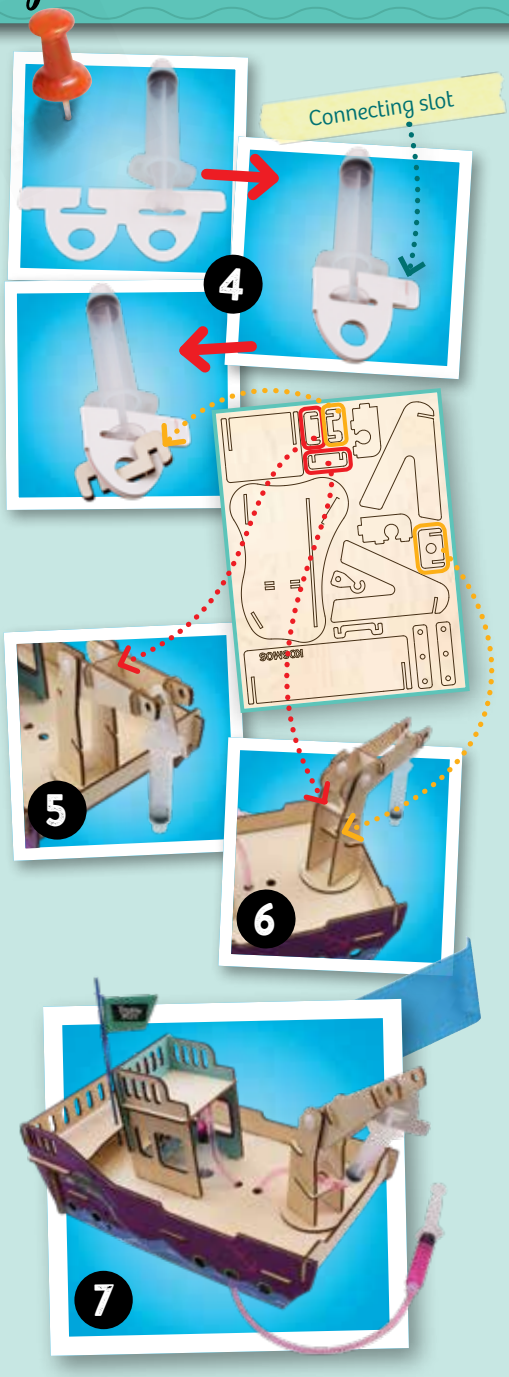
   Make sure that the thumb rest of the syringe plunger is held securely within the assembled connector. You can also attach the cardboard tabs to the back and the front of the thumb rest using two pieces of adhesive tape. Finally, pass the wooden double hook through the hole in the connector attached to the syringe.

5. Attach the double hook, together with the syringe hanging from it, securely to the top of the crane. Behind this, place a wooden support into the precut slot provided.

6. Slot two more wooden supports into the sides of the crane, one from the back and one from the front.

7. Then attach a 30-cm piece of tube to a second syringe and fill them both with tap water, as demonstrated on page 9. Pass the tube through one of the port holes in the side panel of the ship, then pass it under the base panel and then up again, and out through the hole at the back next to the crane. From underneath, insert the end of the tube through the hole in the lowest wooden support and attach it to the other syringe suspended from the crane.

8. Pull the tube taut, so that the end of the syringe is inserted into the hole of the lowest wooden support. Attach the hook to the end of the crane using a 10-cm piece of string. What happens if you carefully press down the plunger of the syringe at the other end of the tube?



9. You can now move the arm of your crane up and down. Next you'll install a hydraulic system on the base panel to allow the crane to rotate to the left and to the right. Turn your ship upside down. Remove one of the connectors from the cardboard sheet, attach it to an empty syringe, and hook it onto the underside of the crane.

10. Take another syringe with a 20-cm length of tube attached (see page 9), fill them both, then pass the tube through the hole that is farthest forward in the side panel and onto where the empty syringe is. Attach the full tube to the empty syringe and then secure the tube in place using a U-shaped piece of wood. **Make sure that the tube is pulled taut.**

11. Turn your ship right side up again. Finally, remove the pieces for the diving chamber from the cardboard sheet, assemble the chamber, and then hang it on the hook. Finished!

Giant Snapper Ahead

By that afternoon, the hydraulic crane was working again and nothing stood in the way of their first dive at the Bermuda Triangle. The fearless Mr. Eisenbart was to be the first to climb into the diving chamber and let the crane lower him 200 meters deep into the water.

And soon he was off. The crane lowered the diving chamber into the sea. Within a few seconds, the viewing port framing Mr. Eisenbart's slightly greenish face vanished into the watery depths. The members of the expedition stood in a circle around the crane and stared anxiously at the cable. The diving chamber had reached a depth of 20 meters … now 30 … now 40. After an hour, the chamber was 150 meters deep. Pepper had to yawn, and quickly covered her mouth with her hand. Somehow, she had imagined that this would be more exciting.

But wait! Had the cable just jerked a bit? The cable suddenly went taut and began to move to the right and left.

"Pull it up right now!" shouted the captain over her shoulder.

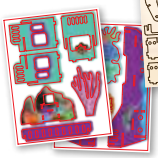
"Up, up!" repeated the parrot, and Pepper began to winch the cable upward. "Up, up!" called the parrot, cheering Pepper on. Three other sailors had to join her at the winch to help before the cable started to roll back up, bit by bit.

As they finally hoisted the diving chamber out of the sea, a sensational sight was revealed: a gigantic, yellow-green scaled fish had clamped its jaws around the chamber, only letting go when it had reached the crane above.

Pepper Mint AND THE Giant Snapper

YOU NEED ...

Cardboard sheet



2 x wood sheets with illustrations

2 x plain wood sheets

6 x short axles

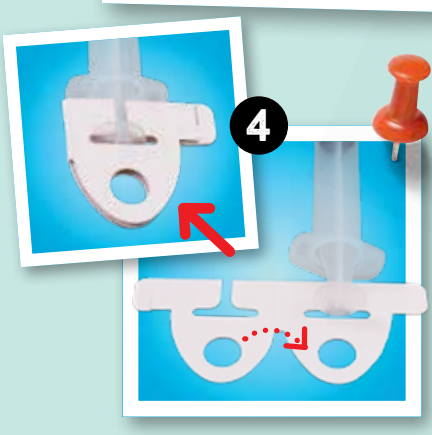
1 x long axle

Tub

20-cm tube

2 x Syringes

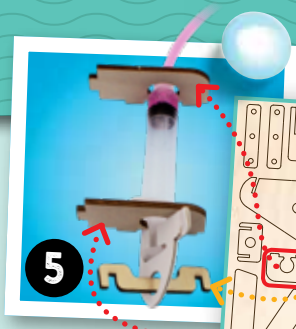
You will also need: ruler, scissors, tap water, adhesive tape



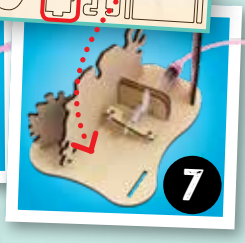
HERE'S HOW!

1. Remove all of the rectangular parts with three precut holes in them from the wooden sheet. Lay four of them out in two overlapping "X" shapes and insert the ends of the six short axles plus the long axle into the holes in the wooden rectangles. Make sure that the long axle and the wooden rectangle with the hook are in the right places.
2. Now place the remaining four wooden rectangles onto the free ends of the axles, as shown in the picture.
3. Push both pieces of the sea monster's head out of the cardboard sheet and attach them to the two wooden rectangles on the left.
4. Cut a 20-cm length of tube, connect it to a syringe, and fill them both as described on page 9. Attach the free end of the tube to an empty syringe. Take a connector out of the cardboard sheet, place it beneath the thumb rest of the empty syringe plunger, and then fold the other side of the connector over the plunger. Join the two sides of the connector together by fitting the slots on the sides one over the other.

5. Next, sandwich the handles on either side of the syringe between two wooden supports; slide one along the barrel of the syringe until it's in front of the handles, and slide the other over the plunger behind the handles. Pass a wooden rectangle with two hooks through the connector.



Tip! The connector must be in a vertical position. You can gently turn the plunger in the syringe until it's pointing in the right direction. If the connector isn't gripping properly, you can attach it more securely by putting two pieces of tape on each side of the plunger's thumb rest.



6. Insert the two wooden panels into the back of the underwater reef.

7. Then attach the reef and the wooden panels to the base panel that goes with them. Insert the two pieces of coral into the precut holes in the base panel.

8. Put your scissors mechanism in place on the base panel. The sea monster should be pointing to the left. Make sure that you set it up as shown in the close-up pictures.

9. Your Giant Snapper is now ready to be used! Carefully press the plunger of the full syringe down and watch what happens! Have a go at snapping at Pepper in the diving chamber!

WHAT'S HAPPENING?

This time, you've linked your hydraulic system up to a mechanical system. As the plunger moves, it extends the scissors mechanism, causing the scissor joints to close and move upward. You've used a simple movement (pressing down the plunger) to trigger a more complex movement. Genius!

Shimmering Spheres

After an experience like that, anyone else might have reconsidered their love of fish — but not Mr. Eisenbart, who now seemed more attached than ever to the importance of his mission. Quite by accident he had discovered a new species, and nothing was going to stop him from presenting it to the world and outdoing his research colleagues once and for all. The only problem was how to capture the fish. Even if he did manage to entice the fish to come closer again, the *Kosmos* wouldn't have enough space to accommodate a deep-sea monster of that size on board. Nor had they the slightest notion what the "Giant Snapper" (as they affectionately called it) even ate — most likely something Pepper herself would not have been happy about. After all, it had attempted to swallow Mr. Eisenbart whole! Or maybe it had just mistaken the shimmering glass of the diving chamber for a tasty treat?

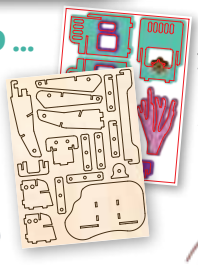
Just then, a number of different things happened all at once. From the engine room came the droning sound of the engine starting up again; from the control room on the bridge came the sound of loud beeping; and on the deck of the ship, the lights came on. They had electricity again! And just in time for dinner too!

The ship's propeller began to rotate around the axle again, whipping up the water and creating bubbles of all shapes and sizes. Pepper moved over to the railing and stood staring intensely into the water. What was that? Was it a large, scaly shadow swimming up through the bubbles?

"Hey!" shouted Pepper. "Could someone shine the light onto the propeller?" In the blink of an eye, just as the light hit the Giant Snapper, Pepper took a quick photo with her cell phone, mere seconds before the fish submerged again and disappeared out of sight. Mr. Eisenbart now had all the proof he needed. And Pepper would never tell anyone that it was the shimmering, frothy bubbles that had dazzled the fish and lured it in. The Giant Snapper would return to its life of freedom, free to wreak havoc in the murky depths of the Bermuda Triangle.

Pepper Mint AND THE Ship's Propeller

YOU NEED ...



Illustrated wooden sheet

Plain wood sheets

Propeller

Motor

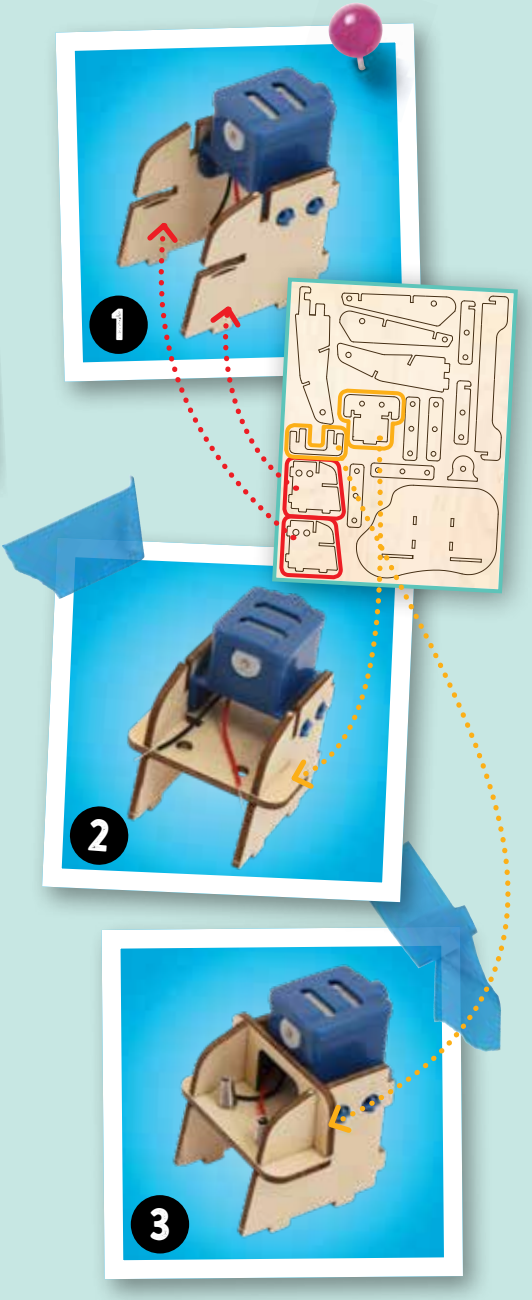
Battery compartment with wires

2 x springs

You will also need: 2 x AA batteries (1.5-volt, type LR6/Mignon)

HERE'S HOW!

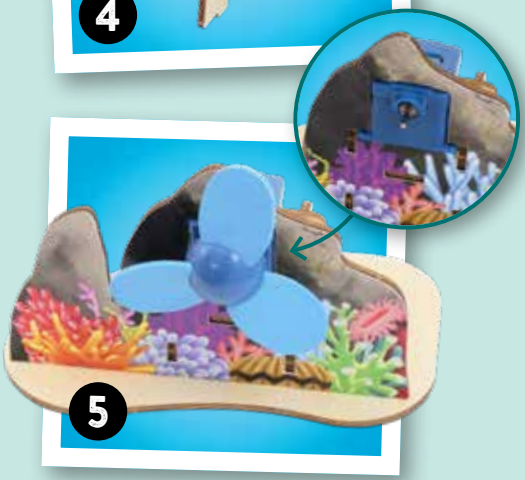
1. Slot the two side pieces onto the pins protruding from either side of the motor casing.
2. Insert a cross panel by sliding it into the slots on each side wall. Make sure that you keep the wires from the motor on the top side of the panel.
3. Insert the two springs into the precut holes, narrow side down. If you move the springs to one side with your finger, to make a little gap, you can insert the wire through the rings. Connect the black wire to one spring, and the red wire to the other spring. To finish, from above, slide another panel downward in front of the motor.
4. From behind, push the whole structure back into the wooden piece printed with the underwater volcano on it.
5. Then place the whole thing onto the base of the ship. At the front of the ship, you'll see an axle protruding from the motor block. This is where you attach your propeller.



You don't need to worry about touching the wire, the springs, or the motor. The electrical current is so small that nothing will happen. But never touch power outlets or uncovered wires around your home — that can be extremely dangerous.

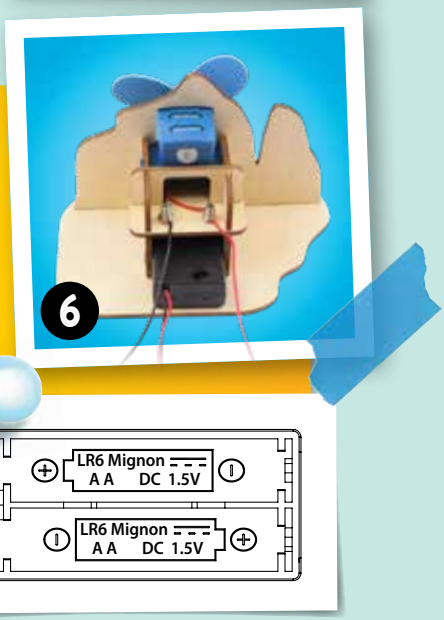
6 **Ask your parents to insert the batteries into the battery compartment. The note below shows how to do this.**

Place the battery compartment into the hollow space under the motor. Move the switch to the "OFF" position and connect the red wire from the battery compartment to the spring that you previously connected to the red wire from the motor. You can do this by moving the spring to one side with your finger, until a gap forms between the individual rings. Now connect the black wire to the other spring — again making sure that everything is positioned correctly. You can now turn on your ship's propeller by moving the switch to the "ON" position.



Please ask an adult to insert or replace the batteries:

- **Open the cover of the battery compartment. Insert two new AA batteries (1.5-volt, type LR6/Mignon), or remove the old batteries and insert new ones. Make sure you put the batteries in correctly by matching the + and – polarity markings! Then close the battery compartment again.**



WHAT'S HAPPENING?

You have just created an electrical circuit. Electricity flows from the battery through the wires that you connected to the springs, into the motor, and then back to the battery again. The motor axle rotates, which causes the propeller to rotate on its own axle. Can you feel the flow of air generated by the propeller?

Tip!

Don't forget to switch off the battery compartment when you're not using the propeller. To do this, just move the switch to the "OFF" position or remove the wires from the springs.

WHAT IS ELECTRICITY?

An electrical current consists of moving "electrons." Electrons are tiny particles that you can visualize as a crowd of tiny people rushing through a tunnel. When they reach a narrow spot in the tunnel, a jam occurs as they all jostle together. The same thing happens with the electrons in an electrical wire. In this case, the wire gets really warm at the narrow spot and may even start to glow. That's how light bulbs work.

WHAT IS VOLTAGE?

We measure the tension of an electrical current in volts. To continue the metaphor, higher voltage corresponds to stronger tiny people. They can push the others more strongly through the tunnel (the "conductor"). If the voltage is too high, the electrons have too much freedom to move around, and can even fly through the air. That's when you see sparks fly.

ELECTRICAL CIRCUIT

An electrical circuit consists of a power source (battery), a conductor (wire), and a device that uses the electricity (motor). For the electric current to be able to flow, the circuit must be complete. Another thing that affects the flow of electrical current is how easy it is for the particles to travel through the "tunnel" — in other words, it depends on how conductive the tunnel is. Some materials such as metals (copper and silver, for example) are very conductive, so we call them conductors. Other materials such as wood, rubber (elastic), and glass are non-conductors, or "insulators".

YOU NEED ...


Stirrer


Tub


Bubble wand

You will also need: tap water, tablespoon, sugar, dishwashing liquid (the "Dawn" brand works well), or bubble-blowing solution

Turn your ship's propeller into a bubble-blowing machine!

HERE'S HOW!

1. To make the bubble-blowing liquid: Fill half of your tub with water, add three level tablespoons of sugar and one tablespoon of dishwashing liquid.
2. Use your stirrer to mix the solution until all of the sugar has dissolved completely. Let the solution sit for a couple of hours.
3. Switch on your ship's propeller, dip the bubble wand into the solution, then hold the wand in front of the propeller.

Tip! If you cover the tub, you can keep the solution for a couple of weeks. You can also label the tub using your own homemade sticker. On a piece of paper, write out the words "Bubble-blowing solution" and then stick it to the outside of the tub using adhesive tape. Keep the solution away from animals and small children.

You've now finished creating your own underwater wonderland! Have fun experimenting as you play!

SUPERSTARS OF SCIENCE

LEONARDO DA VINCI

- Once said: "Water is the driving force of all nature" and "The noblest pleasure is the joy of understanding."
- He lived in Italy in the 15th century.
- He was an anatomist, an architect, a sculptor, an inventor, an engineer, a painter, and a musician – in short, a universal genius.
- He painted the "Mona Lisa" and used water to power many of his experiments:

LEONARDO'S INGENIOUS INVENTIONS

- **A water-propelled mechanical saw, which made splitting thick tree trunks much easier**
- **A paddle boat propelled by pedals, at a time when all other boats used oars**
- **A swing bridge that could be rotated to one side to allow large ships to travel on rivers**

ARCHIMEDES

- He shouted "Eureka" as he ran naked through the streets of the city after discovering Archimedes' principle while taking a bath.
- He was born in Greece in 287 BC.
- He was quite possibly the world's first physicist.

THE LEGEND OF THE GOLDEN CROWN

Legend has it that a king called Hiero once commissioned a goldsmith to fashion a new crown made from pure gold. Once finished, the golden crown weighed exactly the same as the lump of gold that the king had given the goldsmith in order to create the crown. However, the king still suspected that the goldsmith had deceived him. He called on Archimedes and asked him to verify the purity of the crown, without damaging it in any way. Archimedes pondered this difficult task for a long time.

Then, as he was taking a bath, he was struck with a flash of inspiration. Gold was the heaviest known metal at that time. This meant that a piece of gold weighing exactly the same as a piece of another metal would have a smaller volume. Archimedes therefore concluded that if the goldsmith had substituted some of the gold for some other metal in the crown, that the crown, when submerged in water, would displace more water than a lump of gold of equal weight. Archimedes ran to the king with his news. He then measured the displacement of the crown and a lump of gold of equal weight and discovered that the crown displaced more water and was therefore not pure gold. The experiment confirmed that the goldsmith had indeed attempted to deceive the king.

You've almost certainly noticed that your arms and legs are lighter when you're underwater. This is because the water helps to support your weight. Archimedes called this "buoyancy." If two objects have the same weight but different volumes, the one with the higher volume will displace more water, which means that it will have greater buoyancy. This phenomenon became known as Archimedes' principle. You've come across it already, in your adventures with Pepper Mint.

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