EXPERIMENT MANUAL

FUN STEM PROJECTS AND EXPERIMENTS

# Pepper Mint IN THE GREAT Treehouse Engineering ADVENTURE

THAMES & KOSMOS

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# Safety Information

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

Concerning the catapult: **WARNING!** Do not aim at eyes or face. Use the catapult only to shoot paper balls into the air. Never launch projectiles other than those suggested in the toy, e.g. heavy, sharp-pointed or sharp-edged objects. There is a risk of injury. For use under adult supervision.

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

## SAFETY FOR EXPERIMENTS WITH BATTERIES

- To operate the toy, you will need two AA batteries (1.5-volt, type AA/LR6, Mignon) which could not be included in the kit due to their limited shelf life.
- Avoid short-circuiting the batteries. A short circuit can cause the wires to overheat and the batteries to explode.
- Different types of batteries (e.g. rechargeable battery and normal battery) 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 -). Press them gently into the battery compartment. Instruction how to insert and remove the batteries see page 29.
- The toy is not to be connected to more than the recommended number of power supplies. Only use the enclosed battery compartment as power source.
- 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.
- The supply terminals are not to be short-circuited.
- The wires are not to be inserted into socket-outlets.
- 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.
- Avoid deforming the batteries.

### Notes on Disposal of Electrical and Electronic Components

The electronic components of this product are reusable. 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.

# Dear Parents and Adult Supervisors

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

Along with step-by-step instructions, this manual includes a story that unfolds alongside the experiments. The heroine of the story is Pepper Mint — an eleven-year-old girl whose creativity and cleverness help her to find her way through a series of small adventures and to overcome various challenges. She often collaborates on projects with her friends, like Ben Blueberry.

The kit includes a figurine of Pepper Mint herself, and a treehouse, so that your child can play along with the story.

The treehouse set offers a total of nine experiments. Each experiment adds another element to the treehouse: a rope ladder, a hoist, string of lanterns, and so on.

Every construction project provides a short explanation of the physics behind it. Along the way, your child learns why a block-and-tackle hoist can save energy, how a sloping surface causes acceleration, and why a catapult is an energy converter.

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 support your child with advice and practical help, and check the completed assemblies for each experiment.

This kit is not suitable for children under the age of 8. Please keep small children and pets away from the experiments and read through the safety information with your child. Keep the instructions handy for reference at all times.

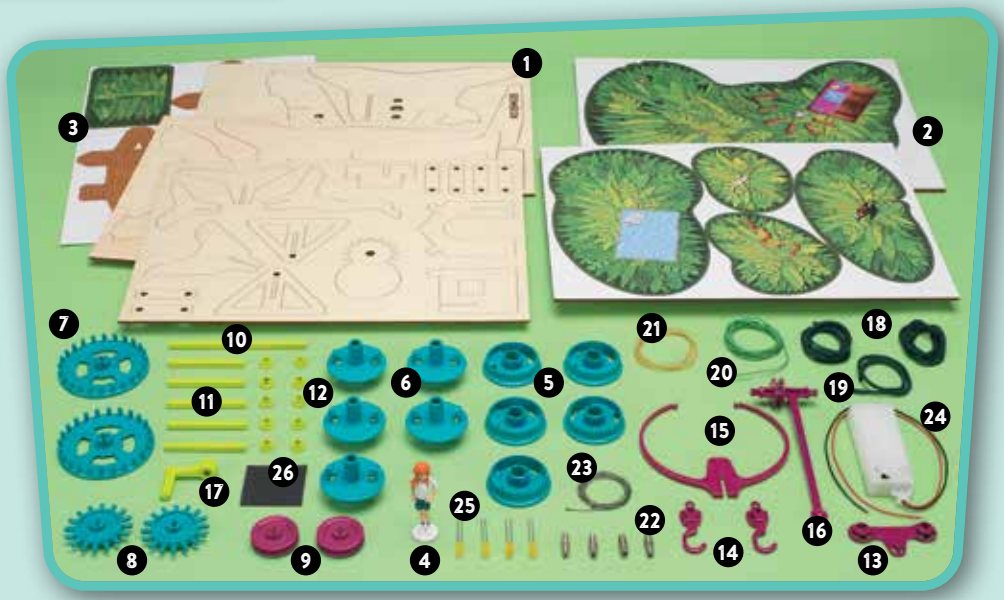
Have fun experimenting and playing!

**Here's what to do:**

1. Read the story or get someone to read it aloud.
2. Perform the experiment.
3. Read the explanations of what is happening in the experiment.

I'm Pepper Mint, and this is my friend Ben Blueberry. We've got lots of good ideas — and sometimes we can get a little carried away with our projects. But they usually work out in the end! This time, we're visiting my Aunt Linda in her jungle treehouse. Come along with us!

# Pepper Mint Kit Contents




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

| ✔ | No. | Description | Quantity | Item Number |
|---|---|---|---|---|
| ❍ | 1 | Wood sheet, plain | 3 | 720573 |
| ❍ | 2 | Wood sheet with printed illustrations | 2 | 720573 |
| ❍ | 3 | Cardboard sheet | 1 | 720565 |
| ❍ | 4 | Pepper Mint figure | 1 | 720566 |
| ❍ | 5 | Fastener, front | 5 | 720707 |
| ❍ | 6 | Fastener, rear | 5 | 720706 |
| ❍ | 7 | Gear wheel, large | 2 | 720709 |
| ❍ | 8 | Gear wheel, small | 2 | 720708 |
| ❍ | 9 | Pulley wheel | 2 | 720710 |
| ❍ | 10 | Axle, long | 1 | 720716 |
| ❍ | 11 | Axle, short | 5 | 720715 |
| ❍ | 12 | Axle stopper | 10 | 720717 |
| ❍ | 13 | Trolley zipline | 1 | 720714 |

| ✔ | No. | Description | Quantity | Item Number |
|---|---|---|---|---|
| ❍ | 14 | Pulley with hook | 2 | 720711 |
| ❍ | 15 | Catapult, part 1 | 1 | 720713 |
| ❍ | 16 | Catapult, part 2 | 1 | 720712 |
| ❍ | 17 | Crank handle | 1 | 720718 |
| ❍ | 18 | Long cord, 40 cm | 2 | 720702 |
| ❍ | 19 | Short cord, 30 cm | 1 | 720702 |
| ❍ | 20 | String, 140 cm | 1 | 720701 |
| ❍ | 21 | Rubber band | 1 | 720700 |
| ❍ | 22 | Spring | 4 | 713882 |
| ❍ | 23 | Conductive thread, 100 cm | 1 | 720704 |
| ❍ | 24 | Battery compartment with cables | 1 | 724040 |
| ❍ | 25 | LED, yellow | 4 | 720705 |
| ❍ | 26 | Sandpaper | 1 | 720574 |

***You will also need:***

*ruler, scissors, colored pencils, craft glue, wood glue, adhesive tape, 5 coins, brown paper, small Phillips-head precision screwdriver, 2 x AA batteries (1.5 volt, type LR6)*

**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



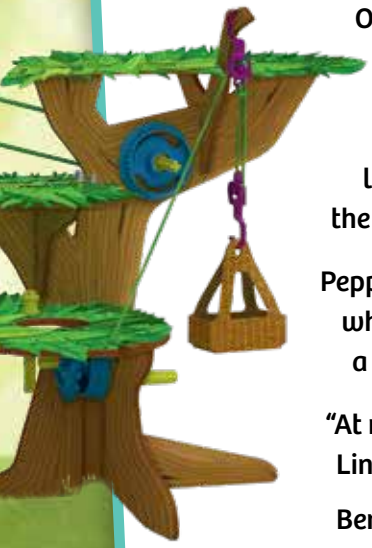

**Tip!**

More background knowledge can be found on pages 32–33.

# Welcome to the Rainforest

"Wow, Aunt Linda, you weren't kidding! You really do live in the middle of nowhere!" Pepper opened the passenger door of the large SUV, maneuvered her bulging backpack onto the ground, and stepped shaky-legged — it had been a pretty bumpy ride — into a green wilderness. Ben jumped out from the back of the car, his wild blue hair looking especially messy after the ride.

Right away, Pepper heard a buzzing in her ear. Then she felt her first mosquito bite. Welcome to the jungle!



Of course, Pepper's Aunt Linda didn't get bitten, because even the bugs respected her. Aunt Linda was a research scientist and an expert on primates. She took Pepper's backpack and loaded it into a basket that was dangling from the end of a rope.

Pepper stared in astonishment. She looked up to see where the rope went and saw a house at the top of a huge tree.

"At night it's better to be up there!" grinned Aunt Linda. "I hope you're not scared of heights!"

Ben looked up at the towering treehouse with a somewhat queasy expression on his face.

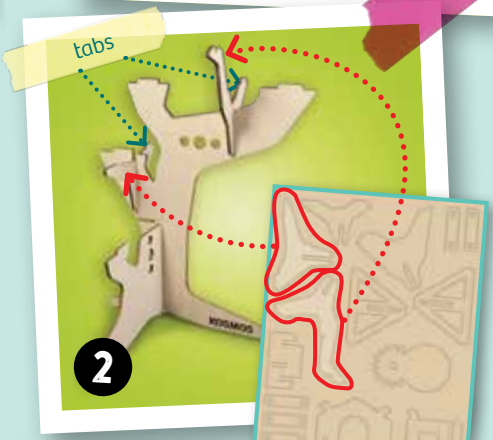
To be clear, Pepper wasn't scared of anything! Sure, sometimes she got nauseous on long car rides, and creatures with more than six legs made her hair stand on end. But a treehouse in the jungle? Pepper jumped up and down with delight at this new adventure. Or, to be more precise, not just with delight ... Where would the bathroom in the treehouse be?

## YOU NEED ...

2 x wood sheets with illustrations

3 x wood sheets, plain

cardboard sheet



## HERE'S HOW!

1. Begin with the right tree trunk. Remove the two large wooden pieces from the sheet with the Kosmos logo at the bottom and fit them together.

### Tip!

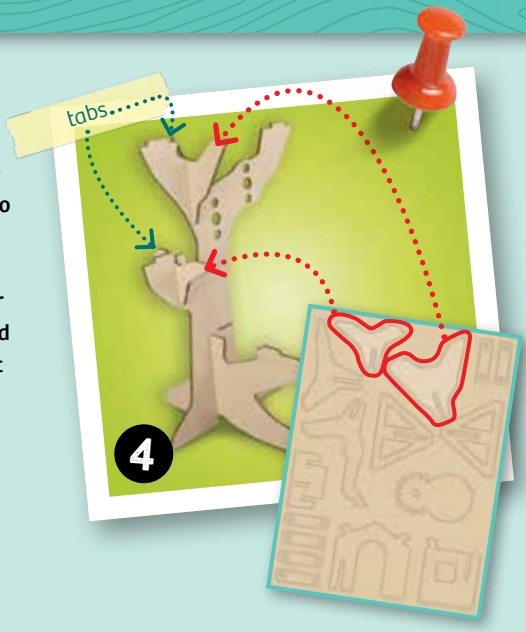
If the pieces snag instead of sliding together smoothly, you can use your sandpaper to make the slots a little wider or the tabs a little narrower.

2. Fit the small branches (the diagram shows you where to find them on the sheet) into the two slots as shown. The tabs should be on the rear side.

3. Now fit together the two pieces from the second wood sheet, as shown in the diagram. This is the left tree trunk.

4 Complete it by adding the small branches from the third wood sheet.

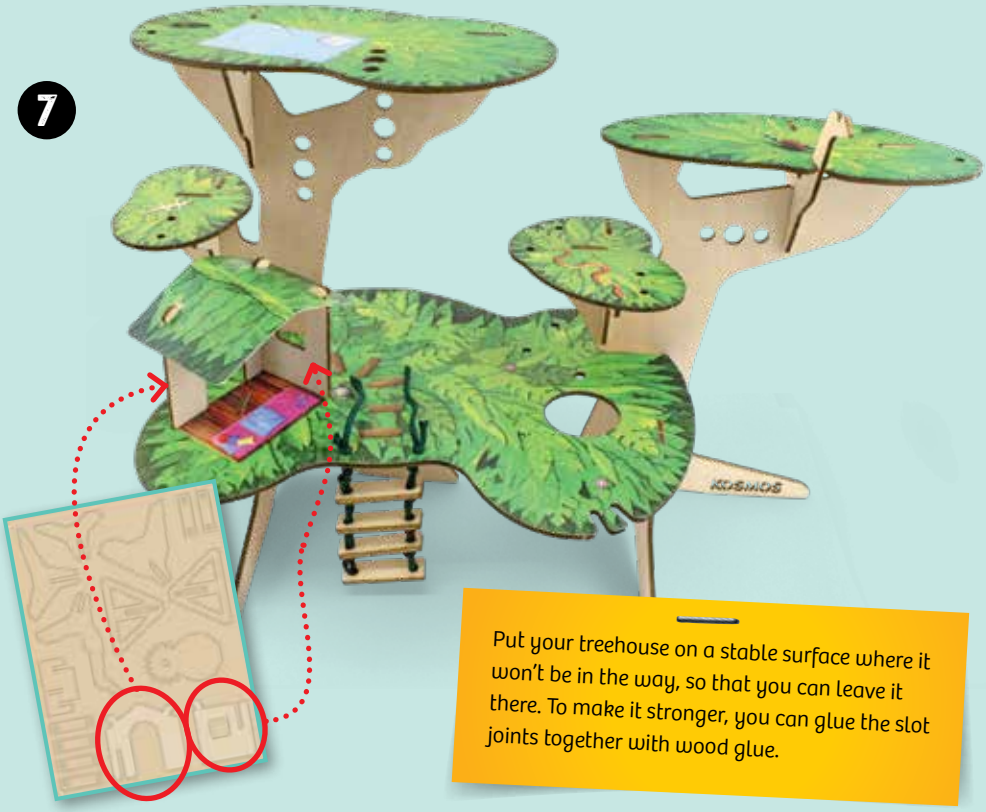
5 Your right and left trunks are joined with the large floor platform. Push the tree trunks into the right and left side slots, until the floor platform rests on the supports and the tabs fit as far as possible into the slots in the floor platform. At the top of the left tree trunk, add the leaf canopy piece with the picnic blanket on it, and complete the right trunk with the platform with the bird on it.




6 Now add the two smaller platforms to the treehouse. The leaf canopy layer with the snake on it goes on the right, and the one with the chameleon on it goes on the left. Make sure the tabs fit right into the slots on the platforms, so that they are flush.

7 You're almost done. Remove both pieces of the hut from the wood sheet, slide them together, and attach the leaf roof from the cardboard sheet. You just need to bend the leaf roof slightly and fit it over the wooden hooks. Now your treehouse is ready for you and Pepper Mint to move in!


7



Put your treehouse on a stable surface where it won't be in the way, so that you can leave it there. To make it stronger, you can glue the slot joints together with wood glue.

# In the Treetops

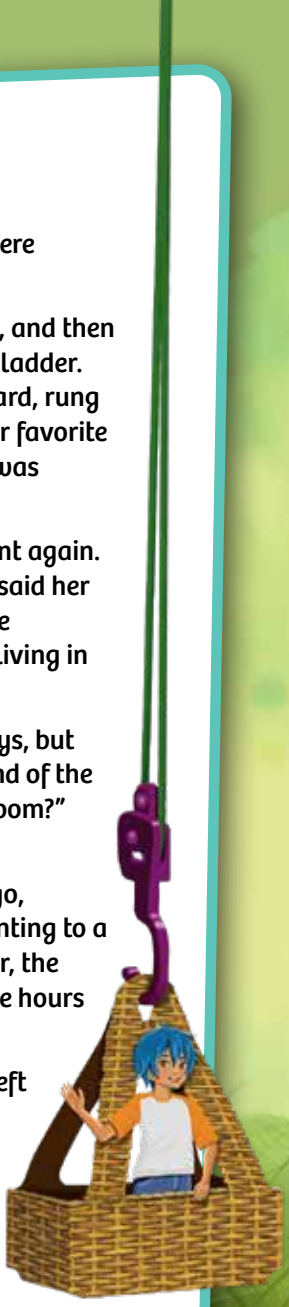
"So how do we get up there?" asked Pepper impatiently. There was something she needed to do — and soon!

Aunt Linda walked once around the broad trunk of the tree, and then climbed as skillfully as a monkey up a shaky-looking rope ladder. Was that the only way up? Pepper climbed fearlessly upward, rung by rung. She wasn't sure she looked quite as graceful as her favorite aunt did. Ben, watching the whole thing from the ground, was turning even greener in the face.

When Pepper reached the top, she gasped with astonishment again. "The best thing about my treehouse is the fantastic view!" said her aunt, standing right beside her. "Over there, you can see the waterfall, and to the left you can see a group of monkeys living in the trees."

Pepper squinted, trying to see the waterfall and the monkeys, but she couldn't see anything amongst the leaves. But the sound of the waterfall reminded her of something. "May I use the bathroom?" asked Pepper, hopping from one foot to the other.

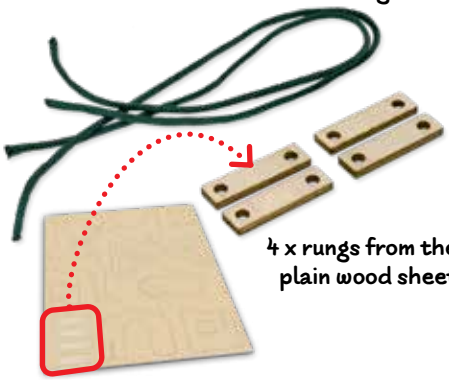
Aunt Linda shrieked with laughter. "If you really have to go, you'd better use that pail in the corner," said her aunt, pointing to a covered bucket. "I have to go and get fuel for the generator, the tank's nearly empty. Will you be okay here for two or three hours without me?"



Understandably, Pepper was a little unsure about being left alone in the treehouse. She didn't really know what a generator was, either. But if she was going to use the bucket, she would only be able to if her aunt was out of sight. "Hey, Aunt Linda, I'm eleven years old! Of course Ben and I will be okay! You'd better go right away!"

Aunt Linda spun around and climbed back down the ladder, where she said goodbye to Ben. As Pepper started walking over to the pail, she heard a call from below: "Don't forget to hoist up the rope ladder, and use the block and tackle to haul up your backpack ... and Ben!"

## YOU NEED ...




## HERE'S HOW!

1. Take one of the cords and tie a knot in it. The knot should be about 5 cm to the right or left of the center, rather than exactly in the center. Practice this "pretzel knot" a few times, until you're happy with the way it looks.

2. Thread both ends of the cord through the hole at the end of one of the rungs and push the rung down onto the knot.

   Now pay close attention: Take the longer end of the cord and tie another "pretzel knot" onto the shorter end, 2 cm above the rung. Then you can thread on another rung and push it down to the knot.

3. The next knot goes another 2 cm away from the last rung. Keep going like this, until you've threaded on the fourth rung, then tie a last knot just above it.

4. Be careful: make sure you use the same end of the cord each time for the knot. If you're not sure whether you're using the right end for the knot, give it a pull. If nothing moves, it's the right one! If the knots slide along, you've got the wrong end!

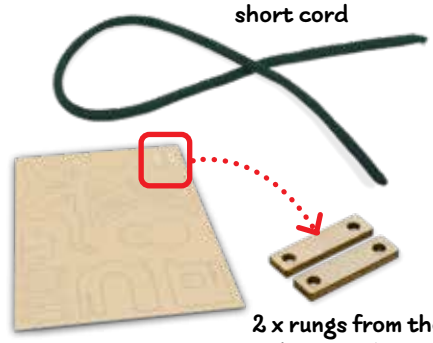
5. Now you need to follow the same steps again with the second cord on the right-hand side of the rungs:
   - Make a "pretzel knot" in the cord. One end must be 5 cm longer than the other.
   - Thread both ends of the cord into the bottom rung.
   - Tie the next knot 2 cm further up, thread the ends into the next rung, then tie another knot, and so on.
   - Tie in the last rung with a knot just above it.

6. Fasten your rope ladder at the front of the main platform by tying one last knot on each side. Make sure you use the correct end of the cord for the knots!


## WHAT'S HAPPENING?

What happens when you pull on the long ends? If you did everything right, the rope ladder pulls up! You can pull it up and down again and again. If nothing moves, you need to check your slipknots.

## YOU NEED ...





## HERE'S HOW!

Using the third cord and the remaining rungs you can make another ladder, a fixed one this time, at the rear of the treehouse on the right. You'll see there are ready-cut holes in the main platform and the platform with the snake on it.

1. Thread both ends of the cord up through the holes in the lower platform, from underneath. The ends of the cord above the platform should be the same length. Make a knot in each piece of cord, 2 cm above the platform, and thread a rung above the knots.
2. Tie another knot on each side, 2 cm above the first rung, and thread another rung, before pulling both ends of the cord through the holes in the upper level platform, and fixing them with knots. Finished!

# Pepper Mint AND THE Hoist

## YOU NEED ...


*You will also need: five large coins*


## HERE'S HOW!

1. Remove the small basket carefully from the cardboard sheet and fold it together as shown in the picture.
2. Take one of the two identical hooks and look at it carefully. It actually consists of a small pulley wheel, with a large hook and a small ring attached to it. Tie the thin string onto the ring as shown in the picture. It's best to use a double knot. Thread the string through the pulley wheel on the other hook.
3. The hook that has loose string over the pulley can be attached to the top of the treehouse as shown ...

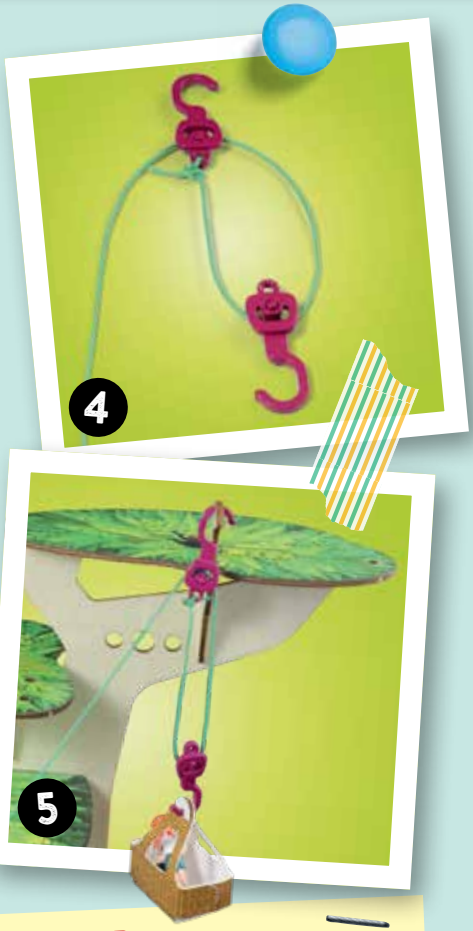
## WHAT'S HAPPENING?

You're using a "fixed pulley". The pulley itself doesn't move along, it just guides the moving rope. Thanks to the pulley, you're changing the direction in which you need to pull to move your "load". Instead of pulling upward, you can now pull downward. That makes it easier to pull, doesn't it?

... Hang the basket onto the lower hook, the one you knotted the string onto. Put your Pepper Mint figure, or a pile of coins, into the basket and try pulling it up to the top.

4. Now you're going to add a "movable pulley". Swap the two hooks around: Now the hook with the loose string is carrying the basket. Attach the other hook, the one that's knotted onto the end of the string, to the top of the treehouse.

5. Thread the loose end of the string up and over the pulley attached to the hook that's fixed at the top, then down again. Put Pepper in the basket and pull her up to the top.




## WHAT'S HAPPENING?

Your basket is now hanging on two strings. The "movable pulley" moves upward when you pull on the end of the string. Did you notice that it's also easier to pull the basket up to the top? In fact you need exactly half as much "effort" (or "force"). By using one fixed and one movable pulley, this "block-and-tackle" hoist has changed three things:

1) You're pulling downward instead of upward.
2) You only need to use half as much effort to pull the basket up to the top.
3) But you need twice as much string — double the length — to transport Pepper up to the top.

## REMEMBER

Both pulley systems need the same amount of "work" to pull the basket up to the top. With the fixed pulley you need the full amount of energy, but only one length of rope. If you use the fixed pulley and the movable pulley together, you only need half as much effort, but you have to pull twice as far (two lengths of rope).

Attach your hoist to the treehouse and transport small "loads" up to the top. Don't ever hang more than 500 g (the weight of two sticks of butter) on your hoist!

# A Sudden Downpour

Pepper easily lifted Ben and their luggage into the treehouse with the help of the pulley system. Ben was already feeling much better. He was amazed at the treehouse and its surroundings. After some sincere "oohs" and "aahs," Ben grabbed his binoculars from his jacket pocket and raised them to his eyes. Pepper guessed that Ben would spend the next few hours watching birds and other animals with his binoculars.

"And what should I do next?" thought Pepper. She really wanted to climb up to the top level, high up in the crown of the tree, and stay up there for a while. Pepper tucked a book and a picnic blanket under her arm, and grabbed a bunch of bananas for a snack. Another rope ladder led upward. Between the branches, Pepper discovered a small belt pulley system which she used to transport herself and her cargo over to the other tree. A pair of monkeys apparently found it funny to hang on the belt pulley and move from side to side, grasping at the bananas.

After arriving safely at the top of the tree, Pepper spread out her blanket and made herself comfortable. The monotonous chirping and humming sounds and the warm air soon made her eyelids feel heavy. Shortly after, snoring sounds could be heard from far away. (Pepper's snoring was a closely kept secret. From down below, Ben assumed it was an interesting bird call coming from high up in the treetop.)

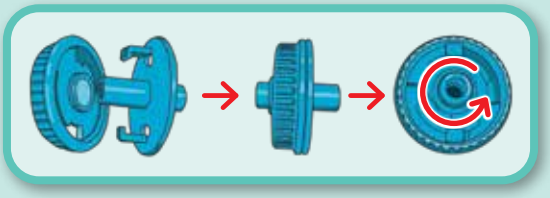
In the middle of a particularly loud snore, Pepper was awoken by a sudden downpour of rain. In just a few seconds, she was completely soaked. Her blanket was as soggy as a dishcloth. She needed something to shield her from the rain, and she needed it fast ...

# Pepper Mint AND THE Belt Pulley

## YOU NEED ...



## HERE'S HOW!



1. Connect the two parts of each fastener through the pre-cut holes in the tree trunk, as shown in the picture. To do this, you need to fit the two parts together, positioning one on each side of the tree trunk, and then turn the front part, as shown in the drawing.
2. Stick a short axle through each of the completed fasteners.


3. At the back of the tree, push a pulley wheel and an axle stopper onto each axle. This should make it so that your pulley wheel doesn't slide off the axle when it moves.

4. Now stretch the rubber band over both pulley wheels, and your rubber band belt pulley system is ready!

The axle stoppers make sure that the moving parts don't fall off the axle. Use as many stoppers as you need!



## Tip!

On the cardboard sheet, you'll find two little monkeys that you can hang onto the belt pulley to make it easier to see the elastic moving. You can turn the pulley wheels by hand, or fit the crank handle onto the end of the axle at the front and use it to turn the pulleys.

## WHAT'S HAPPENING?

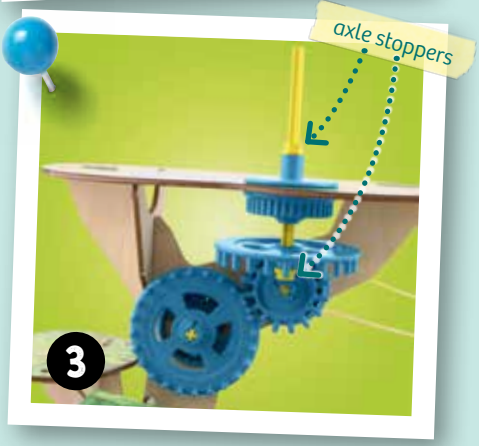
Your stretched rubber band transfers the motion force from one pulley to the other. You've found a way to bridge the gap between the pulleys. And the effort you use to turn one of the pulleys is transferred to the other one. The pulley on the other side turns because it takes less effort to move the pulley than to hold the rubber band in greater tension. The rubber band grips well onto the plastic pulley wheel, stretches when the pulley turns, and pulls itself back together (compresses) again immediately. Would that work with a loose string as well?

## YOU NEED ...


## HERE'S HOW!

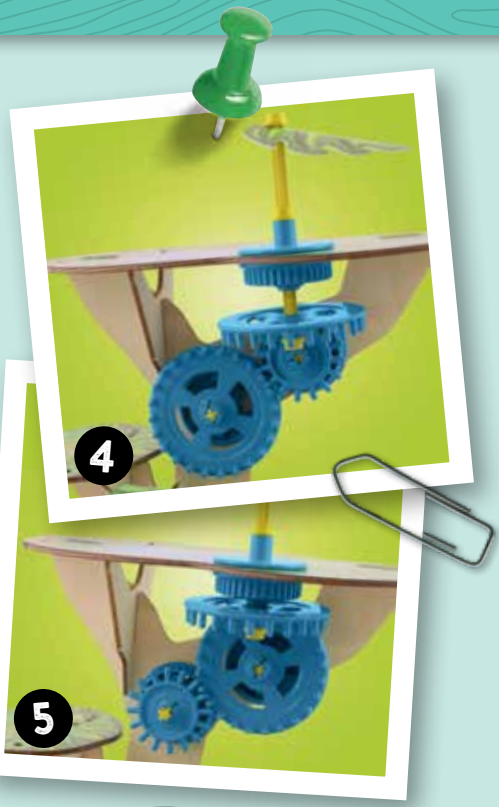
1. Attach two more fasteners, each with front and rear parts. Attach one onto the left tree trunk, and one onto the top level platform with the picnic blanket on it.
2. Fit a small gear wheel onto the right-hand fastener on the tree trunk (the one that holds the pulley wheel onto the back of the treehouse). Push a short axle through the left-hand fastener, and fit a large gear wheel onto the front end.
3. Push a long axle through the fastener on the top platform, then fit a large gear wheel to it underneath the platform, followed by an axle stopper. Fit another axle stopper onto the axle at the top end, and push it downward.
4. Remove the single leaf from the cardboard sheet and fix it to the top of the long axle, using two more axle stoppers to hold it in place. Remove the pulley wheel with the rubber band from behind the gear wheels and attach the crank handle instead. Turn the handle slowly.





## WHAT'S HAPPENING?

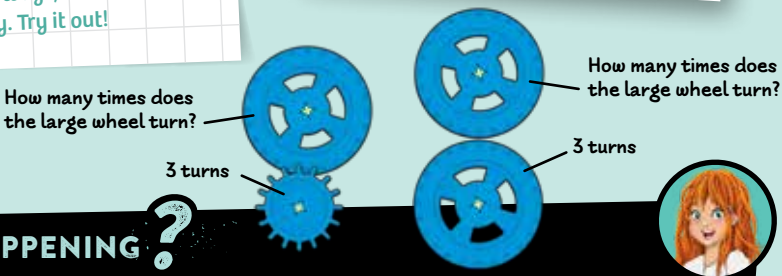
The teeth of the gear wheels mesh together and transfer the movement up to the leaf. The faster you turn the handle, the faster the leaf turns too. If you turn the handle the other way, then the leaf turns the other way too. If you watch the large gear wheel, it's easy to see that the wheels always turn in the opposite directions.




**5** Try swapping the large and small gear wheels on the tree trunk.

### Tip!

You can connect the pulley wheels, gear wheels, rubber band, and crank handle in many different ways, and transfer the motion differently. Try it out!




## WHAT'S HAPPENING?

If the teeth of the gear wheels mesh together, then your gear mechanism is working. Turn the axle behind the large gear wheel at the same speed as before and watch the leaf. Does it still turn just as fast? Or slower? The small gear wheel has 16 teeth altogether, and the large gear wheel has 24. The ratio of the number of teeth on the small gear wheel to the number of teeth on the large gear wheel is 2 to 3 (2 x 8 = 16, 3 x 8 =24). That means that when you turn the small gear wheel three times, the large one will have turned twice. Look at the two drawings above and decide which setup makes the leaf turn faster. Then try it out!

# Monkey Business

In next to no time, Pepper was standing under a shelter made of palm leaves that could be turned to face any direction with the help of a gear wheel mechanism. Pepper was tucking her screwdriver back into her pocket when the rain stopped just as suddenly as it had started. And as if someone had pressed a switch, the sounds of the rainforest noises that had been previously drowned out by the rain grew louder again.

Pepper could hear the monkeys shrieking, the birds singing, and a loud shout from directly beneath her. Wait a second — did she just hear Ben call out for help?

Pepper peered down into the treehouse below and saw a group of curious monkeys surrounding the boy. The largest monkey had already taken the binoculars from him and was chewing on them. Another was hanging on the belt pulley above Ben, pulling at his hair. It appeared as though Ben could not escape. Pepper had to help him! How fortunate that Ben was standing right above the trapdoor that Aunt Linda used to dispose of her leftover food and rubbish. All she had to do was get down, turn the crank attached to the trapdoor, and Ben would fall through the hole in the floor onto a soft compost heap.

Pepper grabbed hold of the nearest dangling vine, tugged on it a couple of times to see if it would hold, and then grabbed onto it tightly and zoomed down on her improvised zipline.

The ride down the zipline was a little too fast and uncontrolled for Pepper. On the way down, she resolved to build a proper zipline sometime, and quickly came up with a number of good design ideas for it in her head ...

# Pepper Mint AND THE Zipline

## YOU NEED ...

large basket from the cardboard sheet

zipline trolley

string

Pepper Mint figure

*You will also need: craft glue, adhesive tape*




## HERE'S HOW!

1. Remove the large basket from the cardboard sheet and fold it together, as shown in the illustrations. Fold over the long flap and stick it down on the base with craft glue or tape. Then tuck the Pepper Mint figure into the holder in the bottom of the basket.
2. Thread a one-meter long piece of string through both wheels of the trolley.
3. Fasten one end of the string to the treehouse — there are two holes for this on the two top level platforms — and hang the basket on the peg at the bottom of the trolley.

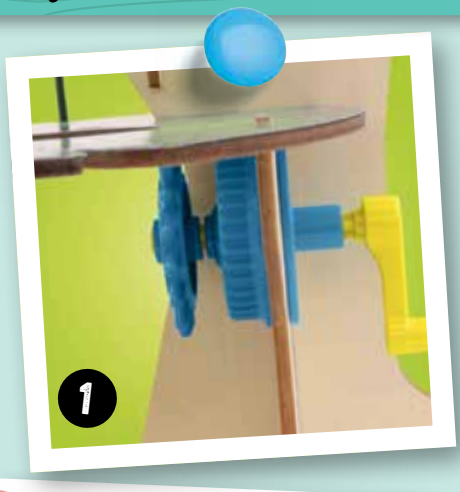
**Tip!** Ask your parents to help you find the perfect place to hang your zipline. The maximum load for the basket is 500 g! You can tie the other end of the string onto a chair leg or hold it in your hand.

## WHAT'S HAPPENING?

As soon as you fix the basket onto the zipline, you take away some of its freedom. Its movement is now limited by the string. Now if you let go of it, gravity doesn't just make it fall vertically to the ground, but instead it moves downward along the zipline. You can change three things: the steepness of the slope (by changing the difference in height between the beginning and end of the string), the length of the string, or the weight of the basket. The steeper the slope and the heavier the load, the faster the basket travels to the bottom. That is because of acceleration and gravitational force. Both of these increase if the "mass" of the basket increases.

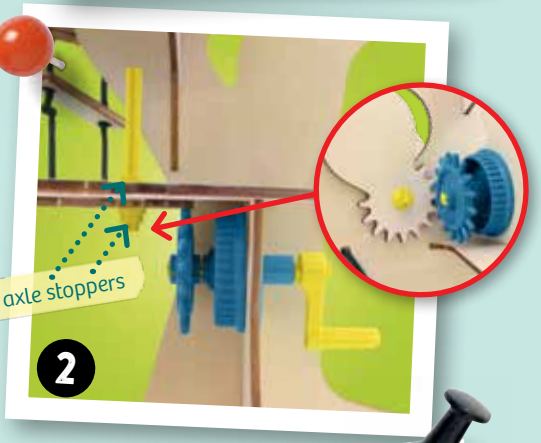
# Pepper Mint AND THE Trapdoor

## YOU NEED ...


## HERE'S HOW!

1. Fix the front and rear parts of the fastener together from both sides of the pre-cut holes in the right tree trunk. Push a short axle through the fastener. Then add the crank handle on the outside and a gear wheel on the inside.
2. Stick a short axle into the pre-cut hole in the main platform, and push the wooden gear wheel and an axle stopper onto it underneath the platform. Make sure the teeth of the two gear wheels mesh together properly. A second axle stopper just above the platform will keep everything in place.
3. You can open and close the trapdoor by turning the crank handle.





## WHAT'S HAPPENING?

Just like you saw with the gear mechanism for the rain shelter, when the gear wheels mesh together, you are transferring movement.

# Treehouse Under Attack

Ben fell through the open trapdoor onto the soft compost pile under the treehouse. "You saved me, Pepper," he exclaimed excitedly as he brushed a banana peel from his head.

The monkeys were wreaking havoc up in the treehouse. They had discovered Pepper's backpack, emptied it, and examined its contents thoroughly — with their mouths! While the compass was immediately spat out, the monkeys seemed to like Pepper's toothbrush. Ben's cherished binoculars were also passed around in the group. Pepper and Ben had to come up with something quick to get rid of this voracious troop of monkeys!

Pepper furrowed her brow and looked around. Her gaze rested on some coconuts and loose branches. A plan began to form in her mind. After a few minutes pondering and a few failed attempts, Pepper and Ben successfully built a small catapult out of branches and vines. They fired the first coconut toward the treehouse. They would scare off the invaders and then climb back up through the trapdoor!

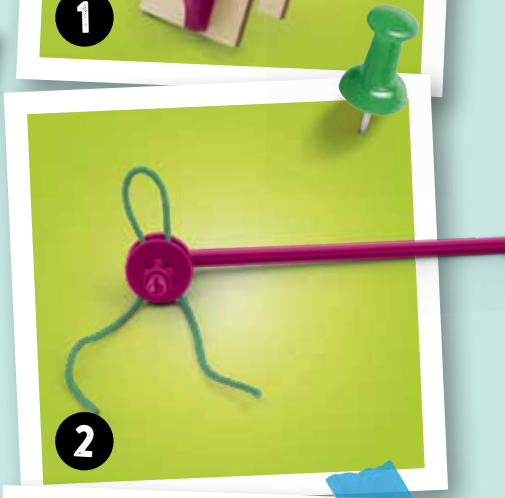
After a few trial launches that flew too high, soon there were coconuts flying through the air and landing with loud "clonks" all over the treehouse. But instead of driving the monkeys away, the warning shots only riled them up more. They ran wildly all around the treehouse. Then, one of the coconuts hit the upper level of the treehouse and caused the bananas Pepper had left there earlier to fall to the jungle floor. No sooner had one monkey discovered the bananas below the treehouse than all of them rushed out of the treehouse to the bananas. "Apparently, monkeys like bananas more than coconuts," thought Pepper.

# Pepper Mint and the Coconut Catapult

## YOU NEED ...


*You will also need: ruler, paper (ideally brown)*

Avoid heavy or sharp-pointed things into the scoop. Never aim at the face!



## HERE'S HOW!

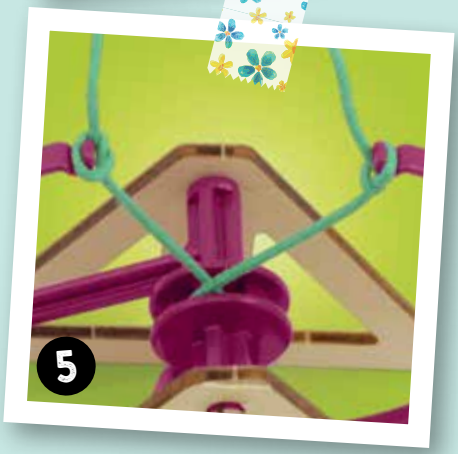
1. Fit the tension arc of the catapult into the slot in the wooden panel from above.
2. Thread the thin string through the reel on the end of the throwing arm — as shown in the picture. The scoop should be facing upward.
3. Add a wooden support to the catapult on each side by fitting them onto the wood panel holding the tension arc. Use the slots on the wooden supports.
4. Mount the throwing arm of the catapult between the wooden supports, by fitting the axle into the holes on each side and letting it click into place. Make sure the scoop on the throwing arm is facing downward here.

5. Now cross the ends of the string over each other and tie them firmly onto the hooks on the tension arc.

6. Pull back the throwing arm to tension the catapult. As soon as you let go, the throwing arm shoots forward.

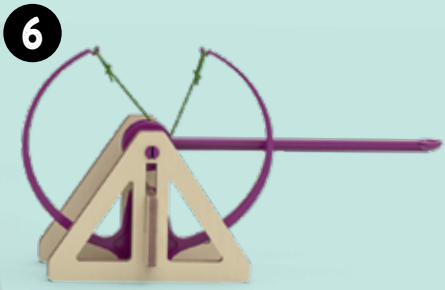
## Tip!

Don't launch anything except small paper balls with your catapult. Crumple up pieces of (brown) paper — about the size of this note — into pellets and see if you can hit the monkey on the elastic belt pulley.


## WHAT'S HAPPENING?

The catapult works like this: When you pull back the throwing arm, the two ends of the cord wind around the reel and tighten up. Because they are not stretchy, they pull the plastic arms of the catapult downward with them. Then when you let go of the throwing arm, the tension arc springs back to its "relaxed" position again. The faster that happens, the more momentum your paper "coconut" has when it's launched.

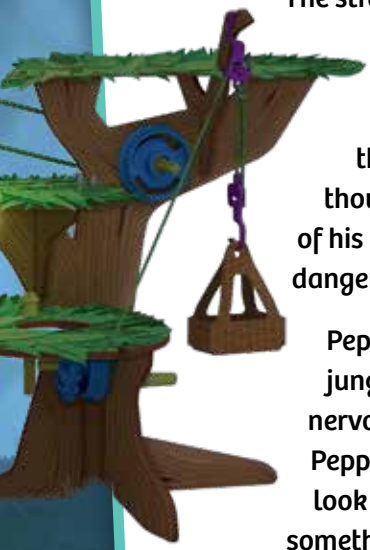



## REMEMBER

You have just converted energy! When you tension the arc by pulling back the throwing arm, the catapult stores energy. When you let go of the arm, the stored energy is converted into the energy of motion (kinetic energy). There are many different kinds of energy, such as mechanical, electrical, and chemical energy. Energy can be stored or converted but it can't be used up. This is called the law of Conservation of Energy.

# Illumination

Soon after Pepper and Ben climbed back up into the treehouse, the sun went down behind the treetops and darkness fell rather suddenly around them. From where they were standing, they could only see the silhouettes of the hoist, the catapult, and the gear mechanism above them. An exciting day was coming to an end! They had accomplished many things and protected the treehouse from the monkeys. Aunt Linda would be amazed to hear about it when she got home!



The strange noises of the rainforest grew louder as night fell, and although Pepper found the setting quite mysterious and beautiful, she did want some light so she could see around the treehouse. Ben must have had the same thought, because he pulled a pack of matches out of his pants pocket and asked, "It's probably too dangerous to light a fire in a treehouse, isn't it?"

Pepper had an instinctive feeling that the creepy jungle noises were getting closer. She jumped up nervously. "Not sure I like the sound of that!" said Pepper. "Come on, let's use the matches to have a look in Aunt Linda's hut. Maybe we'll find a lamp or something." Pepper and Ben went into the dark wooden hut. A few minutes later, they came out again carrying the last match, and a box full of light bulbs, wires, and some springs. Pepper grinned and rolled up her sleeves — she could hardly wait to put her plan into action ...

## YOU NEED ...


*You will also need: scissors, ruler, small Phillips-head precision screwdriver, 2 x AA batteries (1.5 volt, type LR6)*

## HERE'S HOW!

1. Attach two springs onto each of the two small platforms (snake and chameleon) of the treehouse by pushing the narrow ends down into the two side-by-side holes.
2. Cut off two pieces of conductive thread. Each piece should be 30-cm long. Keep the rest for replacements. Now connect the two front springs with one piece of conductive thread and the two rear ones with the second piece of thread. Bend each spring sideways, to make a little gap and tuck in the end of the thread.
3. Take a close look at one of the LEDs. Did you notice that one leg is shorter than the other and that the head is flat on one side, rather than rounded? You need to pay attention to this later, to make sure you hang the LEDs the right way around on the threads.

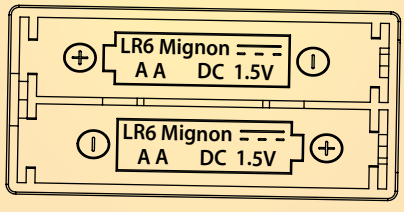


4. Bend both the legs upward and outward, and hang the LED with the rounded side and the longer leg (that's the positive terminal) on the front thread, and the flat side and shorter leg on the rear thread. Add two more LEDs to your string of lanterns, hanging them exactly the same way as you did the first one. You can keep the fourth LED as a spare one or add it in the same way.

5. Ask your parents to put the batteries into the battery compartment. Here's what to do:


An adult should insert and replace the batteries:

- Open the lid of the battery compartment using a small screwdriver and lift the lid up. Do not remove the screw from the lid.
- Insert two new AA batteries (1.5 volt, type LR6), or remove the old batteries and insert new ones. Make sure you put the battery in correctly by matching the + and – polarity markings!
- Close the battery compartment and screw the cover back on.




## WHAT'S HAPPENING?

Your LED has two poles: One is called the cathode (shorter leg) and the other one is the anode (longer leg). LEDs (light-emitting diodes) only light up if you connect both poles with the correct battery wires, because the direction of the electrical current is important. When electricity is flowing, it can only travel through the LED in one specific direction. If you hang the LEDs the wrong way around on the conductive thread, they can't light up, because the electricity can't flow through them. Other electrical components such as light bulbs function differently, and work whichever direction the electricity is flowing.

6. Set the switch on the battery compartment to "OFF." Now you need to be especially careful again: The battery compartment has two wires attached to it — a red one and a black one. Fasten the red wire onto the front spring on the left platform, and the black wire onto the rear spring. Do this by bending the spring to one side and tucking the metal end of the wire into the gap that appears in the spring.


7. Check one last time to make sure all the LEDs are hanging correctly and that the red wire is tucked into the front springs. Everything in the right place? Now slide the battery switch to "ON!"


You don't need to worry about touching the wire, the thread, the springs, or the LEDs. The electrical current is so small that nothing will happen. But don't touch power outlets, uncovered wires, or electrics around your home — that can be extremely dangerous.

## Tip!

You can tuck away the battery compartment underneath, either in the tree trunk or behind the main platform. Slide the switch to "OFF" when you're not using the lanterns, or pull the wires out of the springs.

## WHAT'S HAPPENING?

Your string of lanterns forms an electrical circuit. Instead of using wires and cables, the electricity flows along the conductive thread, which includes metal fibers. By hanging the LEDs over the conductive thread, you are connecting the two pieces of thread so that the electrical current can flow and make your LEDs light up.

## WHAT IS ELECTRICITY?

An electrical current consists of moving "electrons." These are tiny particles, which you can think of as little people. When electricity is flowing, the little people are running through a tunnel. If they get to a narrow spot, it gets more crowded in the tunnel. The same thing happens with electrons in a wire. At the narrow spot, the wire gets really warm and can even begin to glow. That's how light bulbs work.

## WHAT IS VOLTAGE?

We measure the potential of an electrical current in volts. Continuing the tunnel analogy, a higher voltage corresponds to stronger little people in the tunnel. They can push the others more forcefully through the tunnel ("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.

## ELECTRICAL CIRCUIT

An electrical circuit consists of a power source (in this case, the battery), a conductor (the wire), and a device that uses electricity (the LED). 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 to travel along the tunnel — that is, how well it conducts. 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.


Now your treehouse is fully equipped! Have fun experimenting and playing!

# SUPERSTARS OF SCIENCE

## GALILEO GALILEI

- Once said: "Curiosity is the key to problem solving."
- Lived in Italy in the 16th century
- Discovered that the Earth revolves around the sun and went to prison for saying so
- Invented the telescope and the **Golden Rule of Mechanics**

**THE GOLDEN RULE OF MECHANICS**

**Whatever you save in energy, you must spend on distance.**

Like the block-and-tackle hoist, for example

## SIR ISAAC NEWTON

- Once said: "What we know is a drop. What we don't know is an ocean."
- Lived in England in the 17th century and worked as a waiter while he was studying
- An apple is said to have fallen on his head in the garden, which started him thinking about gravity
- Worked out the three laws of motion

**GRAVITATION**

All masses (objects) are attracted to each other. The larger the mass, the greater its force of attraction. Earth's gravitational force is what keeps you on the ground. But you are also attracting the Earth toward yourself, because of your mass, even though you can't feel this happening.

**THE THREE LAWS OF MOTION**

1. All objects are "inert" (and only change their resting or moving state if they are forced to)
2. Force = Mass x Acceleration
3. Action (force) = opposing force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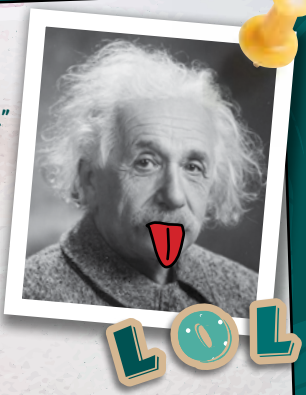
## ALBERT EINSTEIN

- Once said: "I have no special talent. I am only passionately curious."
- Born in the 19th century in Ulm, Germany
- Liked to wear his hair wild and hated socks
- Won a Nobel Prize in physics for discovering the photoelectric effect (look it up on the Internet!), but privately would have preferred to win it for his Theory of Relativity — which produced one of the most famous equations in the world: $E = mc^2$
- He also established the **law of Conservation of Energy**




### CONSERVATION OF ENERGY

Energy cannot be destroyed, nor can it be created. When we talk about "using energy", we mean that the form of energy changes. In a light bulb, for example, electrical energy is converted into light and warmth.

## MARIE CURIE

- Once said: "We must believe that we are gifted for something, and that this thing, at whatever cost, must be attained."
- Was born in Poland in the 19th century and worked as a research scientist in France
- Discovered **radioactivity** and two new chemical elements: Polonium (named after her home country, Poland) and Radium
- Kept a sample of radium by her bed as a night light (very unhealthy!)
- Won the Nobel Prize for physics **AND** chemistry

## 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. Marie Curie had to leave her home country so that she could go to a university, and after she graduated, she still couldn't get a job at a university in Poland. In France, things were a bit more liberal, and in 1906, she became the country's first female professor. Fortunately, things have changed a bit over the last 100 years!