Experiment Manual

THE AMAZING Tightrope-Walking Gyrobot

THAMES & KOSMOS

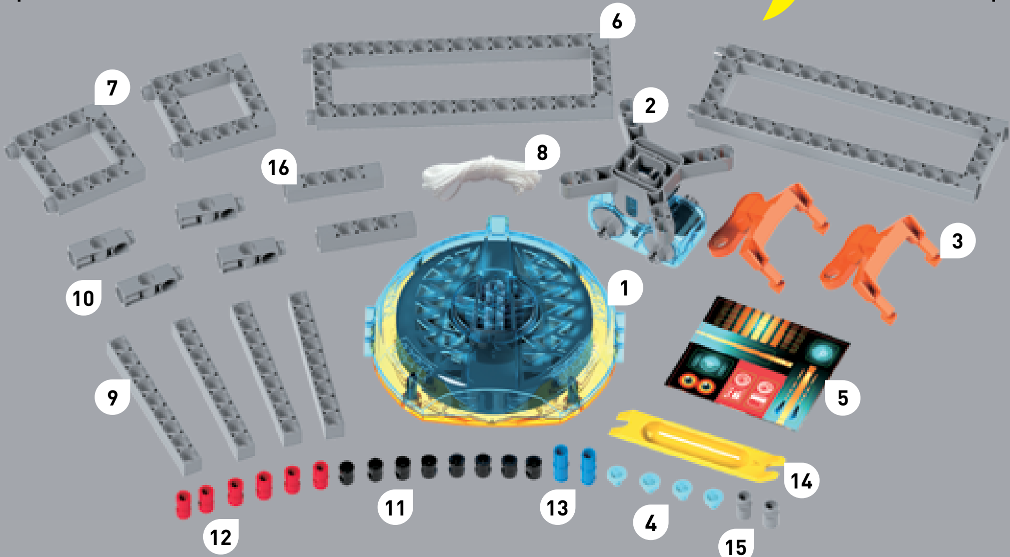
Franckh-Kosmos Verlags-GmbH & Co. KG, Pfizerstr. 5-7, 70184 Stuttgart, Germany | +49 (0) 711 2191-0 | www.kosmos.de
Thames & Kosmos, 89 Ship St., Providence, RI, 02903, USA | 1-800-587-2872 | www.thamesandkosmos.com
Thames & Kosmos UK LP, 20 Stone Street, Cranbrook, Kent, TN17 3HE, UK | 01580 713000 | www.thamesandkosmos.co.uk

KIT CONTENTS

Good to know!

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

What's in your experiment kit:



Checklist:

✓	No.	Description	Qty.	Part No.
○	1	Head unit	1	723146
○	2	Body unit	1	723147
○	3	Legs (orange)	2	723145
○	4	Pin caps (light blue)	4	723142
○	5	Sticker sheet	1	723144
○	6	Large frame (gray)	2	723143
○	7	Square frame (gray)	2	719851
○	8	Cotton string (white, 200 cm)	1	714240
○	9	9-hole rod (gray)	4	719057
○	10	3-hole dual rod (gray)	4	718536
○	11	Short anchor pin (black)	8	721921
○	12	Anchor pin (red)	6	702527
○	13	Joint pin (blue)	2	717768
○	14	Anchor pin lever (yellow)	1	702590
○	15	Pivot anchor pin (gray)	2	620302Y
○	16	5-hole cross rod (gray)	2	620302Z

YOU WILL ALSO NEED:

3 AAA batteries (1.5-volt, type LR03), small Phillips-head screwdriver

TIPS

YOU WILL NEED THE ANCHOR PIN LEVER WHEN YOU WANT TO TAKE YOUR MODELS APART. IT HAS TWO DIFFERENT SIDES FOR DIFFERENT SIZED PARTS.

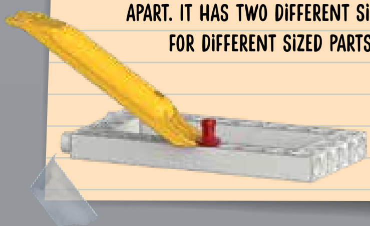
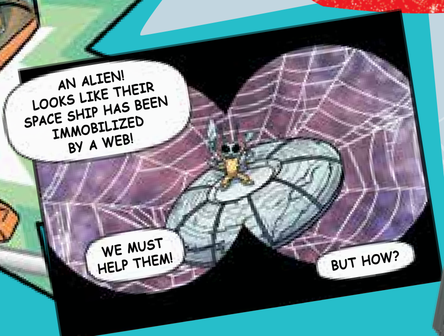


TABLE OF CONTENTS

TIPS

YOU CAN FIND ADDITIONAL INFORMATION ABOUT GYROSCOPES IN THE CHECK IT OUT SECTIONS ON PAGES 16 TO 20.



Yay! **Let's begin!**

620302-02-110321

WARNING!

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

Keep packaging and instructions as they contain important information.

Safety for Experiments with Batteries:

- → Never perform experiments using household current! The high voltage can be extremely dangerous or fatal!
- → Three AAA batteries (1.5-volt, type LR03) are required, which are not included in the kit because of their limited shelf life.
- → Avoid short circuiting the battery. A short circuit can cause the wires to overheat and the battery to explode.
- → Different types of batteries 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.
- → The batteries are to be inserted with the correct polarity. Press them gently into the battery compartment (see page 12).
- → 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.
- → Dispose of used batteries in accordance with environmental provisions, not in the household trash.
- → The supply terminals are not to be short-circuited.
- → Avoid deforming the batteries.

Notes on Disposal of Electric 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.

IMPORTANT INFORMATION

Dear Parents and Adults,

Children want to explore, understand, and create new things. They want to try things and do it by themselves. They want to learn! They can do all of this with Thames & Kosmos experiment kits. With every single experiment, they grow smarter and more knowledgeable.

With this kit, your children can learn about gyroscopes in a fun, hands-on way. They can develop fine motor skills and strengthen their powers of observation when playing with this amazing balancing robot. The experiments are designed to encourage your children, but they can also be challenging. So please help your children as they experiment and play with this kit. For safety, you should supervise the insertion of the three AAA batteries (1.5-volt, type LR03).

Before setting up and experimenting, read the instructions together with your child and discuss the safety instructions. Help your child build and operate the gyrobot with advice and a helping hand — especially with more difficult steps and experiments.

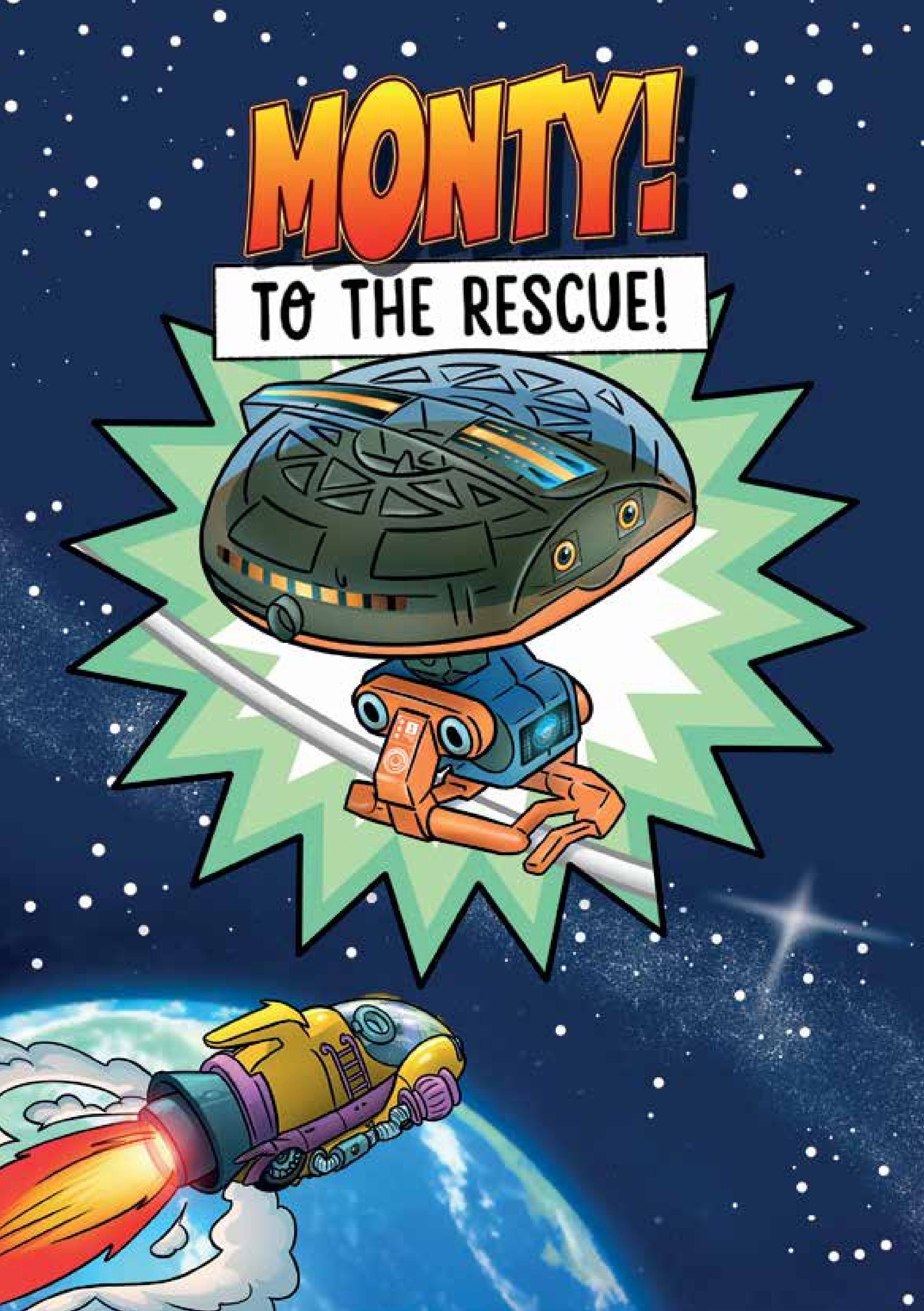
Younger children in particular, who cannot yet read, need an adult's assistance in assembling the gyrobot and the tightrope frame, and in carrying out the experiments.

The gyrobot is kept in balance by a motorized internal spinning gyroscope, which has to reach operating speed after it is turned on before the robot can safely balance. Make sure that your child does not attempt to balance the gyrobot until it reaches full speed.

Never leave the gyrobot operating unattended or above people or animals to avoid the risk of falling, damage, or injury. It is best to operate the gyrobot on the tightrope frame, which can be built with the parts included. You can also tether the gyrobot to the tightrope using the small safety loop and a string, to prevent it from crashing to the floor if it should fall off the tightrope. This is explained on page 13. Please note all of the usage tips on page 13 so that your child can enjoy using the gyrobot for a long time.

We hope you have a lot of fun with this experiment kit!

Have fun!

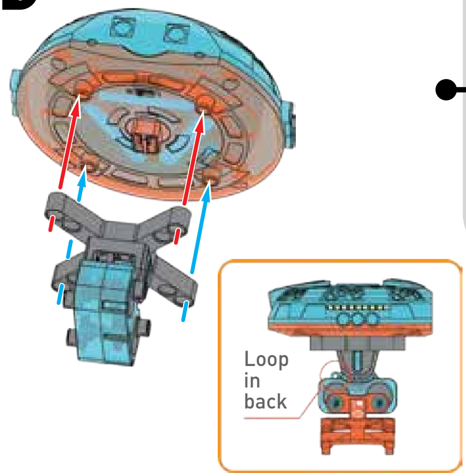

MONTY!
TO THE RESCUE!


TOM & IZZY
IT'S QUIET IN THE JUNKYARD. EVERYONE HAS GONE TO SLEEP ... ... EXCEPT TOM AND IZZY.
HERE, WHERE OTHER PEOPLE JUST SEE JUNK, HEROES SEE ENDLESS POSSIBILITIES.
THE THRUST MUST BE INCREASED BY FACTOR 10.
WE NEED MORE BOOST ...
... TO OVERCOME THE GRAVITY.
I FOUND SOMETHING!
IT'S THE PIECE WE NEEDED!
HMM ... THAT COULD WORK.
... AS LONG AS IT ISN'T BROKEN.
DON'T WORRY! THIS SMALL LEAK WILL BE EASY TO PLUG.
ALRIGHT, LET'S GET TO WORK!

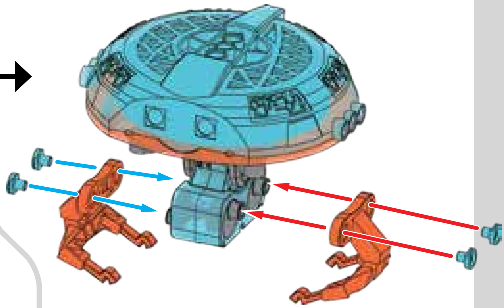

IZZY CAN REPAIR ANYTHING. SHE IS A GENIUS WHEN IT COMES TO MECHANICS.
TOM ON THE OTHER HAND IS A SCIENTIST THROUGH AND THROUGH ...
... HE'S ALWAYS GAME TO TRY OUT AN EXPERIMENT!
TOGETHER, THEY CAN BUILD ANYTHING!
I THINK IT'S READY!
YES! WE DID IT!
NOTHING CAN STOP US NOW!
WHERE SHOULD WE FLY NEXT?
WHEREVER WE WANT!
WE CAN GO ANYWHERE!

CONTINUED ON PAGE 14.

1

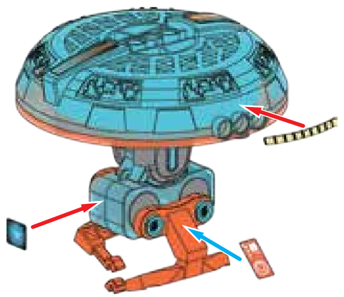


2

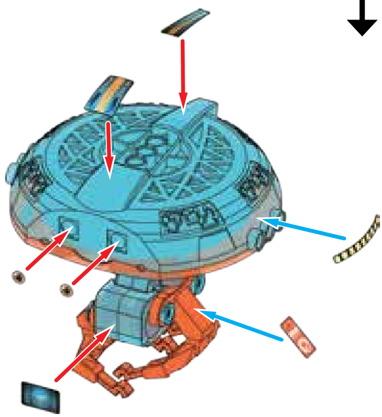


! Press the blue pins firmly into place!

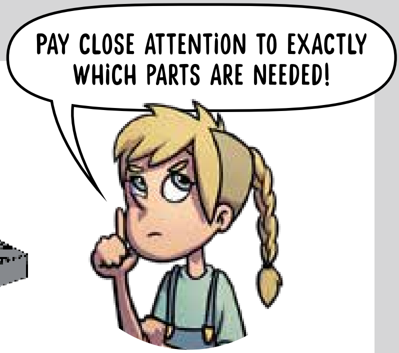
3



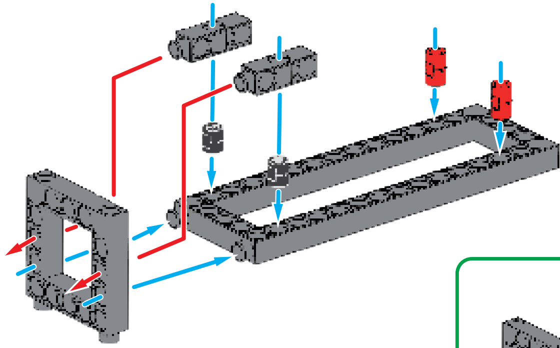
4

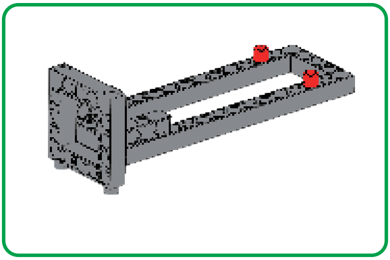


TIGHTROPE FRAME

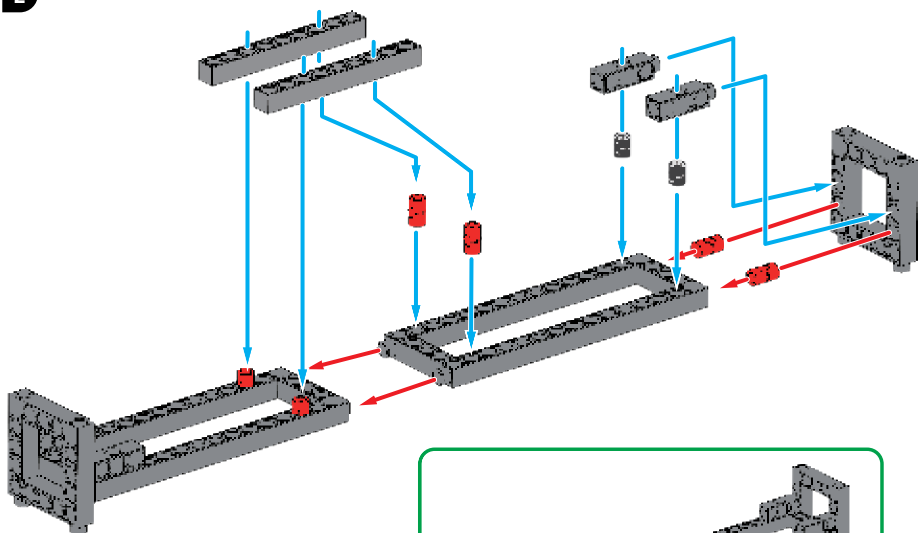


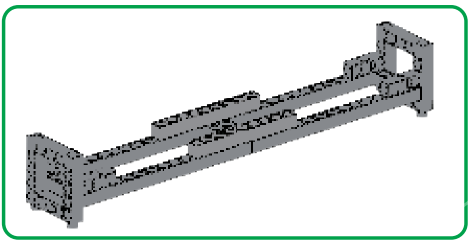
1



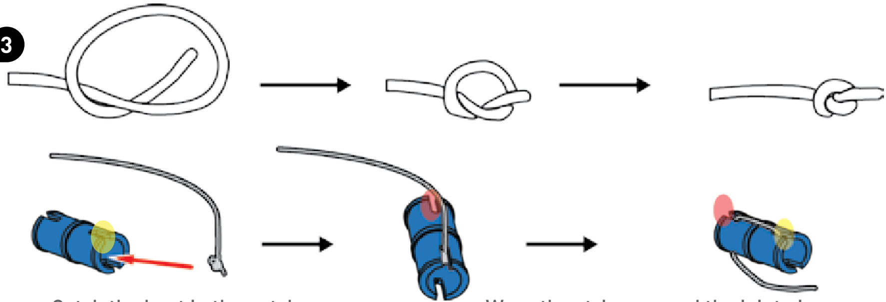


2





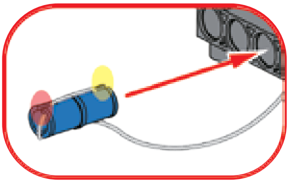
3



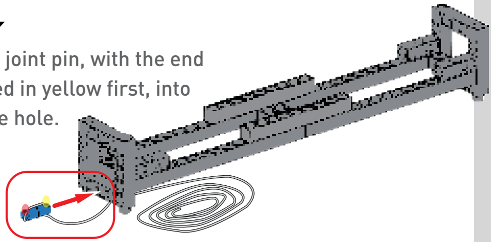
Catch the knot in the notch highlighted here in yellow.

Wrap the string around the joint pin, guiding it through all four notches.

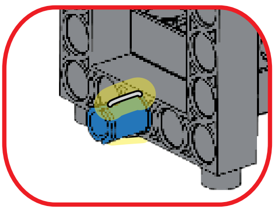
4



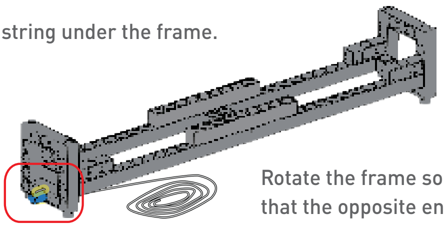
Insert the joint pin, with the end highlighted in yellow first, into the middle hole.



5



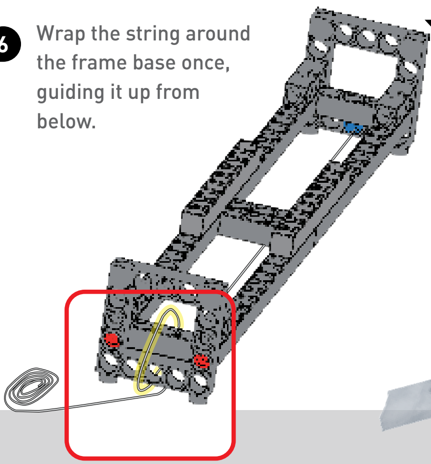
Pull the string under the frame.

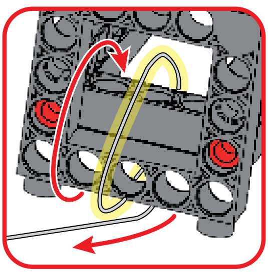


Rotate the frame so that the opposite end is facing you.

6

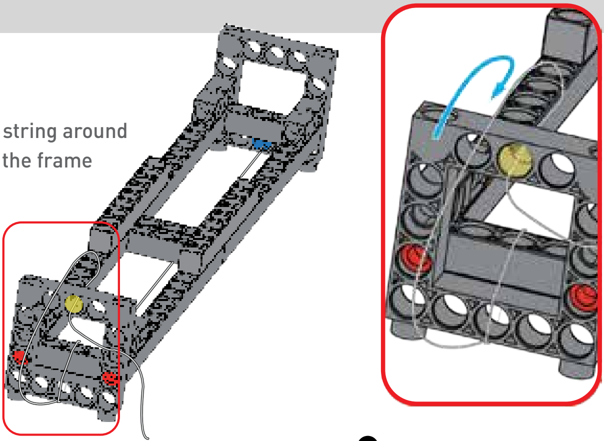
Wrap the string around the frame base once, guiding it up from below.





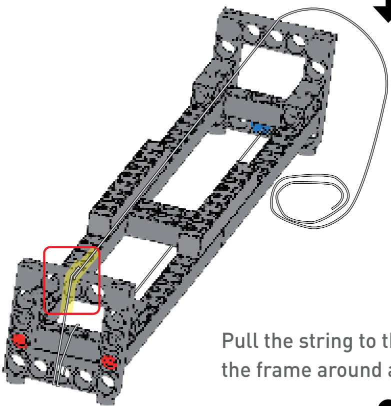
7

Guide the string around the top of the frame once.

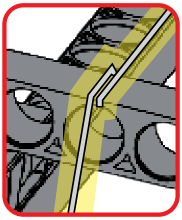


Thread the string from behind through the hole highlighted here in yellow.

8

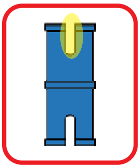


Pull the string back over the top of the frame, as shown here:

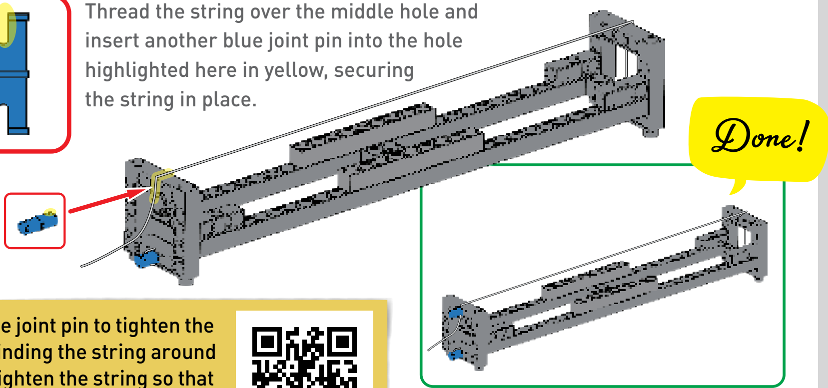


Pull the string to the opposite end of the frame and then rotate the frame around again, so the free end of the string is facing you.

9



Thread the string over the middle hole and insert another blue joint pin into the hole highlighted here in yellow, securing the string in place.



Rotate the joint pin to tighten the string, winding the string around it. In this way, tighten the string so that it is totally taut and doesn't droop at all. Scan this QR code for a helpful video.

The gyrobot walks the tightrope

Starting the gyrobot:

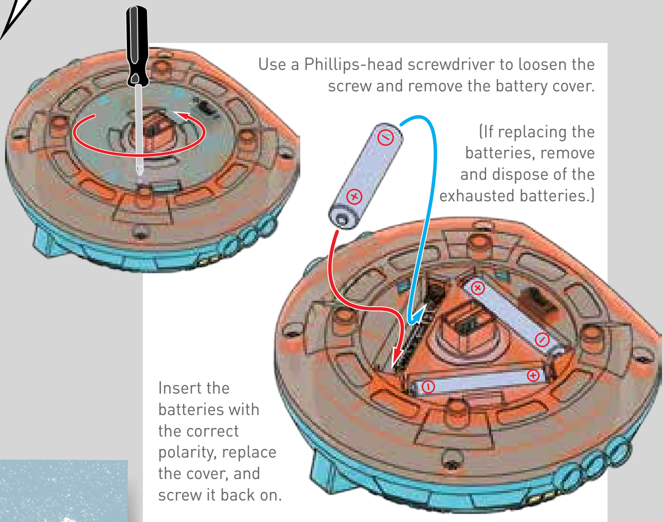
Turn on the gyrobot by sliding the small switch. Hold it level in the air by its head. The gyrobot shouldn't touch any surfaces or the tightrope yet!

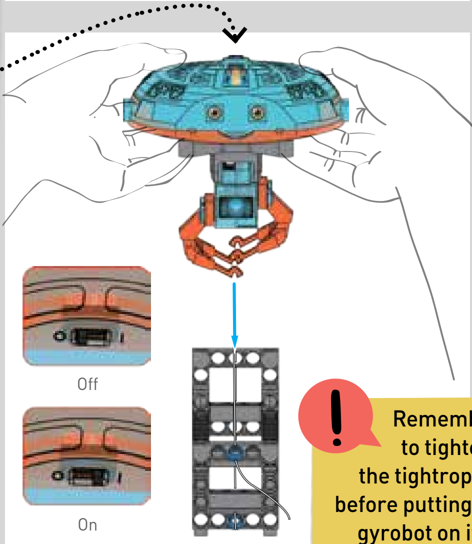
Now, you must wait approximately 15 seconds for the gyroscope inside the gyrobot's head to pick up speed. You can hear the motorized gyroscope spinning faster and faster. When the gyroscope has reached its maximum speed, you can carefully place the gyrobot on the tightrope or a flat surface.

Always align the gyrobot's head parallel to the surface on which it is supposed to balance! Hold it in this position and then release it carefully onto the surface.

Inserting and replacing the batteries

WARNING! Observe the information on handling batteries on page 2!



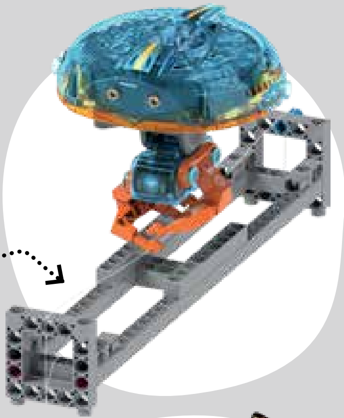


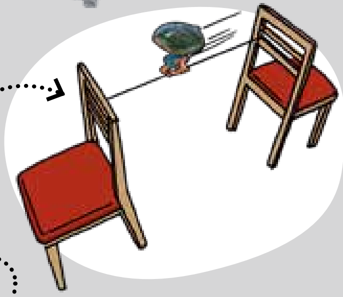
! Remember to tighten the tightrope before putting the gyrobot on it!

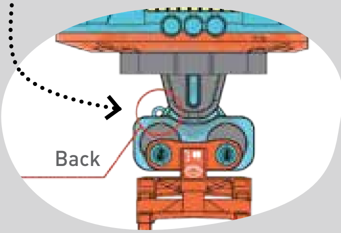
TIPS

FOLLOW THESE TIPS TO KEEP THE GYROBOT SAFELY BALANCED:

- IT IS BEST TO USE THE TIGHTROPE FRAME AS DESCRIBED PREVIOUSLY IN THIS MANUAL.
- WHEN THE GYROBOT BALANCES ON A TIGHTROPE, THE STRING MUST BE TOTALLY TAUT! IT CANNOT BE SAGGING.
- DO NOT ATTACH OR REMOVE ANY PARTS WHEN THE GYROBOT IS SWITCHED ON.
- WHEN BALANCING THE GYROBOT ON THE STRING, MAKE SURE THAT YOU PUT ITS FEET ONTO THE STRING PROPERLY: THE NOTCHES SHOULD FIT ONTO THE STRING EXACTLY.
- NEVER LET THE GYROBOT BALANCE ABOVE HIGH SPACES, PEOPLE, OR ANIMALS — IT COULD FALL, BREAK, OR CAUSE INJURY.
- NEVER INSERT THIN OR SHARP OBJECTS INTO THE GYROBOT'S HEAD OR GEARS!
- IF YOU SET UP THE GYROBOT TO BALANCE ON THE STRING WITHOUT THE FRAME (FOR EXAMPLE, ON THE STRING STRETCHED BETWEEN TWO CHAIRS), USE THE SAFETY LOOP ON ITS BODY: GUIDE A STRING THROUGH THE SAFETY LOOP AND AROUND THE TIGHTROPE, AND THEN TIE THE TWO ENDS OF THE STRING TOGETHER.
- BE VERY CAREFUL IF YOU EXPERIMENT WITH THE GYROBOT BALANCING ON UNEVEN OR SOFT SURFACES (LIKE PILLOWS)!
- KEEP LONG HAIR AND CORDS AWAY FROM THE GYROBOT'S HEAD AND BODY!
- IF THE GYROBOT'S SOUND CHANGES WHILE BALANCING, CHECK THAT THE BODY AND LEGS ARE STILL PROPERLY CONNECTED AND THAT ALL PARTS ARE PRESSED TOGETHER FIRMLY.
- NEVER TILT THE GYROBOT OR ITS HEAD SUDDENLY WHEN IT'S RUNNING — THE GYROSCOPE COULD BREAK!
- IF YOU NOTICE THAT THE GYROBOT IS RUNNING SLOWER OR FALLING OUT OF BALANCE MORE OFTEN, THEN THE BATTERIES MAY BE EXHAUSTED. REPLACE THEM WITH NEW BATTERIES.







Powering down:

After switching the gyrobot off, the gyroscope will continue to rotate and its legs will continue to move for a while. **Take it off the string (or other surface) immediately after switching it off!** The gyroscope is no longer spinning fast enough to keep the gyrobot balanced.

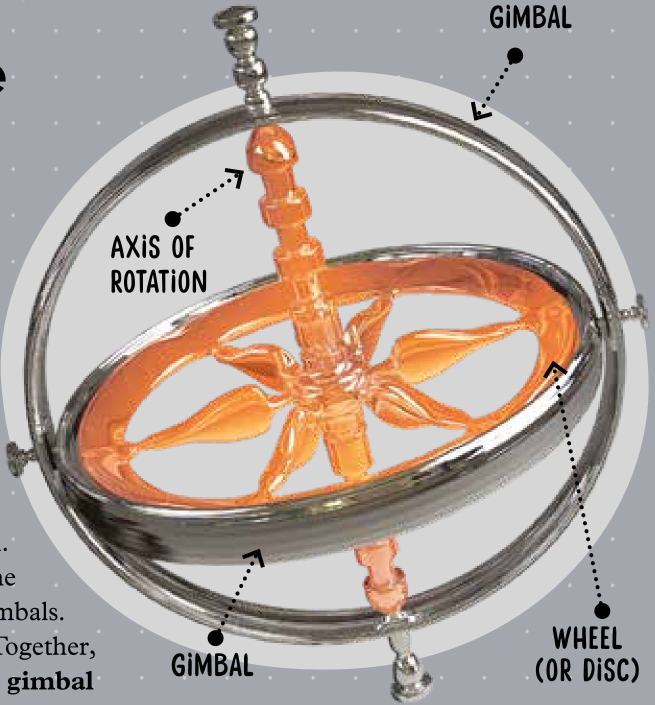

MONTY!
NO PROBLEM, BRO. MONTY CAN DO THIS! BALANCING IS ITS SPECIALTY.
THE SUBJECT APPEARS TO ALSO BE SIGNALING A QUITE OPTIMISTIC OPINION REGARDING THIS RESCUE PLAN.
SEE!? HELPING PEOPLE IS FUN. I WAS RIGHT.
FUN IS IRRELEVANT. WE ARE IN THE SERVICE OF SCIENCE AND ...
UH-OH....
"UH-OH" WHAT? LET ME SEE! GIMME THE BINOCULARS!
OKAY, THIS NO LONGER LOOKS FUN!
INCREASE YOUR SPEED, MONTY!
I REALLY SHOULD HAVE DESIGNED IT TO BE A BIT FASTER.
IIIP! EEK!
PICK UP THE PACE, MONTY!


ACCORDING TO MY CALCULATIONS, A POSITIVE CONCLUSION TO THIS DANGEROUS SITUATION IS NOT INEVITABLE.
I HEAR YOU. I'M ALREADY STARTING THE ENGINES!
WEEEE!
IIIIIIIP! EEP EEEP!
IIIIIIIIIIIP!
HAHAAAAA! EAT DUST, SPIDERS!
WE ONLY WANTED TO HELP ...
WOW, THAT WAS CLOSE! THANKS!
OF COURSE!
YOU CAN DROP ME OFF AT THE NEXT SOLAR SYSTEM. WHAT BROUGHT YOU TO THIS CORNER OF THE UNIVERSE, ANYWAY?
YOU SPEAK OUR LANGUAGE?
INTRIGUING.
THE QUEST FOR SCIENCE AND FUN!

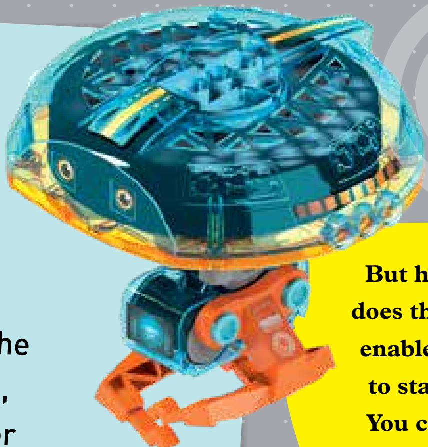
CHECK IT OUT

How does the gyrobot balance?

The gyrobot's secret is a gyroscope, which is a wheel mounted inside a special frame. The wheel spins rapidly around a central axis of rotation. The frame can rotate independently of the wheel, so it can assume any orientation in space even as the wheel stays in one orientation. This is achieved by suspending the wheel inside multiple rings, or gimbals. Each ring can pivot on one axis. Together, these suspension rings make up a **gimbal suspension.** Physics explains how the rapidly rotating wheel remains spinning in one orientation. This special phenomenon is the reason gyroscopes can be used for measuring and maintaining the orientation of objects.



The gyroscopic wheel is inside the gyrobot's head. If you look through the transparent plastic housing, you can see the wheel rotating inside. It is powered by electricity from the batteries installed inside of it, which power an electric motor that spins the wheel.



But how, exactly, does the gyroscope enable the gyrobot to stay balanced? You can find out in the following experiments!

EXPERIMENT 2

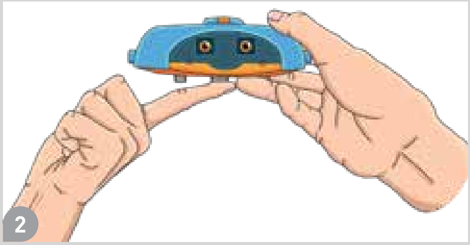
Balancing act

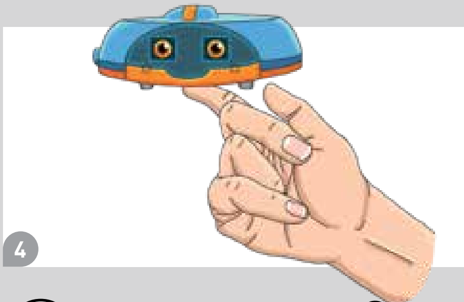
You will need

- **Gyrobot's head (carefully removed from the body)**

Here's how

1. Turn on the gyroscope using the switch shown on page 12 and wait for it to get up to its top speed.
2. Place the gyrobot's head on the middle or index finger of one of your hands and hold it with your other hand. Make sure you hold the head low over a table or soft surface, like a sofa, so that nothing can happen if your attempt to balance it doesn't work right away.
3. Align the head parallel to the surface below it. Check that your fingers are centered under the head and carefully let go of it with your other hand.
4. Now you can have the head balanced on one or two fingers. Hold your other hand close to stabilize the head if necessary.
5. Try this: When the head is well balanced on your finger, place the index finger of your other hand on the head and your thumb below. Try to change the position of the head slightly. Do you feel the gyroscopic forces?





WHAT'S HAPPENING?

In this experiment, you can experience the **gyroscopic effect** firsthand. This effect occurs when a wheel turns very quickly. This creates a force that tries to maintain the axis of rotation of the wheel. In other words, the force prevents the wheel from tilting out of the plane in which it is already spinning. As long as a gyroscope is rotating, it always maintains the original position of its axis of rotation.

Therefore, you probably observed the following: If the gyrobot's head tilts, the gyroscopic effect pushes it back so that the axis of rotation is maintained. This is how the head balances on your finger, and how the body balances on the rope.

Trying to change the position of the head a bit with your other hand is not that easy, is it? You feel resistance. This is the force of the gyroscopic effect that fights against the change in position. The gyroscope's axis of rotation tries to hold its position.

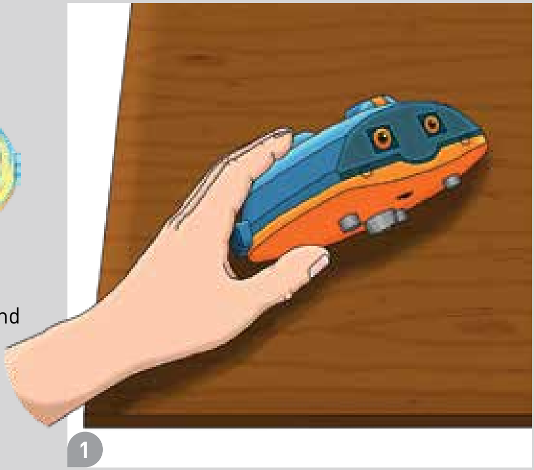
On edge

You will need

– Gyrobot's head

Here's how

1. Place the gyrobot's head on a flat surface with its eyes facing up toward the ceiling and the edge of the back of its head resting on the surface. Do not put the head completely upright, but tilt it slightly to the side. Do not turn the gyroscope on yet.
2. Let go carefully. What happens?
3. Now turn on the gyroscope inside the head and wait for it to get up to its top speed.
4. Now position the head on the surface as in step 1. Hold it in place for a little while and then gently let go. What happens?



WHAT'S HAPPENING?

With the gyroscope turned off, the gyrobot's head falls over. The reason for this is **gravity,** which is a force that pulls all bodies and objects on Earth toward the center of the Earth. It is thus also referred to as **gravitational pull.** This arises from the fact that the Earth is much heavier than all the bodies on it. The more massive an object, the stronger its pull on other objects. Due to gravity, things on Earth always fall toward the surface of the Earth and do not "fall" away from the Earth.

With the gyroscope turned on, the head no longer falls over. It turns slowly in its slightly tilted position. Again, it is the gyroscope's gyro effect that makes the head balance on its edge like this. **The gyroscopic effect even holds the entire gyrobot in position against the force of gravity!** If the head begins to tilt due to gravity, the gyroscopic effect directs it back to its axis of rotation.

EXPERIMENT 4

Spinning top

You will need

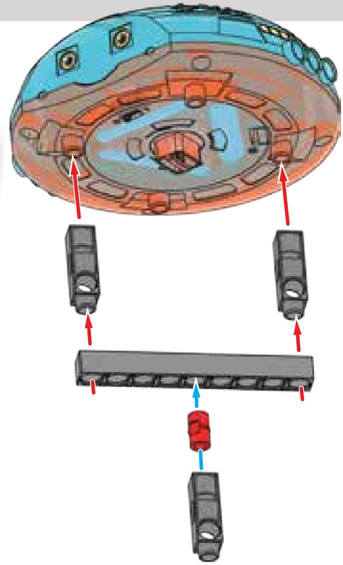
- Gyrobot's head
- 3 x 3-hole dual rods
- 9-hole rod
- Red anchor pin

TIPS

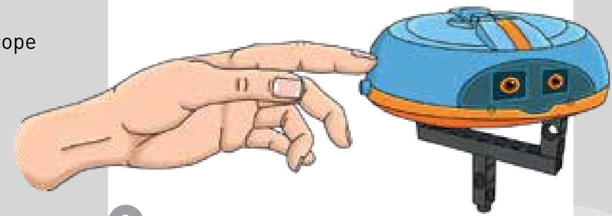
FOR THIS EXPERIMENT, YOU WILL NEED TO DISASSEMBLE THE TIGHTROPE FRAME TO GET SOME OF THESE PARTS.

Here's how

1. Assemble the four rods and the red anchor pin as shown in Figure 1. Then attach the gyrobot's head to the assembly as shown.
2. On a tabletop, balance the assembly on the tip of its bottom rod. With the gyroscope switched off, gently push the head from the side with your finger or a pen. What happens to the whole assembly?
3. Repeat the experiment with the gyroscope switched on. Wait for the gyroscope to get up to its top speed and then gently push the head from the side (which is perpendicular to its axis of rotation). What do you observe?



1



2

WHAT'S HAPPENING?

With the gyroscope turned off, the gyroscope assembly falls over when pushed. When the gyroscope is switched on, the results are different. When pushed, the assembly turns on the tip of the rod and remains in balance. The gyroscopic effect keeps the gyroscope in its axis of rotation. This is how toy spinning tops work too: Only when a top is spinning does it balance on its tip.

However, **external forces** (such as when you push on the head, and also the force of friction between the tip of the rod and the tabletop) can affect the gyroscopic effect. The gyroscope reacts by swerving a little. You can see this firsthand: The model does not turn evenly around the axis of rotation, but wobbles a little. The gyroscope changes its axis of rotation when exposed to external forces. This deviation of the axis of rotation is not arbitrary: The axis of rotation always deviates on a constant circular path. The axis of rotation turns around another invisible axis. This process is called **precession**.

CHECK IT OUT

Gyroscopes – A HISTORY –

Spinning tops, including the common toys you are probably familiar with, have been around for hundreds of years. The gyroscope, on the other hand, was invented about 200 years ago by a German scientist named Johann Gottlieb Friedrich von Bohnenberger, who was an astronomer, mathematician, and physicist. He simply called his invention a "Machine." In 1852, the French physicist Léon Foucault developed Bohnenberger's "Machine" into a new device called a gyrocompass. This was used to determine the location and course of sailing ships. Incidentally, the name gyroscope comes from the Greek words: *gyros* = circle, and *skopos* = to look.

GYROSCOPES TODAY

These days, many devices use technology that relies on the same gyroscopic effect that the gyrobot relies on to keep its balance. For example, did you know that gyroscopes are also built into **smartphones**? A gyroscope is used when the screen of a smartphone changes orientation when turned on its side. When you play a game on a smartphone in which you control a character by tilting or rotating the smartphone, you use the gyroscope: The current position of the smartphone is determined by the gyroscope, which maintains its orientation even when the smartphone is tilted. Of course, the gyroscopes built into smartphones are much smaller than the gyroscope in the gyrobot. The gyroscope is assembled with many other sensors and measuring instruments on the **circuit board** (the brain, so to speak) of a smartphone.

Since gyroscopes always remain in their spatial orientation, even if the spatial orientation of their suspension changes, gyroscopes are used in **aircrafts**. In every airplane cockpit there is a gyroscope that is part of a device called an **artificial horizon**: This device shows the pilots a horizontal line that remains the same, even if the aircraft is tilting to make a turn, for example. The gyroscope maintains its original horizontal position even in an airplane flying at an angle. This enables pilots to see exactly how their aircraft is positioned in the air, relative to the ground. Pilots need this information when steering the aircraft if they are unable to orient themselves with the surface of the Earth — for example, due to darkness or clouds.

EXPERIMENT 5

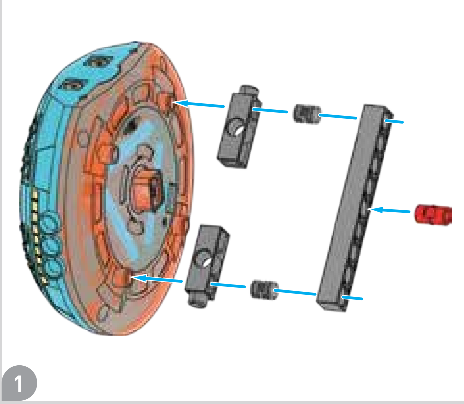
Sidewinder

Here's how

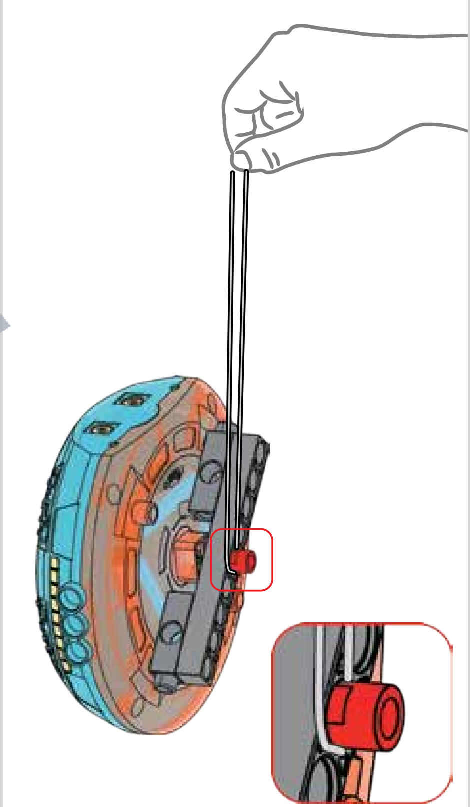
1. Assemble the model using the rods and anchor pins as shown.

2. This entire experiment should be conducted close to the surface of a table, so that if the model falls, it will not break. You can put a soft material underneath it as well, to protect it should it fall.

   Hold both ends of the string in one hand to form a long loop. Hold the gyroscope assembly sideways, turn it on, and wait for it to get up to maximum speed. Now carefully rest the red anchor pin in the bottom of the loop and hold it there for a few seconds. Slowly let go of the gyroscope assembly. What happens?



1



2

The closer the string is to the gray rod, the better it will hang.

WHAT'S HAPPENING?

Amazingly, the gyroscope assembly appears to defy gravity as it dangles in the loop of string, supported only at the red anchor pin. But you know that it is not magic at work here; rather, it is the physics of the gyroscopic effect that keeps the gyroscope assembly balanced.

The spinning gyroscope resists moving out of the vertical plane in which it is spinning. The axis of rotation is horizontal, through the loop. This keeps the assembly from falling to the side out of the loop. This, combined with the fact that the upward force of the string is enough to balance the downward force of gravity on the model, keeps the model suspended in the loop.

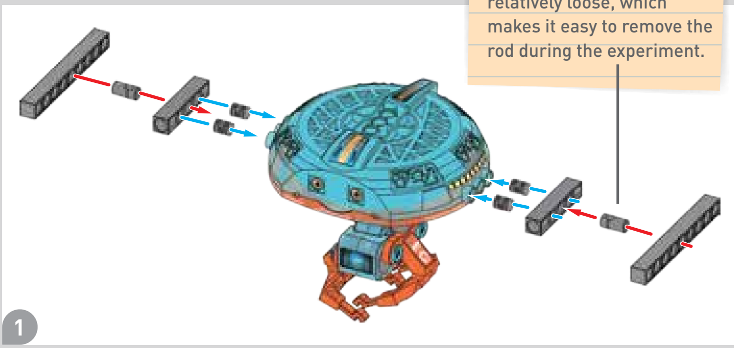
EXPERIMENT 6

That's using your head

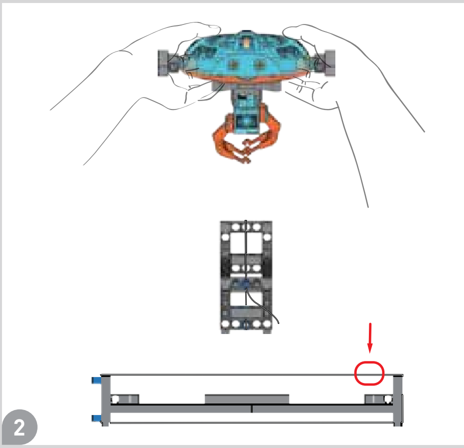
Here's how

1. Starting with the assembled gyrobot model, attach the rods and anchor pins to the side of its head as shown. Make a hypothesis about how these added pieces will affect the gyrobot.

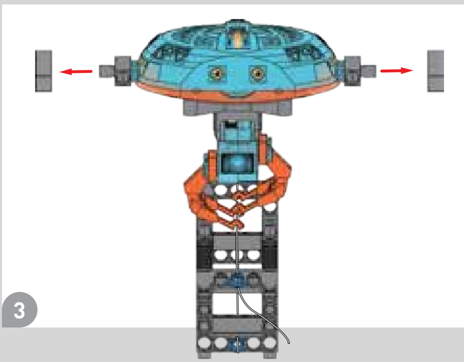
The shorter side of the pivot anchor pin makes a tight connection with the rod, while the longer side is relatively loose, which makes it easy to remove the rod during the experiment.



2. If you disassembled the tightrope frame, reassemble it according to the instructions starting on page 9. Turn on the gyrobot and wait for it to reach its top speed. Balance the gyrobot on the tightrope. Observe its performance.



3. Remove one or both of the 9-hole rods and repeat the experiment. What happens?



WHAT'S HAPPENING?

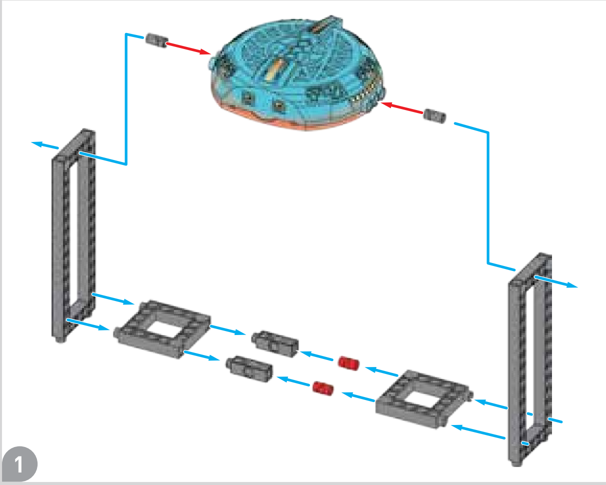
Despite the fact that the additional pieces add weight, they do not have much of an effect on the balancing or walking behavior of the gyrobot. This is because the gyroscopic forces are powerful enough to counteract the extra forces applied to the model by these additional pieces, and the additional pieces do not weigh very much relative to the entire gyrobot. Even when the assembly is asymmetrical, the gyrobot still remains balanced.

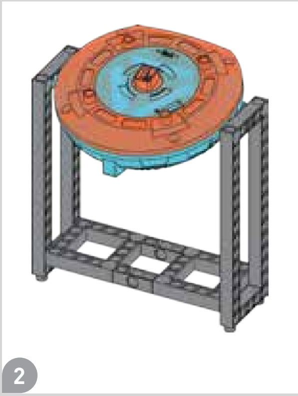
EXPERIMENT 7

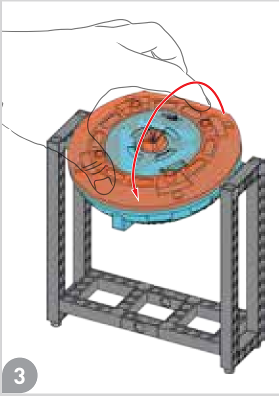
Heads or tails

Here's how

1. Assemble the model using the frames, rods, and anchor pins as shown.
2. You will see that, because the gyrobot's head is top-heavy, it will flip over and rest upside down. Before turning the gyroscope on, try flipping the head upright. What happens?
3. Flip the head upright again and turn the gyroscope on. Hold the head upright until the gyroscope has reached its full speed. Let go of the head. What happens?


1

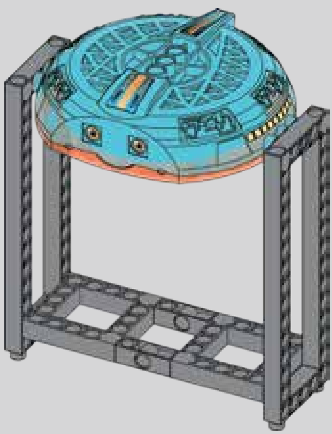

2


3

WHAT'S HAPPENING?

When the motorized gyroscope is off, the head always tips over and rests upside down. This is because the heavy weight of the wheel inside the head is above the pivot points. The head's **center of gravity** is in an unstable position above the pivot points, so the model tips upside down. Once the center of gravity is below the pivot points, it is stable again.

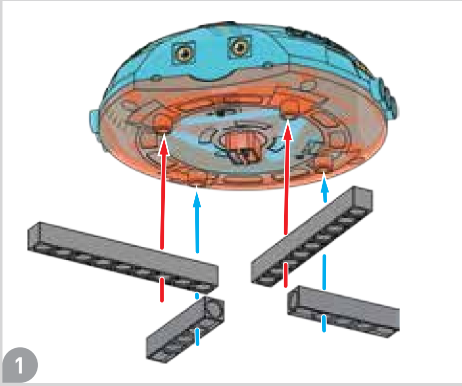
When the gyroscope is turned on, the gyroscopic effect resists the forces acting on the head that are pulling it upside down. Therefore, it takes longer for the head to flip upside down. However, the stabilizing force of the gyroscope is not enough to keep the head balanced upright indefinitely.

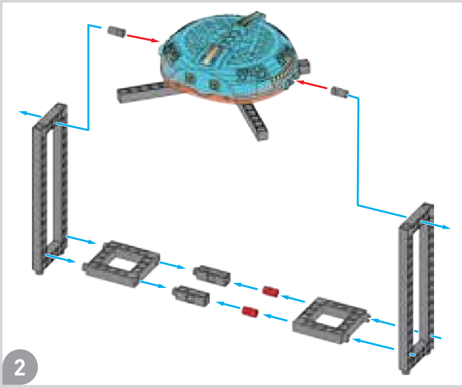


Arms wide open

Here's how

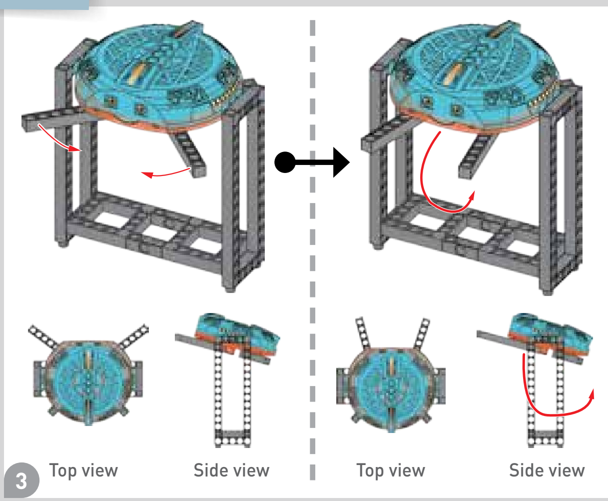
1. Attach the four rods to the gyrobot's head as shown.
2. Hang the head assembly in the frame similar to how it was hung in the previous experiment.
3. Turn the gyroscope on and wait for it to reach its top speed. What do you observe about the position of the head? Now rotate the two arms inward toward each other as shown. How does this affect the position of the head?





WHAT'S HAPPENING?

The arms affect the center of gravity of the head assembly. When the arms are extended away from the pivot point, the center of gravity of the head assembly also shifts, and this pulls the model downward on this side. The gyroscope is not quite strong enough to compensate.



Keep going!

Do you have your own ideas for experiments you can try with the gyrobot? Now that you know how to safely operate it, try out your own experiments.

Text: Tanja Sautter
Project manager: Thomas Nolde
Technical product development: Genius Toys Taiwan Co., Ltd; Dr. Petra Müller

Manual design concept: Atelier Bea Klenk, Berlin
Manual layout: ideas, Michael Schlegel, Würzburg.
Manual assembly illustrations: Genius Toys Taiwan Co., Ltd
Manual illustrations and story comics: Bianca Meier; Daniel Alles; Murat Kaya
Manual photos: Jaimie Duplass & beror (all stickers, ©fotolia); Nata Studio U1 ur; Stock Up U1 ul; sNorrisPhoto p. 1 mr, p 16 or; Tomas Nevesely p. 18 ul; Inked Pixels p. 20 or; Konstantin Savusia p. 20 m; Jag_cz p. 20 mr; High Mountain p. 1 ur, p. 20 um (all previous ©shutterstock.com); Genius Toys Taiwan Co., Ltd. p. 3 o, p. 13 or, p. 16 u, p. 17 o, p. 18 o

Packaging design concept: Peter Schmidt Group GmbH, Hamburg
Packaging layout: Studio Gibler, Stuttgart
Packaging photos: Nata Studio (Finger); Stock Up (Gyroscope)(both ©shutterstock.com); Genius Toys Taiwan Co., Ltd.

Editing: Ted McGuire; Additional Graphics and Layout: Dan Freitas

Distributed in North America by Thames & Kosmos, LLC. Providence, RI 02903
Phone: 800-587-2872; Web: www.thamesandkosmos.com

Distributed in United Kingdom by Thames & Kosmos UK LP. Cranbrook, Kent TN17 3HE
Phone: 01580 713000; Web: www.thamesandkosmos.co.uk

Printed in Taiwan

Kosmos Quality and Safety

More than one hundred years of expertise in publishing science experiment kits stand behind every product that bears the Kosmos name. Kosmos experiment kits are designed by an experienced team of specialists and tested with the utmost care during development and production. With regard to product safety, these experiment kits follow European and US safety standards, as well as our own refined proprietary safety guidelines. By working closely with our manufacturing partners and safety testing labs, we are able to control all stages of production. While the majority of our products are made in Germany, all of our products, regardless of origin, follow the same rigid quality standards.

Do you have any questions?
Our customer service team will be glad to help you!

Thames & Kosmos US
Email: support@thamesandkosmos.com
Web: thamesandkosmos.com
Phone: 1-800-587-2872

Thames & Kosmos UK
Web: thamesandkosmos.co.uk
Phone: 01580 713000

620302-03-110220