EXPERIMENT MANUAL

GYROSCOPES & FLYWHEELS

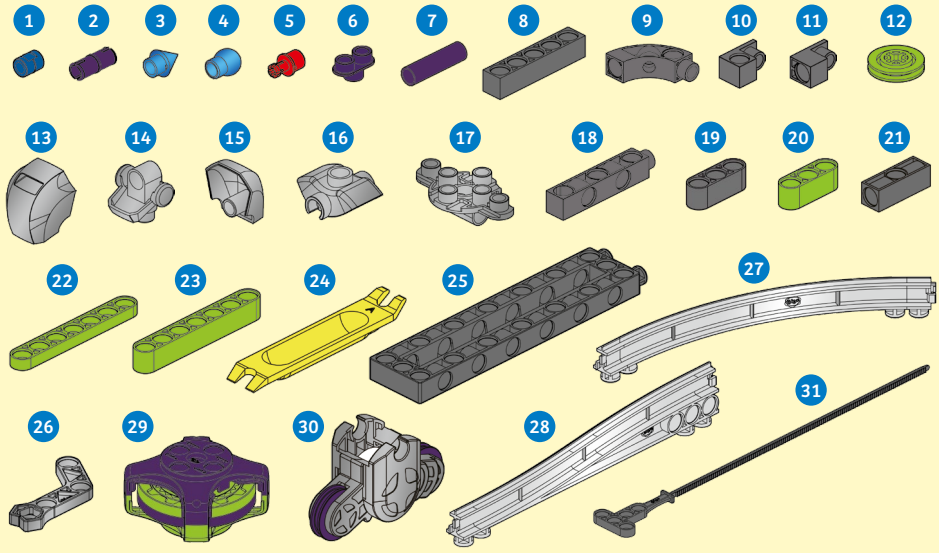
THAMES & KOSMOS

Franckh-Kosmos Verlags-GmbH & Co. KG, Pfizerstr. 5-7, 70184 Stuttgart, Germany | +49 (0) 711 2191-0 | www.kosmos.de
Thames & Kosmos, 301 Friendship St., Providence, RI, 02903, USA | 1-800-587-2872 | www.thamesandkosmos.com
Thames & Kosmos UK Ltd, Goudhurst, Kent, TN17 2QZ, United Kingdom | 01580 212000 | www.thamesandkosmos.co.uk

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

US: techsupport@thamesandkosmos.com
UK: techsupport@thamesandkosmos.co.uk

What's inside your experiment kit:



Checklist: Find – Inspect – Check off

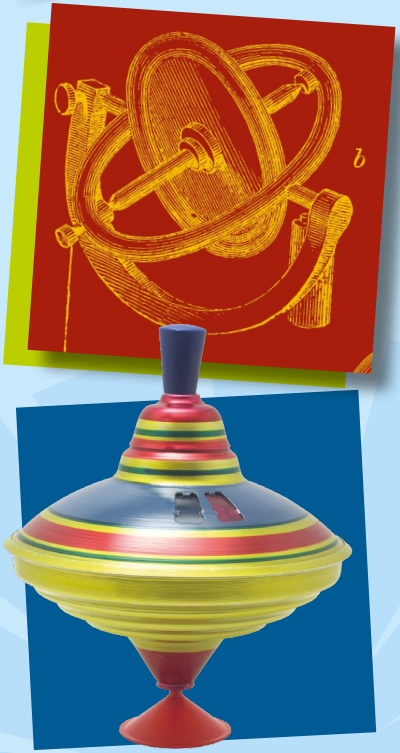
✔	No.	Description	Qty.	Item No.
❍	1	Short anchor pin	19	7344-W10-C2B
❍	2	Joint pin	3	1156-W10-A1P
❍	3	Cone pin	1	7128-W10-E2TB
❍	4	Sphere pin	1	7128-W10-E1TB
❍	5	Shaft plug	2	7026-W10-H1R
❍	6	Two-to-one converter	6	7061-W10-G1P
❍	7	Tube, 30 mm	3	7400-W10-G1P
❍	8	5-hole rod	4	7413-W10-K2D
❍	9	Curved rod	4	7061-W10-V1D
❍	10	90-degree converter - X	2	7061-W10-J1D
❍	11	90-degree converter - Y	2	7061-W10-J2D
❍	12	Small pulley	2	7344-W10-N3G
❍	13	Head 1, front	1	7396-W10-G1TD
❍	14	Head 2, neck	1	7396-W10-G2TD
❍	15	Head 3, back	1	7396-W10-G3TD
❍	16	Gyro cover plate	2	7395-W10-E2TD

✔	No.	Description	Qty.	Item No.
❍	17	Rod-to-tube connector	1	7395-W10-E3TD
❍	18	5-hole dual rod B	1	7026-W10-S2D
❍	19	3-hole wide rounded rod, black	5	7404-W10-C1D
❍	20	3-hole wide rounded rod, green	3	7404-W10-C1G2
❍	21	3-hole cross rod	3	7026-W10-X1D
❍	22	7-hole flat rounded rod	2	7404-W10-C3G2
❍	23	7-hole wide rounded rod	2	7404-W10-C2G2
❍	24	Anchor pin lever	1	7061-W10-B1Y
❍	25	13x3 Frame	2	7406-W10-A1D
❍	26	Arm flat rod	2	7395-W10-E1TD
❍	27	45-degree curved track	4	7395-W10-F1
❍	28	Sloped track	4	7395-W10-F2
❍	29	Rip-cord gyroscope	1	7395-W85-A
❍	30	Flywheel engine	1	7395-W85-B
❍	31	Rip cord	2	7395-W10-D1D

››› TABLE OF CONTENTS

TIP!

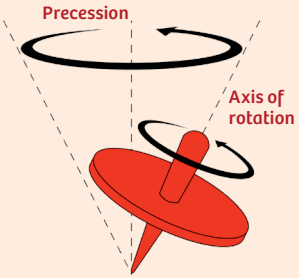
You will find supplemental information in the "Check It Out" sections on pages 8, 21, 26, and 32.

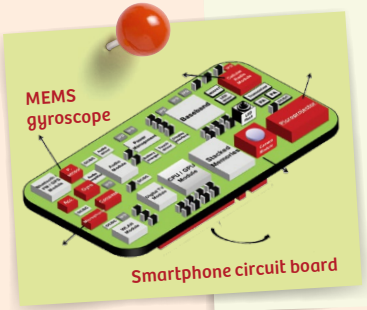


CHECK IT OUT

Precession

You saw in the previous experiments that the gyroscopic effect keeps the spinning gyroscope from falling over. However, the gyroscope will react to external forces applied to it by changing the direction of its axis of rotation. This change in the orientation of the rotational axis is called **precession.** Even as the rotor is spinning around the axis of rotation, the axis of rotation itself is rotating around a second axis.





Electronic Gyroscopes

How does your phone know to change its screen's orientation when the phone is turned on its side? How do cameras and video game controllers detect shaking? They use gyroscopes!

Gyroscopes are used in phones and other electronic devices to detect movement in three dimensions. The gyroscopes in smartphones are much smaller than the gyroscope in this kit.

These microchip gyroscopes are small enough to fit on the phone's printed circuit board along with all the other sensors and electronics. Microchip gyroscopes are called **MEMS (micro electro mechanical systems) gyroscopes.**

A Brief History of Gyroscopes

Although tops have been around for hundreds of years, the gyroscope is a more recent invention.

The first known instrument that was similar to a gyroscope was made by John Serson in 1743. It was used as a way to locate the horizon in foggy conditions at sea.

The first gyroscope was made by Johann Bohnenberger in 1817, who called his invention the "machine."

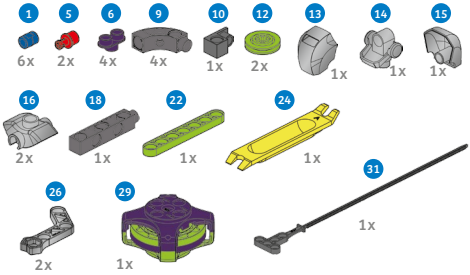
It was Léon Foucault who gave the gyroscope its name. He used a gyroscope to demonstrate the rotation of Earth, which is why gyroscope's root words are the Greek words *skopeein* for "to see" and *gyros* for "rotation."

With the use of electric motors gyroscopes were able to spin almost indefinitely. This allowed them to be used in important navigational instruments such as heading indicators and gyro-compasses.

EXPERIMENT 4

The spinning robot

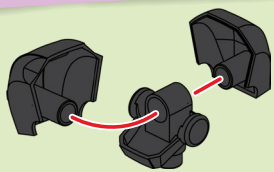
YOU WILL NEED



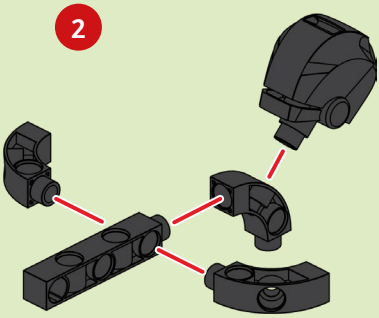
Determining location with gyroscopes

Image a robot in a factory assembly line needs to turn its arm to pick up a part, and to do so, the robot needs to know exactly where in space its arm is located. A gyroscopic sensor helps the robot do this. The sensor works based on the principle of how gyroscopes respond to forces (pushes and pulls). This experiment demonstrates how this works in principle.

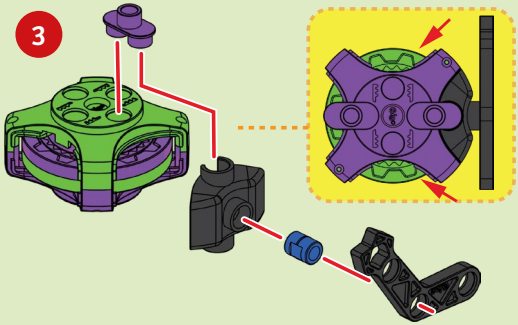
1



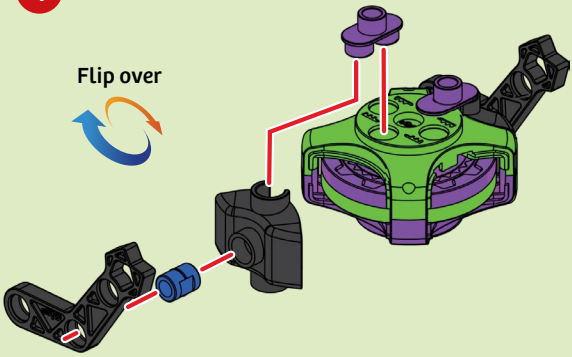
2



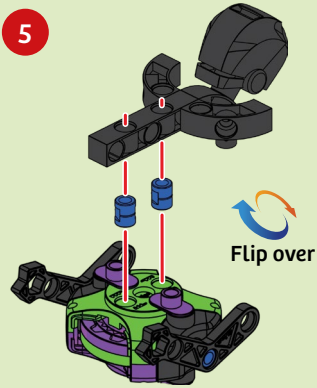
3



4



5



CONTINUED ON NEXT PAGE

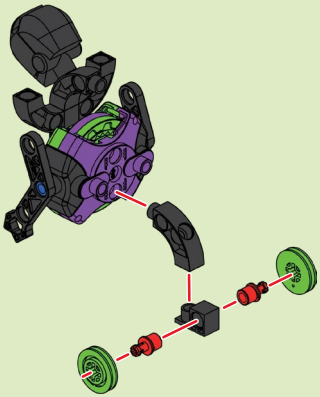
EXPERIMENT 4

HERE'S HOW

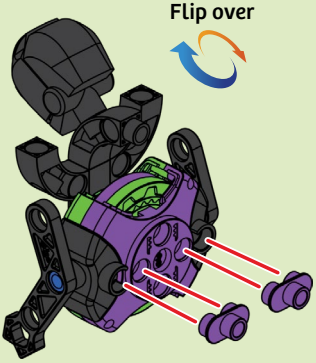
1 to 8 Assemble the model.

9 Pull the rip cord so that the rotor disk in the gyroscope turns clockwise. Does the rest of the model rotate clockwise or counterclockwise? Repeat this with the wheel turning counterclockwise.

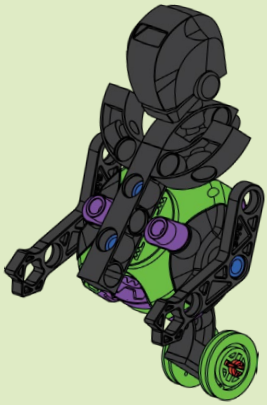
7



6



8



WHAT'S HAPPENING?

When the rotor disk rotates clockwise, the body rotates clockwise. Then when the rotor disk rotates counterclockwise, the body also rotates counterclockwise. When the disk spins, the model is experiencing what is called a **torque**. Torque is a force that causes something to rotate. When you turn a bolt using a wrench, you are applying a torque. This is why the model spins in the direction that the disk is spinning.

So, how is the factory robot able to use a gyroscope to find its arm's position? It does this by measuring the amount of torque that a gyroscope inside the arm experiences when it turns and using the torque measurements to calculate the distance and direction the arm moved.