Barbie™

STEM KIT

SCIENCE SAVES THE DAY!

Storybook and
Experiment Manual

THAMES & KOSMOS

Dear Parents,

Science and engineering are extremely exciting and vast fields. This kit, along with the illustrated story and instructions in this manual, provides an engaging way to teach simple science and engineering concepts to children ages 4 and up.

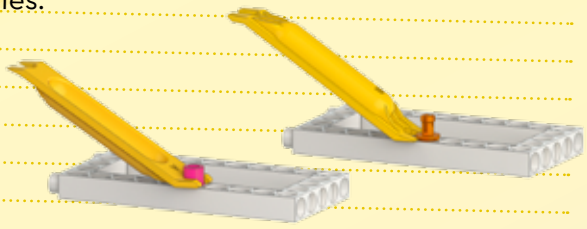
Please do the experiments, building projects, and activities in this kit together with your children.

Read the story with your children. As Barbie™ and Nikki™ solve problems by building, making, and experimenting with various things in the story, you can build, make, and experiment alongside them.

Most of the materials you will need are included in the kit. Some additional items are required. These are always listed in *italic type* at the beginning of each experiment.

The models are assembled step by step using a plastic construction system. It will require a little practice and patience at first. Please assist your children when they need your help, but also let them try to build the models by themselves. Your children will be happy to have your help with the models or assembly steps that pose particular difficulties.

The colorful, snap-together plastic building pieces make it easy for small hands to put the models together and then take them apart for the next model. Use the yellow part separator tool to remove stubborn pins and plugs from holes.



We wish you and your child lots of fun building, discovering, and learning!

Safety Information

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 the packaging and instructions as they contain important information.

Store the experiment material and assembled models out of the reach of small children.

If the plastic components should get wet, please dry and clean them thoroughly before the next use.

Clean all equipment after use.

Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.

Do not eat or drink in the experimental area.

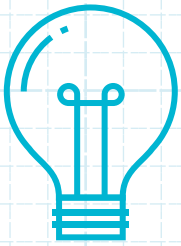
For experiments involving foodstuffs: Do not replace foodstuffs in original container. Dispose of immediately.

What is STEM?

STEM is an acronym that stands for science, technology, engineering, and mathematics. As with the humanities, including language, literature, art, and history, it is important for everyone to have at least a baseline education in STEM disciplines. Some people will choose to go on to study one or more of these fields in depth and pursue a STEM-related career. If you find this kit exciting, we encourage you to try other STEM kits, programs, and classes.

Barbie™ STEM KIT

SCIENCE SAVES THE DAY!



Project Checklist

Check off the projects as you complete them.

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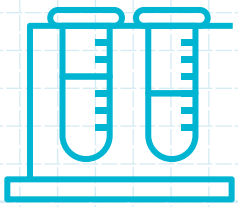

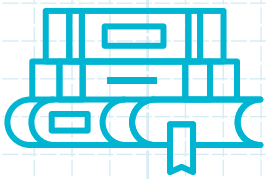

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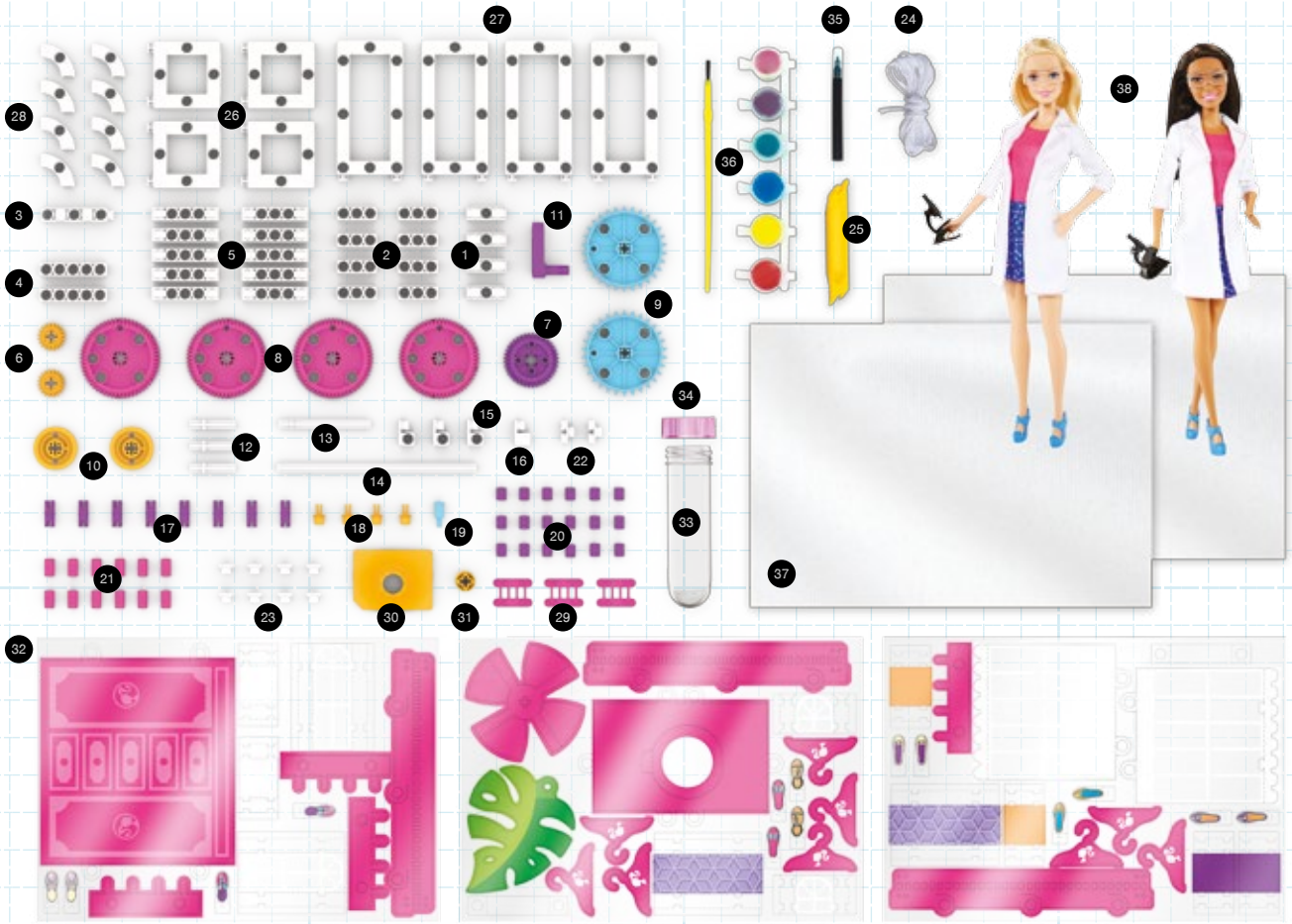
Kit Contents



✔	No.	Description	Quantity	Item No.
❍	1	3-hole cross rod	4	7026-W10-X1W1
❍	2	3-hole rod	8	7026-W10-Q2W1
❍	3	5-hole dual rod B	1	7026-W10-S2W1
❍	4	5-hole rod	2	7413-W10-K2W1
❍	5	5-hole cross rod	10	7413-W10-K3W1
❍	6	Small gear	2	7026-W10-D2O1
❍	7	Medium gear	1	7346-W10-C1P1
❍	8	Large gear	4	7026-W10-W5K
❍	9	Large sprocket	2	3569-W10-C1B1
❍	10	Medium pulley wheel	2	7344-W10-N2O
❍	11	Crank	1	7063-W10-B1P
❍	12	Axle (35 mm)	3	7413-W10-O1W
❍	13	Axle (70 mm)	1	7061-W10-Q1W
❍	14	Axle (150 mm)	1	7026-W10-P1W
❍	15	90-degree converter X	3	7061-W10-J1W1
❍	16	90-degree converter Y	1	7061-W10-J2W1
❍	17	Joint pin	8	1156-W10-A1P
❍	18	Shaft plug	4	7026-W10-H1O
❍	19	Shaft pin	1	7026-W10-J3B

✔	No.	Description	Quantity	Item No.
❍	20	Short anchor pin	18	7344-W10-C2P
❍	21	Anchor pin	12	7061-W10-C1K1
❍	22	Two-to-one converter	2	7061-W10-G1W1
❍	23	Button pin	8	7061-W10-E1W1
❍	24	String (100 cm)	1	R39#1301
❍	25	Part separator tool	1	7061-W10-B1Y
❍	26	Rounded square frame	4	3941-W10-B1W
❍	27	Rounded short frame	4	3941-W10-A1W
❍	28	Rounded curved rod	8	3941-W10-C1W
❍	29	Belt connector	3	3941-W10-D1K
❍	30	Smart furniture adapter A	1	3941-W10-E1O
❍	31	Smart furniture adapter B	1	3941-W10-E2O
❍	32	Die-cut plastic sheets (Set of 3)	1	K41#3941-US
❍	33	Test tube	1	717120
❍	34	Test tube lid	1	717949
❍	35	Black felt-tip marker	1	714020
❍	36	Set of 6 paint colors and brush	1	717947
❍	37	White cotton fabric sheet	2	717948
❍	38	Barbie or Nikki scientist doll	1	718061

For some experiments, you will also need: *scissors, bowl or plastic tub, water, two hardcover books, paper clips, tape, paper towel, seam sealant (optional), measuring cup, food coloring, spoon, 6 drinking glasses or cups, baster, sugar, a few coins, plant leaves, paper plate or paint palette, newspaper, pin or clip, fresh white carnation (or a stalk of celery), double-sided tape*

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

US: techsupport@thamesandkosmos.com

UK: techsupport@thamesandkosmos.co.uk

Spinning Closet Rack

THE STORY BEGINS . . .

"Hey Barbie, I'm here!" Nikki called out from Barbie's front door. She waited a moment, but there was no reply. "Barbie? Where are you?"

"I'm up here. Come quick!" Barbie called from upstairs. Her voice sounded faint.

Nikki raced upstairs. She looked in the bedroom and the den but couldn't find Barbie. She checked the closet and was about to move on when she did a double take.

Barbie was sitting on the floor of her closet buried in a pile of clothes.

"This is a new look for you," Nikki smiled.

"Nikki, I am so glad you're here. I have to find something to wear to the Annual Animal Shelter Gala," Barbie said. "I can't find anything!"

"That's not surprising," Nikki teased, reaching out a hand to help Barbie stand up.

"I know," Barbie sighed. "I just don't have enough space."

The floor was covered in shirts, pants, flip-flops, horse-riding boots, soccer uniforms, and even a couple of ballet tutus. Barbie was ready for anything, except the Gala.

"If only there were a better way to sort through all this," said Nikki.

Barbie looked up excitedly.

"That's it! Nikki, you're a genius," said Barbie. "There is a better way! I just need a pen and some paper." Barbie grabbed a pen from her bag and started sketching.

Nikki saw Barbie's idea coming to life on paper and started sketching some of her own.

Spinning Closet Rack

"Here's my solution." Barbie showed the sketch to Nikki. "It's a spinning closet rack. It doubles the usable hanging space, and it rotates so the clothes come back around."

"Sounds like a fun project. Let's build it!" Nikki beamed.

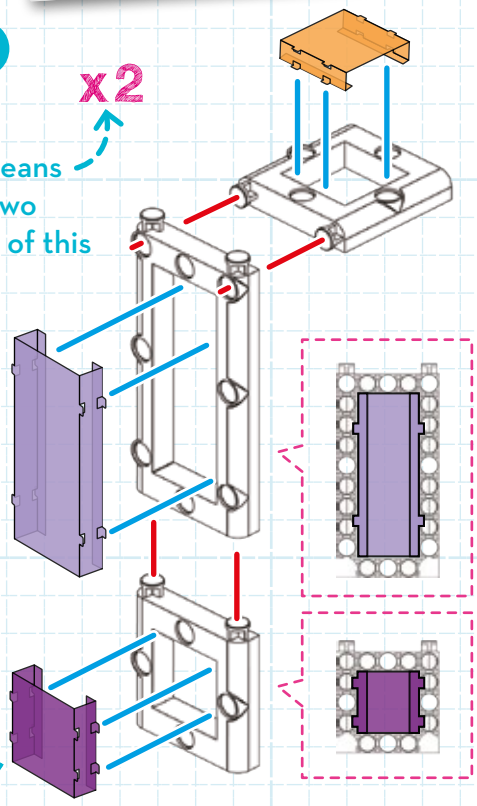
BUILD

Help Barbie and Nikki build the spinning closet rack. Follow the assembly steps in order. The lines drawn between parts show you how the parts go together.

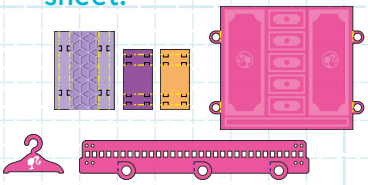
1

x2

This means build two copies of this step.



These parts are from the die-cut plastic sheet.



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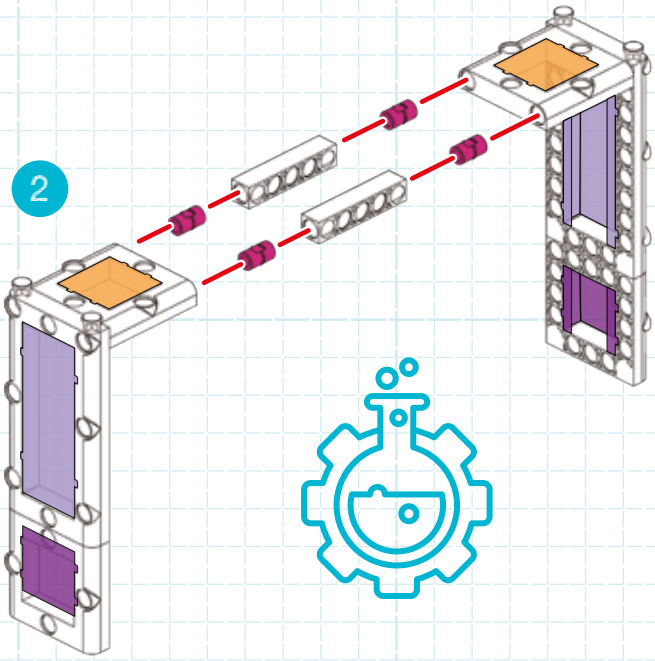
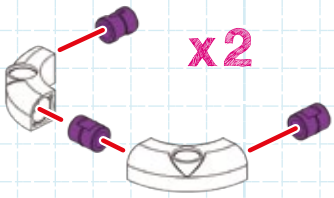


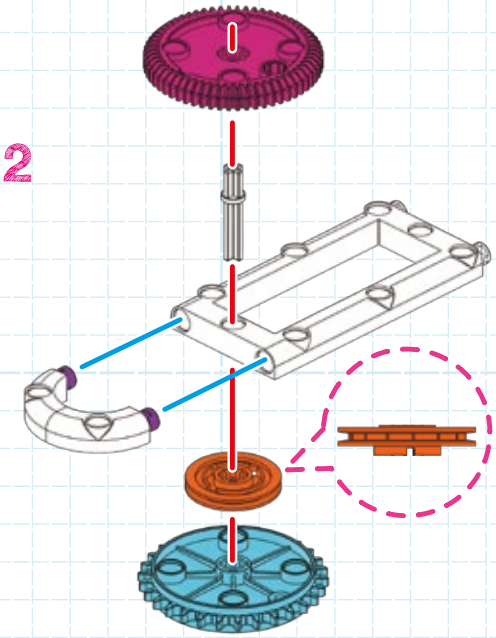
3

x2



4

x2



Spinning Closet Rack

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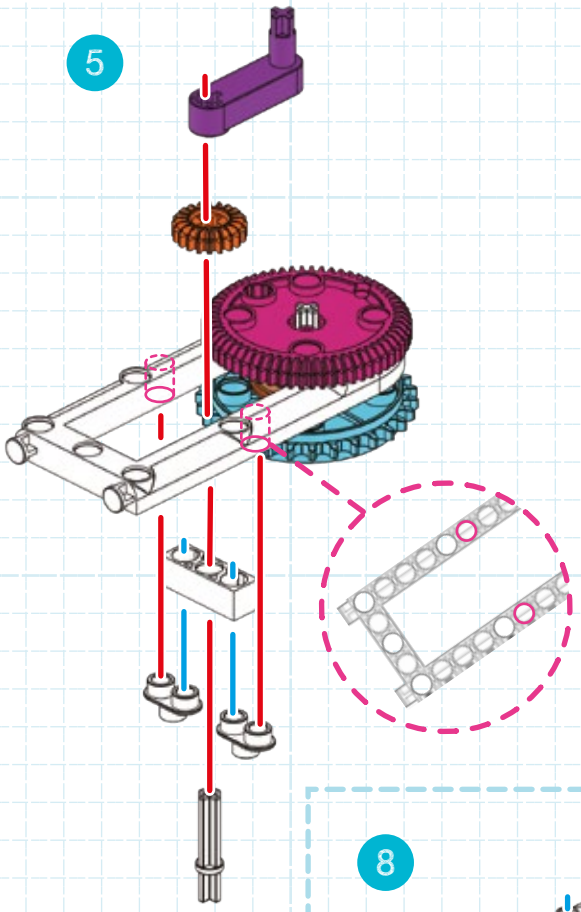

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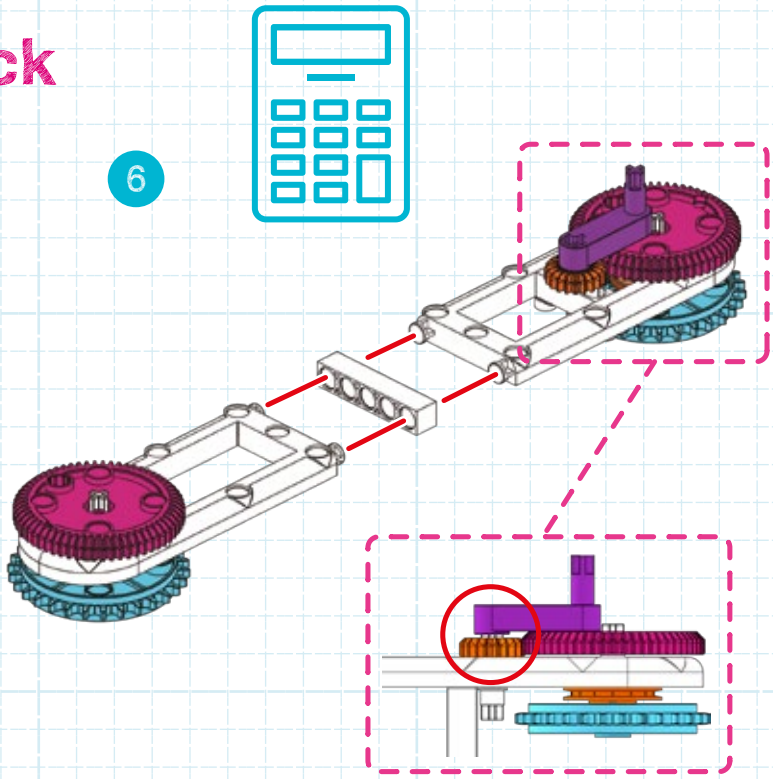

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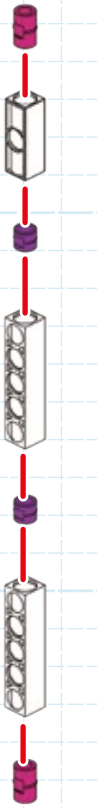
x4



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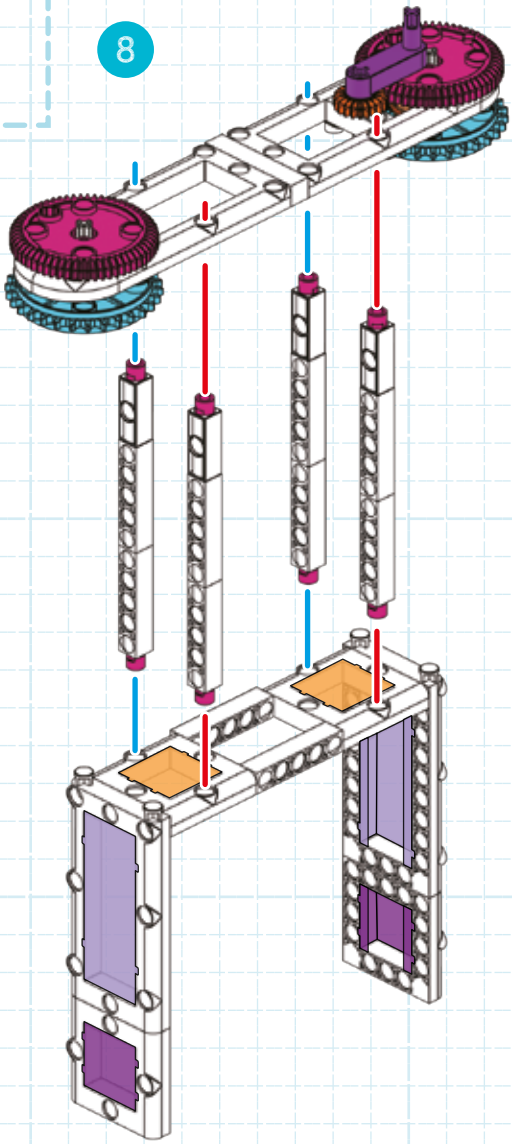

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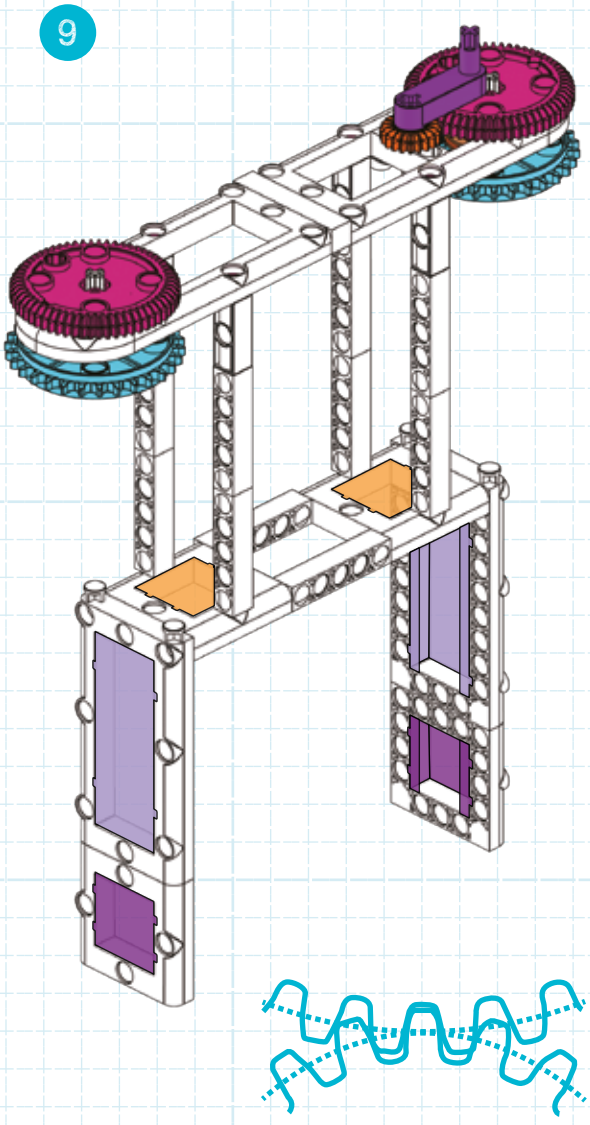
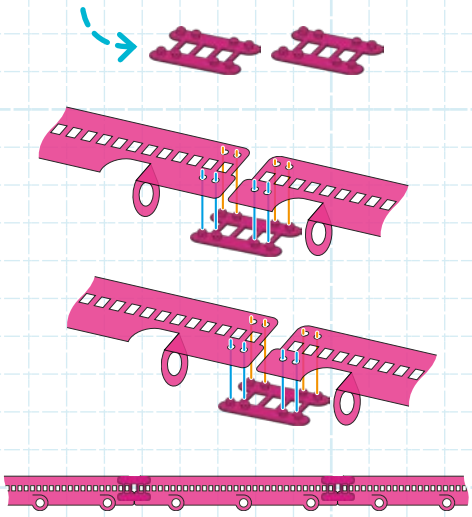


Spinning Closet Rack

This symbol means mirror this step on the other side of the model.

10 Connect the belts with these connectors.



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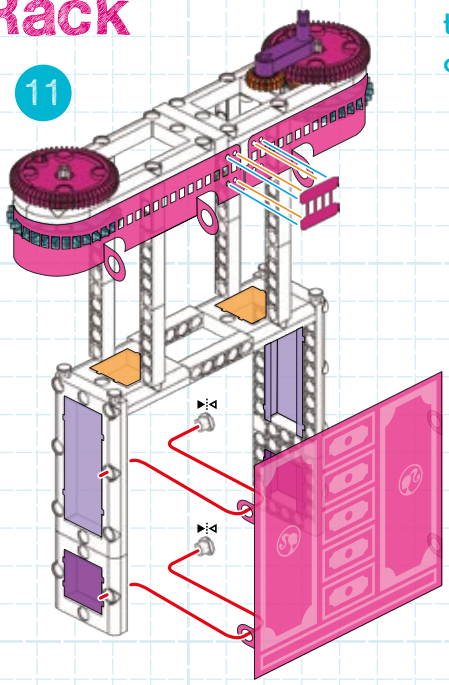

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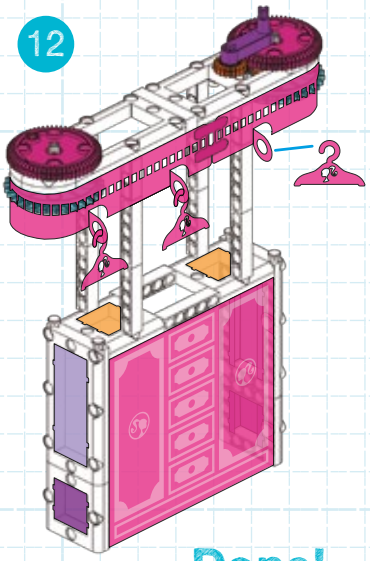


Done!

When they were finished building the spinning closet rack, Nikki tested it by turning the crank.

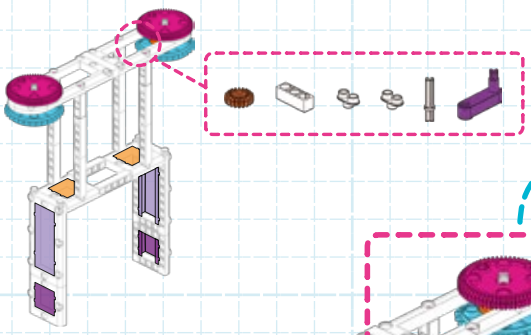
"Hmm . . . it turns kind of slowly," Barbie remarked.

"I think I know how to make it go faster," said Nikki.

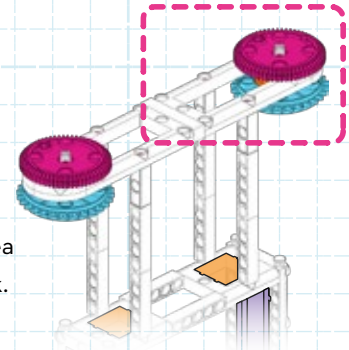
EXPERIMENT

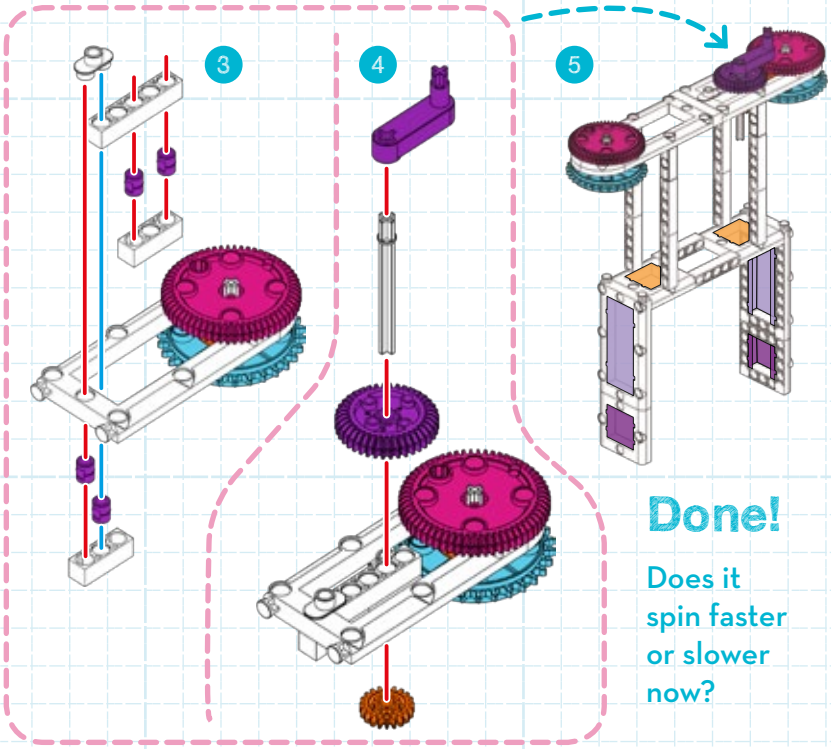
Do you have an idea for how to make the closet rack spin faster? Try this!

1 Remove these six pieces from the model.



2 Complete the following two steps in the area outlined in pink.





Done!

Does it spin faster or slower now?

Spinning Closet Rack

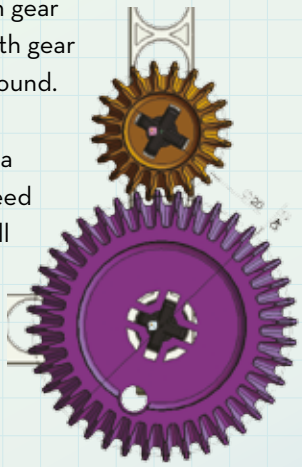
"If we change the positions of the large and small gears, every turn of the crank will make the dress rack turn more," Nikki explained.

"Thank you, physics class!" Barbie said as she picked up a gear. "Nice work!"

WHAT'S HAPPENING?

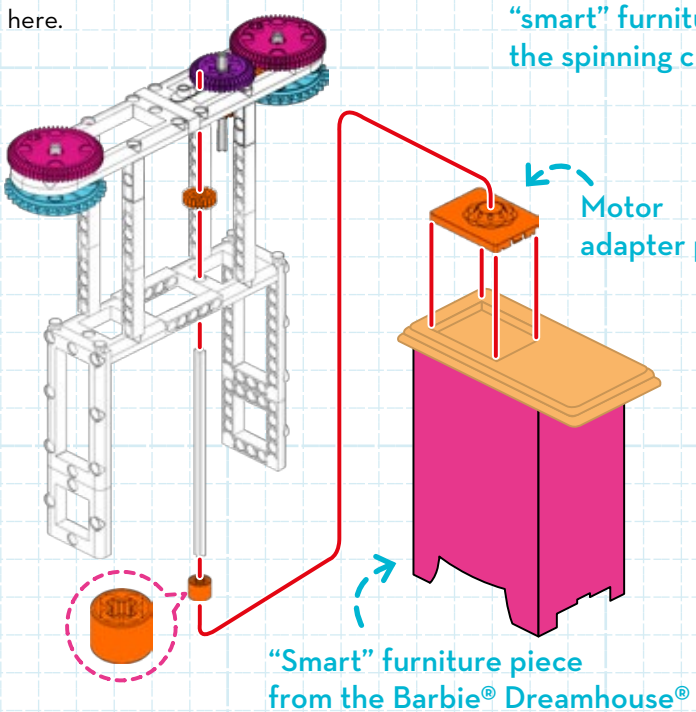
Why is it harder to carry a heavy box up the stairs while running than walking? That is because it requires more power to move the box when you are running. Power in physics means the amount of work that is done over time. Gears are used in many different devices to transfer power. A gear is a rotating wheel that is connected to an axle and has teeth or cogs. One way gears transfer power is to cause another gear to spin faster or slower. In the spinning closet rack model, when you turn the small 20-tooth gear around once, the large 60-tooth gear only turns a third of the way around. In the rebuilt model that moves faster, when you turn the medium 40-tooth gear around once, the large 60-tooth gear turns two-thirds of the way around. You doubled the speed!

When a large gear turns a small gear, it increases the speed of the small gear. When a small gear turns a large gear, it decreases the speed but also increases the torque, or turning force, of the large gear.



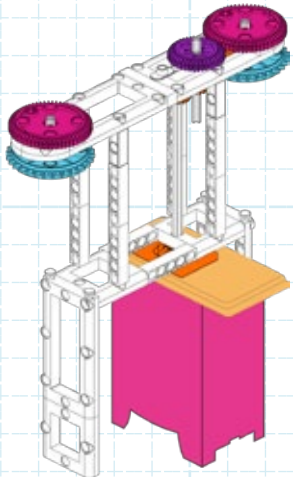
BONUS EXPERIMENT

1 Remove the die-cut plastic panels and the crank. Then attach the parts shown here.



If you have a Barbie® Dreamhouse® like this, you can use the included "smart" furniture piece to motorize the spinning closet rack! Here's how!

2 Press the button on the "smart" furniture piece to turn on the motor.



The motor inside the furniture piece turns the axle, which turns the gears at the top of the spinning closet rack. These gears make the hanger belt go around!

Chromatography Dress

After all of Barbie's clothes were organized on the spinning closet rack, she and Nikki started to look for a dress for the Gala.

"This is so much better," Barbie said, gesturing to the spinning closet rack. "I owe you!"

"Well, I still need a dress for the Gala, too. I was hoping you had something I could borrow," Nikki grinned at the filled rotating closet.

"I think I might have something that will work," Barbie said, laughing.

But try as they might, they couldn't find the perfect dresses.

"I know! Why don't we make our own," Barbie suggested. "I have black dye and white fabric. We could make a black cocktail dress."

"I would love something more colorful," Nikki replied.

"Me too. I know! Remember in chemistry class when we learned about chromatography?"

"You mean the lab where we separated colors and made those cool designs?" asked Nikki.

"Exactly! We can separate the black dye into other colors. We'll have the most unique dresses at the Gala. I can see the gorgeous patterns now!"

"Let's do it," Nikki replied.

EXPERIMENT

Help Barbie and Nikki make a chromatography dress.

You will need: Fabric sheet, black marker, string, *bowl or plastic tub, water, two hardcover books, paper clips, tape, paper towel, scissors, seam sealant (optional)*

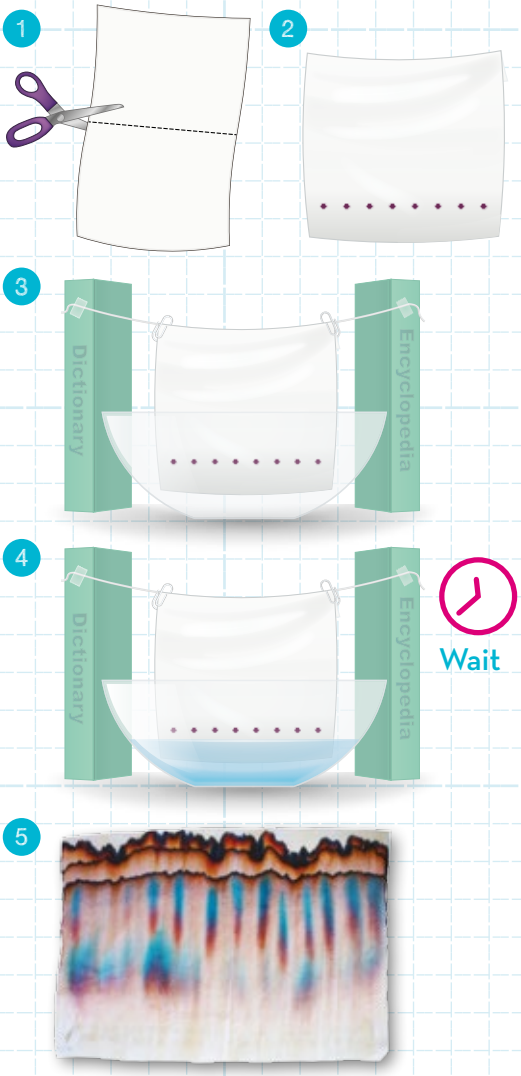
1. Cut the fabric sheet in half as shown.

2. Use the black marker to draw a row of dots about 1 centimeter above the bottom edge of the fabric. Place the dots about 1–2 centimeters apart along the bottom edge of the fabric. Make the dots very dark by tracing over them a few times.

3. Stand the books up on either side of the bowl as shown. Hang the string from book to book over the bowl, and secure it with tape. Hang the fabric sheet from the string with paper clips as shown. The bottom of the fabric should be 2–3 centimeters above the bottom of the bowl.

4. Fill the bowl with 2–3 centimeters of water. The water should touch the bottom edge of the fabric but not the ink dots. Observe the ink moving up the fabric. It may take a few hours for the ink to reach the top of the fabric. Let the experiment run until you see the ink colors separate and you are happy with the result. Remove the fabric, and let it dry on a paper towel.

5. Repeat this process several times on the same fabric until you are happy with the result. You can seal the edges of the fabric with a liquid seam sealant to keep them from fraying.

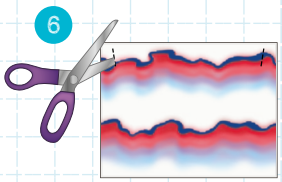


Chromatography Dress

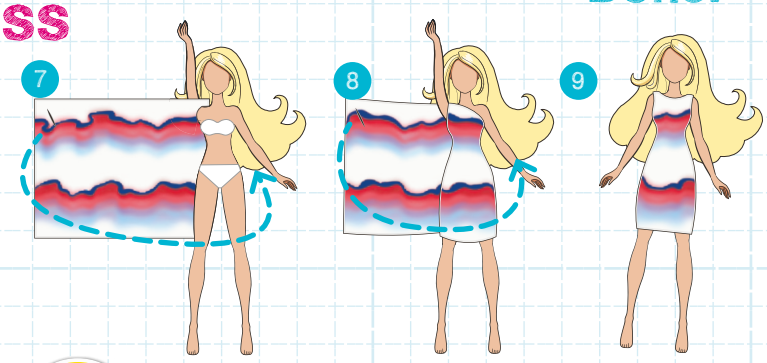
6 Cut small slits in the two upper corners of the fabric.

7 Insert the doll's arm into one of the slits and wrap the dress around the doll.

8 Insert the other arm through the other slit.



Adjust the wrap dress on the doll. You can belt it with a small strip of fabric.



"That looks so cool," Nikki said. "Let's do the same thing to our lab coats! We'll really stand out in chem class!"

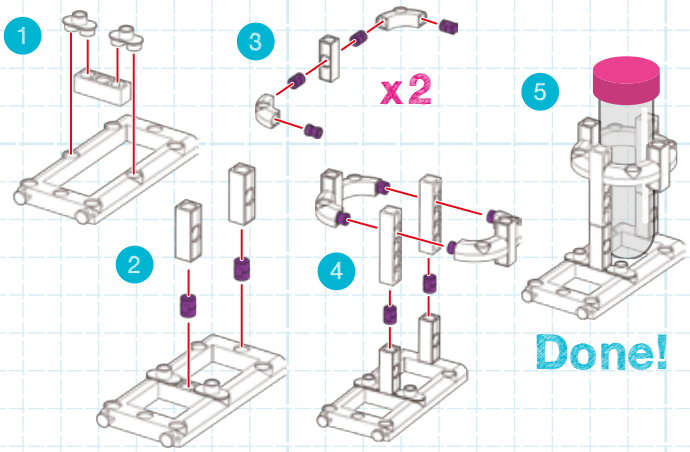
"These colorful gradients are really speaking to me. Maybe I want to wear a rainbow spectrum dress to the Gala," Nikki said.

"That would look really good. But how do you make a rainbow?" Barbie asked.

"One time, we made a rainbow in a test tube," Nikki answered. "Let's try it. We need some stuff from the kitchen."

BUILD

Help Barbie and Nikki make a rainbow in a test tube. First, follow these steps to build a test tube holder.



WHAT'S HAPPENING?

What happened to the ink from the marker in this experiment? A lot of materials appear to be uniform, but they are actually a mixture of different substances. In this experiment you saw that the ink from the black marker is actually a combination of different color dyes!

The method used in this experiment to separate the different dyes in the marker ink is called *chromatography*. Chromatography comes from the Greek words *chroma*, which means "color," and *graphein*, "to write." So when you are doing chromatography, you are writing in color!

Chromatography works by dissolving the substance that you want to separate, in this experiment the dyes in the marker ink, into what is called the *mobile phase*. The mobile phase is then passed through a stationary phase. In chromatography the mobile phase moves, just as the name suggests, while the stationary phase does not. In this experiment what do you think was the stationary phase? What part of the separation process did not move?

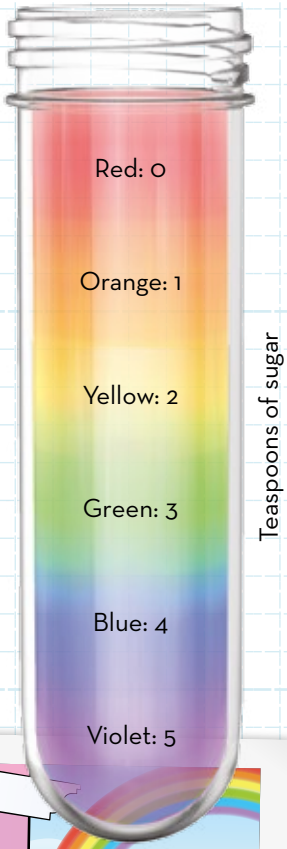
In this experiment the stationary phase was the cloth. When the water and ink pass through the cloth, the different dyes are separated because they are attracted to the cloth by different amounts. The dyes that have a strong attraction to the cloth do not move much, so they stay at the bottom edge of the cloth.

It may seem strange that the dye would be attracted to the cloth. But the water is actually able to move vertically up the cloth because it is pulled by its attraction to the cloth. This phenomenon is called *capillary action*.

Rainbow Colors

EXPERIMENT

Follow these instructions to make a rainbow in a test tube using solutions of different densities.



You will need: Test tube, test tube holder, *measuring cup, food coloring (red, yellow, green, and blue), spoon, 6 drinking glasses or cups, baster, sugar, water*

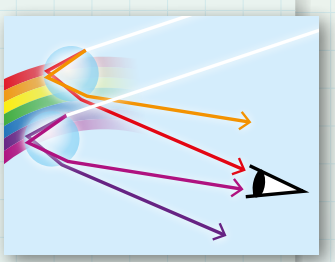
1. Put a half cup of water into each drinking glass.
2. Use the food coloring to color the water in the glasses red, orange, yellow, green, blue, and violet. For orange, mix red and yellow. For violet, mix red and blue.
3. Add teaspoons of sugar to the colored water according to the amounts listed in the diagram to the right.
4. Stir to dissolve the sugar in the water completely.
5. Use the baster to carefully put equal amounts of the solutions into the test tube in the following order: violet, blue, green, yellow, orange, and red. Add the liquid slowly, so as to disrupt the layers below as little as possible.
6. Observe the test tube. What happens to the colors?

WHAT'S HAPPENING?

Why did the rainbow form in the test tube? What is it about the liquids in this experiment that allows them to sit one on top of the others? The answer is density. *Density* is how compact a substance is, so the liquids that are denser are at the bottom of the test tube while the liquids that are less dense are on the top.

Density is the amount of matter, or "material," that is contained within a volume. Since the volumes of all the liquids in this experiment are the same, the amount of matter has to be different. The term for the amount of matter in an object is called the *mass* of an object.

How do rainbows appear in the sky? Just like the black ink, white light can also be separated into different colors. However, to separate light you can't use chromatography; instead a property called *dispersion* is used. Dispersion is the spreading out of the different colors of light as they pass through a different material. A rainbow is formed when light from the Sun hits droplets of water that are in the atmosphere.



Barbie and Nikki were examining the rainbow in the test tube when Barbie looked out the kitchen window and gasped.

"Amazing!" Barbie shouted in awe.

"It's a REAL rainbow!" Nikki added.

"Maybe it's a sign you should wear the rainbow dress," Barbie joked.

"I'm not sure how to turn the rainbow into a dress. I can't wear this test tube. And aren't rainbows in the sky just light shining through tiny water droplets?"

"That's true. Everything you see is just light shining into your eyes!" Barbie said.

"That gives me a new idea for the perfect dress!" Nikki announced. "Optical illusions!"

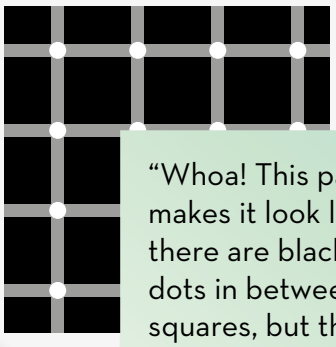
Optical Illusion Dresses

See the last six pages of this manual for the full-size optical illusion patterns.

Nikki looked up examples of optical illusions on her phone and showed them to Barbie.

"I like this one the best. It looks like it's swirling around, but it's not," Nikki said. "That would make an amazing dress pattern."

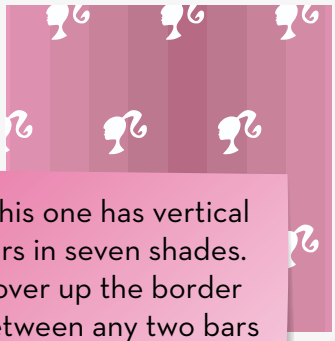
"And I like this one. The lines look slanted, but they're actually straight!" Barbie said. "See for yourself — hold a ruler up to one of the gray lines."



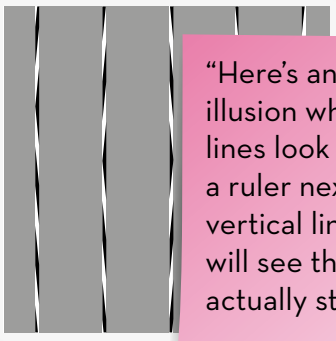
"Whoa! This pattern makes it look like there are black dots in between the squares, but there aren't!" Nikki said with amazement.

"This pattern looks like it's twirling, but of course it isn't actually moving."

"The colors are really deceiving in this one. The blue and the green look different, but they are the same! Fold the paper to compare them side by side!"



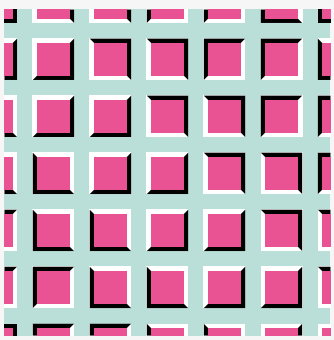
"This one has vertical bars in seven shades. Cover up the border between any two bars with your finger, and it looks like the two bars are the same color."



"Here's another illusion where straight lines look bent. Hold a ruler next to the vertical lines, and you will see that they are actually straight!"

"I love this one. It looks like the pattern is moving inward toward the center."

Barbie and Nikki looked at different patterns for a while and then started making the dresses.



"This pattern is cool! It looks all wavy, like the pattern is rippling."

Optical Illusion Dresses

EXPERIMENT

Help Barbie and Nikki make the optical illusion dresses. Cut the paper sheets from pages 27-32.

Key

- New fold/crease
- Fold, then unfold
- Flip to other side
- Permanent fold
- New position
- Back side of paper
- Old position
- Front side of paper

1. Cut out a square piece of paper.
2. Fold in half and unfold.
3. Fold in half the other way and unfold.
4. Fold sides into center and unfold.
5. Flip over.
6. Fold the two vertical creases to the midline.
7. Flip over.
8. Fold the top edge to the bottom.
9.
10. Fold the bottom edge upward, along a new line.
11. Flip over.
12. Fan the bottom corners outward.
13. Flip over.
14. Fold these small corners inward along diagonal lines and unfold.
15. Fold to make a diamond.
16. Fold corners diagonally.
17.
18. Fold sides in to midline.
19.
20. Fold inner corners down.
21. Flip over.
22. **Done!**

Try making dresses from all of the optical illusion patterns.

WHAT'S HAPPENING?

Optical illusion patterns use colors and shapes to trick your brain into thinking you are looking at something different than what is really printed in the pattern.

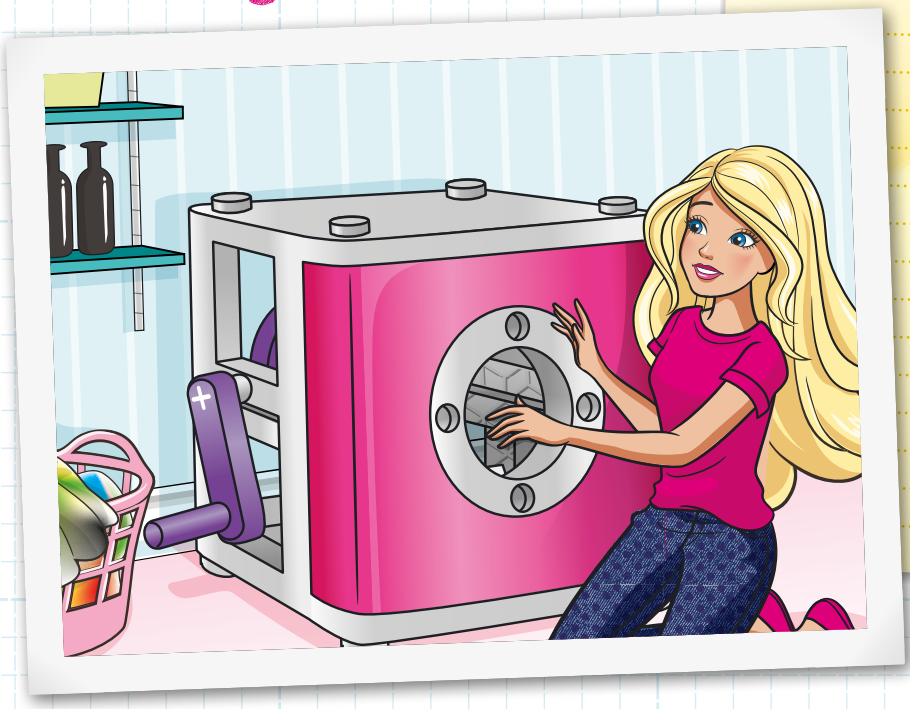
Your eyes gather light, which they turn into electrical signals, which are then sent to your brain for processing. Because of the way your brain and eyes process images and light, what we see doesn't always match reality. Your brain and eyes use the context of an image, or what is around the image, to perceive and understand an image. By altering the context in different ways — such as those you can see for yourself in the optical illusion patterns in this manual — optical illusions are made.

"I'm going to wear this dress to the Gala," Nikki stated, twirling around in her beautifully patterned dress. "I just hope the optical illusions don't make anyone dizzy."

"It's such a unique dress. It will be a great conversation starter," Barbie said. "We've found your dress, but look at the mess we've made with these experiments!"

"If we work together, we'll have everything cleaned up in no time," said Nikki.

Washing Machine



Nikki and Barbie picked up the clothes and put them on the spinning closet rack.

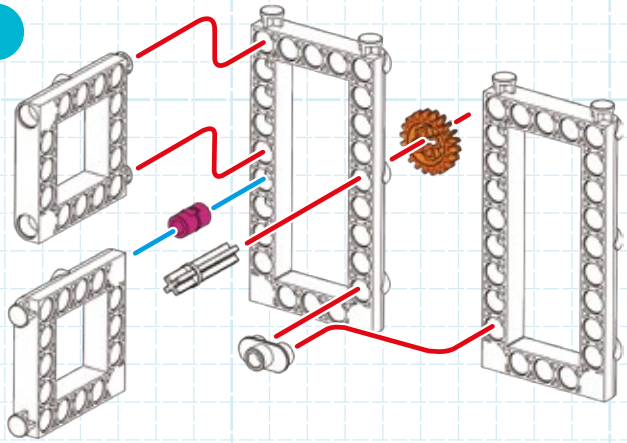
"The colors from our experiments got everywhere!" said Barbie. "I'm going to do a load of laundry. But first I need to fix the washing machine. Can you help?"

"Yes, I'd love to help. What seems to be the problem?" Nikki said.

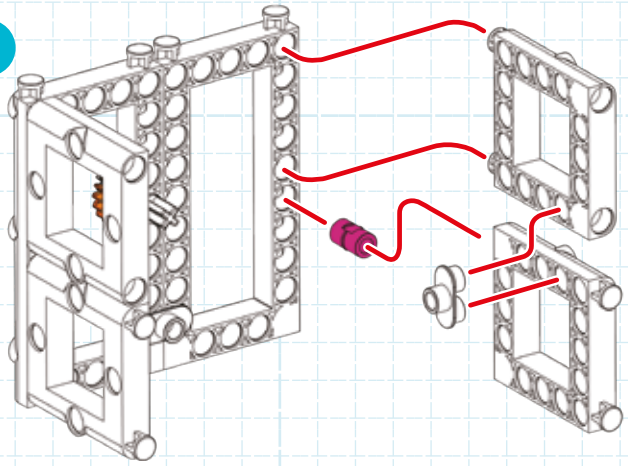
BUILD

Help Barbie and Nikki fix the washing machine. First, assemble it by following these instructions.

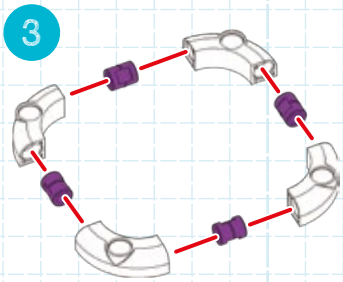
1



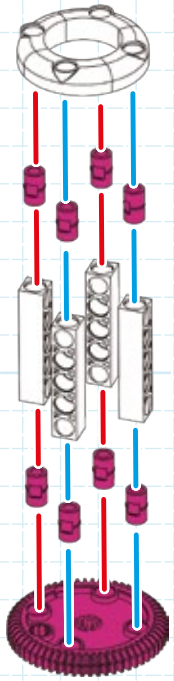
2



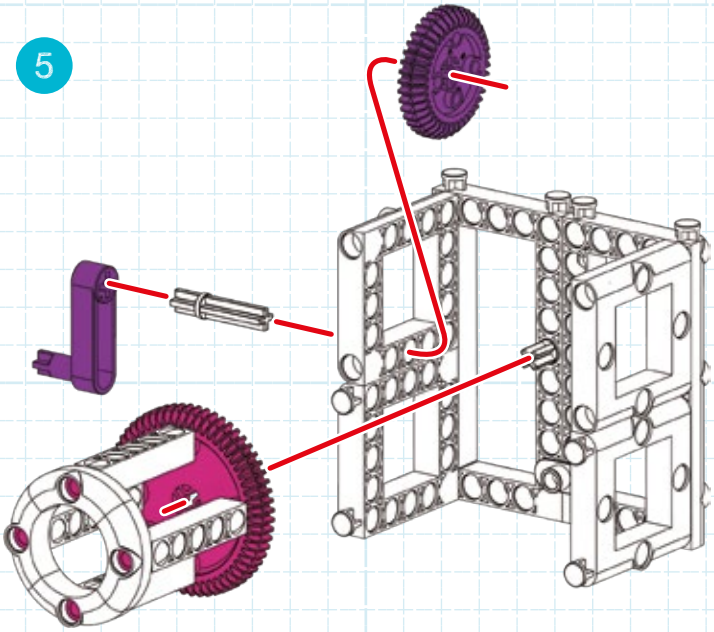
3



4

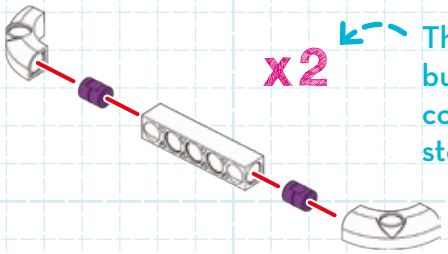


5



Washing Machine

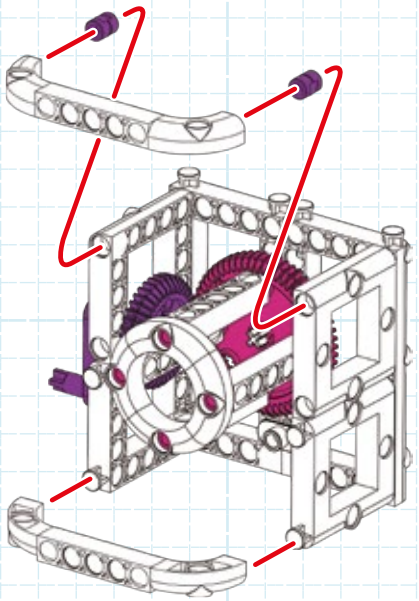
6



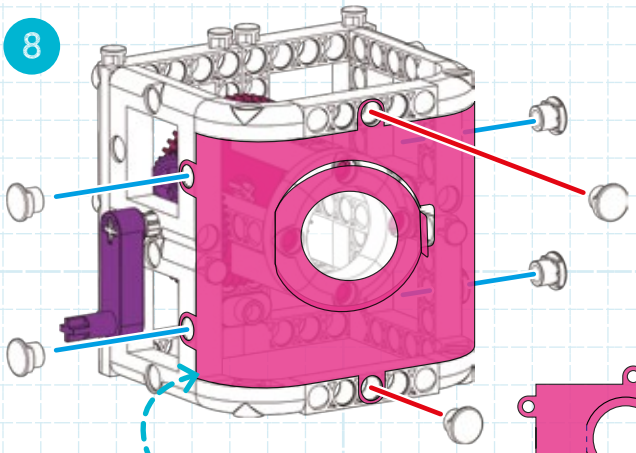
x2

This means build two copies of this step.

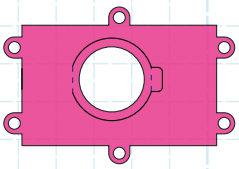
7



8



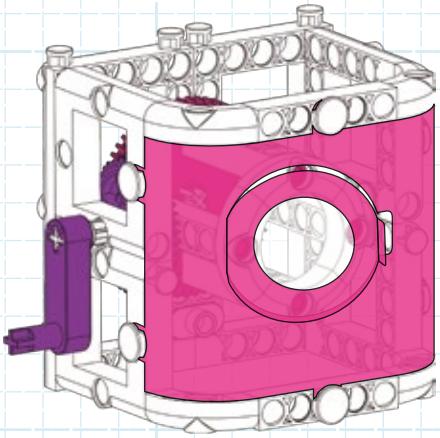
This part is from the die-cut plastic sheet.



9

Done!

What happens when you turn the crank?



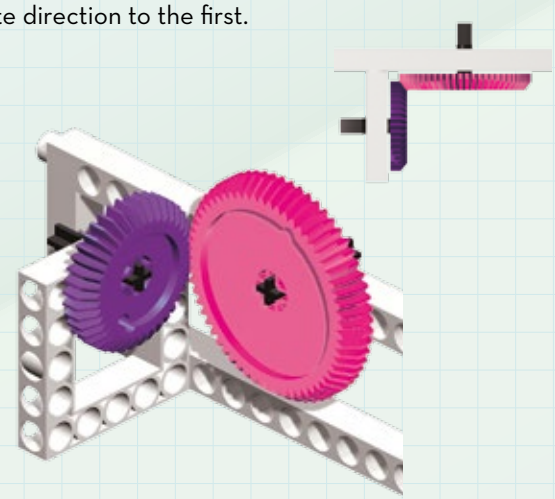
"Hmm . . . the washing machine seems to be running a little slowly," said Nikki, pointing to her clipboard. "Let's change the gearing and the location of the crank to make it faster."

"Good idea," responded Barbie. "Hopefully this means it will be done in half the time!"

They changed the gearing in the washing machine and tested it. It ran faster. Barbie and Nikki high-fived.

WHAT'S HAPPENING?

How do angled gears work? In addition to transferring power between gears, gears can also change the direction that an axle rotates. In the washing machine, turning the hand crank causes the axle of the large gear in the back to spin at 90 degrees to the axle of the hand crank. Gears that are at an angle to one another are called *bevel gears*. When two gears are meshed together, the second gear turns in the opposite direction to the first.

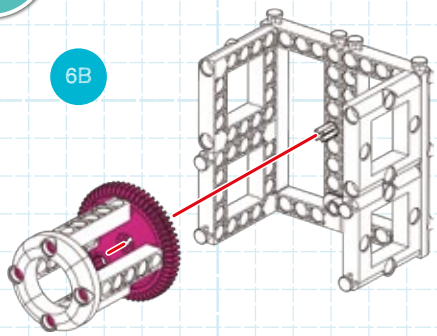


Washing Machine

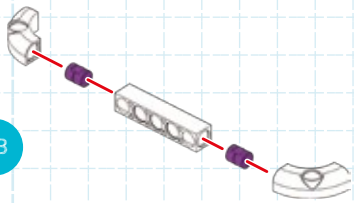
EXPERIMENT

Help Barbie and Nikki change the gearing on the washing machine. Keep the model the same as before for steps 1-5 and start with alternate step 6B.

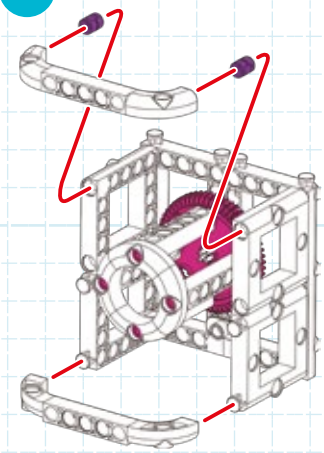
6B



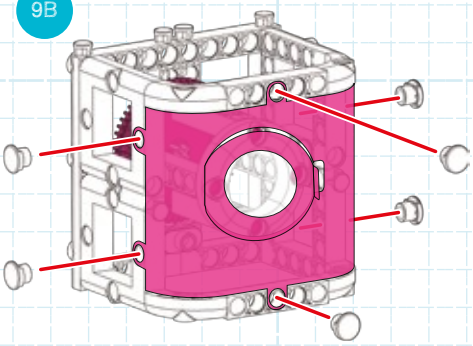
7B



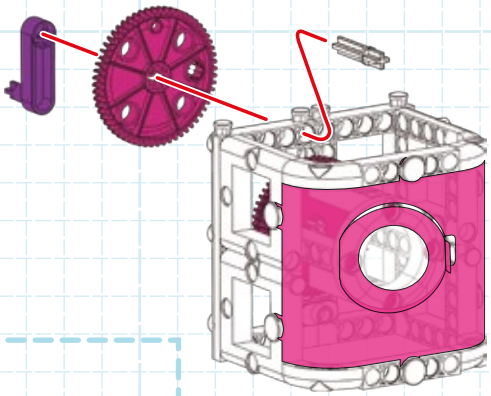
8B



9B

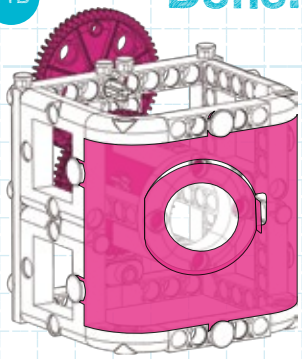


10B



11B

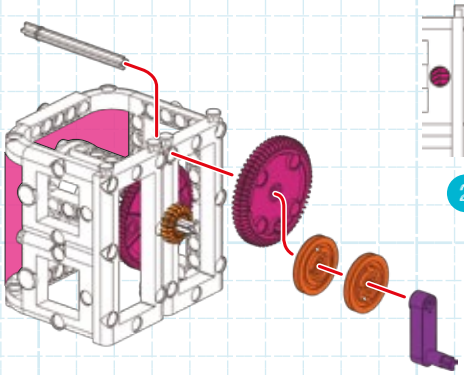
Done!



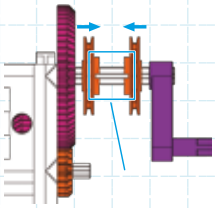
Compare the speed of the second model to the speed of the first. Which turns faster?

BONUS EXPERIMENT

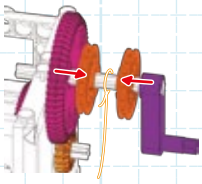
You can also use this gravity motor to run your washing machine automatically.



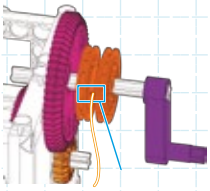
1 Reconfigure the model as shown here. Two pulley wheels are added.



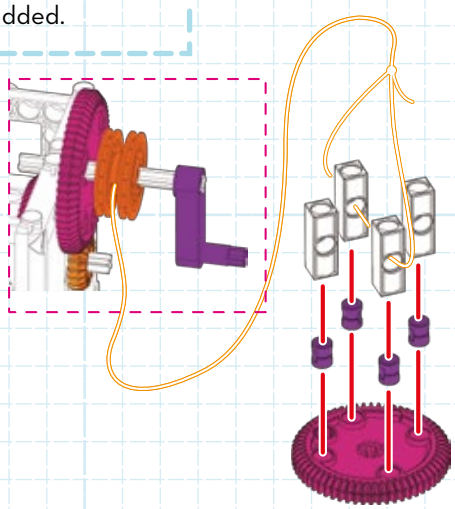
2 Make sure to align the two notches in the pulley wheels.



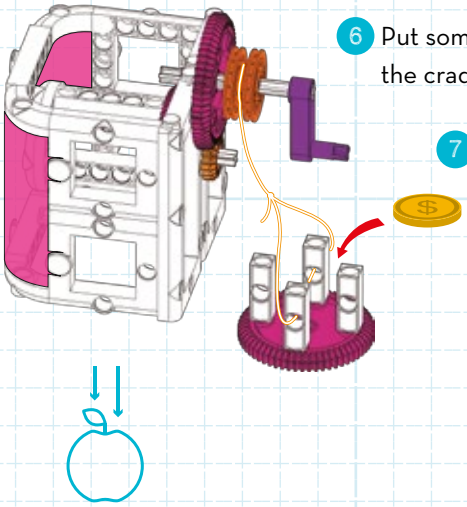
3 Tie the string around the axle.



4 Slide the pulleys together so the string comes out of the hole where the two notches meet.



5 Build the weight holder and tie the other end of the string to it as shown.



6 Put some small weights into the cradle, such as coins.

7 Hold the washing machine at the edge of a table. Wind the string all the way up with the crank. Let the weight drop off the edge of the table. What happens?

Rotating Shoe Rack

Back in the closet, Barbie and Nikki stared at a mountain of shoes and shoe boxes.

"You must walk a lot," Nikki said. "And run and dance and horse ride. You have a pair of shoes for everything!"

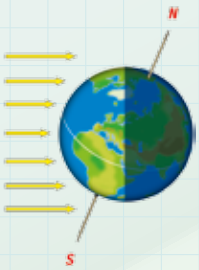
"It's a lot, but I wear all of them. If only it were easier to find the right pair when I needed them," said Barbie.

"Come on. We can organize these shoes with a shoe rack – even better, a rotating shoe rack," Nikki said.

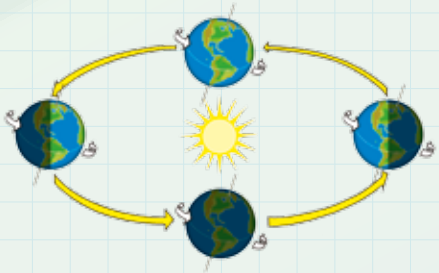
"That sounds great!" said Barbie. "What's the plan?"

WHAT'S HAPPENING?

What causes day and night? Since the Earth is round, the light from our Sun only illuminates one side of the planet at a time. The side that the sunlight is hitting is experiencing day, while the other half is experiencing night. So, why isn't one side of the Earth always day and the other side night? Because the Earth is actually spinning like a top around an imaginary line called an *axis*! This spinning motion, called *rotation*, is the reason that the Sun rises in the east and sets in the west. One rotation of the Earth around its axis is a day.



What causes the seasons? The axis that the Earth is spinning on is not straight up and down but tilted. So at one time half of the Earth, known as a *hemisphere*, is tilted toward the Sun while the other is tilted away from the Sun. The half that is tilted toward the Sun experiences summer, and the half that is tilted away experiences winter. The movement of the Earth around the Sun in an ellipse, called a *revolution*, is what causes the seasons to change. One revolution is equal to one year.



"Well, the rack would rotate by season. The same way the Earth rotates around the Sun and makes our seasons change," said Nikki.

"Because the Earth is tilted toward the Sun, right?" asked Barbie.

"Exactly! When the top half of the Earth is tilted towards the Sun, it's summer in the top half. At the same time, the bottom half is tilted away from the Sun, so it's winter in the bottom half," explained Nikki. "Then the Earth rotates around the Sun, and the seasons switch."

"That makes sense. But how does that work on a shoe rack?" Barbie asked.

"Summer shoes will be in front in the summer, and winter shoes will be in the back. Then we'll rotate the rack when the seasons change."

"I think I got it," Barbie smiled. "Let's start building."

Rotating Shoe Rack

BUILD

Help Barbie and Nikki build the rotating shoe rack.

1

x4

2

x4

3

x2

4

5

1

6

7

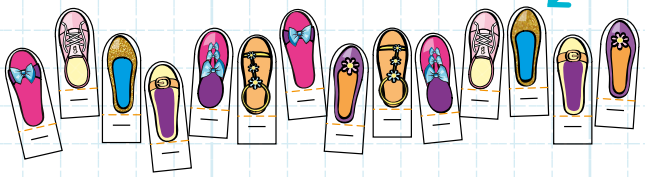
The shoes go on the tabs.

Done!

WHAT'S HAPPENING?

What is a gear train? When two or more gears work in a sequence they are called a *gear train* or *transmission*. Transmissions are often found in cars, which takes the power from the engine and transfers it to the wheels. The advantage of having a transmission is that it gives a wide range of different gear ratios, which are useful in different situations. For example, when you are riding a bicycle up a hill, it is easier to use a smaller gear and spin faster, and on a flat surface it is easier to use a larger gear and spin slower.

Can you organize the shoes in pairs on the rack so that the rack rotates in the correct order when you turn the crank? Spring, Summer, Fall, Winter!



Greenhouse with Fan

"Okay, we've organized a year's worth of shoes, but I still don't know what I'm going to wear to the Gala," Barbie sighed.

"How about a botanical print? Something floral?" suggested Nikki.

"Oh, that might work! Let's go to the greenhouse to find some inspiration."

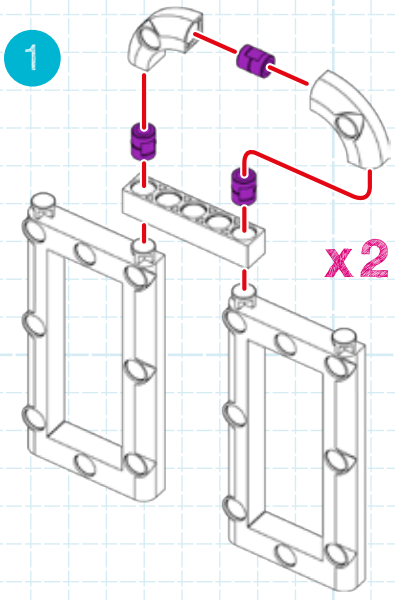
In the greenhouse, Barbie noticed that the leaves on some of the plants looked wilted.

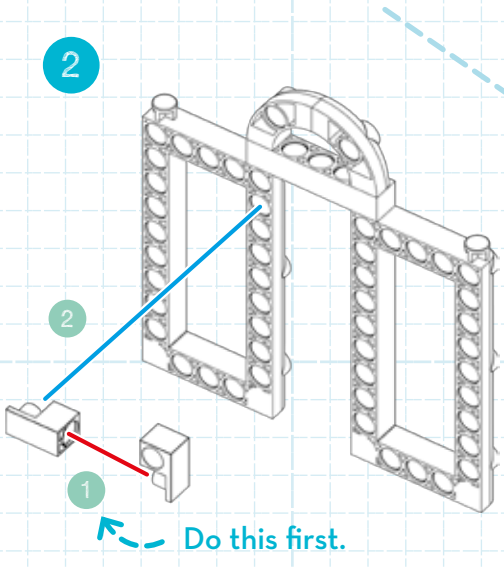
"I think it's too hot in here," Barbie said. "We need to build a fan to cool it off. The fan will blow the warm air out and cooler air in."

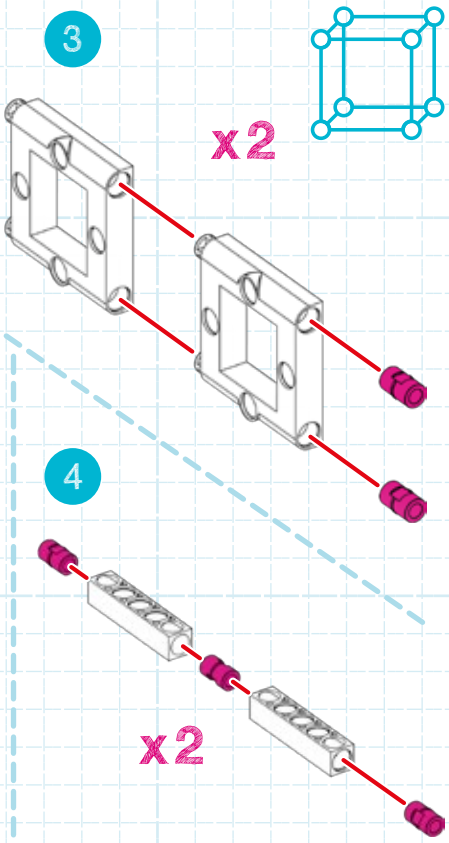
She started to sketch designs for the fan.

BUILD

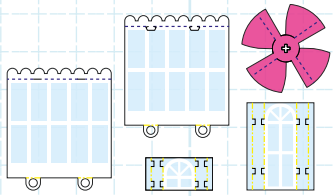
Help Barbie and Nikki build the greenhouse with spinning fan.





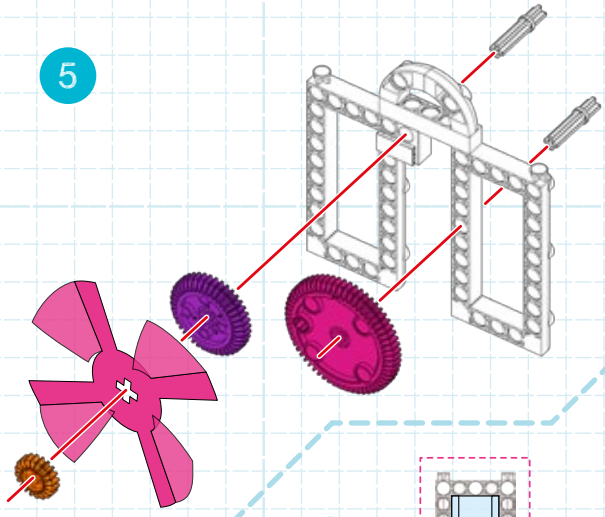


Greenhouse with Fan



These parts are all from the die-cut plastic sheet.

5



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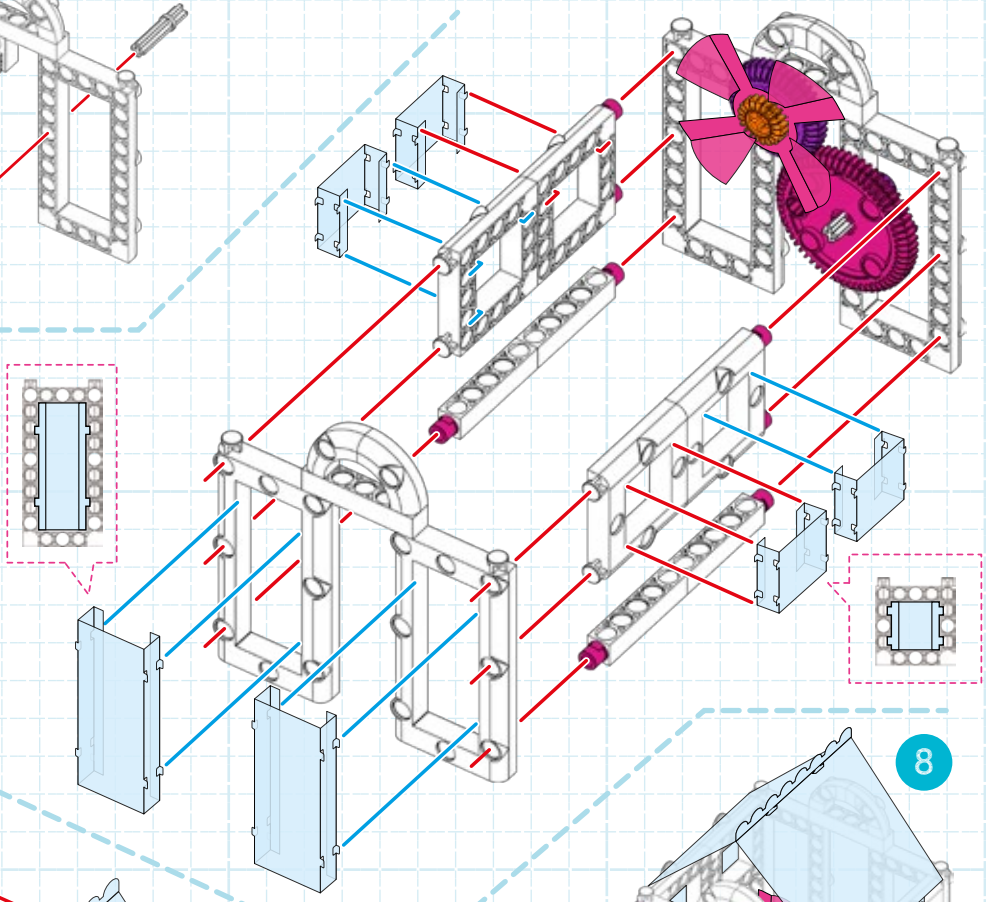

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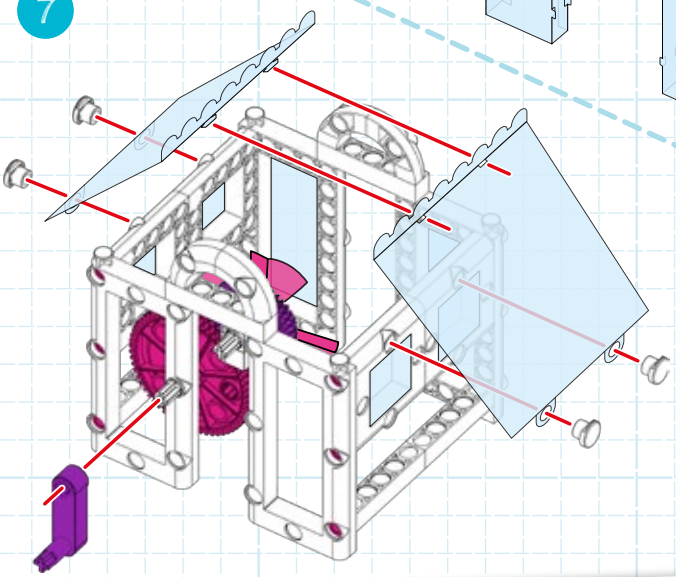

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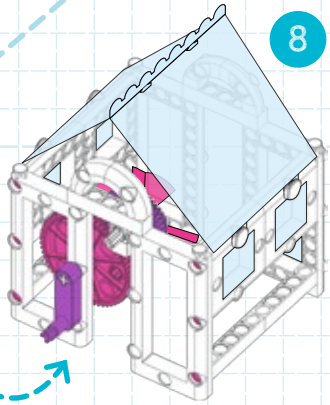
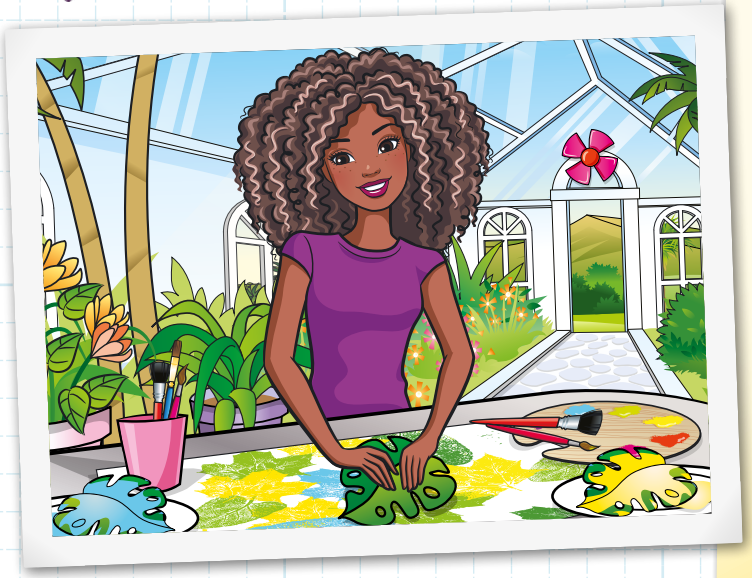


Done!

What happens when you turn the crank?



The fan cooled down the greenhouse in no time.

"Much better!" Barbie exclaimed.

"Yes, and I have an idea for your dress," Nikki said. "Let's make a leaf-print dress. These leaves all have such pretty patterns on them. It's the veins that take water and nutrients from the stem to the tips of the leaves. We can use the leaves to print these patterns onto fabric with paint, and then we can make a dress out of the fabric."

"I love it," said Barbie.

They gathered a bunch of leaves from the greenhouse and the garden and started making the leaf-printed fabric.

Leaf-Print Dress

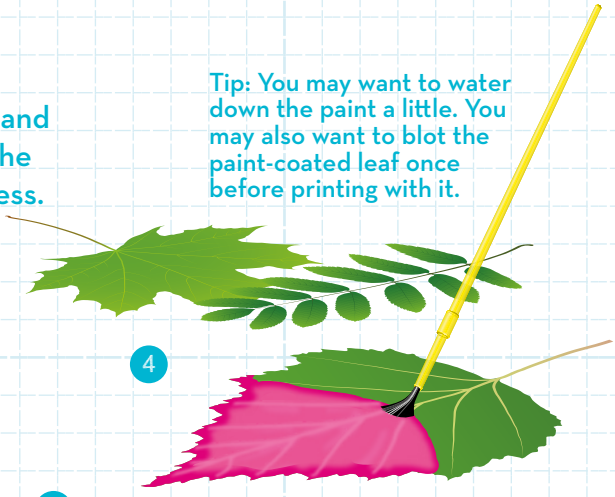
EXPERIMENT

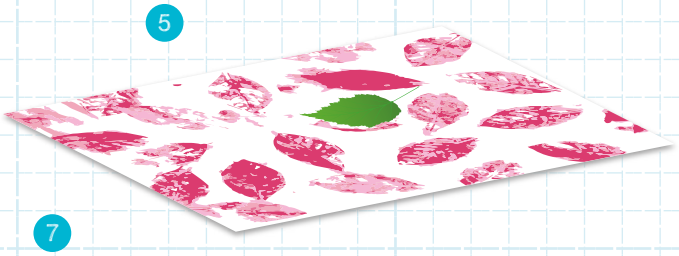
Help Barbie and Nikki make the leaf-print dress.

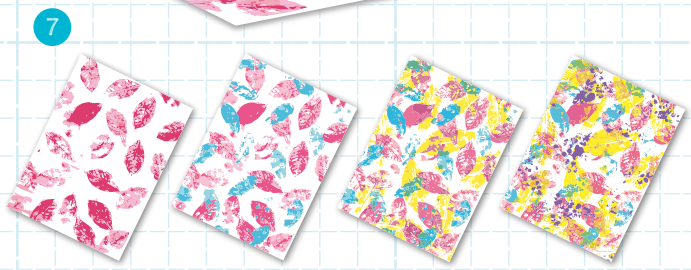
You will need: Brush, set of paints, fabric sheet, *plant leaves, paper plate or paint palette, newspaper or paper towels, water, scissors, seam sealant (optional), pin or clip*

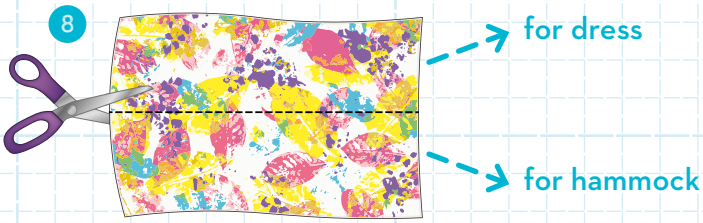
1. Gather some leaves of different shapes and sizes.
2. Cover a flat work surface in newspaper or paper towels. Wear clothing that you do not mind getting paint on, as the paint may stain. The paint is non-toxic. If you get any on your hands, it will wash off easily with water.
3. Choose and mix your first paint color. You can use the paper plate or palette to mix the paints to make different colors.
4. Paint one side of the leaf using the brush.
5. Immediately place the leaf paint side down on the fabric. Press the leaf firmly down onto the fabric, then peel it up again.
6. Continue painting leaves and pressing them onto the fabric until you are happy with the pattern you have created.
7. Repeat this process with additional paint colors, printing over some parts of the previous prints.
8. Cut the fabric sheet in half as shown. Save one half of the fabric for the hammock model.
9. The other half can be wrapped around the doll and clipped, pinned, or stapled in the back to form a dress as shown.

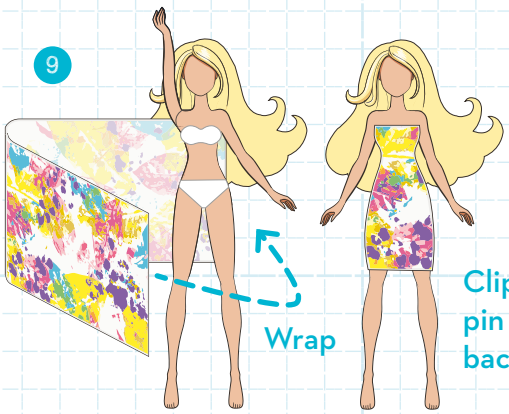
Tip: You may want to water down the paint a little. You may also want to blot the paint-coated leaf once before printing with it.









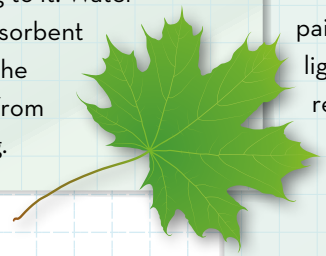


Tip: You can seal the edges of the fabric with a liquid seam sealant to keep them from fraying.

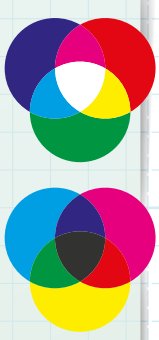
WHAT'S HAPPENING?

How does leaf printing work? Plants turn water, nutrients, and energy from sunlight into food through a process called *photosynthesis*. This happens in the leaves. The plant must transport the water and nutrients from the soil up to each cell in each leaf. The veins in the leaf are like pipes through which water and nutrients flow. The veins are often thicker than the rest of the leaf, so when you make a leaf print, the veins get pressed into the fabric more and leave more of an impression.

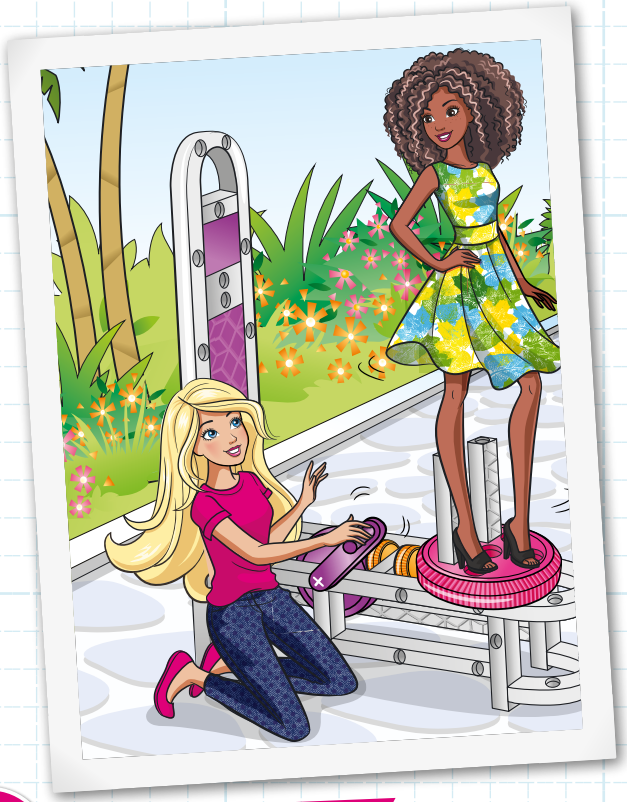
In addition, the surface of a leaf is waxy. Water beads up on the surface instead of sticking to it. Water-based paint sticks to the porous, absorbent fabric much better than it sticks to the leaf. This is why the paint transfers from the leaf to the paper during printing.



Why does mixing two colors of paint together create a new color? Our eyes see light waves of different wavelengths as different colors. We see light consisting of all wavelengths as white light. When you mix red, green, and blue light, you see white light. However, paint mixes differently than light. Each color of paint absorbs some wavelengths of white light, subtracting those out of the color that reflects into your eye. The final color you see is made of whichever wavelengths are not absorbed by the paint particles.



Dress-Design Platform



"This looks fabulous," Barbie exclaimed while holding up the leaf-print dress. "But I'd love to see it on. Can you model it for me, so I can see it from all sides?"

"Sure thing," Nikki replied.

"I have an idea: I'm going to build a special rotating platform so it's easy to see the dress from every angle. Can you hand me those gears," said Barbie.

"It's like a high-tech fashion show," said Nikki.

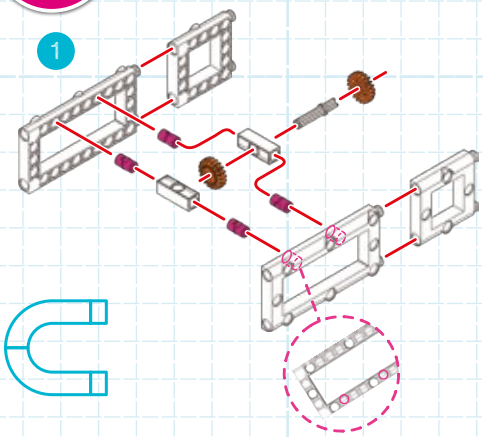
They built a rotating dress-design platform. Nikki put on the leaf-print dress and stepped onto the platform.

"Okay, crank away. But not too fast," Nikki said. "I don't want to get too dizzy!"

BUILD

Help Barbie and Nikki build the dress-design platform.

1



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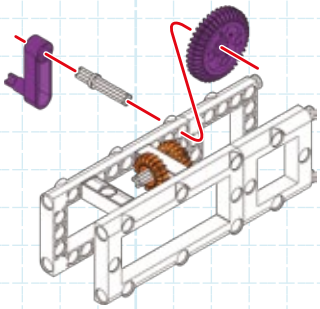

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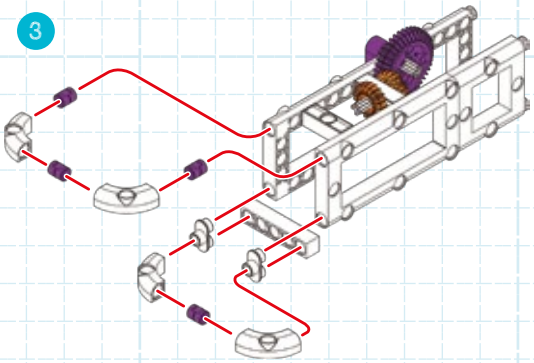

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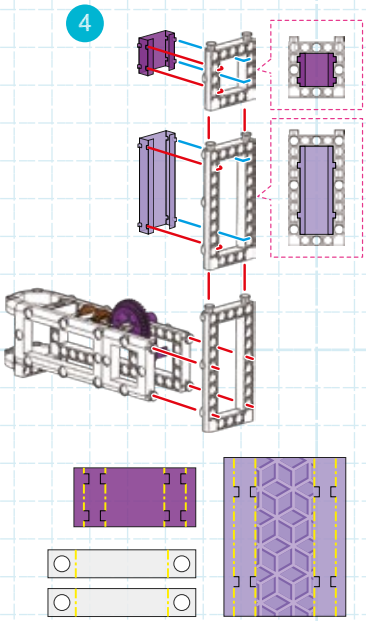

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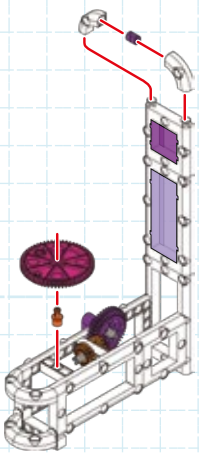

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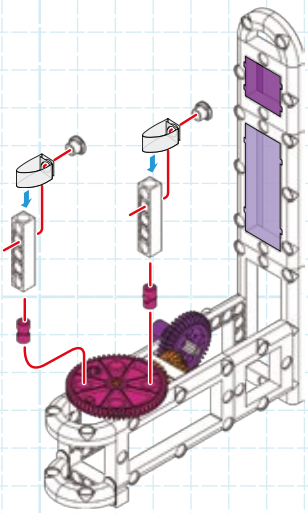

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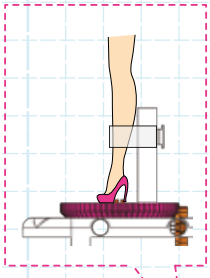
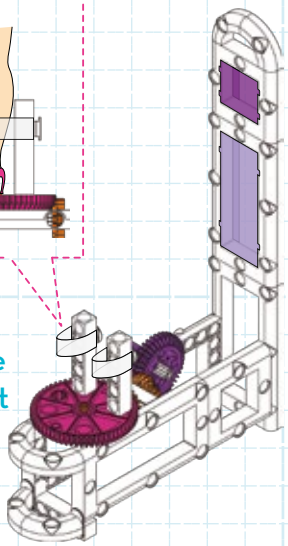
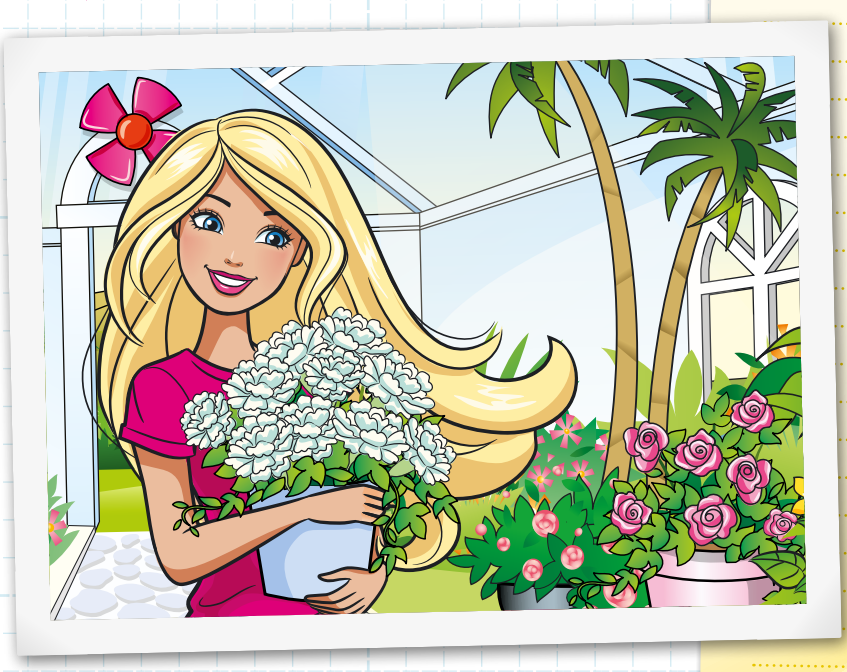
Done!





Secure the doll with the straps. What happens when you turn the crank?

Dye a Flower



"It's perfect," Barbie said as Nikki modeled the leaf-print dress on the dress-design platform. "This is the dress for the Gala. Thank you, Nikki!"

"Success! It's so unique – it's so you!" Nikki said. "But I think it's missing something."

"I do need a necklace. Maybe we can make one with these white flowers from the greenhouse," said Barbie.

"You will be like a walking botanical garden," Nikki joked.

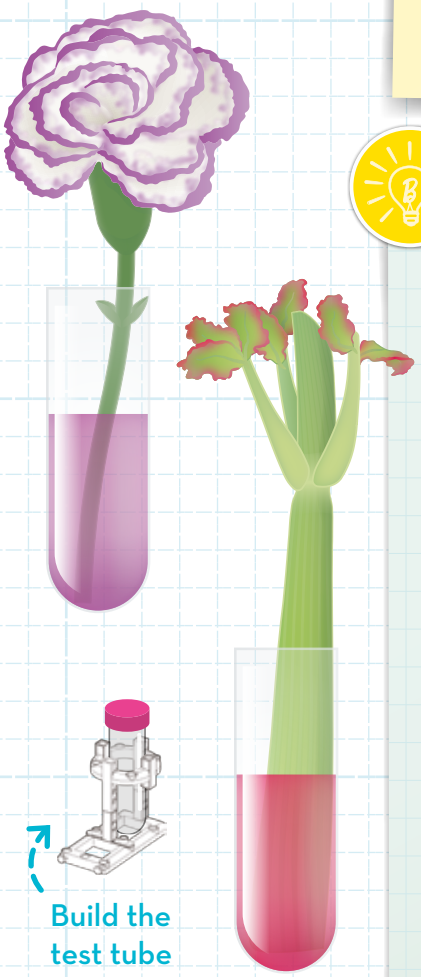
"Here, help me dye these flowers for the necklace. If we color the water, the flowers will draw the colored water up through their stems, and the petals will change color."

"You know, it's not unlike the chromatography experiment we did earlier. The plants use capillary action, too," Nikki explained. "I'm going to use this in my next science fair project!"

EXPERIMENT

Help Barbie and Nikki dye the flowers for the necklace.

You will need: Test tube, test tube holder, *fresh white carnation (or a stalk of celery), food coloring, water*

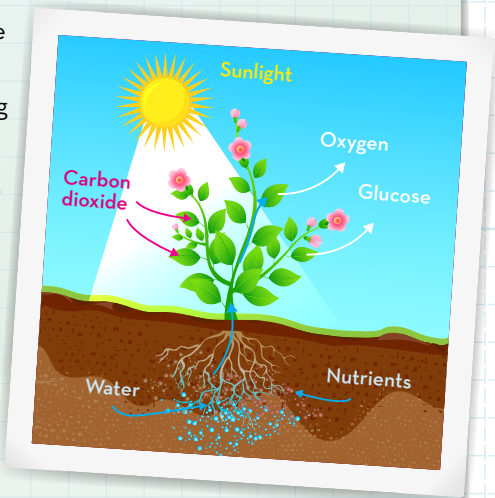


1. Fill the test tube halfway with water.
2. Put 15 to 20 drops of food coloring into the water.
3. Cut 2 centimeters (1/2 inch) off the bottom of the stem of the flower or celery stalk at an angle.
4. Place the flower or celery stalk in the test tube.
5. Observe the flower or celery stalk over the next few days.

Build the test tube holder from page 9.

WHAT'S HAPPENING?

In the same way the water moved up the cloth in the chromatography experiment, capillary action is at work inside of plants to move water up their stems. Some plants, called *vascular plants*, have a system of tubes that run from their roots to their leaves and flowers. This system of tubes transports nutrients, food, and water throughout the plant, just like our arteries and veins. When you cut off the bottom of the celery or flower, you were opening these tubes for the food coloring and water to pass through. The process by which water goes through a plant is called *transpiration*.

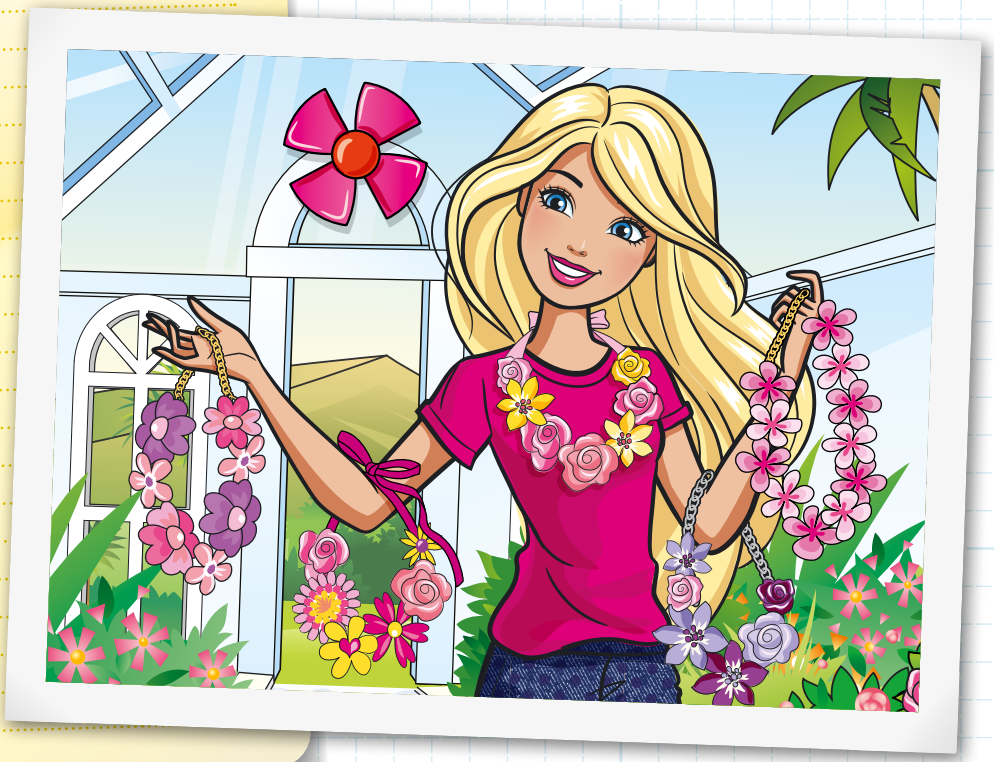


Necklace and Accessory Holder

Barbie and Nikki made lots of flower necklaces in lots of different colors.

"Well, I guess we got a little carried away making necklaces," Barbie said. "I think we need a place to organize these."

"How about a rotating accessory holder? I already know how it will work. We're getting good at building machines with gears," Nikki said as she started to draw up a plan.



BUILD

Help Barbie and Nikki build the accessory holder.

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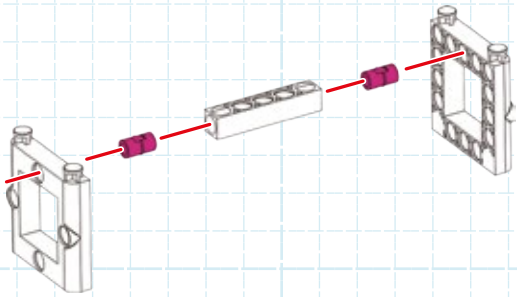

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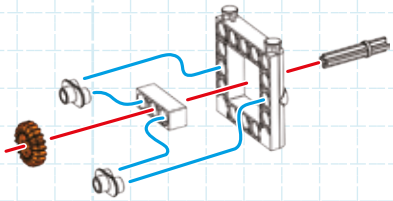

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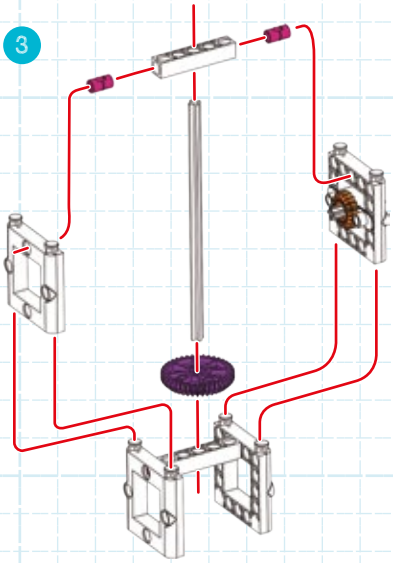

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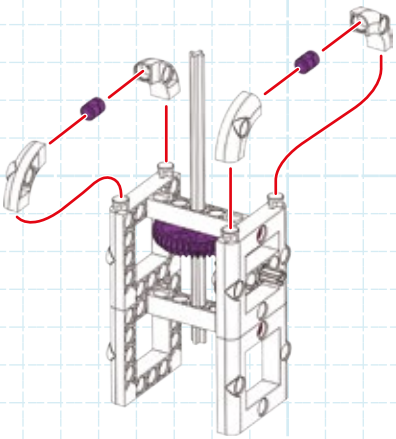

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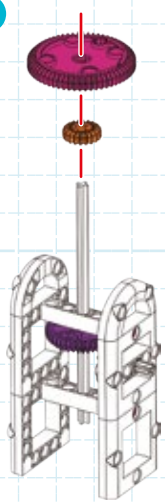

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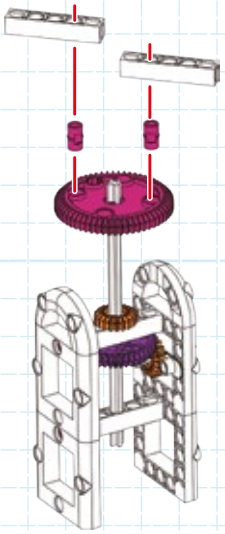

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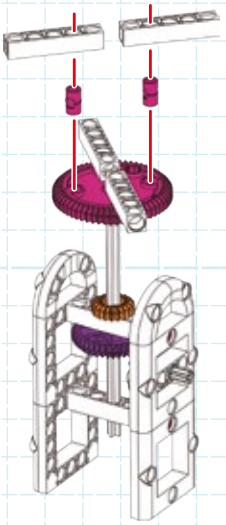
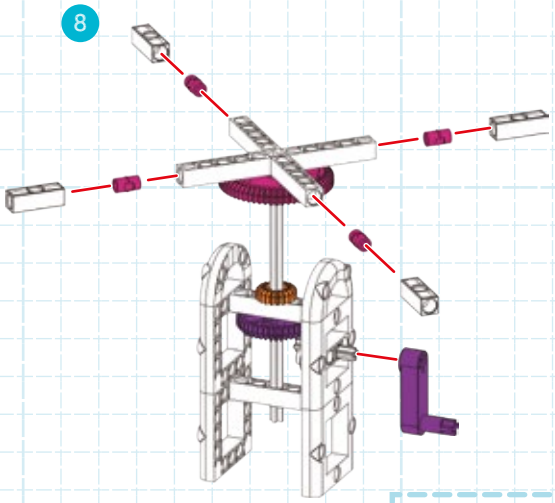
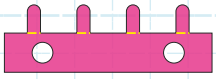


Necklace and Accessory Holder

8



If you don't have a few necklaces to hang on the holder, you can make some using the string and the plastic building pieces as beads.



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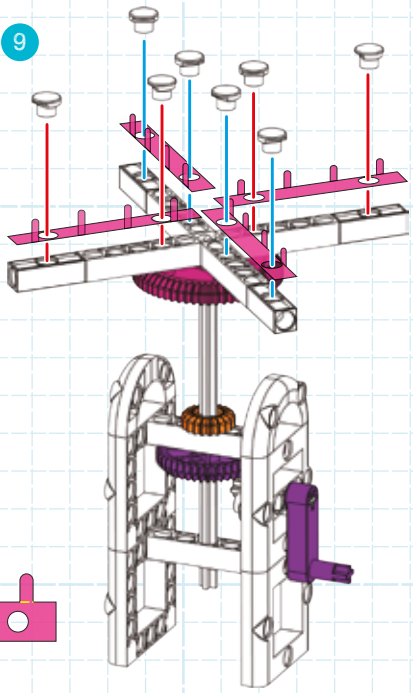
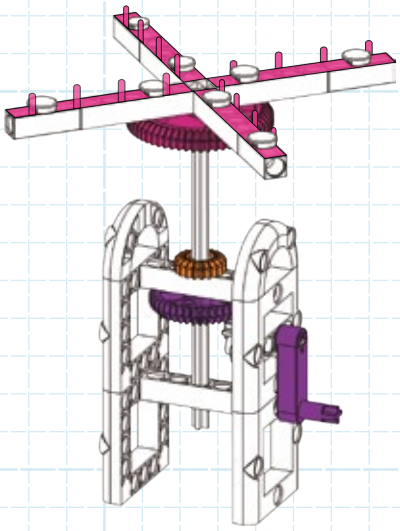


10

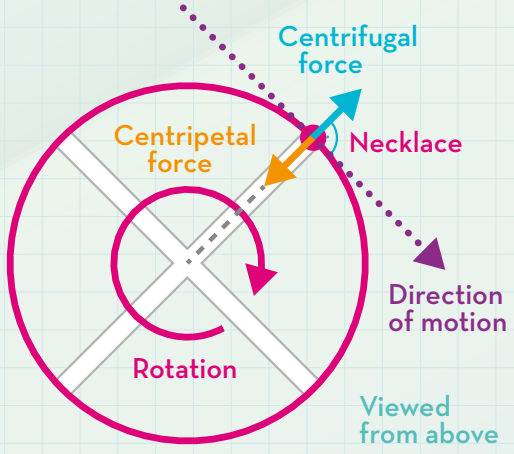
Hang necklaces from the hooks. What happens when you turn the crank?

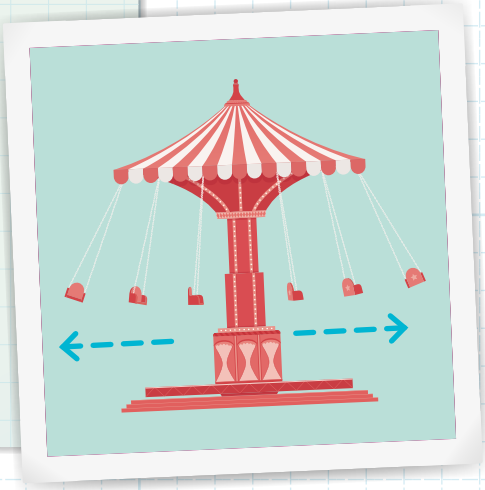


Done!

WHAT'S HAPPENING?

Why do the necklaces fly outward when the necklace holder is turned? When a car goes around a corner quickly or sharply, you feel what is called a *force* push you toward the outside of the corner. A force is simply a push or a pull. As the necklace spins around on the rotating holder, from its perspective, it experiences a force that pushes it outward, called the *centrifugal force*. But then why does the necklace not fly off the holder? This is because the necklace also experiences another force, called the *centripetal force*, toward the center that keeps it on its circle path. If there were no centripetal force, then the necklace would just fly off in a straight line.





Rotating swing rides at amusement parks work the same way your necklace holder works. When the ride spins around, the chairs fly outward and upward due to the forces acting on them.

Hammock with Fan

"What a day! We've made our dresses for the Gala," Barbie started.

"And we built all sorts of machines and made rainbows and necklaces," Nikki continued.

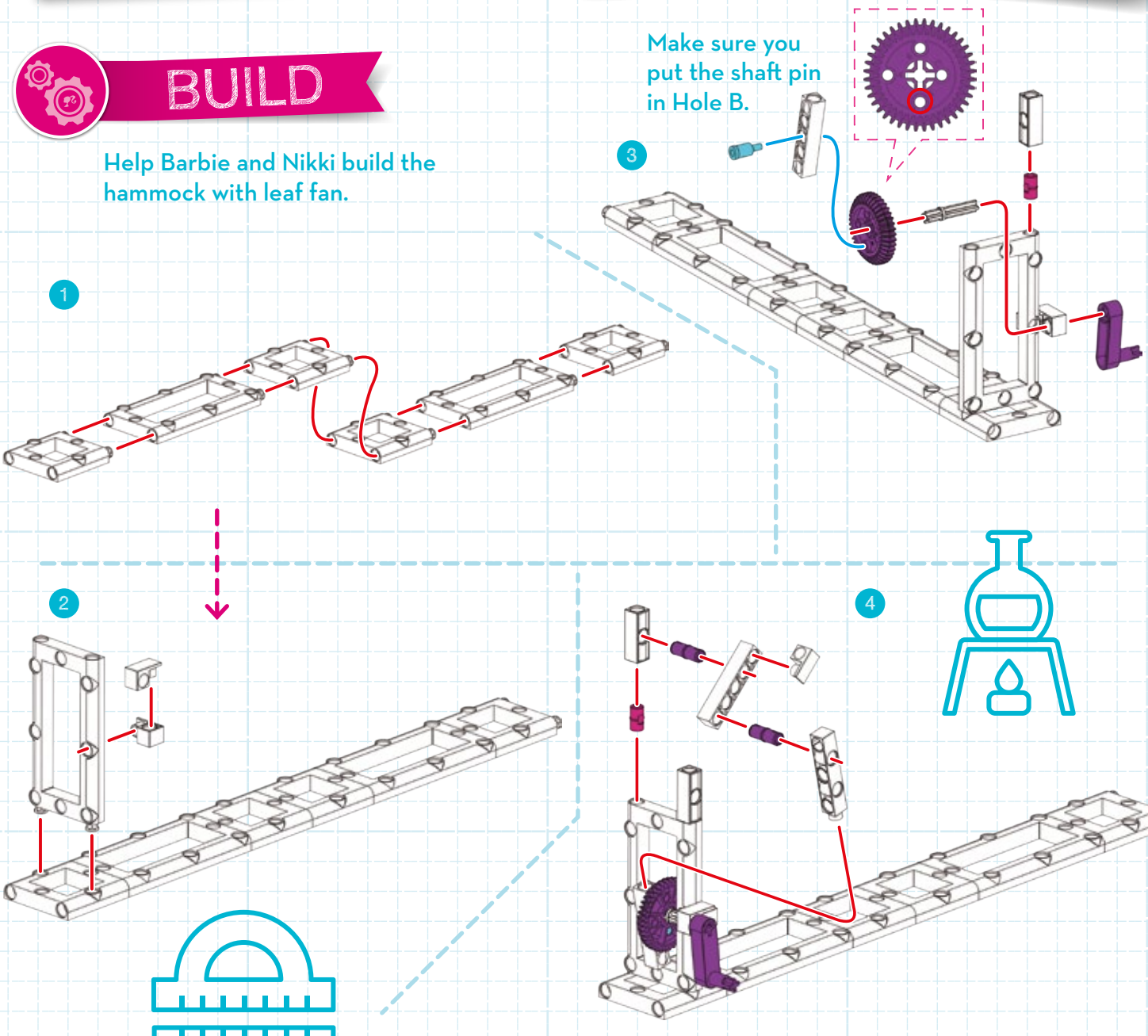
"All this experimenting and building has tired me out! I think it's time to set up our hammocks," Barbie said.

"We can use these big leaves from the greenhouse to gently fan us when we are lying in our hammocks. This mechanism changes the rotating motion of the crank into the up-and-down fanning motion of the leaf," Nikki explained.

BUILD

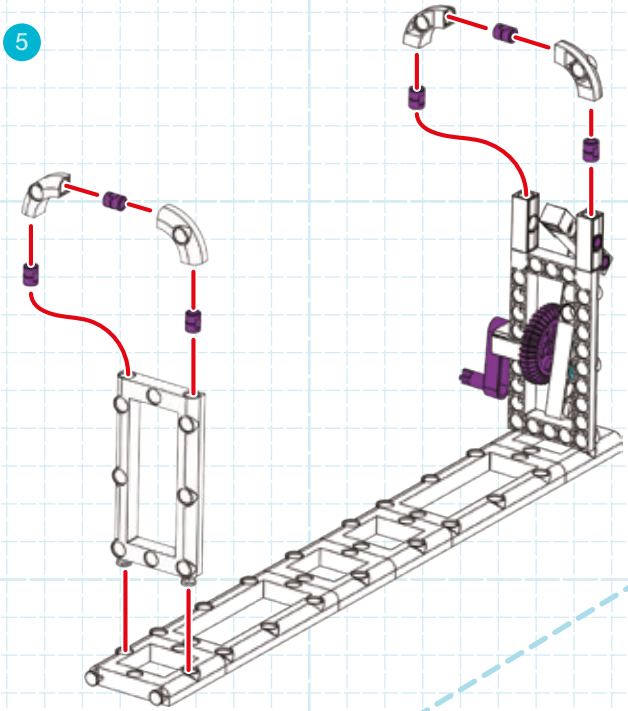
Help Barbie and Nikki build the hammock with leaf fan.

Make sure you put the shaft pin in Hole B.



Hammock with Fan

5



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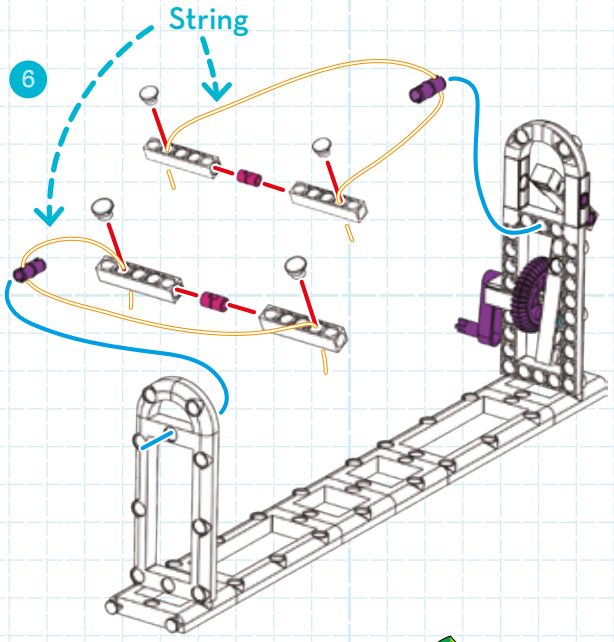

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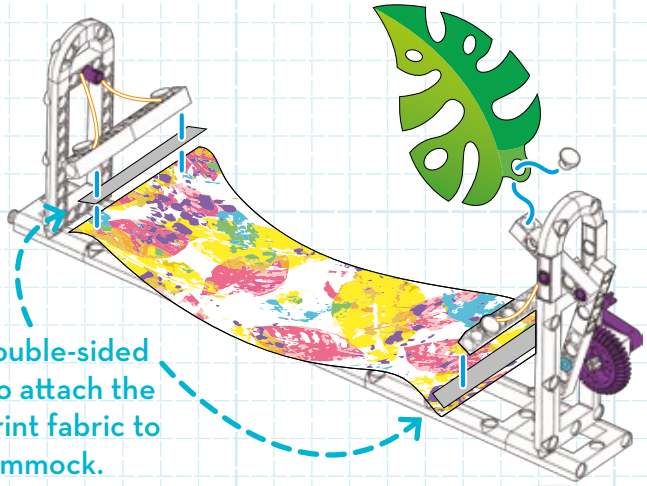


Use double-sided tape to attach the leaf-print fabric to the hammock.

8 **Done!**

What happens when you turn the crank?

For an extra challenge, try setting up the hammock to run using the gravity motor from the washing machine experiment.

"The breeze from this leaf fan feels amazing," said Nikki.

Barbie and Nikki relaxed in their hammocks with their sketchbooks. Their minds were filled with new ideas inspired by all their creative problem solving.

Nikki wrote a summary of their observations. Barbie started drawing up plans for a new invention. What new projects and experiments would they try tomorrow?

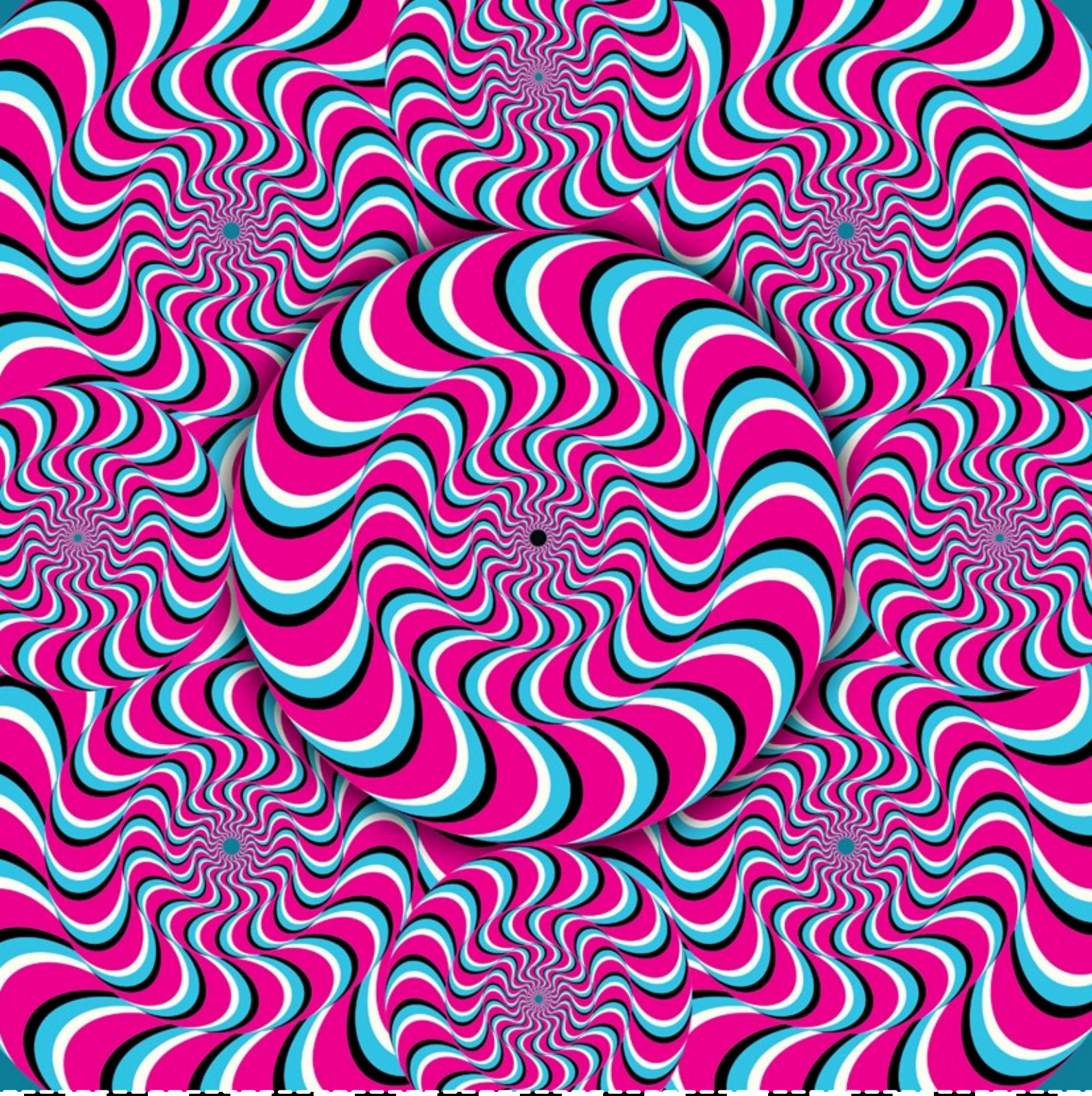
THE END

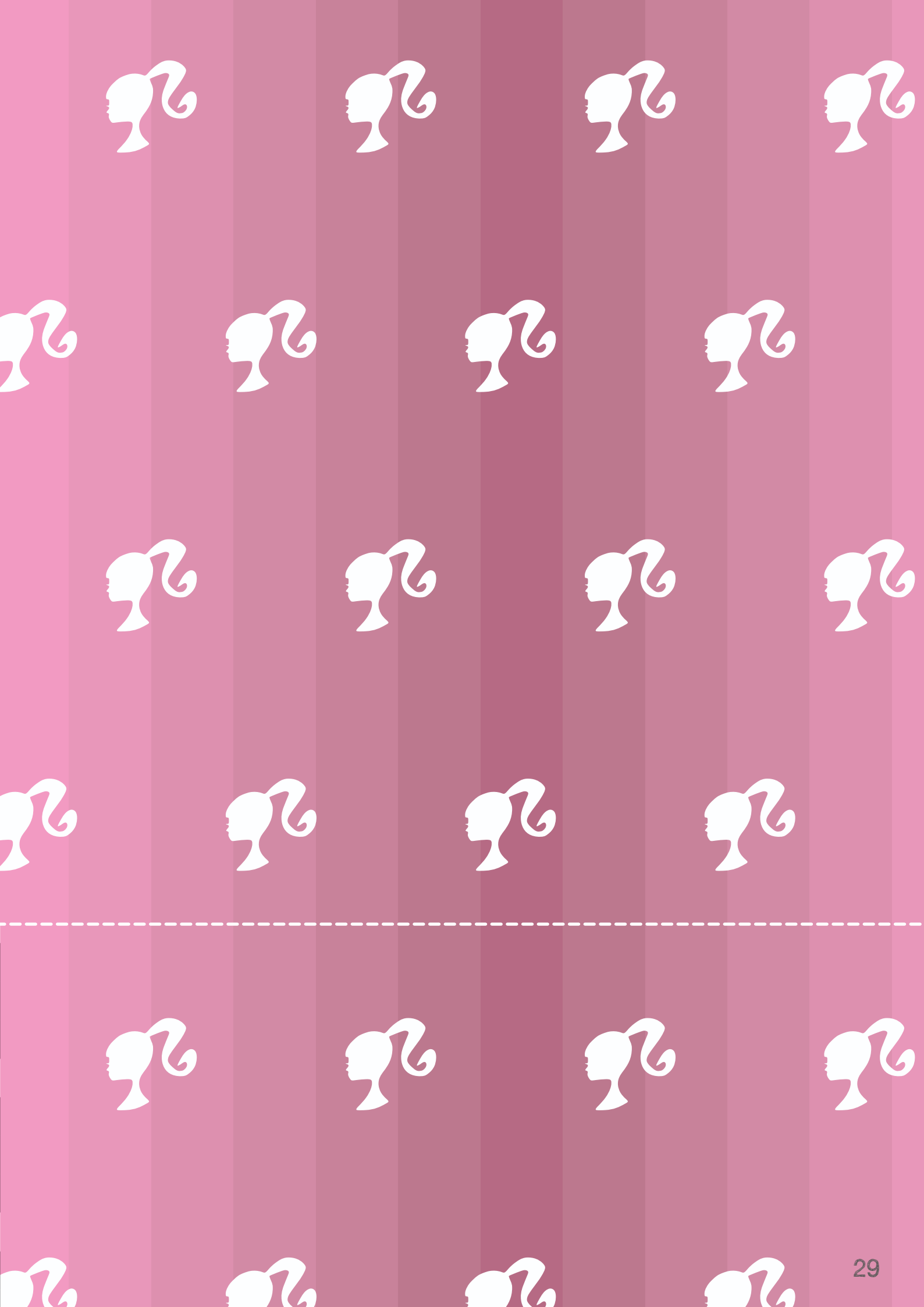
Optical Illusion Dresses

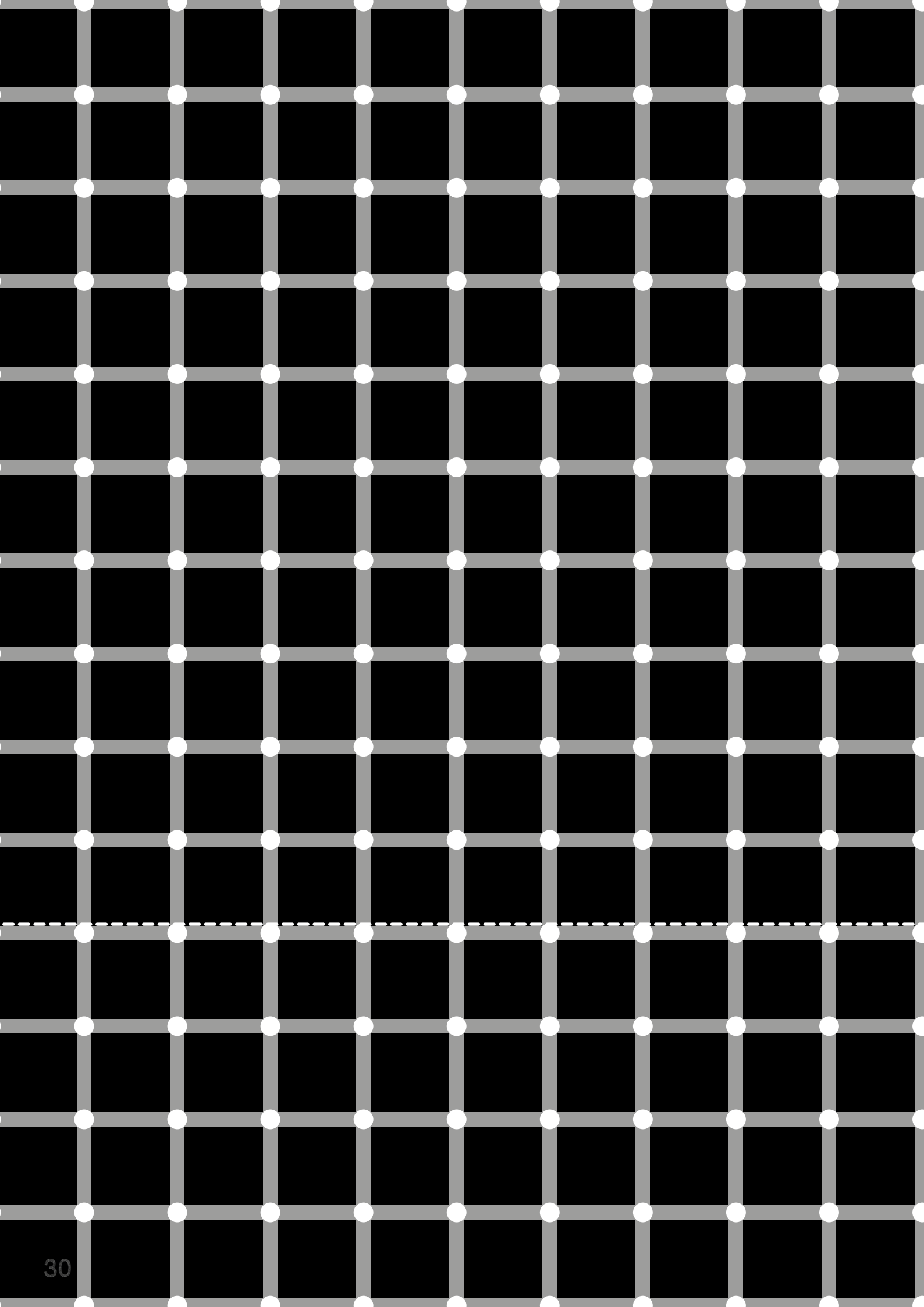
EXPERIMENT

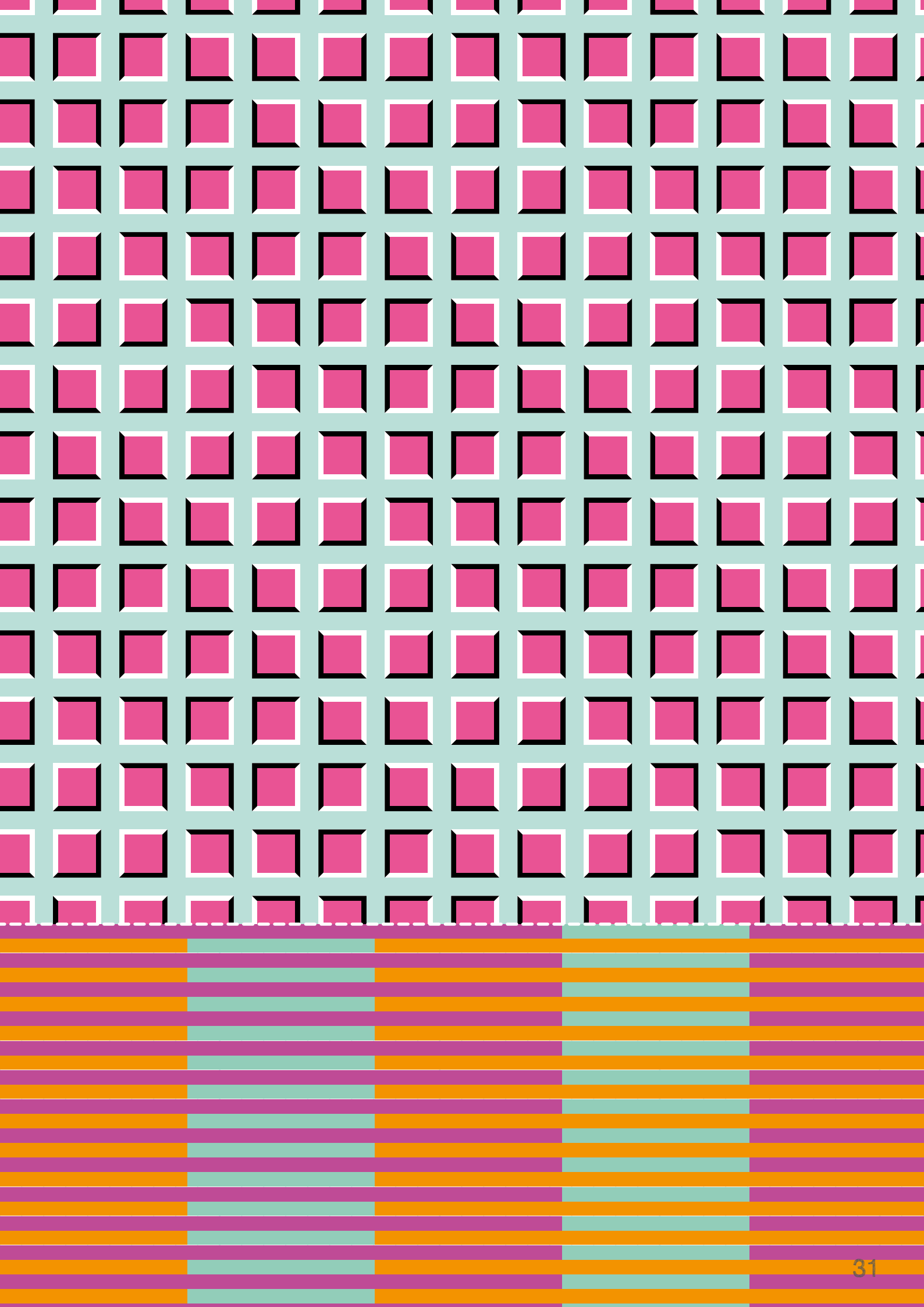
See page 12 for the instructions to make the optical illusion dresses.

Cut along the dashed lines and along the inner edge of the page to remove the optical illusion pattern squares from pages 27-32. Make sure they are perfectly square.









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