

Propeller Car

Although a sailboat or land yacht can't easily sail upwind, it's possible to make it happen with clever engineering. Investigate how mechanical forces can change an object's motion and how these forces can act from a distance.

🕒 30–45 min. 📦 Advanced 🎓 Grades 6–8



Teacher Support

Key objectives

Students will:

- Understand how forces can change an object's motion
- Understand how forces can act from a distance
- Explore the relationship between energy and forces

Things you will need

- LEGO® Education BricQ Motion Prime Set (one for every two students)
- Masking tape
- Medium-sized tabletop electric fans (ideally, 1 for every 10 students)

Additional resources

[Building instructions book, pages 104 - 122](#)

[Student Worksheet](#)

[Assessment Rubric](#)

Educational standards

- NGSS MS-PS2-2
 - ISTE 7c
 - CCSS.ELA-LITERACY.RST.6-8.3
- Lesson extension
- CCSS.MATH.CONTENT.6.RP.A.1

Prepare

- Review the online student material. Use a projector to share this material with your students during the lesson.
- Make sure that you've covered Newton's three laws of motion in an earlier lesson.
- Consider the abilities and backgrounds of all of your students. Differentiate the lesson to make it accessible to everyone. See the *Differentiation* section below for suggestions.
- Set up the fans on the floor, allowing at least 3 yards in front of each, so the propeller cars have room to move. Use a strip of tape to mark a starting position in front of each fan (*perpendicular to the fan*).

Engage

(Whole Class, 5 Minutes)

- Watch the student video [here](#), or access it via the online student material.
 - Facilitate a quick discussion about which force makes a propeller car move.
 - Ask questions, like:
 - What makes a wind turbine move? (*Wind, which is generated by differences in atmospheric pressure.*)
 - Which forces make a wind turbine move? (*The shape of the blades affects the force vectors of the wind, which results in a rotational motion.*)
 - Tell students that they're going to build a propeller car, and investigate how wind force can change its motion.
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Explore

(Small Groups, 30 Minutes)

- Ask the students to work in pairs to build the Propeller Car model. Tell them to take turns, one partner searching for the bricks while the other builds, switching roles after each step has been done.
- You can find support for building in the *Tips* section below.
- Direct them to the three experiments in the student material, and distribute the Student Worksheets (Teacher Support – Additional Resources).

Experiment 1: Into the Wind

- Ask the students to set their propeller cars on the starting line, facing toward the fan.
- Tell them to turn on the fans and observe how their cars move.
- Have them record their observations on their Student Worksheets.

Experiment 2: Downwind

- Ask the students to switch the position of the propeller so that it's facing backward, or to flip the gear assembly upside down, so the gray gear is on top.
- Have them turn on the fan to observe what happens to their cars when they're facing forward, and then backward.
- Have them record their observations on their Student Worksheets.

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Experiment 3: More Fan Blades

- Have the students add the extra blades and run the experiment again. If there's enough time, have them try these variations:
 - Propeller gear module facing up
 - Propeller gear module facing down
 - Propeller gear module facing backward
 - A 4-bladed propeller
 - A 6-bladed propeller (*see page 3 of the building instructions book for a hint*)
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Explain

(Whole Class, 5 Minutes)

- Gather your students together to review and discuss their experiments.
 - Ask questions, like:
 - What could you change to make your car switch from going toward the wind (*upwind*) to going away from the wind (*downwind*)? (*The gearing, or the direction of the propeller.*)
 - What causes the propeller car to move upwind (*toward the fan*)? (*The sum of the force vectors acting on the vehicle push it upwind.*)
 - Can a wind-powered car travel faster than the wind is blowing? (*Yes! Some of the cars in the video we watched at the beginning of class were moving a lot faster than the wind was blowing.*)
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Elaborate

(Whole Class, 5 Minutes)

- If time allows, explain the forces at work (*force vectors*) in detail.
 - Allow time for the students to disassemble their models, sort the bricks back into the trays, and clean up their workstations.
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Evaluate

(Ongoing Throughout the Lesson)

- Give feedback on each student's performance.
- Facilitate self-assessment.
- You can use the assessment rubrics provided to simplify the process.

Observation Checklist

- Measure your students' proficiency in describing how different forces and mechanisms can change an object's motion.
- Create a scale that matches your needs. For example:
 1. Needs additional support
 2. Can work independently
 3. Can teach others

Self-Assessment

- Have each student choose the brick that they feel best represents their performance:
 - Green: With some help, I can describe how an invisible force combined with a gear train can change an object's motion.
 - Blue: I can describe how an invisible force combined with a gear train can change an object's motion.
 - Purple: I can describe and explain how an invisible force combined with a gear train can change an object's motion.

Peer-Feedback

- Encourage your students to assess their peers by:
 - Using the brick scale above to score each other's performance
 - Presenting their ideas and giving constructive feedback

Tips

Model Tips

- Have the groups start testing as soon as they finish building. They should take turns as they make adjustments to ensure that everyone has a chance to try out the models.
- Choose ONE fan speed to use for all of the tests. Any speed will do.
- If your fan is too big or too powerful, try moving it farther back from the starting line. You can use a piece of furniture to block some of the fan's airflow.

- If your fan is too small, move it closer to the models or try moving the fan by hand, following the models.
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Differentiation

Simplify this lesson by:

- Having your students try only the base-model variable of having the car move upwind

Increase the difficulty by:

- Challenging the students to figure out how to make their cars drive upwind more efficiently
 - Asking the students to figure out how to replace the fan with a flywheel to make their cars move
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Extensions

(Note: This will require additional time.)

To incorporate math skills development, ask your students to explore the concept of a ratio and use ratio language to describe the gear ratio relationship between the rate at which the propeller blades turn and the rate at which the wheels turn.

CCSS.MATH.CONTENT.6.RP.A.1