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ONE WHEEL ON THE CART

LESSONS

WHEELS & AXELS

CREATIVE POWER
PLAY LEARN GROW
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4th & 5th grade
teacher plan

Lesson 2: ONE WHEEL ON THE CART

Students practice designing transportation and including wheels in their designs. This lesson serves as an introduction to the idea of mechanical advantage and the idea that a simple machine like a wheel and axle will require less force to move objects across distances.

Objectives:

Students will explore the ideas of work, effort/force, and enhancing transportation with wheels (mechanical advantage). They will also practice design thinking and process, with criteria and constraints. At the close of this lesson, students will be able to describe how wheels help do work.

Vocabulary used in this activity:

Work, effort, distance, weight, advantage, benefit, method, situation, constraint, design

Standards

NGSS 3-5 ETS1, ETS1.A, ETS1.B, ETS1.C, ETS1-1, PS3.C, LS1.A, 5-PS2

CCSS-Math MP2, MP3, MP6, MP7, MP8

CCSS-ELA SL.4.1, SL.5.1, SL.4.1c, SL.5.1c, SL.4.1d, SL.5.1d, CCRA.L1, CCRA.L.6, W.4.2, W.5.2, W.4.8, W.5.8

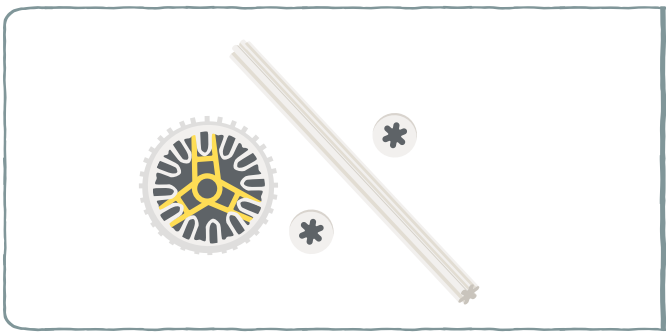
Time needed: 35-45 minutes

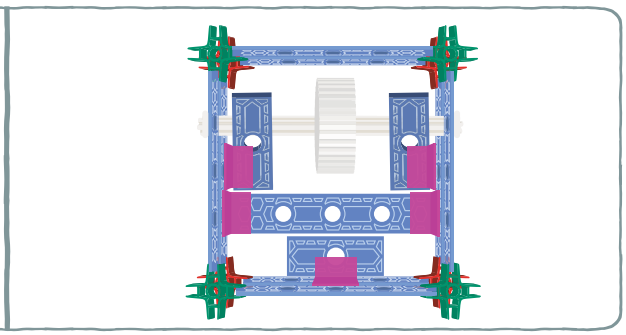
Materials and Supplies:

Paper, pencils/crayons, cart or wheeled chair, rock or well-built and closed container full of heavy items, Brackitz planks (1x1 and 1x2), and 3 and 4-way hubs. Give out exactly one tire and axle-spline and two lock-washers to each group.

Set-up and Preparation: Prepare trays of building materials ready to be handed out; help students cooperatively form groups of 2-3 to work together.

Background Knowledge: Prior to this lesson, students do not need special background knowledge.





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35-40 minutes

Whole Class — 10 minutes

"How do we move things around that need to be moved? (Have class list ideas - cars, trucks, etc.) Let's think about this in terms of a need or situation we would like to change - we need to get things and people to places faster and easier. Why don't we just walk everywhere and carry everything? Let's make a list of the ways to move things and people around." Ask students to think of all the ways we move people and objects around - carts, wheelchairs, buses, trains, and more. List on board or chart paper. "Which of these ways of moving things is easiest and fastest? What do all of these ways of moving things/people have in common?"

Instructor Notes and Tips

You may read the Richard Scarry book to help prime the idea of transportation for students. You may also ask for specific examples:

- How will we change classes/get to the cafeteria? (walking, wheelchairs)
- What are fun ways to move when we are playing (roller skates, scooters)
- If you wanted to go to your friend's house, what are three ways to get there? (car, bike, walking)
- What brings some students to school? (bus, car)

Note how many things that are named have wheels, and see if students can be supported to notice this common feature. Try to move the discussion towards "vehicles" as items that help us move things more quickly/easily.

Group Exploration — 10 minutes

Feel the work! "Moving something from one place to another is always work, even when we are moving ourselves. Let's see if we can feel the work being done. If we want to move this rock from 'Start' to 'X marks the spot,' how can we do the work?

1. Push it
2. Pull it
3. Lift and carry
4. ROLL IT"

Have students rotate through stations of these options. Then ask, "What is easiest? Why do wheels help?"

Reach this conclusion:

It's easier to move items when it doesn't depend on just us and our muscles. Wheels offer a mechanical advantage - a way to do this work with less force.

Create start and stop spots for each station, so that students can line up for this exercise. Have each group take a turn carrying, pushing, pulling, and rolling (by cart or rolling chair) a rock or heavy container box. Each student's turn should take twenty to thirty seconds or less, and if four or five students are carrying/rolling at once, this means "feeling the work" should take six to seven minutes.

When you ask which is easier, help students consider feeling their muscles. Students may also talk about speed, and this is an excellent time to point out that greater speeds are more achievable when using something with wheels because it gives us an advantage of doing work using less force to move the same distance. With the mechanical advantage of wheels, we could go the same distance with **less force from us** AND go faster. Advantage means having an edge or better method, like if we got a head start in a race, or have a way to go faster.

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Group Challenge 15 minutes

"If we want to create a way for a small creature to move things around that uses less force, what Brackitz on your trays could you use? (Wheels!) In this case, you have a design constraint - only one wheel. Before building something with one wheel to try and help move blocks/books, write down the answer to this question: how will you know if your design is working? What will you test to decide if it's helping?"

Pass out trays of planks, connectors, wheels, and axles that are already prepared for groups. This is a chance for students to begin building. Watch to make sure groups are able to share tasks and ideas functionally.

Reflection 5 minutes

"I gave you only one wheel to see if you could build, even if I had a limitation on your building materials. That's called a constraint. Can one wheel still help create an advantage for moving around so you can move things more easily (using less force)? How will we know if it is helping? Was it hard to design this? What would make your design better?"
Can one wheel still help?
Does it make work easier?
What challenges did you face to design this?
What would you like to change or add to your designs?

Make sure that before this section of the lesson closes, students understand the basic idea of doing the same task (moving Gingerbread from A to B or moving books) with less force.

CHALLENGE ADVANCED STUDENTS

In discussion, ask students to come up with their own definition of the word "advantage" and examples of when they or someone else has had an advantage or disadvantage.

In the reflection, ask students to reconsider what advantage means, and to define what "mechanical advantage" means. You may also support students to research what simple machines are and to learn about other simple machines.

SIMPLIFY FOR YOUNGER GROUPS

In discussion, show some videos of vehicles that use four wheels and vehicles that use fewer than four wheels. Ask students if they notice that vehicles using fewer than four wheels often need work from people to roll the wheels.

In the group challenge, ask students if they need to build something that can be pushed/pulled and if they have ever seen a cart like this. Lead students to building a one-wheeled cart or wheelbarrow.

Name

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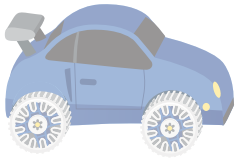
Student Worksheet

How do wheels help move things more easily? Why do we move boxes on carts? Why do we use shopping carts and rolling luggage?

Can you explain mechanical advantage in your own words?

What are the differences and similarities between these items: cars, bikes, and carts?

Differences	Similarities



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Student Worksheet

Before you made your one-wheeled design, you were asked: “How will you know if it is working and helping to move things? How will you test your design?” Write your answer here:

You made something with just one wheel. Draw your design here:

Name

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Student Worksheet

Can one wheel still help? ○ Yes ○ No

Does your design allow work to happen with less force? How?

Who would use your design?

Where would be the best place to use it?

What would be the best things to move in your design?

Was it hard to design this? Why or why not?

What would you like to change or add to your designs?