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V2.3

WHAT GOES UP MUST COME DOWN

LESSONS

PULLEYS & CRANKS

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

Lesson 1: WHAT GOES UP MUST COME DOWN

Students consider the challenges of moving things and people up and down, and revisit the idea of how simple machines make the work of moving more effective.

Objectives:

Students will consider that getting from one place to another can involve moving objects and materials, and can require up and down movement (not just across). At the end of this lesson students will have started to think of using simple machines, like pulleys, to create movement in another direction.

Vocabulary used in this activity:

fragile, work, effort, weight, heavy, advantage, disadvantage

Standards

NGSS 5-PS2 Motion and Stability: Forces and Interactions, 3-5 ETS-1 Engineering Design, ETS-1 Designing for a Need, ETS1.A Defining Engineering Problems, ETS-1.B Design Solutions

CCSS-Math MP2, MP3, MP5

CCSS-ELA SL.K.1, SL.K.1.A, SL.K.1.B, SL.K.5, W.K.3, CCRA.L.6, SL.1.1, SL.1.1.A, SL.1.1.B, SL.1.5, L.1.5.C

Time needed: 35-45 minutes

Materials and Supplies:

paper, pencils/crayons, Brackitz Pulley Bucket, string, Brackitz planks and hubs, and weighted objects (pebbles, marbles, or pennies). **Important: do not supply the pulley and crank in this lesson.**

Resources/Optional Reading:

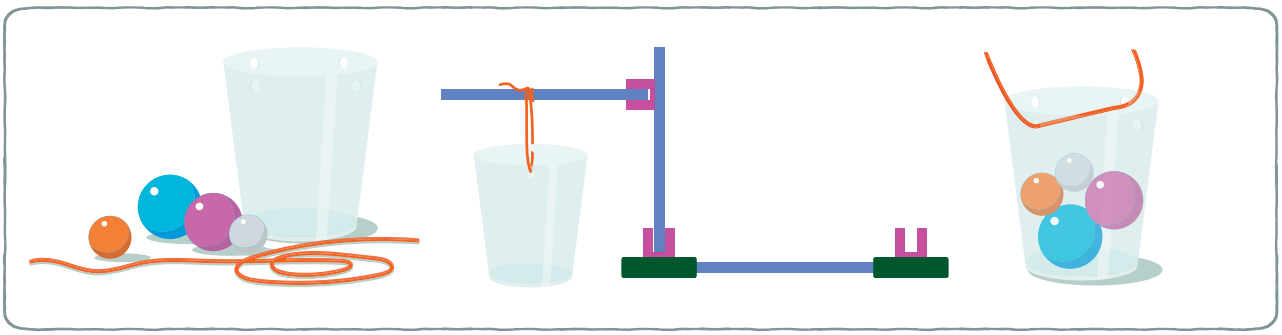
Evan Moor's Simple Machines and John B. Beaver's Simple Machines Grades 6-12 Force, Motion, and Energy

Set-up and Preparation:

Help students cooperatively form groups of 2-3 to work together.

Background Knowledge:

Prior to this lesson, students do not need special background knowledge. Introducing students to the ideas of simple machines and mechanical advantage from Unit 2 can be helpful.



Lesson 1: WHAT GOES UP MUST COME DOWN

35-40 minutes

10 minutes

"When you think about ways to get from one place to another efficiently or with less work, what comes to mind first?" (Students should easily think of vehicles from the previous unit: bikes, scooters, skateboards, cars, busses.) "Yes, vehicles and things with wheels come to mind easily, not only because we learned about them in the last unit but because most of us interact with vehicles every day. What are things you can think of that vehicles have in common?" (Students may name: wheels, can carry people or things, have to be driven/navigated, most are best on paths or roads, etc.) "One thing that most vehicles have in common is that they help move people and things ACROSS - across roads, paths, and sidewalks. But, what helps move us up and down?"

Discuss, with the goal of arriving at the idea that most machines that can move us/objects up and down and change direction are not vehicles. Try to help students think of examples. (Elevators and pulleys in both flagpoles and wells are great examples.)

Instructor Notes and Tips

If the brainstorming needs some assistance, consider asking for specific examples: "What are all the ways we can get from . . .?"

- Home to school (walking, bikes, bus, car)
- Class to playground (walking, scooter, wheelchair)
- First floor of a building to the second floor (walking + stairs, ramp, or an **elevator**)

Pulleys can also move things horizontally, but vertically is more common and may be easier to focus on for now.

Group Exploration 10 minutes

"If we want to move something up and down using a machine, how can we tell that work is being done? I've set up stations. You can pull something heavy (pulley cup filled) up from the floor onto your tables. You have to use just your muscles and this rope. What are things that would help you know work is being done?"

Ask students what they felt, observed, and noticed. Students may be interested in considering that "work" is felt because of the amount of force and the distance or time the force needs to be exerted. Discuss how holding the same amount of weight for ten seconds is different than for two minutes, and that carrying a heavy box for forty steps may feel very different than for four steps.

Fill your pulley cups enough so that force can be felt, but not so much that it's a hazard (marbles and pebbles work well). If you can throw your rope over something a bit higher, like a bookshelf, that will help make this point.

Have each child in each group take a turn.

Prime them with ways to experience the force needed to do this work - muscles, string on hands. Students may mention that lifting with their hands is imprecise or "can spill," and you can help them understand that this is a design-based reason to rethink lowering and lifting everything by hand.

Lesson 1: WHAT GOES UP MUST COME DOWN

Group Challenge 15 minutes

"What could we do to try and build with Brackitz planks, hubs, this same cup, and this string to help move the things up and down?
Experiment with your planks and hubs, along with the cup and string. Is there a way to have the Brackitz pieces control moving the cup up and down without swinging or tipping it? What successes do you have? What issues do you notice? What improvements would you like to make given the issues you notice?

This is a challenge for students to build a way to lift and lower the cup. Certainly they can tie the string through a hub or a hole in a plank but then they basically are building a seesaw, lever, or other less stable system. In most cases, this will result in an issue where getting things up and down is limited in range and difficulty guiding the cup up and down safely. Help students notice and explore this issue. Ask, "Would you want to ride in this?"

Reflection 5 minutes

"What did you notice about trying to use these pieces to solve this problem? What worked or almost worked? What didn't?" (Give each group thirty seconds to say something that worked; something that didn't, or both.)
"Were you able to guide or control the string? What would have made it easier?
There is another kind of simple machine that helps to move things up and down that we'll learn about in this unit, and it will help us with problems where we need to make the work of moving things up and down easier."

Before this lesson completes, help students consider that there is a way to facilitate changing the direction of force to move things up and down. Refresh them on the idea of using machines to make work easier/smoother from Unit 2.

CHALLENGE ADVANCED STUDENTS

In discussion, talk about dimensions and directions: a vehicle is most likely to help us in a horizontal direction, but why can't our vehicles that use wheels and axles climb walls and go up? (Discuss gravity.) For this, we need a different kind of solution. What have they seen or used in real life?
In the group challenge, have students reverse engineer the pulley cup, and draw how they would use it with Brackitz planks and hubs to build a way to go up and down. Have groups discuss what they understand about pulleys now. What other problems could this simple machine help solve?

SIMPLIFY FOR YOUNGER GROUPS

In discussion, remind students about simple machines and ask, "What does someone who can't use the stairs do to get up and down a building with more than one floor?" Although pulleys can also move things across, for now, help students think in just one more dimension.
In the group challenge, help groups who are stuck by asking them explicitly what the pulley cup reminds them of in real life or by asking them if they think this is similar to a well, an elevator, or raising a flag up a pole.

Name

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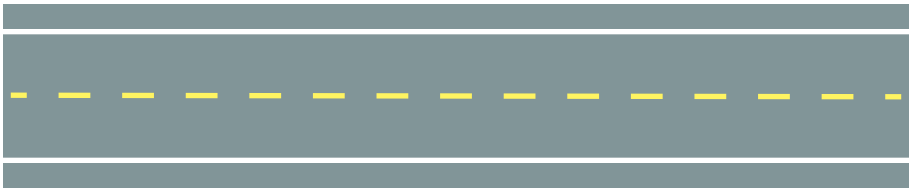
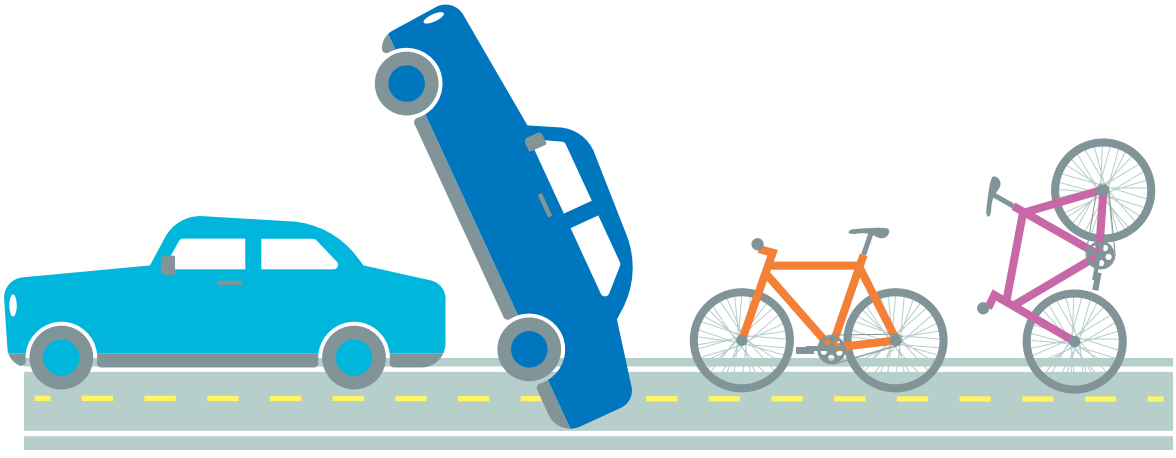
Student Worksheet

One way to get somewhere is in a vehicle. Here is a road:



Circle the pictures that show how vehicles are used in real life on a road like this:



Name _____

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Vehicles are very good at moving across or back and forth, but not as good at moving us _____ and _____.

Who does the work walking up and down stairs? _____

And who does the work if we go up and down in an elevator? _____

Draw how you think an elevator works. What makes it go up and down?

Draw your design for how to move a small creature up and down here: