

TOPIC

Simple and Compound Machines

SCIENTIFIC AND ENGINEERING PRACTICES

- 3.2** The student will demonstrate an understanding of scientific and engineering practices by (a.) planning and carrying out investigations.
- With guidance, plan and conduct investigations
 - Use tools and/or materials to design and/or build a device that solves a specific problem

- 3.2** The student will demonstrate an understanding of scientific and engineering practices by (b.) developing and using models.
- Use models to demonstrate simple phenomena and natural processes
 - Develop a model (e.g., diagram or simple physical prototype) to illustrate a proposed object, tool, or process

FORCE, MOTION AND ENERGY

- 3.2** The student will investigate and understand that the direction and size of force affects the motion of an object. Key ideas include (c.) simple machines increase or change the direction of a force and (d.) simple and compound machines have many applications.

BACKGROUND INFORMATION

Machines exist to help perform a particular task and make work easier. There are two different types of machines: simple and compound.

A simple machine is a simple device used to alter the magnitude or direction of a force. There are six basic types of simple machines:

1. **Lever** – A board or bar that rests on a turning point. Examples include a seesaw, hammer and crowbar.
2. **Wheel and axle** – An axle is a rod that goes through a wheel that lets the wheel turn. Examples include roller skates, wagon, tires on a car and a doorknob.
3. **Pulley** – Made up of a wheel and a rope. The rope fits on the groove of the wheel and one part of the rope is attached to a load. Examples include a crane, flag pole and clothes line.
4. **Screw** – An inclined plane that winds around a nail. Some are used to raise and lower things while others are used to hold things together. Examples include a jar lid, light bulb, key ring and stool.
5. **Inclined plane** – A flat surface that is higher on one end. Examples include a ramp, slide, slanted road and a path up a hill.
6. **Wedge** – Made up of two inclined planes used to push two objects apart. Examples include a nail, fork and a knife.

A compound machine is when two or more simple machines are operating together. Some compound machines consist of just two simple machines, like a wheel barrel and a corkscrew. Other compound machines, such as bicycles, consist of many simple machines. But big compound machines, such as cars, consist of hundreds or even thousands of simple machines.

Drinking water distribution systems and wastewater treatment plants use compound machines called pump stations to move, or pump, clean water to homes and businesses and move dirty water to the local treatment plant. Pump stations are needed to move water from homes and businesses, through pipes, and then ultimately to a plant. Without pump stations, clean and dirty water would not make it up and down the pipes buried below hills and valleys.

Virginia American Water provides drinking water service for the City of Alexandria. They distribute clean water to homes and businesses through pipes or water mains located underground. Alex Renew Enterprises is the company that manages the local wastewater treatment plant. They clean water after it has been used in homes, schools and businesses. Once cleaned, water is returned to local water resources.

MATERIALS FOR TEACHER

- 12 mason jars
- 4 medium-large size balloons
- 1 roll of electrical or packaging tape
- 12 bendy straws
- Scissors
- Water
- Clear tape
- Marker that writes on tape (to create a label)
- Water

- Machine handout (1 copy for each student)

VOCABULARY

Machine, simple machine, compound machine, pump station

AVAILABLE HANDOUTS

- Pump Station Labels
- Machine Handout for Teach and Student
- Set-up Instructions

STUDENT/TEACHER ACTIONS

TEACHER ACTIVITY PREP:

- Students will be broken up into four groups.
- Every student will receive a machine handout.
- Each group will receive supplies to represent a compound machine, including 3 prepped mason jars, 3 straws, clear tape and a permanent marker.
- Prior to lesson, prep the mason jars and straws for Part 2 of activity. See “Set-up Instruction” handout for guidance. You’ll have to complete the prep work for four student groups.

TEACHER ACTIVITY INTRODUCTION:

1. Break students up into four groups.
2. Tell the students to spend a few minutes in their group brainstorming ways that water moves from the top of a hill to the bottom of a hill.
3. After they have a few minutes to brainstorm, ask the students to share their ideas. Some ideas may be as simple as rolling a bottle down the hill.
4. After discussing their ideas, have the students brainstorm ways to get water from the bottom of a hill to the top of a hill.
5. After they’ve discussed this for a few minutes in their groups, ask each group to share some of their ideas. Some of their ideas may include simple machines like a pulley or wheel and axle. If so, highlight these examples as machines.
6. Ask the students what they think of when they hear the word “machine.”
7. Ask the students to share why we use machines.
8. Share that all machines are used to make our work easier. Share that the groups may have found that moving water down a hill is easier than moving it up a hill. This is because gravity will cause water to roll down the hill. However, it is not as easy to get water up the hill. Gravity naturally wants to pull the water to the bottom of the hill.

9. Share that this is why some groups suggested the use of a machine to move water up and down a hill.
10. Share that below the hills and valleys in their community, there are pipes that carry water to and from homes, schools and businesses. Gravity can help move water through the pipes, but sometimes machines are needed, especially to move water uphill.
11. Share with the students that there are two types of machines: simple machines and compound machines.
12. Share with the students that they are going to learn about both types today and how they are used to move water up and down hills and through their community.

TEACHER ACTIVITY INSTRUCTION:

Part 1: Simple Machines

1. Distribute a machine handout to each student.
2. Tell students you are going to discuss simple machines first. Share the definition of a simple machine from the background information.
3. Share that there are six different types of simple machines.
4. Review the definitions of the six types of simple machines. As you review the definitions, have the students draw a line on their handout connecting the type to the correct definition.
5. Once complete, the groups should also talk about how their simple machines make work easier.

Part 2: Compound Machines

1. Tell students you are now going to discuss compound machines. Share the definition of a compound machine from the background information.
2. Share that the students are going to build a model that represents a type of compound machine used to make a business's job easier. However, the model is going to represent a compound machine that is made up of thousands of simple machines.
3. Ask students to think about ways they have observed the movement of water from one place to the next.
4. Ask if the students think simple or compound machines are used to help move the water.
5. Ask the students to think of some businesses responsible for moving large amounts of water every day.
6. Share that wastewater, drinking water and water distribution companies move millions of gallons of water every day. They are responsible for moving clean water from a water treatment plant to your house. They are also responsible for moving dirty water from your house to a wastewater treatment plant.
7. Remind students they just learned about simple

machines. Ask the students if they think one simple machine could do this type of work.

8. Share that by combining many simple machines, they create a compound machine, which can help with this work.
9. Share that the compound machine used by these businesses to move water from one place to the next are called pump stations.
10. Distribute the following supplies to each group:
 - 3 prepared mason jars
 - 1 balloon
 - 3 straws
 - scissors
 - water
 - 1 roll of clear tape
 - permanent marker
11. Ask students to think about ways they use water every day at home.
12. Share that the mason jar with water in it (but no balloon) represents the water we use every day at home. Have students label this jar "House" with their tape and marker.
13. Ask students: Who is responsible for cleaning all of the dirty water they use? Share that the local wastewater treatment plant cleans the water (AlexRenew).
14. Have students tape the label "Wastewater treatment plant" to the empty mason jar.
15. Ask students how the water they use every day makes it from their house to the treatment plant.
16. Share that water travels through pipes. Point out the straws at each group and say that they represent pipes under the ground that carry water to and from treatment plants.
17. Have students place the straws in their mason jars. Use the "Set-up Instructions" handout as a guide.
18. Ask students to observe the shape of the straws. Point out the slopes and bends.
19. Once everything is assembled, ask students if they think the water from the jar labeled "house" could easily make it through the pipes (straws) to the jar labeled "treatment plant" without the use of a machine. The answer should be no.
20. Share that since this process isn't easy. Wastewater treatment plants, like AlexRenew, use pump stations to help transfer the water.
21. Share that the hills and valleys in the community create the need for pump stations. Pump stations are a compound machine used to help treatment plants move water to and from treatment plants.
22. Have students in each group push down on the balloon covering the "pump station" jar. They will see water move

from the “house” to the “pump station” to the “treatment plant.”

23. Reiterate that pump stations are a compound machine, machines made up of many simple machines. Ask the students what type of simple machines might make up a pump station.
24. Share that this model shows how machines are used to make work easier.
25. Share that AlexRenew operates 4 pump stations around the city to move dirty water from the houses in Virginia to their wastewater treatment plant.

TEACHER ACTIVITY CONCLUSION:

- Ask students why machines are helpful.
- Share that machines are found all around and are used every day.
- Remind students to pay attention to the things they do throughout the rest of the day. Have them make note of the task they are doing and if it is easier because of a machine.
- Remind students that machines are used by businesses

every day to provide us things we need, or to help us get rid of things we don’t need.

• Share the following facts about AlexRenew:

- They have one treatment plant.
- Every day they treat 35 million gallons of dirty water from homes, schools and businesses. That is enough water to fill 53 Olympic-size swimming pools every day!
- It takes a drop of water 24 hours to make it through the cleaning process at the plant.
- Share the following facts about Virginia American Water:
 - They distribute 14 million gallons of water to the Virginia community every day. That is enough water to fill over 21 Olympic-sized pools every day.
 - They maintain about 280 miles of main pipe to carry water to homes, schools and business in the Virginia community. If you stretched this amount of pipe out, it would stretch from Washington D.C to Connecticut.

ASSESSMENT

QUESTIONS

- What is a simple machine?
- How many types of simple machines are there?
- What are some examples of simple machines?
- What is a compound machine?
- What are some examples of compound machines?

JOURNAL/WRITING PROMPT

- What is your favorite simple machine and why?
- What is your favorite compound machine and why?
- Write about a machine you would like to invent. How will it make work easier for others?

EXTENSIONS AND CONNECTIONS

- Have students log the different types of simple and compound machines they use in a week, and how many times they use each machine. For example, they will ride in a car several times a week. Create a chart or bar graph to display results and highlight machines used most often.
- Invite someone from AlexRenew to school to better explain pump stations and show videos/photos of local pump stations.

STRATEGIES FOR DIFFERENTIATION

- Break lessons up into two lessons. Spend the first lesson explaining the difference between simple and compound machines. In the first lesson have students go on a scavenger hunt to find simple machine examples, instead of teacher providing. In the second lesson, have students build the entire pump station model instead of the teacher prepping most elements before class.