The PowerWheel

GRN-200

About the PowerWheel:

The PowerWheel is a micro hydro generator—an amazing tool for teaching lessons about energy, hydro-power, and other renewable sources of energy. Students from kindergarten through college can use this tool to charge cell phones, power laptops and more… all from the power of a water faucet!

Your PowerWheel Bundle includes:

- Fully assembled PowerWheel
- LED light strip
- Bridge rectifier
- All wiring necessary to convert the AC output to DC (for powering battery-powered devices)
- User's manual with mini-lessons and suggestions for use

Lesson Plans:
What You Need to Know

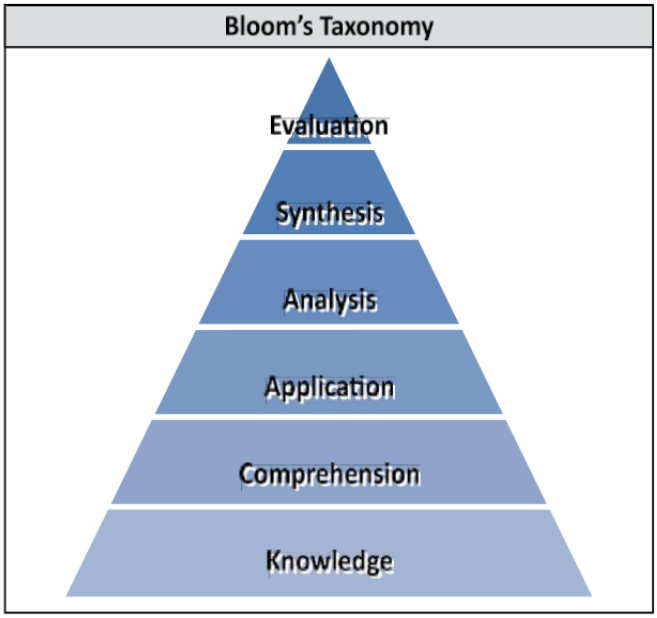
As you review the activities in this document, keep in mind:

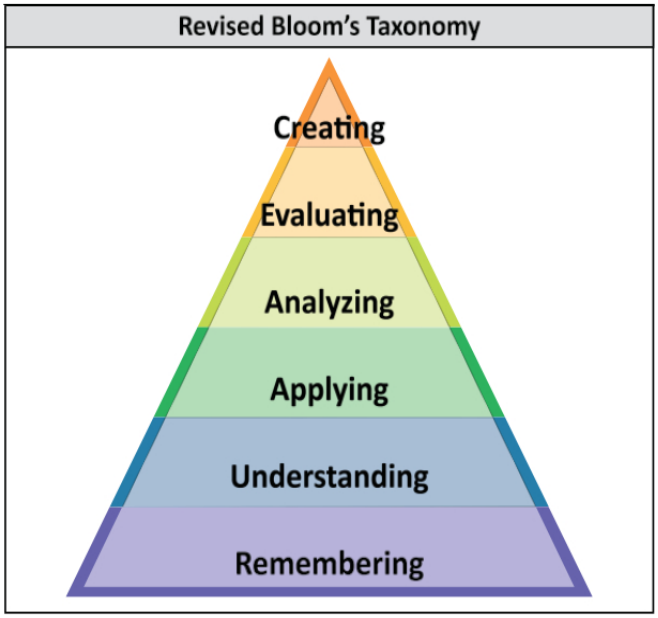
- These lessons are a baseline; you can always change, expand, or modify them to meet your specific curriculum needs and grade level.
- They are aligned with the National Science Standards.
- The questions that are included are based upon Bloom's Taxonomy. We want to encourage all educators to utilize teaching techniques that support and promote students pushing up the taxonomy to the Synthesis-Evaluation-Creating level of learning.

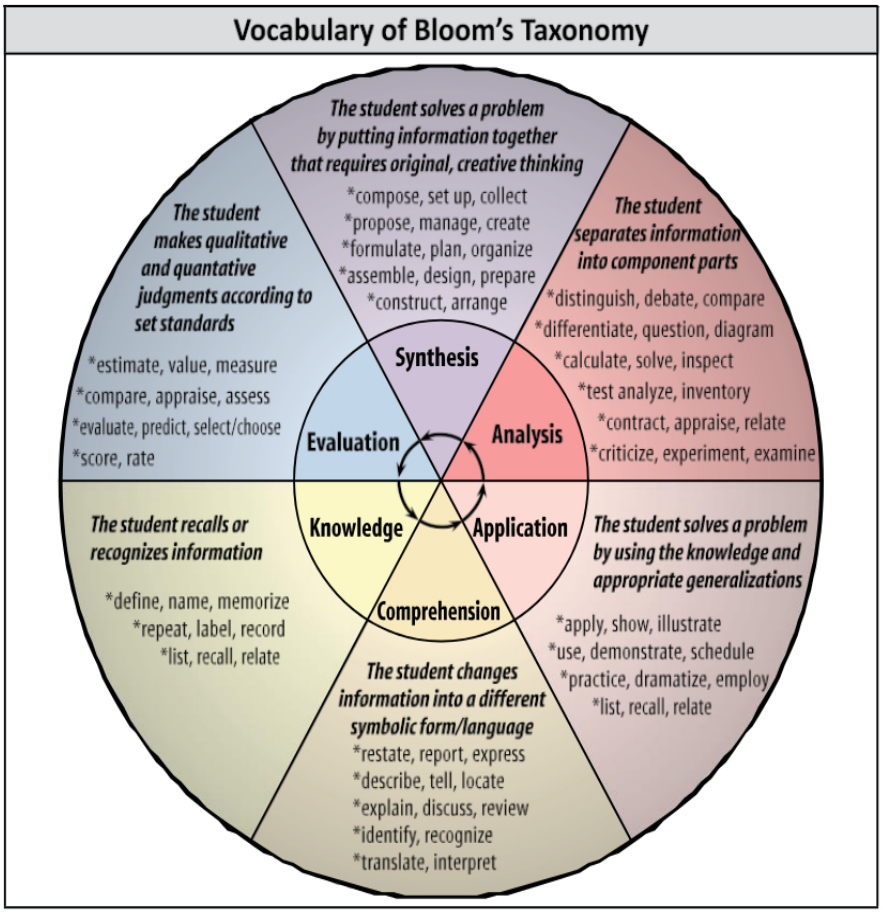
5 Francis J. Clarke Circle, Bethel, CT 06801

Phone (203) 74-TEACH (83224)
www.TeacherSource.com

Bloom's Taxonomy







Parts of the Power Wheel

Suggested Grade Level: Grades 5-12

Time Needed: 30 minutes

Equipment Needed: PowerWheel

Pre-Lesson Set-Up: Check the manual to review the parts of the PowerWheel, and review the questions provided below.

Teacher Instructions:

- Hold up a PowerWheel and ask students to list everything they see on a piece of paper. Remind them to be as specific as possible. (This teaches observation skills.)
- Using the questions below, conduct an inquiry lesson so that students can determine the purpose, abilities, and limitations of the PowerWheel.

Student Questions:

1. What are the different parts/things that you see when you look at the PowerWheel?
2. Have you seen these parts before?
3. Where have you seen any of these parts before?
4. How have you seen these parts used before?
5. What do you think each of these parts does?
6. Based upon your observations what do you think the PowerWheel does?

   After fielding answers to question 6 is a great time for the students to see the PowerWheel in action. For instance, use the PowerWheel to power up the LED light string and any other attachment.

7. In general terms, explain how the PowerWheel works.

   Have the students describe how it works, step by step. For instance, the first step is turning on the water. Then what happens? What happens next? You may have to demonstrate the PowerWheel a few times.

8. What can the PowerWheel do?
9. Do you think the PowerWheel could provide enough electricity to charge your cell phone? Power up a laptop computer? Start a car? Turn on the lights in your house?
10. What are some things that you think the PowerWheel can't do?
11. Why do you think the PowerWheel can't do those things?

Discovering Types of Energy

Suggested Grade Level: Grades 5-12

Time Needed: 30 minutes

Equipment Needed: PowerWheel

Pre-Lesson Set-Up: Prepare a short definition of each type of energy: POTENTIAL, KINETIC, MECHANICAL, ELECTROMAGNETIC, RADIANT, and CHEMICAL. Next, prepare a handout that lists the different types of energy. Leave the definitions blank for students to either discover or write down as they watch the demonstration.

Teacher Instructions:

- List the types of energy on the board: POTENTIAL, MECHANICAL, KINETIC, ELECTROMAGNETIC, RADIANT, and CHEMICAL.
- Have students try and guess which one fits as you proceed to demonstrate the "conversion" points on the PowerWheel.
- Turning on the PowerWheel, point out the following:
    - The water in our pressurized residential water supply has POTENTIAL ENERGY.
    - Once the water (mass) is flowing, it has KINETIC ENERGY.
    - The water running through the PowerWheel turbine is converted into MECHANICAL ENERGY.
    - The MECHANICAL ENERGY is transmitted by the drive belt and pulleys to the generator and is converted into ELECTROMAGNETIC ENERGY.
    - If connected to the light strand, this ELECTROMAGNETIC ENERGY can be converted into RADIANT ENERGY.
    - If hooked to the cell phone, this ELECTROMAGNET ENERGY can be converted into CHEMICAL ENERGY.

Student Questions:

1. How would you define Potential Energy, Mechanical Energy, Kinetic Energy, Electromagnetic Energy, Radiant Energy, and Chemical Energy?
2. Can you identify these types of energy in other places/situations?

PowerWheel Snapshot Lessons

"Five-minute lessons remembered for a lifetime"

By encouraging observation, asking questions, and promoting students to look, listen, and think, we can help them become better prepared to make informed decisions about energy.

Each of these five-minute lessons can be done separately or in a sequence, depending upon your priorities and time allowed.

Snapshot 1: Seeing and hearing how electricity is made using hydro power.

Snapshot 2: Showing how the PowerWheel works.

Snapshot 3: Comparing types of light bulbs (LED and incandescent).

Snapshot 4: Determining if we save energy when we turn off the lights in our homes when not in use.

Suggested Grade Level: Grades 3-12

Time Needed: 5-10 minutes per snapshot lesson

Equipment Needed: PowerWheel, LED lights, incandescent light

Pre-Lesson Set-Up: Watch the PowerWheel video (https://youtu.be/UPxw3fGFeh8) to review the process of doing each "snapshot." Start at 1:57 and continue watching until the 4:50 mark.

Snapshot 1: Demonstrate the PowerWheel as a micro-hydro generator.

Have the observers help you define these words:

Micro=small

Hydro=water

Generator=going to make something

Summarize: The PowerWheel is using water to make something—in this case, electricity.

The PowerWheel is an example of how energy and electricity are created using hydro power.

Offer local examples of hydro power around you that utilize dams, rivers, turbines, or other methods of creating hydro electric power.

Snapshot 2: Demonstrate how the PowerWheel works to make electricity.

Explain that you are going to use tap water to make electricity. You should have the PowerWheel hooked up to the LED lights. Turn on the water and watch the LED lights glow.

Turn water off and ask the observers to watch and tell you what happens when you turn on the water again. What do they see? What do they hear? What do they think is happening?

Encourage them to identify each step and be specific, such as: *the water turned on, the pelton wheel turned, which turned the pulleys, which turned the generator shaft, which created the electricity which lit the string of LED lights.*

Ask observers: How do I make the lights even brighter?

More water = more water pressure = turbine goes faster = pulley wheels go faster = generator shaft turns faster = more electricity created = brighter lights.

Summarize: The PowerWheel is a micro-hydro generator that uses water to create electricity. Go through the specific steps with the observers again.

Snapshot 3: Comparing LED to incandescent lights.

Get LED lights to a moderate level of brightness where the PowerWheel is not working very hard. (You can tell by the sound.)

Unhook the LED lights but keep PowerWheel and water running.

Show the observers the incandescent bulb. Ask, "If I hook up this bulb to the PowerWheel and don't change the amount of water going through the PowerWheel—thus not changing the amount of electricity being produced—will I get the same amount of light, less light, or more light than I got from the LED lights?

Listen to their answers and ask them to expand on what they thought would happen. For instance:

More = bulb is bigger so there will be more light.

Less = takes more energy because it is bigger/older…will create heat etc.

The same = amount of electricity is same.

Hook up the incandescent bulb to PowerWheel. Ask observers, What do they see? What do they hear? What do they think is happening? Who was right? Was there more, less or the same amount of light?

Ask observers, How do I make the lights get brighter?

More water = more water pressure = turbine goes faster = pulley wheels go faster = generator shaft turns faster = more electricity created = brighter light.

Turn on more water.

Ask observers, What do they see? What do they hear? What do they think is happening? Were they correct in their predictions? Which light bulbs are most efficient? What type would they buy if they wanted to use the least amount of electricity?

Summarize: There are choices that everyone can make to save electricity and energy, including what type of light bulbs we choose to use.

Snapshot 4: Does turning off the lights save energy and electricity?

Using the incandescent light, turn up the water to make the incandescent light brighter. Tell your observers that you are going to unplug the light. Instruct them to listen to the PowerWheel.

Unplug the incandescent light.

What do they see? What do they hear? What do they think is happening?

Explain that the faster turbine turning and the higher level of noise is because the PowerWheel is not having to work as hard. In other words, the "load" of work is off, and the PowerWheel can now be turned down. This saves electricity, energy and water.

You can illustrate this in another way: imagine if you draped yourself over the back of another individual and had them drag you to the other side of the room. If you suddenly released yourself from that person, would they be able to walk faster or would they go slower? Releasing the load on the PowerWheel turbine by turning off the light allows the PowerWheel to go faster. We don't need the power, so we can turn down the water source and save energy and electricity.

Summarize: We make choices every day when it comes to saving energy. What kind of choices are there? What choices do you make?

Extra Credit:

In any of the snapshots above, you can use the various gear ratios available on the PowerWheel to set up a whole different set of observations and questions. For example:

- What gear ratio will make the PowerWheel use the most energy to turn on the LED lights?
- What gear ratio will make the PowerWheel use the least energy to turn on the LED lights?
- If I want the PowerWheel to run even faster, what gear ratio would I use?
- Will changing the gear ratios help make the lights become brighter?
- If I want to turn the largest pulley by hand, which gear ratio would make it easiest for me to light up the LEDs?

NGSS Correlations

Our Power Wheel and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

4-PS3-2
Students can make observations of the Power Wheel to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS3-4
Students can use the Power Wheel in an investigation to apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Middle School

MS-PS2-3
Students can make observations of the Power Wheel and use the data collected in an investigation to ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-5
Students can make observations of the Power Wheel and conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

MS-PS3-5
Students can use the Power Wheel in an investigation to construct, use, and present arguments to support the claim that when the motion energy of any object changes, energy is transferred to or from the object.

High School

HS-PS2-5
Students can plan and conduct an investigation with the Power Wheel to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

HS-PS3-1
Students can plan and conduct an investigation with the Power Wheel to collect data for use in a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-3
Students can plan and conduct an investigation with the Power Wheel to design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-PS3-5
Students can plan and conduct an investigation with the Power Wheel to develop and use a model of two objects interacting through electric or magnetic fields to illustrate forces between objects and the changes in energy of the objects due to the interaction.

Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons. For us, "*Teachers Serving Teachers*" isn't just a slogan—it's our promise to you!

Please visit our website for more lesson ideas:

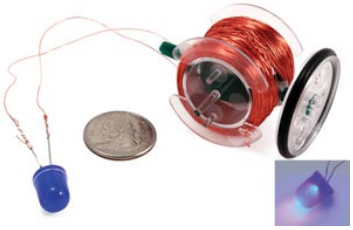
TeacherSource.com/lessons

Check our blog for classroom-tested teaching plans on dozens of topics:

http://blog.TeacherSource.com

To extend your lesson, consider these Educational Innovations products:

Transparent Alternator Kit (GRN-200)



Our ingenious Transparent Alternator Kit takes the mystery out of how electricity is produced. This little device can be assembled easily in 20 minutes without tools. That's when the discoveries begin! What can you power with your alternator? How is electricity generated from a magnet and some copper wire? A wonderful hands-on introduction to electricity. With modifications, you can produce enough electricity to charge a cell phone!

Light Bulb Experiment Kit (OHM-300)

Demonstrate the difference between parallel and series circuits in a way that students can easily understand. This kit contains 4 Light Bulb Holders with Fahnestock Clips, 4 pairs of wires with alligator clips, 10 Miniature Light Bulbs, 8 D Cell Battery Holders, and 8 D batteries.

HomoMotor Kit (KIT-700)

Introduce your students to one of the simplest devices, the homopolar or 'one pole' electric motor. Credited to Michael Faraday, it does not involve the polarity change of more complex motors. Includes instructions to make three styles of HomoMotors: pinwheel, spiral, and butterfly. Students build the motor, make it run, and can then break it down to make a different one.

Hand-Powered Flashlight (SS-234)

Change kinetic energy from your hand into light energy. This hand-held 'dynamo' is easily visible. It clearly demonstrates how electrical energy can be produced by moving an electrical conductor through a magnetic field—a discovery made by Michael Faraday in 1831. This unit has a built in non-rechargeable, non-replaceable battery that can provide light for many hours showing the efficiency of modern LED lighting technology. However, no batteries are ever required—no bulbs to replace.