# *Power of the Waterwheel*

## A Lesson on Power and Work

Lesson based

### *Objective*

Students will create a waterwheel and measure mass, distance, and time to calculate force, work, and power. Students will practice math skills as well as draw connections between force, work, power, and how they relate to hydropower in engineering.

### *Mentors Scientific Background*

Force is the measure of mass times acceleration. In the case of a hanging mass its gravitation force (weight) can be measured with the acceleration due to gravity.

*Force = Mass x g* *where g~10*

Work is defined as the amount of energy transferred by a force acting over some distance.

*Work = Force x Distance*

Power is the rate at which work is performed. The average power over a certain period of time is calculated using the amount of work performed in that time.

*Average Power = Work / Time*

We will calculate power and work by measuring force, distance, and time.

Hydropower is defined as power that is derived from the energy of moving water.

### *Introduction to challenge*

Discuss the basic scientific concepts of force, work, power, and how they relate. Give examples of how engineers use these concepts and equations in real-life projects (i.e. civil, mechanical, and electrical engineers collaborate on the construction of dams that generate electricity from the flow of water). Explain the concept of hydropower. Students should brainstorm in groups.

### *Instructions*

Be sure to explain how the set up should look and how the water will be poured onto the wheel.

1. Attach the index cards to the two-liter bottle to create water wheel. (This is where students can be creative in their design)
2. Tie the string to the cap-end of the bottle so that the string can wrap-up around the neck of the bottle it rotates along the rod.
3. Attach the 100g weight to the loose end of the string. The mass should be wound up around the neck of the bottle as it spins under the water.
4. Measure the mass of the hanging weight and record on worksheet.
5. Test the waterwheels in a group competition. Pour water from about 4 inches above index cards through the funnel (for even flow). Test outside. Students should hold their dowel rod, while a mentor pours the water (to ensure consistency).
6. Time how long it takes to life the mass .5 meters. Record on worksheet.
7. Have students complete worksheet, calculating force, work, and power.
8. Record what each team gets for their power, and announce a winner.

### *Closing*

Discuss why each team calculates about the same amount of work. Question students as to why they think that team had the most power (based on the equations). Also discuss and explain why the fastest spinning water wheel generated the most power.

*Materials (one set per group)*

¼ inch dowel rod, about 2 feet
2-liter bottle, with hole drilled through cap and bottom
5 index cards, tin foil, cardboard
1 meter of string
Scissors
Tape
60 gram weight (tennis ball)
Stopwatch
Scale
Water bottle
Funnel
Worksheet

*Resources*

http://www.teachengineering.com/view_activity.php?url=http://www.teachengineering.com/collection/cub_/activities/cub_energy/cub_energy_lesson02_activity1.xml

http://www.need.org/needpdf/infobook_activities/SecInfo/HydroS.pdf

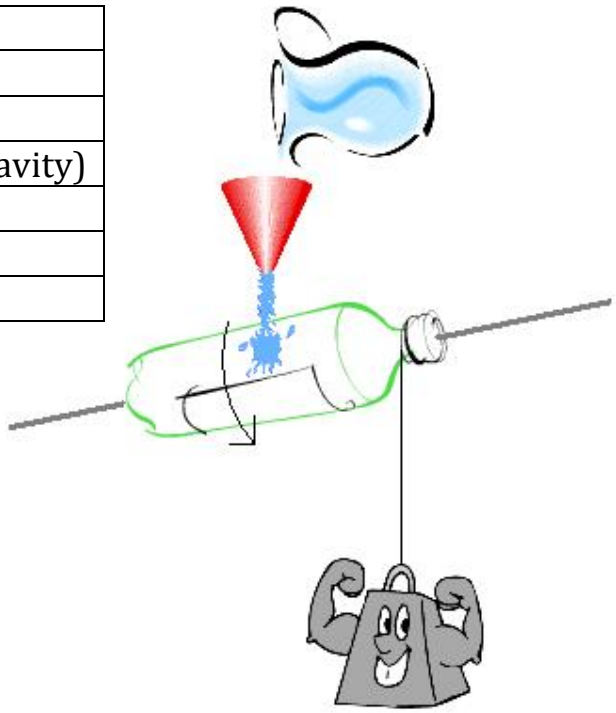
*Worksheet*

Have students record their data and perform their calculations on the following worksheet

Name:_____

Record your data here:

| | |
|---|---|
| **Mass** (kilograms) | |
| **Distance traveled** (meters) | |
| **Time** (seconds) | |
| **Acceleration** (meters/second$^2$) | ~10 (from gravity) |
| **Force** (Newtons) | |
| **Work** (Joules) | |
| **Power** (Watt) | |





Calculate the work done by your waterwheel:

Work = Force x Distance

Calculate the power your waterwheel produced:

Power = Work / Time

What is Hydropower?