Energy can be changed from one form to another. When you peddle a bike, your body uses up stored food energy (in calories) and converts this into kinetic energy of motion measured in joules. When you connect an electric motor to a battery, electrical energy stored in the battery is converted into rotational kinetic energy causing the motor shaft to turn.

A millstone paddle wheel uses the gravitational energy of falling water to turn the millstone wheel and perform work by grinding wheat, or even running simple machinery to cut wood in a lumber mill.

The energy in Joules of an object falling from a height near the surface of Earth can be calculated from

$$E = mgh$$

where m is the mass of the falling body in kilograms, g is the acceleration of gravity (9.8 meters/sec^2) and h is the distance of the fall in meters.

Problem 1 – Nevada Falls in Yosemite Valley California has a height of 180 meters. Every second, 500 cubic feet of water goes over the edge of the falls. If 1 cubic foot of water has a mass of 28 kilograms, how much energy does this waterfall generate every day?

Problem 2 – For a science fair project, a student wants to build a water hose powered hydroelectric plant to run a light bulb. Every second, the light bulb needs 60 Joules to operate at full brightness. If the water hose produces a steady flow of 0.2 kilograms every second, how high off the ground does the water hose have to be to turn a paddle wheel to generate the required electrical energy?

Problem 3 – A geyser on Saturn's moon Enceladus ejects water from its caldera with an energy of 1 million Joules. If g = 0.1 meters/sec^2, and the mass moved is 2000 kilograms, how high can the geyser stream travel above the surface of Enceladus?

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Answer: 1 day = 24 x 60 x 60 = 86,400 seconds, then the total mass is 500 x 28 x 86400 = 1.2 billion kilograms. E = 1.2 billion kg x 9.8 x 180 = **2.1 trillion joules** per day. Note: since 1 watt = 1 Joule/second, this waterfall has a wattage of 500 x 28 x 9.8 x 180 = 25 megawatts.

Problem 2 – For a science fair project, a student wants to build a water hose powered hydroelectric plant to run a light bulb. Every second, the light bulb needs 60 Joules to operate at full brightness. If the water hose produces a steady flow of 0.2 kilograms every second, how high off the ground does the water hose have to be to turn a paddle wheel to generate the required electrical energy?

Answer: 60 = 0.2 x 9.8 x h so h = **30.6 meters** (or 90 feet!).

Problem 3 – A geyser on Saturn's moon Enceladus ejects water from its caldera with an energy of 1 million Joules. If g = 0.1 meters/sec^2, and the mass moved is 2000 kilograms, how high can the geyser stream travel above the surface of Enceladus?

Answer: 1,000,000 = 2000 x 0.1 x h, so h = **5,000 meters or 5 kilometers**.