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 \( g = 0.1 \text{ meters/sec}^2 \), and the mass moved is 2000 kilograms, how high can the geyser stream travel above the surface of Enceladus?
**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?

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. \( E = 1.2 \text{ billion kg} \times 9.8 \times 180 = 2.1 \text{ trillion joules} \) 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: \( 60 = 0.2 \times 9.8 \times h \) so \( h = 30.6 \text{ meters} \) (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 \( g = 0.1 \text{ meters/sec}^2 \), and the mass moved is 2000 kilograms, how high can the geyser stream travel above the surface of Enceladus?

Answer: \( 1,000,000 = 2000 \times 0.1 \times h \), so \( h = 5,000 \text{ meters or 5 kilometers} \).