

# Energy Transfer - Generator

Model No. ET-8771B



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## Table of Contents

<b>Equipment List.....</b>	<b>3</b>
<b>Introduction.....</b>	<b>4</b>
<b>Basic Setup.....</b>	<b>4</b>
<b>Collecting Data with the ET-Generator.....</b>	<b>5</b>
<b>Alternate Setup Options (Attaching Accessories).....</b>	<b>6</b>
a) Attaching the ET-Flywheel Accessory (ET-8773) to the ET-Generator.....	6
b) Attaching the ET-Gearing Accessory (ET-8775) to the ET-Generator.....	7
c) Attaching the ET-Hydro Accessory (ET-8772) to the ET-Generator.....	8
d) Attaching the ET-Wind Turbine Accessory (ET-8783) to the ET-Generator.....	9
<b>Suggested Experiments.....</b>	<b>11</b>
Experiment 1: Understanding Power and Energy Transfer with an AC Generator.....	11-13
Experiment 2: Investigating Rotational Kinetic Energy with a Flywheel.....	14-15
Experiment 3: Investigating the Concepts of Gear Ratios and Mechanical Advantage.....	16-17
Experiment 4: Using a Turbine to Understand Hydroelectric Power Generation.....	18-20
<b>Appendix A: Specifications.....</b>	<b>21</b>
<b>Appendix B: DataStudio Setup Instructions.....</b>	<b>21</b>
<b>Appendix C: Technical Support.....</b>	<b>22</b>
<b>Appendix D: Copyright and Warranty Information.....</b>	<b>23</b>

# Energy Transfer - Generator

Model No. ET-8771B

## Equipment List



Included Equipment	Replacement Model Number
1. Energy Transfer - Generator Assembly	003-12194
2. Pulley, three-step	648-10122
3. Knob, Energy Transfer - Generator	648-10434
4. Plug with Red/Green Light Emitting Diode (LED)	003-06188
5. Plug with 100 ohm Resistor	003-08431
6. Spool of thread	699-011

Optional Accessories (for use with ET-Generator)	Model Number
Energy Transfer - Flywheel Accessory	ET-8773
Energy Transfer - Gearing Accessory	ET-8775
Energy Transfer - Hydro Accessory	ET-8772
Energy Transfer - Wind Turbine	ET-8783

Additional Equipment Recommended	Model Number
PASCO Computer Interface and Data Acquisition Software	Various (See PASCO catalog)
Voltage Sensor (with banana plugs)	PS-2115 or CI-6503
Large Rod Base and Stainless Steel Rod (90 cm)	ME-8735 and ME-8738
Hanging Mass Set	SE-8759
No-Bounce Pad	SE-7347

## Introduction

The Energy Transfer - Generator (ET-8771B) is used for demonstrating the conversion of stored gravitational potential energy into electrical energy.

The generator includes a 3/4 inch neodymium magnet, which spins between two 400-turn coils, and is visible inside a semi-clear plastic housing. A plastic rod clamp is molded to the generator for attaching the housing to a support rod.

Two plug attachments, a light-emitting diode (LED) plug and 100-ohm resistor plug are included. Both the LED and resistor plug insert into the banana jack outputs on the generator's housing. Each plug contains two jacks for connecting a voltage sensor to the generator for collecting data with a computer.

The LED plug allows the user to visually see the electrical effects of turning the shaft on the generator. As the student rotates the generator, the LED lights. The resistor plug is recommended for use with sensors, so the student can measure the effects of generator rotation on power, voltage, and energy.

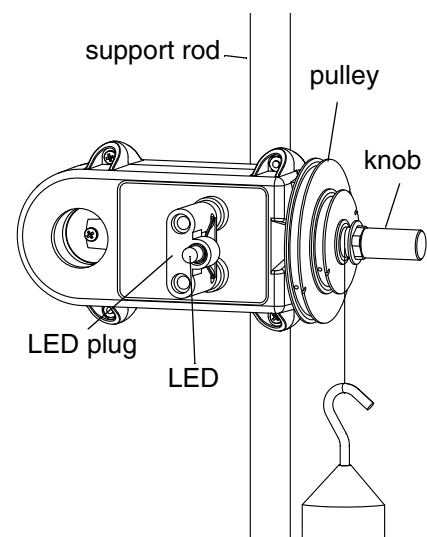
A three-step pulley keys into the shaft on the side of the housing and is removable. The ET-Flywheel Accessory (ET-8773), ET-Hydro Accessory (ET-8772), ET-Gearing Accessory (ET-8775), and ET-Wind Turbine attach to the generator's molded shaft and are recommended for other types of energy transfer experiments.

## Basic Setup

**Note:** The basic setup uses a pulley and hanging mass. If you have purchased accessories for the ET-Generator, see “Attaching Accessories to the Generator” later in this manual.

### Attaching a Pulley with Hanging Mass to the ET-Generator

1. Use the rod clamp on the side of the ET-Generator to mount the generator to a support rod.
2. Insert the LED plug into the jacks on the generator (Figure 1a).



**Figure 1a: Mounting the generator on a support rod**

3. To attach the pulley, align the tab on the inner hole of the pulley with the indented slot on the black shaft on the generator; then slide the pulley onto the shaft. Fasten the knob on the screw to hold the pulley in place.
4. Cut a small piece of no-bounce foam, and place the foam underneath the hanging mass (Figure 1b).
5. Cut a piece of string to tie to the hanging mass and pulley (Figure 1b).
6. Tie a double knot in the string and hook the knot in the notch on the edge of the second step of the pulley.
7. Attach the other end of the string to the hanging mass.
8. Wind the string up on the smallest step of the pulley such that the string falls out when the mass reaches the bottom of the foam pad.
9. Adjust the position of the hanging mass or the height of the generator so that the knot slips out just as the mass reaches the foam.)



**Figure 1b: Basic Setup with Mass**

## Collecting Data with the ET-Generator

**Note:** For real-time data collection, a computer interface is required.

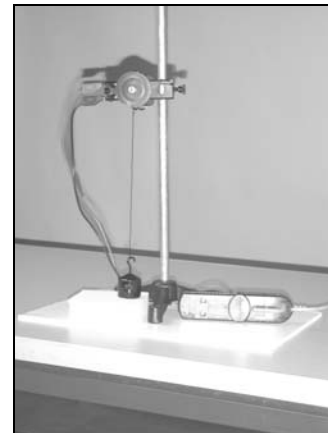
1. Insert the resistor plug into the jacks on the generator.

**Note:** For electrical studies, use the resistor plug\* and a Voltage Sensor.

2. Connect a Voltage Sensor to a computer interface (PASPORT or ScienceWorkshop) connected to DataStudio.

**Note:** If you are using a PASPORT Voltage Sensor (PS-2115), a PASPORT computer interface is required. If you are using a *ScienceWorkshop* Voltage Sensor (CI-6503), a *ScienceWorkshop* computer interface is required.

3. With the Voltage Sensor, connect the black banana plug to the black jack and red banana plug to the red jack on the ET-Generator.
4. Setup your experiment in DataStudio. (For the DataStudio setup procedure, see Appendix B of this manual.)



**Figure 2: Setup for data collection**

- In DataStudio, click the **Start** button. Let the mass fall, and record the power or other measurement in DataStudio.

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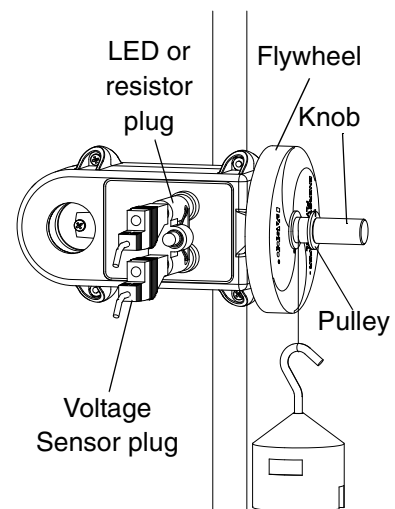
*\*Note: The LED (light-emitting diode) plug is used for demonstration, rather than data collection. The LED on the plug emits a green flash when the current is in one direction and a red flash when the current is in the opposite direction. The lights coincide with the turn rate of the pulley, so the change is usually too fast for the human eye to detect. The viewer may see a combination of red and green colors in any one instant.*

## Alternate Setup Options

The ET-Generator can also be used with the ET-Flywheel Accessory (ET-8773), ET-Gearing Accessory (ET-8775), or the ET-Hydro Accessory (ET-8772). This section outlines the instructions for attaching these three accessories to the ET-Generator.

### A. Attaching the ET-Flywheel Accessory (ET-8773) to the ET-Generator

- Mount the Generator to a rod stand in a horizontal orientation.
- Remove the three-step pulley from the ET-Generator.
- Slide the flywheel onto the generator shaft. Align the metal pin on the back of the flywheel with one of the holes on the square-shaped flange on the shaft. Secure with the knob.
- Tie a length of thread to a 50 g hanging mass.
- Tie a double knot in the thread and hook the knot in the slot on the pulley on the front of the flywheel. Turn the flywheel to wind up the thread on the pulley.



**Figure 3: Generator with Flywheel Accessory**

**Note:** To collect data, insert a resistor plug or LED plug into the banana jacks, connect banana plugs from a Voltage Sensor into the plug, and click the **Start** button in DataStudio. When you release the flywheel and the mass falls, data appears in a display. (For DataStudio setup instructions, see Appendix B.)

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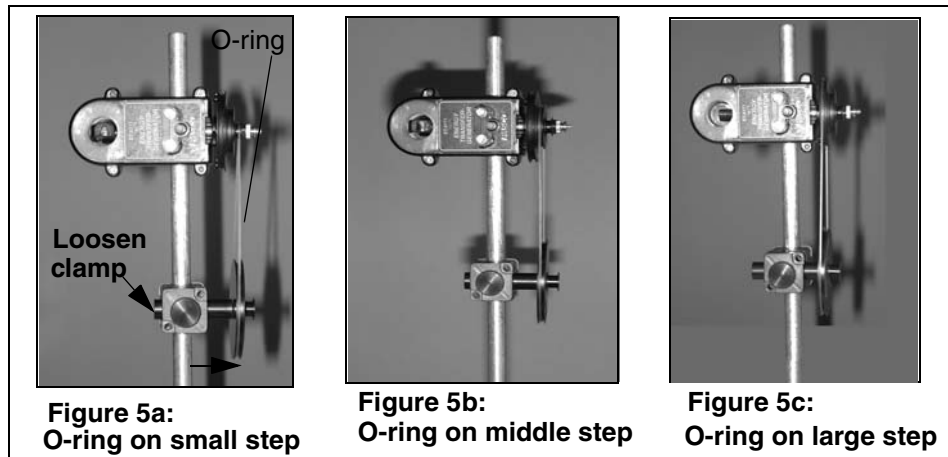
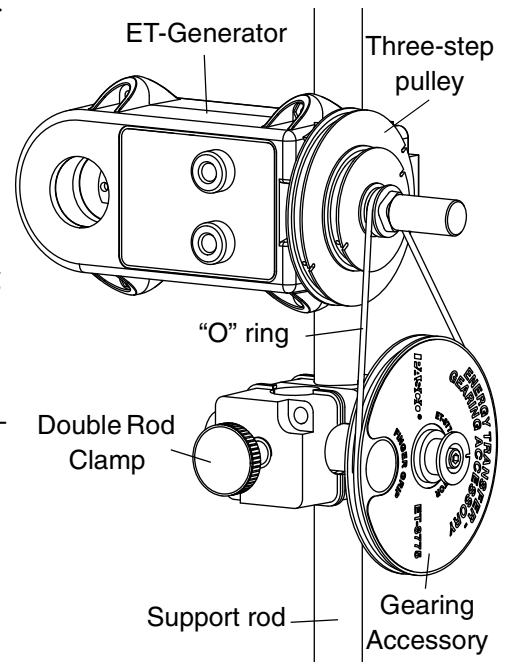
*Note: The ET-Flywheel is typically used for studies of rotational kinetic motion. For power and efficiency comparison studies, collect separate data runs with the 3-step pulley, ET-Flywheel, and ET-Gearing Accessory. (For more information, see Experiments 2 and 3 in this manual.*

### B. Attaching the ET-Gearing Accessory (ET-8775) to the ET-Generator

- Slide the double rod clamp (provided with the Gearing Accessory) over a rod stand. Use the thumbscrew on the clamp to secure the clamp to the rod. Move the clamp down about one-half the length of the rod.

**Note:** The Gearing Accessory is typically used for studying the effects of gear ratio on power output. For a gear ratio experiment, see Experiment 3 in this manual.

2. Insert the shaft of the Gearing Accessory into one of the holes on the rod clamp. To hold the Gearing Accessory in place, tighten the thumbscrew on the rod clamp. Put the rod clamp on the support rod.
3. Slide the ET-Generator over the rod in a horizontal orientation (about 3 inches above the Gearing Accessory) such that the generator's shaft is pointing in the same direction as the Gearing Accessory's shaft.
4. Wrap the "O" ring around the large pulley on the ET-Gearing Accessory and over one of the steps on the 3-step pulley. The position of the Gearing Accessory can be changed up or down to tighten the "O" ring. Do not overstretch the ring. (See Figures 5a-c).
5. Vertically align the Gearing Accessory with a step on the three-step pulley. If necessary, move the accessory in and out, and/or up and down to line up. (**Note:** The screw on the rod clamp can be loosened to move the Gearing Accessory horizontally for alignment with any step on the three-step pulley.)



6. Cut a 30 centimeter (cm) or 1 foot (or longer) piece of thread and tie an open knot in both ends of the thread. Attach one end to a hanging mass and one end to the shaft on the Gearing Accessory.

**Note:** For load studies, tie a double knot in both ends of the thread. You must have enough tension in the thread to hold the weight and perform experiments. When the Gearing Accessory is used, do not hang the weight from the pulley.

**Optional:** The ET-Flywheel Accessory can also be attached to the ET-8775 Gearing Accessory. Replace the 3-step pulley with the flywheel and connect both with the O-ring.

**Note:** To collect data, insert the resistor plug into the banana jacks, connect banana plugs from a Voltage Sensor into the resistor plug, and click the **Start** button in DataStudio. When you rotate the gear, the mass falls, and data appears in a display. (For DataStudio setup instructions, see Appendix B.)

### C. Attaching the ET-Hydro Accessory (ET-8772) to the ET-Generator

1. Attach the ET-Hydro Accessory housing to the molded case of the ET-Generator (ET-8771B) using the two captured screws and the supplied screwdriver.
2. Put the turbine blade on the shaft and tighten the ET-Generator knob onto the shaft screw. Put a finger in the recess of the housing and hold the magnet to keep it from turning.
3. Insert the pointed end of a plastic nozzle into the spring clip in the turbine housing..

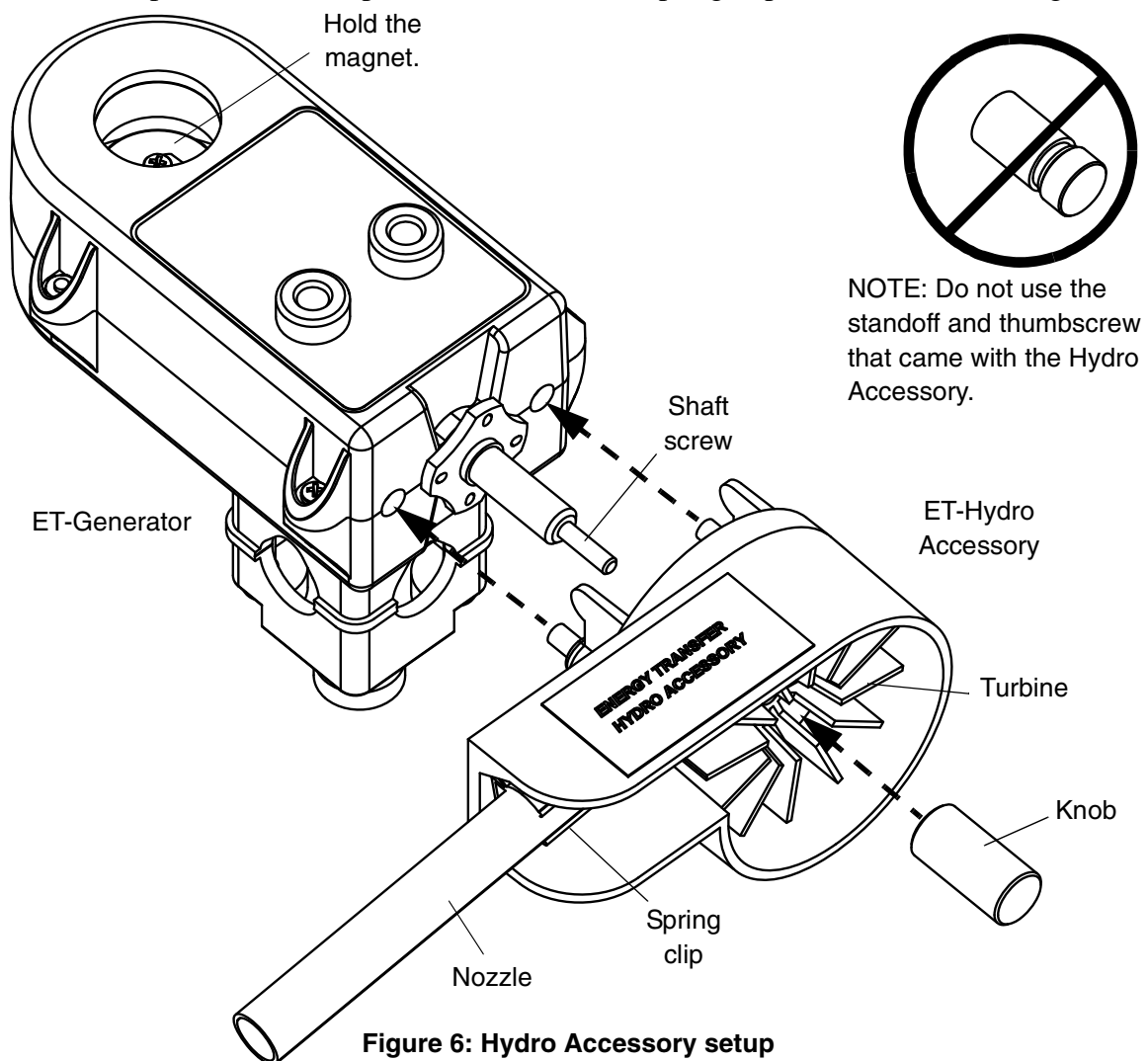


Figure 6: Hydro Accessory setup



**Note:** The clip can turn to adjust where the water stream from the nozzle hits the turbine. To increase the water flow, cut or trim the nozzle end.

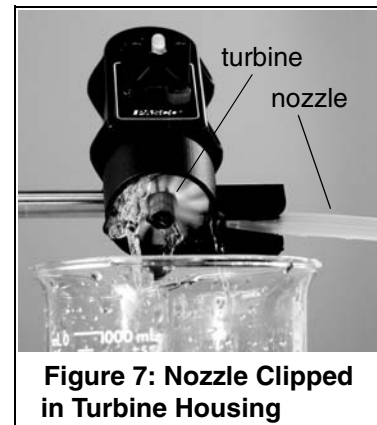
4. Connect the nozzle to a piece of tubing connected to an external water supply. (Figure 7).

**Note:** Have a beaker or container below the housing to collect water exiting the turbine.

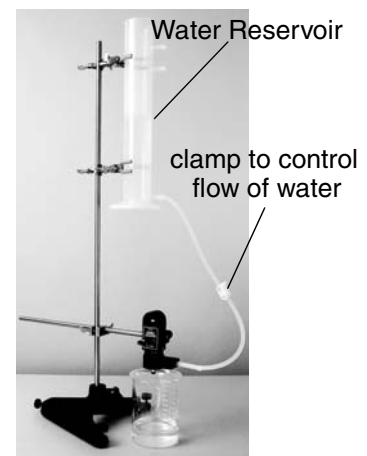
5. Run the water supply through the nozzle of the turbine and watch the turbine spin.

**Note:** To collect data, insert the 100-ohm resistor plug into the banana jacks, connect banana plugs from a Voltage Sensor into the resistor plug, and click the **Start** button in DataStudio. When you run water through the turbine, data appears in a display. (For DataStudio setup instructions, see Appendix B.)

**Note:** The ET-Hydro Accessory is typically used for studies of hydroelectric power generation. See Experiment 4 in this manual.



**Figure 7: Nozzle Clipped in Turbine Housing**



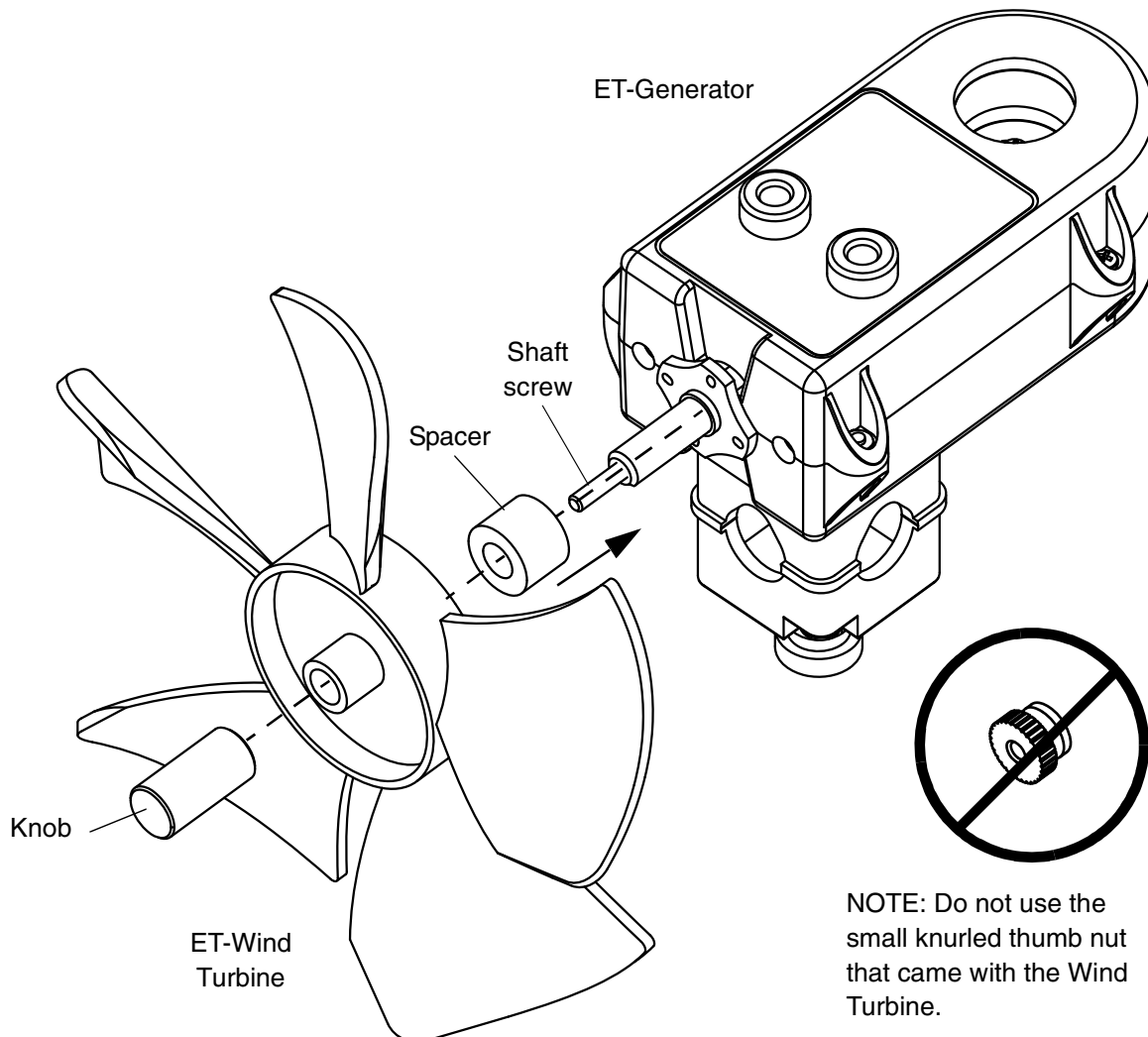
**Figure 8: Typical Setup**

#### D. Attaching the ET-Wind Turbine (ET-8783) to the ET-Generator

1. Remove the three-step pulley from the ET-Generator.
2. Slide the small spacer that comes with the Wind Turbine onto the generator shaft.
3. Push the Wind Turbine onto the generator shaft so that the blades of the turbine curve away from the generator. Note that the wind turbine is designed to fit tightly on the generator shaft.
4. Screw the ET-Generator knob onto the shaft. (Do not use the small thumb nut that came with the wind turbine.)
5. Insert the LED plug into the jacks on the generator and blow on the wind turbine.

**Note:** To collect data, replace the LED plug with the 100-ohm resistor plug, connect banana plugs from a Voltage Sensor into the resistor plug, and click the **Start** button in DataStudio. When air

blows through the wind turbine, data appears in a display. (For DataStudio setup instructions, see Appendix B.).



**Figure 9: Wind Turbine Setup**

## Suggested Experiments

### Experiment 1: Understanding Power and Energy Transfer with an AC Generator

Equipment Required	
ET-Generator (ET-8771B)	Computer interface ( <i>ScienceWorkshop</i> or <i>PASPORT</i> )
DataStudio Software	Voltage Sensor (PS-2115 or CI-6503) with banana plugs
Large Rod Base (ME-8735)	Stainless Steel Rod (ME-8738)
No-Bounce Foam (SE-7347)	Hanging Mass Set (SE-8759)

#### Setup:

In the “Basic Setup” section of this manual, follow the setup instructions under part A. Attaching the Pulley with Hanging Mass to the ET-Generator.

#### Procedure

1. For demonstration: Insert the plug with the light-emitting diode (LED) into the banana jacks and watch the LED light as you turn the generator (Figure 1-2). The red/green light diode shows that the generator produces an AC voltage.
2. With banana jacks, connect a voltage and/or current sensor to the banana plug outlets. In DataStudio, set the sample rate between 500 to 1000 Hz to show the AC signal. (For DataStudio setup instructions, see Appendix B of this manual.)
3. In DataStudio, create a graph of power vs. time. In DataStudio, click the **Start** button and rotate the pulley. DataStudio measures the amount of energy generated. (Note: The area under the curve is energy).

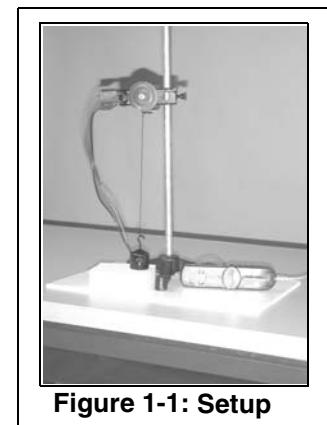


Figure 1-1: Setup

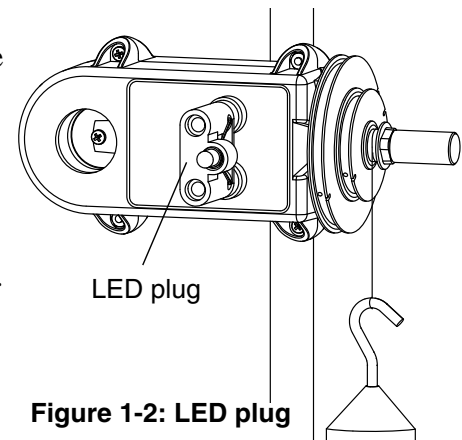


Figure 1-2: LED plug

#### Analysis

1. Using just a Voltage Sensor (either *PASPORT* or *ScienceWorkshop*): Calculate the power dissipated in the known resistor using the equation  $P=V^2/R$ .
2. Using a *PASPORT* Voltage/Current sensor: Calculate the power dissipated in the resistor using the equation  $P=IV$ .
3. Calculate the change in gravitational potential energy, where  $PE = mgh$ .

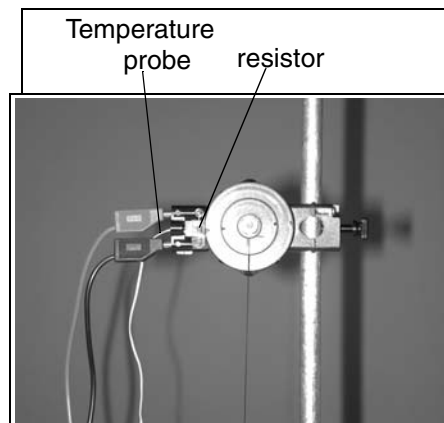
- From the area under the graph, record the electrical energy generated.
- Calculate the efficiency (percent of energy transferred) using the equation,  $\text{efficiency} = \text{energy generated}/mgh \times 100$ . Where does the rest of the energy go?

### Experiment Variations

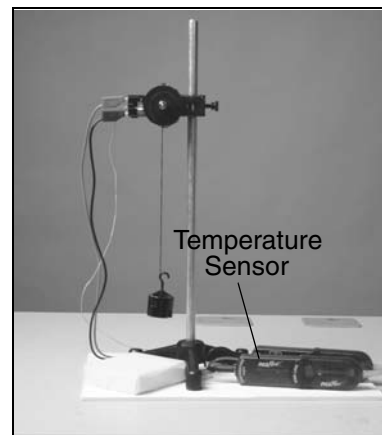
- Vary the height:** Change the generator's height (distance mass falls) to one-half of original value. Does the percent of energy transferred (efficiency) increase, decrease, or remain about the same?
- Vary the mass:** Return the generator's to its original height (distance to ground). Change the falling mass to 50 g. Does the percent of energy transferred increase, decrease, or remain about the same?
- Vary the radius:** With the height and mass at their original amounts, change the pulley radius to the big pulley. Does the percent of energy transferred increase, decrease, or remain about the same?
- Vary the load:** Return the height, mass, and radius to their original amounts. Change the load resistor to 50 or 200 ohms (not included). Does the percent of energy transferred increase, decrease, or remain about the same?

### Further Study: Thermal Pollution

- Tape the PS-2517 Fast Response Temperature Probe (accessory to the PS-2125 Temperature Sensor) over the 100-ohm load resistor (Figure 1-3a). In DataStudio, set the sample rate to 10 Hz.



**Figure 1-3a: Close-up with Temperature Probe**

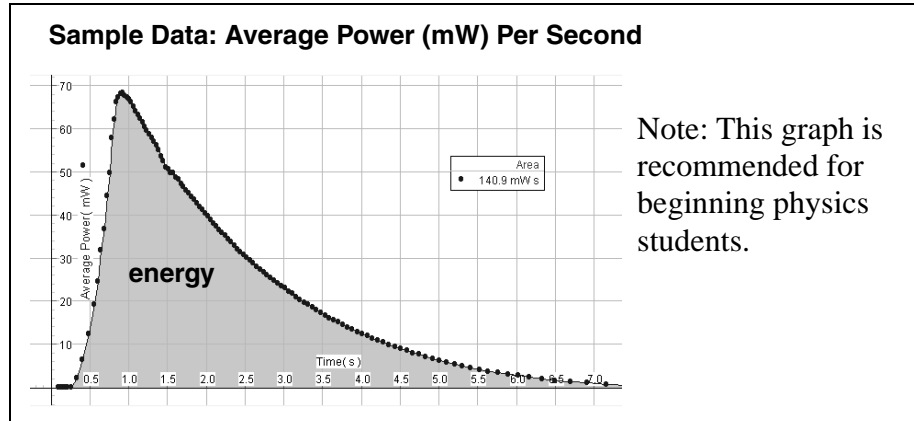


**Figure 1-3b: Setup with Temperature Sensor**

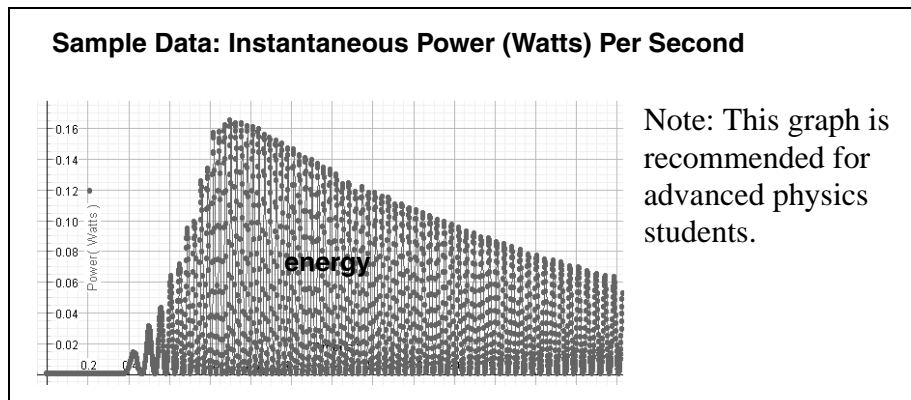
- Repeat the procedure from Experiment 1. Keep rotating the pulley until you notice a temperature increase. (The point here is that most of the energy we use is ultimately turned into heat (thermal pollution), adding to the global warming effect).

### Sample Results/Teacher's Notes (Experiment 1)

a) This graph is of average power, and for each turn of the magnet, it shows the average power generated for that small time. The area under the curve is energy (notice almost the same value as the energy for instantaneous power) but should be easier to comprehend for the beginner.



b) The graph below is the actual instantaneous power, and the area under the curve is energy. For beginning students, this graph would be hard to understand. They might ask, why is it going up and down?



c) For a theoretical perfect sine wave, Average Power = Max (peak) Power/2. For the generator we used, the Average Power = Max (peak) Power/2.4.

## Experiment 2: Investigating Rotational Kinetic Energy with a Flywheel

Equipment Required	
ET-Generator (ET-8771B)	Computer interface (PASPORT or <i>ScienceWorkshop</i> )
DataStudio software	Voltage Sensor (PS-2115 or CI-6503) with banana plugs
Large Rod Base (ME-8735)	Hanging Mass Set (SE-8759)
ET-Flywheel Accessory (ET-8773)	Stainless Steel Rod (ME-8735)
No-Bounce Foam Pad (SE-7347)	

### Introduction:

In this experiment, you will investigate the storage of rotational kinetic energy of a flywheel attached to a generator.

### Setup

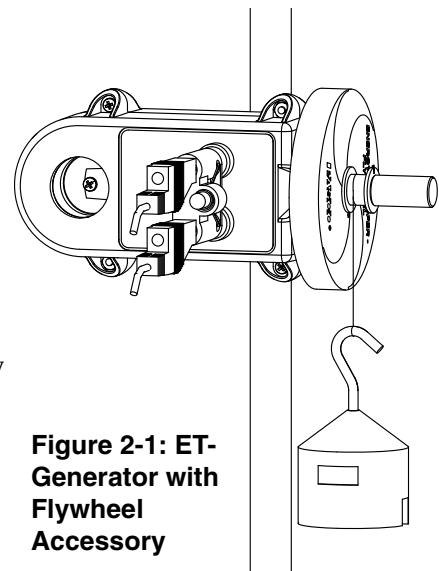
In the “Alternate Setup Options” section of this manual, follow the setup instructions under “Attaching the ET-Flywheel Accessory (ET-8773) to the ET-Generator.”

### Procedure (Part I):

1. With the flywheel setup, repeat the procedure from Experiment 1. Does the percent of energy transferred (efficiency) increase, decrease, or remain about the same as compared to without the flywheel?

### Part II: Rotational Kinetic Energy

1. Measure the mass and radius of the flywheel. Ignore the small pulley.
2. Remove the resistor plug. Plug the Voltage Sensor directly into jacks on the ET-generator and repeat the experiment procedure in Part I. In DataStudio, create an AC voltage graph. (Note: Do not use an electrical load (i.e. resistor plug or LED plug).



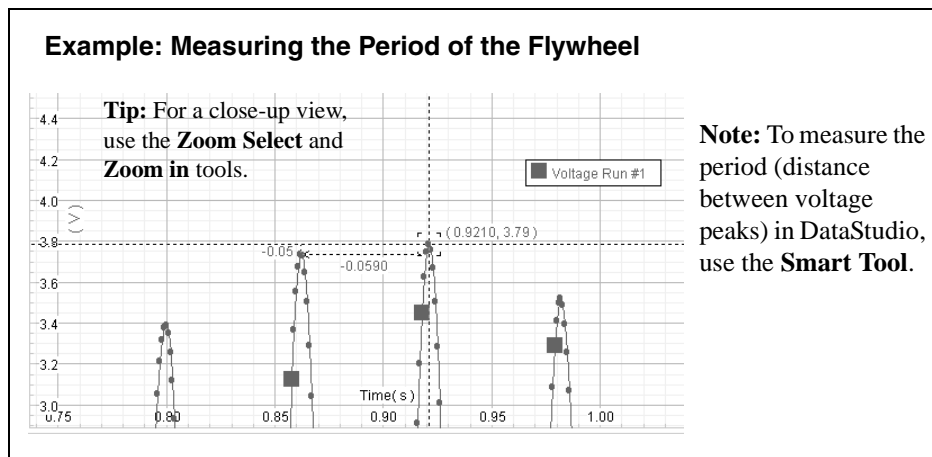
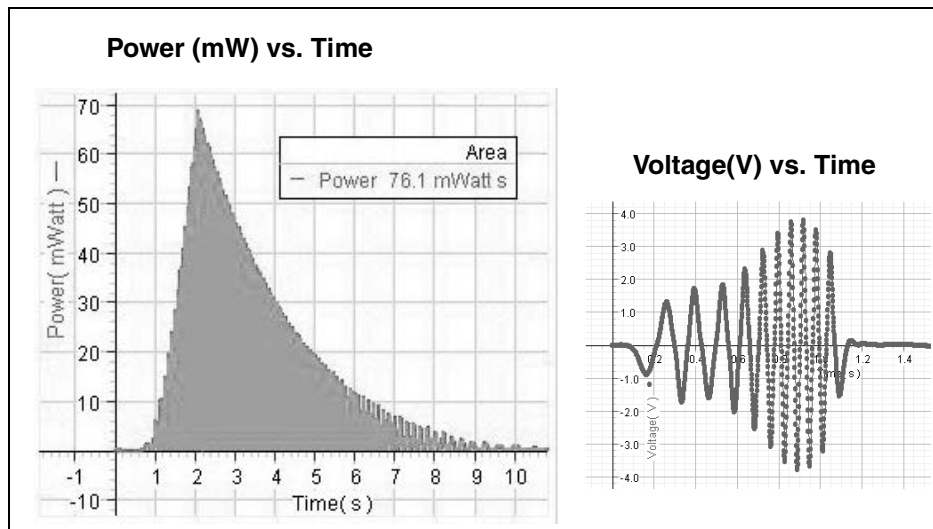
**Figure 2-1: ET-Generator with Flywheel Accessory**

### Analysis

1. Measure the period ( $T$ ) from the A.C. voltage graph. Use the Smart Tool to measure the period where the voltage is the highest. This is where the flywheel is spinning the fastest. [Note: Since there is no electrical load, the energy from the falling mass is being stored in the flywheel.]

- Calculate the maximum rotational kinetic energy of the spinning flywheel. Use the equation  $KE_{\text{rotation}} = (1/2)I\omega^2$ , where  $I$  is the rotational inertia of the disk and  $\omega$  is the angular velocity or  $(2\pi)/T$ . Also use the equation  $I = 1/2mR^2$ , where  $m$  is the mass (kg) and  $R$  is the radius (m) of the flywheel.
- Calculate the change in gravitational potential energy, where  $PE = mgh$  of the falling mass.
- Calculate the efficiency, where the percent of energy transferred to the flywheel, is  $KE_{\text{rotation}}/mgh \times 100$ . Is this percentage greater or less than the percentage you calculated earlier for the transfer into electrical energy?

### Sample Data/Results (Experiment 2)



## Experiment 3: Investigating the Concept of Gear Ratios and Mechanical Advantage

Equipment Required	
ET-Generator (ET-8771B)	Computer interface (PASPORT or <i>ScienceWorkshop</i> )
DataStudio software	Voltage Sensor (PS-2115 or CI-6503) with banana plugs
Large Rod Base (ME-8735)	Hanging Mass Set (SE-8759)
ET-Gearing Accessory (ET-8775)	Stainless Steel Rod (ME-8738)
No-Bounce Foam Pad (SE-7347)	

### Setup

In the “Alternate Setup Options” section of this manual, follow the setup instructions under part b, “Attaching the ET-Gearing Accessory (ET-8775) to the ET-Generator.”

### Procedure:

1. Wrap a piece of thread around the shaft on the ET-Gearing Accessory and tie it to a 50 g falling mass (Figure 3-1).
2. Repeat the experimental procedure from Experiment 1 for each of the three gear ratios. Which gear is the most efficient? Compared to the 3-step pulley in Experiment 1, does the percent of energy transferred (efficiency) increase, decrease, or remain about the same?

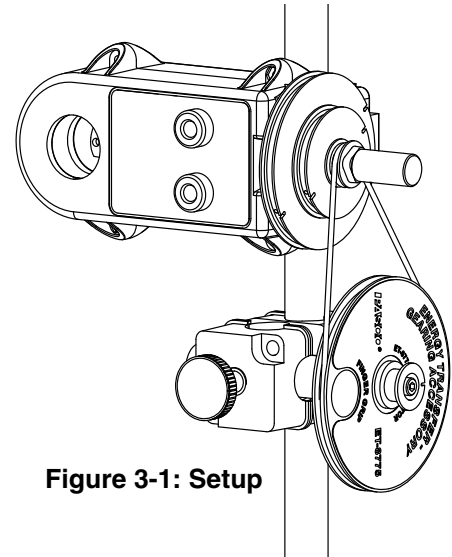


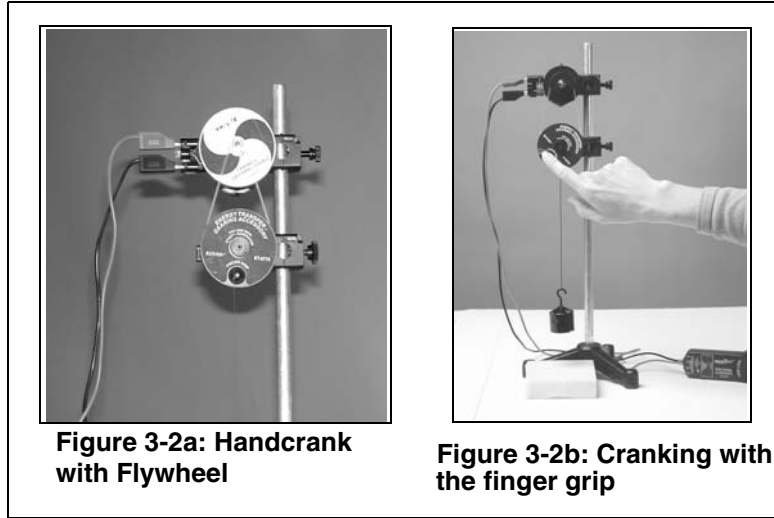
Figure 3-1: Setup

### Experiment Variations

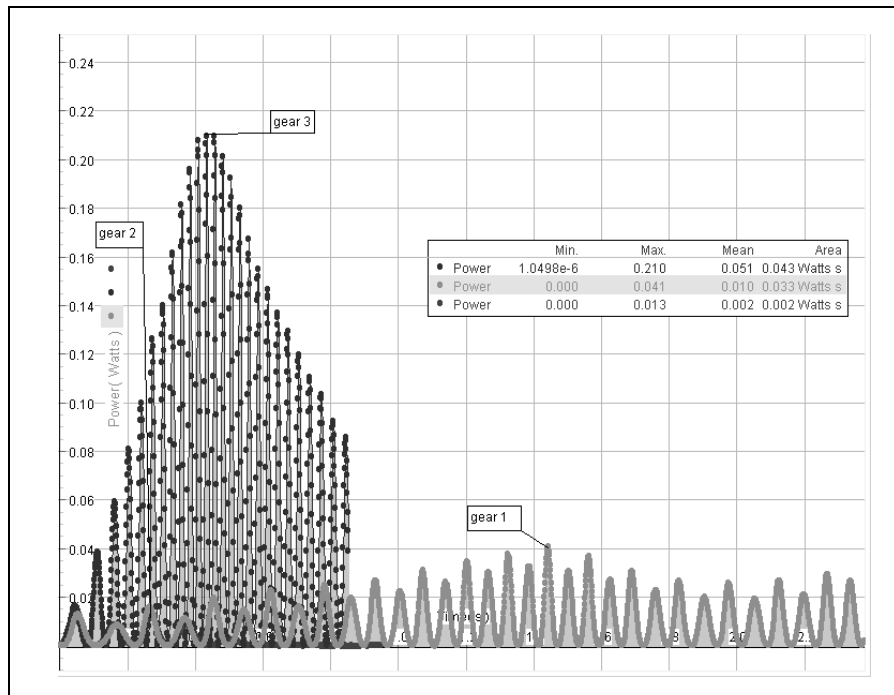
- a) Use the ET-Gearing Accessory with the ET-Flywheel Accessory (Figure 3-2A.)



b) Use the finger hole in the ET-Gearing Accessory to manually crank the generator and light the LED (light-emitting diode) (Figure 3-2b).



**Sample Data/Results**



## Experiment 4: Using a Turbine to Understand HydroElectric Power Generation

Equipment Required	
ET-Generator (ET-8771B)	Computer interface
DataStudio software	Voltage Sensor (PS-2115 or CI-6503) with banana plugs
Large Rod Base (ME-8735)	Stainless Steel Rod (ME-8737)
ET-Hydro Accessory (ET-8772)	Finger Clamps (SE-9445) or Buret Clamps (SE-9446)
Water Reservoir (ME-8594)	Beaker or container to collect water

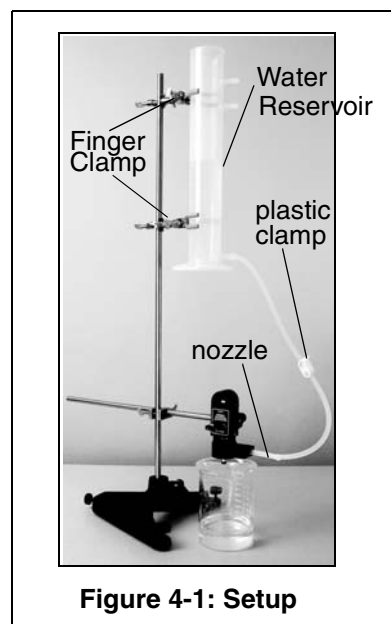
### Setup Procedure:

In the “Alternate Setup Options” section of this manual, follow the setup instructions under part c, “Attaching the ET-Hydro Accessory (ET-8772) to the ET-Generator.”

1. Mount an empty Water Reservoir (ME-8594) to a rod stand with fingered clamps (SE-9445). See Figure 4-1.
2. Connect a piece of clamped tubing from the bottom hose fitting on the Water Reservoir to a nozzle.
3. Insert the nozzle into the clip inside the ET-hydro housing. The clip is spring loaded and can turn to adjust where the water stream hits the turbine. If necessary, you can cut (trim) the nozzle end to increase the water flow. You may wish to support the hose using a buret clamp (SE-9446).



**WARNING:** To avoid the risk of shock or electrical injury, do not allow the Generator, resistor or banana plugs, sensors, or other electrical equipment to become wet. Keep water away from all electrical devices and wires. Always follow standard electrical safety precautions in your classroom.



**Figure 4-1: Setup**

### Experiment

1. Plug the 100-ohm resistor plug into the banana jacks.
2. Connect a Voltage Sensor to the resistor jacks and to a computer interface.

3. Fill the Water Reservoir with about 700 mL of water. Prepare to measure the mass of the water that flows by one of two methods:
  - a) Place a beaker underneath the Hydro Accessory to catch the water exiting the turbine during the experiment. Weigh the water in the beaker. OR
  - b) Read the volume in the Water Reservoir (graduated cylinder) before and after data collection. Use the volume to calculate the mass.
4. In DataStudio, click the **Start** button. Open the clamp to the bottom tube to allow water to run through the turbine. In a display, measure the electrical energy generated.
5. Record the mass of the water.

### Analysis

1. Determine the average height through which the water falls. Use the drawing of the Water Reservoir (Figure 4-2) to calculate the following:  $h_{avg} = \frac{h_{top} + h_{bottom}}{2} - h_{nozzle}$  where  $h_{avg}$  is the average water height,  $h_{top}$  is the highest point of the water level in the cylinder,  $h_{bottom}$  is the bottom of the cylinder, and  $h_{nozzle}$  is the level of the water in the nozzle.

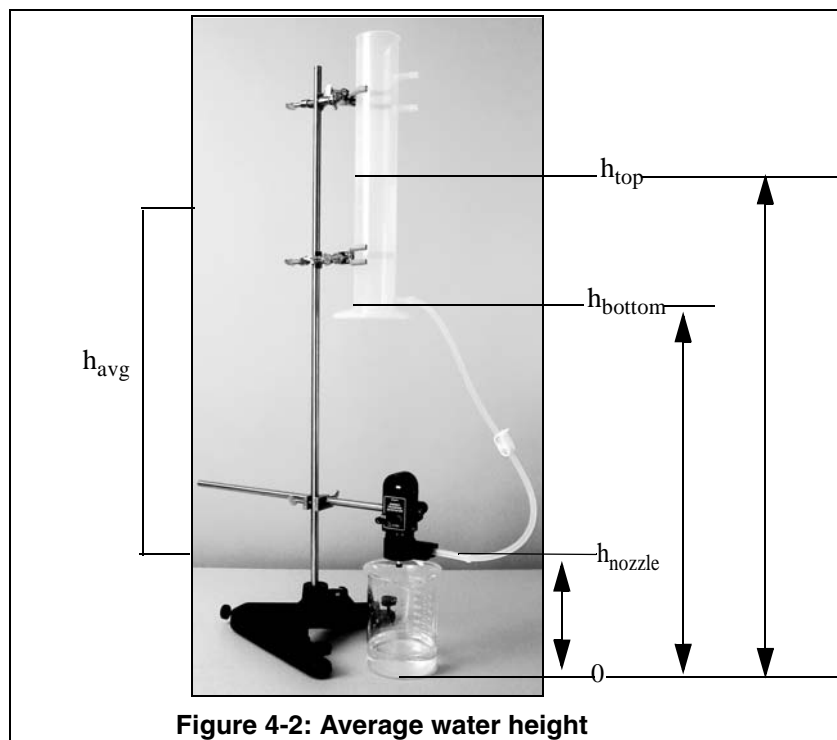


Figure 4-2: Average water height

2. Calculate the change in gravitational potential energy, where  $PE=mgh$ .
3. Calculate the efficiency (percent of energy transferred), where  $efficiency = \frac{\text{energy generated}}{mgh} \times 100$ . Where does the rest of the energy go? Why is the efficiency here so much less than for the flywheel generator?

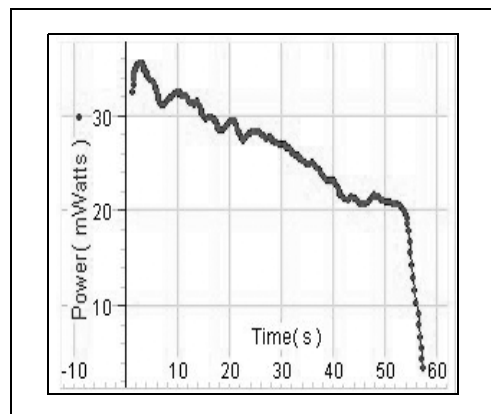
## Experiment Variations

Repeat the experiment with nozzles of different orifice sizes.

Repeat the experiment, but change the angle of the stream and the place on the fin where the stream hits the turbine. What effect do these have on the efficiency?

Take one run with the Water Reservoir as its highest point on the rod stand. Then take another run of data with the same amount of water through the turbine, but with the reservoir at half the height. Be careful not to change the nozzle angle, etc. Using the buret clamp will help. Compare the energy total and efficiency (percent of energy transferred) for the two heights.

## Sample Data/Results



## Appendix A: Specifications

Part included:	Description
<b>Generator</b>	Neodymium magnet, 19 mm
<b>Resistor Plug</b>	100 ohms
<b>LED plug</b>	Maximum recommended load is 200 g.
<b>Three-step Pulley</b>	Plastic (step 1: 1.3 cm diameter, step 2: 3.2 cm dia., step 3: 5.2 cm dia.)
<b>Thread</b>	137 meters (150 yards)

## Appendix B: DataStudio Setup Instructions

The instructions below outline the recommended experiment setup for PASPORT and *ScienceWorkshop* sensors. Follow the steps specific for the type of sensor and interface (i.e. PASPORT or *ScienceWorkshop*).

Procedure	Steps
<b>PART I:</b> Plug the sensors into the interface:	<p><b>PASPORT:</b> <b>a)</b> Plug the Voltage/Current Sensor(s) into a PASPORT interface. <b>b)</b> Connect the PASPORT interface (i.e. USB Link, PowerLink, etc.) to a USB port on your USB-compatible computer. <b>c)</b> When the PASPORTAL window opens, select "Launch DataStudio."</p> <p>OR</p> <p><b>ScienceWorkshop:</b> <b>a)</b> Plug the Voltage and/or Current Sensor(s) into a <i>ScienceWorkshop</i> interface. <b>b)</b> Launch DataStudio.</p>
<b>PART II:</b> Set up your experiment	<p><b>PASPORT:</b> <b>a)</b> In the Experiment Setup window, scroll to the Voltage-Current Sensor, and set the sample rate to 1000 Hz.</p> <p>OR</p> <p><b>ScienceWorkshop:</b> <b>a)</b> In the Welcome to DataStudio window, double click "Create Experiment." <b>b)</b> In the Sensors list, click and drag the Voltage (or Current Sensor) to an analog channel on the picture of the interface (i.e. to the same letter in which you have the sensor connected.) <b>c)</b> In the Experiment Setup window, double click on the sensor's icon to set the sample rate and select the measurement units.</p>

<p><b>PART III:</b> Create the power and angular frequency equations</p>	<p>On the main toolbar, click the <b>Calculate</b> button to open the Calculator dialog. To create a new equation, click the <b>New</b> button and enter the equation in the equation box. <b>a)</b> Instantaneous power=<math>V^2/R</math>, where <math>V</math>= the voltage and <math>R</math> is 100 ohms, the resistance of the resistor. Click the <b>Accept</b> button. In the Variables menu, select “data measurement” and then “voltage” for the voltage. Select “constant” for “<math>R</math>” (the resistor) and enter 100. Click the <b>Properties</b> button to open the Data Properties window and type in watts for the measurement name. Click the Accept button again. <b>b)</b> Average power= amplitude (10,10,1,P)/.0024, where <math>P</math>=power. Use the Special menu to select the amplitude function and replace “<math>x</math>” with “<math>P</math>.” Click the Accept button. Under Variables, select “data measurement” and “power” for the “<math>P</math>” variable. Click the <b>Properties</b> button to open the Data Properties window and type in mW for the measurement unit. Click the Accept button again. <b>c)</b> Angular frequency=<math>6.28/\text{period}</math> (10,10,1,v) where “<math>V</math>” is the voltage. Click the <b>Properties</b> button to open the Data Properties window and type in rads/s for the units. Click the Accept button again. (Note: To measure the period between peaks, use the Smart Tool.) <b>Note:</b> To save the equation, click the <b>Accept</b> button. To edit the finished equation, double click on the equation in the Data list. (For more information about creating equations, see the DataStudio online help.)</p>
<p><b>PART IV:</b> Collect Data</p>	<p><b>a)</b> From the Data list, drag each of the parameters (i.e. voltage, power, etc.) over a y-axis in a separate graph display. <b>b)</b> Click the <b>Start</b> button on the main toolbar.</p>

## Appendix C: Technical Support

For assistance with the Energy Transfer - Generator (ET-8771B) or any other PASCO products, contact PASCO as follows:

Address: PASCO scientific

10101 Foothills Blvd.

Roseville, CA 95747-7100

Phone: (916) 786-3800

FAX: (916) 786-7565

Web: [www.pasco.com](http://www.pasco.com)

Email: [support@pasco.com](mailto:support@pasco.com)

For the latest information about the Energy Transfer - Generator and this manual, go to the PASCO web site at [www.pasco.com](http://www.pasco.com) and enter ET-8771B in the search window.

## Appendix D: Copyright and Warranty

### Copyright Notice

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### Warranty

For a description of the product warranty, see the PASCO catalog.

### Product End of Life Disposal Instructions

This electronic product is subject to disposal and recycling regulations that vary by country and region. It is your responsibility to recycle your electronic equipment per your local environmental laws and regulations to ensure that it will be recycled in a manner that protects human health and the environment. To find out where you can drop off your waste equipment for recycling, please contact your local waste recycle/disposal service, or the place where you purchased the product.

The European Union WEEE (Waste Electronic and Electrical Equipment) symbol (to the right) and on the product or its packaging indicates that this product **must not** be disposed of in a standard waste container.

