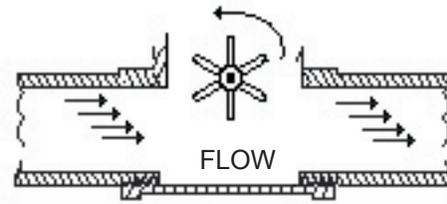


Note to the Teacher

Pressure, Resistance, and Fluid Flow

Another form of Mechanical Potential Energy is Pressure, symbolized by P.



If we were to increase the pressure applied to the pipe in the figure above using either a piston or a water tower, we would see an increase in the fluid flow, designated as Q. Also, if we were to increase the resistance of the pipe shown above, we would decrease Q. Using this information Mechanical Engineers have developed the following equation:

$$P = QR$$

Or we can rearrange Equation 7 and say that:

$$Q = P/R \quad \text{Eq 8}$$

Please note that Equations 7 and 8 imply the following:

1. There is a direct relationship between the flow, Q, and the pressure, P. That is, if the pressure increases, the flow increases. If the pressure decreases, the flow decreases.
2. There is an indirect relationship between the flow, Q, and the resistance, R. That is, if the resistance increases, the flow decreases. If the pressure decreases, the flow increases

Ohm's Law for Electricity

In 1826, a German physicist, Georg Ohm, developed the relation between current flow, I, the electric potential, V, and the electrical resistance, R. The relationship is known as Ohm's law and is expressed in the following manner:

$$V = IR$$

Two other ways of expressing Ohm's Law are:

$$I = V/R$$

$$R = V/I$$

Please note that these equations imply the following:

There is a direct relationship between the current, I, and the voltage. That is, if the voltage increases the current flow also increases (assuming the resistance remains constant). Also, if the voltage decreases, the current decreases.

There is an inverse relationship between the current, I, and the resistance, R. That is, if the resistance increases the current decreases (assuming the voltage remains constant). Also, if the resistance decreases, the current increases.

You can determine any single value of the three (voltage, resistance or current), if you can determine the other two.

Note to the Teacher

On Completing the Lesson, Students Will Be Able to:

- Demonstrate Ohm's Law
- Explain and use Ohm's Law to solve problems
- Assemble a circuit with a voltage and resistance source
- Use a multimeter to measure current, voltage and resistance

Materials Needed:

- 3 fixed resistors: 50 Ohm, 100 Ohm and 200 Ohm
- 4 Alligator clips
- 1 9 volt battery
- (optional but preferred) 1 9 volt battery snap on piece with positive and negative wires attached
- 1 Digital multimeter capable of measuring as little as 10 milliamps

Math versus Science

As students complete the investigations, they will begin to understand the relationship between mathematics and science. Mathematics is pure; when you plug numbers into equations, you will get the same result every time. Science, on the other hand, is dependent on multiple variables that may or may not be in control of the investigator. A good scientist will eliminate as many uncontrollable variables as possible so that they are able to analyze and measure the results of their investigation.

Experimental Error

There are many things that can cause your experimentally measured numbers to fall off-target from the predicted values. Here are a few:

- **Systematic error** is something in the experiment that always throws off the data in the exact same way. Some examples of systematic errors are a dead battery, improperly connected components, or a defective motor.
- **Random error** is caused by small factors that constantly change and affect the experimental results. In this experiment, random error may be caused by inconsistent starting points, imprecise measuring procedures, or a fluctuating battery level.

There are many things that can cause your experimentally measured numbers to fall off-target from the predicted values. Here are a few:

- Clutch Slippage: At higher torque, the clutch slips to reduce the chance of damage to the motor. This results in a shorter distance being traveled.
- Motor temperature
- Friction
- Battery power varies due to charge level

This investigation includes worksheets where students can capture data and write conclusions.

How to Use the Lesson Materials

1. Review the other lesson materials thoroughly.
2. Read the remainder of this document. It will serve as a general guide for how to teach the lesson content.

Note to the Teacher

3. Have your students review the Introduction for Students, under Guide and Ohm's Law under Helper Link. You may also wish to have them review Current, Voltage and Resistance.
5. Modify and add to the lesson in the way that will best serve your classroom.
6. Teach the lesson, drawing on lesson materials where appropriate. The Ohm Lesson Procedures document asks students to perform a simple experiment where they measure voltages, resistances and amperages from simple circuits with fixed resistors to demonstrate Ohm's Law.
7. Assign the "Checking for Understanding" Quiz/Worksheet.