Activity 1.2.5 Mechanical System Efficiency – VEX

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Introduction

Energy cannot be created or destroyed, but energy can be converted from one form to another. By design, an engineer creates an energy conversion system to change an input energy form into a desired output energy form. However, within a conversion system, input energy can be changed into less desirable forms of energy. Less desirable forms of energy conversion can occur due to resistance and friction, resulting in conversion to thermal energy. Engineers strive to decrease undesirable energy conversions within a system, or energy "losses", by planning with system efficiency in mind. Efficiency is the ratio of desired output energy compared to input energy.

A common form of energy conversion today occurs through electromagnetic induction. Electromagnetic induction transfers mechanical energy into electrical energy. The electrical energy is then transmitted to industries and homes to be used in a variety of ways, many of which include conversion back to mechanical energy.

Equipment

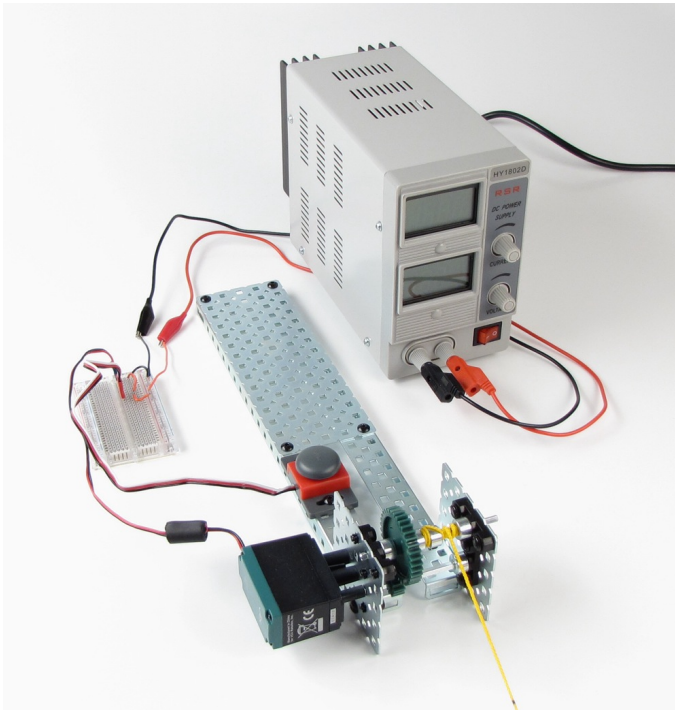
Winch system and materials from **Activity 1.2.5a Mechanical Efficiency Winch Construction**
Permanent marker
Multimeter
Stopwatch or other device for timing seconds
Variable power supply with current and voltage display and user's manual

Procedure

In this activity you will investigate an energy conversion system designed to change electrical energy into mechanical energy. You will determine the efficiency of the system by collecting data regarding power input and output. Remember units and precision when recording data.

Caution: Consult the user's manual for your specific power supply. This procedure is based on the RSR Variable Power Supply, Model HY1802D. Adapt the procedure to the power supply in your classroom.

1. Confirm all connections and parts are functioning correctly and make necessary corrections.
   a. Confirm that connections are correct according to Activity 1.2.5a Mechanical Efficiency Winch Construction.
   b. Turn the variable power supply on.
   c. Turn the current dial fully clockwise so that the power supply will deliver a constant voltage.
   d. Turn the voltage clockwise until the voltage display is approximately 7.2 V (7 - 7.5 V is acceptable).
   e. Press the bump switch briefly and confirm that the winch turns.
   f. Remove leads from the front of the variable power supply and plug the leads in with the colors reversed.
   g. Press the bump switch briefly and confirm that the winch turns in the opposite direction.



   h.
   i.

2.Measure and record both weights to attach to the winch.

Weight #1 to be lifted = 417_____ g (0.0) Convert to 4.08_____ Newton (N) (0.000)

Weight #2 to be lifted = 124_____ g (0.0) Convert to 1.21_____ Newton (N) (0.000)

1.Attach the weight. Place the device so that the weight freely hangs from the edge of a table.

2.Mark the winch cable using permanent marker a few inches below where the cable wraps around the shaft. Measure 15 cm down and mark a second point using permanent marker. These will become your winch start and stop points.

Length to be lifted (distance between start and stop point) = _____**80.5** cm (0.0)

Convert to _____**.805** meters (m) (0.000)

1.Use the bump switch and color coding of the leads in the power supply to operate your winch. Wind the winch cable until the start mark reaches the winch shaft.

a. Start the winch winding upward with the bump switch.

b. Start the stop watch when the start mark reaches the shaft.

c. Record the voltage and current displayed on the variable power supply.

d. Stop the stop watch when the stop mark reaches the winch shaft.

e.

Weight to be lifted = _____**417** g (0.0)

Convert to _____**4.08** Newton (N) (0.000)

Voltage = _____**7.5** V (0.0)

Current = _____**.26** A (0.0)

Time = _____**16** s (0.0)

g.

1. Unwind the winch cable so that the start mark on the winch cable is lined up with the winch axle.
2. Add a second weight. Repeat step 5 using two weights.
3. Weight to be lifted = **124** g (0.0)

Convert to **1.21** Newton (N) (0.000)

Voltage = **7.5** V (0.0)

Current = **.19** A (0.0)

Time = **13** s (0.0)

Work involves the amount of **force (F)** exerted over a specific **distance (d).** Work is not related to time. If two winches lift identical weights the same distance, they do the same work, even if one winch takes longer. Use the following formula to determine how many **joules (J)** of work it took to lift the weight in the system. As you carry your units through to the solution, change the final answer from N·m to the equivalent J.

1. Determine the work done by the winch system.

Formula	Substitute / Solve	Final Answer (0.000)
Work = d · F (use units m · N)	W= .805mx 4.08N	3.2844J
	W= .805mx 1.21N	.97405J

Power involves time, force, and distance. Two winches, one slow and one fast, do the same amount of work to lift a given weight through a given because they use the same force and cover the same distance. Time is not a factor. But to cover the distance faster, the faster winch uses more power. Use the formula below to calculate the output power of the system in **watts (W).** As you carry your units through to the solution, change the final answer from J/s to the equivalent W.

1.

2.Determine the output power of the system.

Formula	Substitute / Solve	Final Answer (0.000)
P(out)= W/t	P=3.2844/16	.205275
	P=.97405/ 13	.074927

1.To calculate the power of an electrical system in watts, multiply the current times voltage. Substitute and solve to discover how many watts were put into your system. As you carry your units through to the solution, change the final answer from A·V to the equivalent unit W.

Formula	Substitute / Solve	Final Answer(0.000)
P_{in} = IV	P=.26x7.5	1.95W
	P=.19x7.5	1.425

1. In order to compare the energy input versus the output, the efficiency of the system must be determined. Use the given formula to calculate efficiency.

Formula	Substitute / Solve	Final Answer (0.0)
Efficiency=P(out)/ P(in)	E= .205275/1.95	10.5%
	E=.074927/1.425	5.3%

Conclusion

1. List and describe three factors that reduced efficiency in the winch system.

Lifting less weight.
Taking more time to lift the weight.
Reducing the current.

1. Describe one strategy for making the system even more efficient.

Raising the current would make the system more efficient.

1. Explain two or more reasons why automotive engineers are concerned with eliminating inefficiency from vehicles.

They want to be able to use less fuels and so working vehicles can do more work with less power saving money.