Activity: Efficiency of an Electro-Mechanical System

Purpose

Electromagnetic conversions are one of the most common ways to convert energy into a useful form. From electric pencil sharpeners to automobiles, electromagnetic conversions are anywhere a motor is. A motor can also be used as a generator to produce electricity. In this is experiment, you will determine the efficiency of a motor-generator system.

Equipment

- Lego Kit: 2 motor-mass assemblies, 2 Lego light bulbs, 3 electrical connectors, and platform.
- Two equal weight washers each tied to ~0.5m thread or fishing line. Other end of thread tied to extension on motor/generator
- Calculator.
- Yard stick.

Procedure

1. Work in a group of 3-4 students at each station

2. Turn the left gear. What do you notice happening to the gear on the right?

3. Which side is acting like a generator? Which side is acting like a motor?

4. Unwrap the string and bring the washers back down to the same height.

5. Turn the left gear again until the left washer reaches the motor. This time try to get both of the washers to reach the top at the same time. Is this possible? Why or why not?

6. Is your generator-motor system 100% efficient? Explain

The efficiency of a system is the ratio of your output to your input.

$$\textit{Efficiency} = \frac{\textit{Output}}{\textit{Input}} \times 100\%$$

In this case, we will use the height each washer raised as a measure of work (energy) done. We will now measure height and calculate the efficiency of our system.

7. Unwrap the string and bring the washers back down to the same height. Measure the distance from the floor to the bottom of the washers (should be same for both washers). Record your data on the table provided.

   - Initial Height = _____cm

Trial 1: Generator-Motor

8. Turn the left gear until the left washer reaches the motor and stops. Use a steady and fairly fast rotational speed. Measure the height of each washer. Record your data on the table provided.

   - Height of left washer = _____cm

   - Height of right washer = _____cm

Trial 2: Generator-Lamp-Motor

9. Unwrap the string and bring the washers back down to the same height. Connect a Lego lamp to the top of the black connector.

10. Turn the left gear until the left washer reaches the motor and stops. Use a the same steady and fairly fast rotational speed. Measure the height of each washer. Record your data on table provided.

    - Height of left washer = _____cm

    - Height of right washer = _____cm

Trial 3: Generator-Double Lamp-Motor

11. Unwrap the string and bring the washers back down to the same height. Put 2 Lego lamps on top of each over and on top of the black connector. What do you think is going to happen this time?

12. Turn the left gear until the left washer reaches the motor and stops. Measure the height of each washer. Record your data on table provided.

    - Height of left washer = _____cm
    - Height of right washer = _____cm

13. Based on what you saw, which trial do you think was the most efficient? Which trial do you think was the least efficient?

14. Enter your height data in the table and calculate Efficiency.

Discussion Questions

1. Which trial had the lowest efficiency? Why?

2. How was energy lost in each trial?

Trial 1 (generator-motor):

Trial 2 (generator-lamp-motor):

Trial 3 (generator-double lamp-motor):

3. What do you think would happen if you connected the motor on the right to yet another motor with a weight attached?

NAME : _____ DATE: _____

Trial	**Initial Height (cm)**	**Final Height of Left Washer (cm)**	**Final Height of Right Washer (cm)**	**Left Washer Distance (cm)** (Height of Left Washer- Initial Height)	**Right Washer Distance (cm)** (Height of Right Washer- Initial Height)	**Efficiency (%)** $efficiency(\%) = 100\% \times \frac{height_{R\ washer\ moved}}{height_{L\ washer\ moved}}$
Generator-Lamp-Motor						
Generator-Motor	(same as above)					
Generator-Double Lamp-Motor	(same as above)					