Solar Transmissions

Summary: By learning about transmissions, students begin to explore the many aspects of building a solar car.

Objectives

Students will be able to

- describe the transmission of a vehicle;
- demonstrate how energy is transferred from a motor to a wheel; and
- explain how solar energy can be used to power a car.

Rationale

Through learning about transmissions, students gain an understanding of the basics of automobile design.

Materials

- Each group of students will need a ***Transmission Investigation Kit***

Getting Ready

Visit the KEEP or the National Renewable Energy Laboratory (NREL) websites for a list of companies that sell small educational solar panels. Build at least one transmission system to become familiar with the process and be prepared for the kinds of difficulties students may encounter.

Background

Transportation, in the past, allowed early cultures to explore further into new areas, as well as expand trade and develop communities. Over the years, technology has changed dramatically. The shift from hauling goods on the backs of animals to animals pulling wagons was a leap that enabled people to move larger quantities of goods much faster. In the last several hundred years, with the advent of steam and internal combustion engines, the industrial age was able to spread the reach of commerce and culture.

Today, automobiles are Americans' primary ground transportation method. Almost all cars in the United States are powered by gasoline. The fuel (potential energy) is burned in the car's engine, and then energy is transferred to the wheels, creating movement (kinetic energy). There are many other factors and structures involved in actually getting the car to move at high speeds, but the main idea is that potential energy in fuel is converted to kinetic energy (moving a wheel). The other important consideration is that the fuel used to provide the potential energy is gasoline, which is derived from oil, a fossil fuel that is not renewable.

Besides being nonrenewable, there are other concerns associated with using gasoline. These include issues with its extraction, transfer, and combustion, all of which have environmental impacts. The debate over drilling in the Arctic National Wildlife Refuge is one example of a debate over extraction issues. Finally, there are many health and environmental concerns when gasoline is burned, including ground level ozone (smog) and global climate change (greenhouse gases). There are also economic, political, and societal concerns with oil consumption. All of these concerns lead many to believe that Americans need to look into alternative energy sources to make cars move.

There are a number of alternative energy sources for ground transportation. Scientists, with government support, are developing fuel from renewable energy sources, such as using biomass to create ethanol. Electric cars are either powered by being plugged into an outlet (which stores energy in a battery that powers the car once it is unplugged) or they get their electricity from solar panels. Hybrid cars have two motors, one that runs on gasoline and one that runs on electricity.

Whether a car is powered by gasoline, batteries, ethanol, or the sun, the general principles of what makes a car move are the same. Energy is converted from one form to another to move wheels that propel the car. Although often unappreciated, the transmission, which is the system that transfers energy from the motor to the wheels, is the integral component of this movement. In a bicycle, energy is used

Grade Level: 5–8 (9–12)

Subject Areas: Art and Design Education, Science, Technology Education

Setting: Classroom and sunny area

Time:
Preparation: 50 minutes
Activity: Three 50-minute periods

Vocabulary: Photovoltaic panel, Transmission

Major Concept Areas:

Theme I

- Definition of energy
- Natural laws that govern energy

Theme II

- Development of energy resources
- Development of renewable energy resources
  - Solar energy

Theme III

- Quality of life
  - Lifestyles
  - Health and safety
  - Economic

Theme IV

- Future outlooks for the development and use of energy resources

Standards Addressed:

Wisconsin Model Academic:
ADE: D.8.3, D.8.6, H.8.4, H.8.5, K.8.1, K.8.3
SC: A.8.1, A.8.7, B.8.1, B.8.2, C.8.1, C.8.2, C.8.3, C.8.4, C.8.5, C.8.6, C.8.7, C.8.10, D.8.5, D.8.6, D.8.8, D.8.9, G.8.3, G.8.5, G.8.7

TE: A.8.1, A.8.2, A.8.3, A.8.5,

(Standards cont.)

B.8.1, B.8.3, B.8.4, B.8.5, B.8.6, C.8.1, C.8.2, C.8.3, C.8.4, C.8.5

Common Core ELA: SL.6-8.1, W.6.7

Common Core Math: MP1, MP3, MP5

NGSS: MS-PS3-3, MS-ETS1-2
SEP: Constructing Explanations and Designing Solutions, Engaging in Argument from Evidence
DCI: ETS1.B: Developing Possible Solutions, PS3.A: Definitions of Energy
CCC: Energy and Matter, Influence of Science, Engineering, and Technology on Society and the Natural World

Transmission Investigation Kit Materials

- A solar photovoltaic panel with at least a 3 volt @ 3 watt output and attached wires (available from science supply companies)
- A battery to test the monitor (optional)
- Small 1.5 V motor
- Variety of wheels (store bought or handmade)
- Copy of ***Transmission Technique Ideas*** (optional)
- Gears (optional)
- Sturdy wire such as pieces cut from a metal hanger
- Rubber bands
- Other supportive material as needed (see diagrams in ***Transmission Technique Ideas***)

to spin a crank, which moves a chain connected to another smaller crank, which spins the axle and wheel, moving the bike forward. The same concept applies to a car. The transmission is used not only to move power from one place to another, but also to trade speed for torque. It is important to build a transmission with a "transmission ratio" that gives the car a medium acceleration and medium top speed. This ratio allows for a balance between how quickly the car starts and accelerates and its continuous movement.

Of course, getting the wheels to move is just the beginning of the "auto" mobile (self-movement) of the car. Other design considerations (structural as well as aesthetic), then come into play and also affect car movement and the efficiency of energy transfer. However, until ground transportation moves beyond the need to rotate a wheel, a car's transmission will always be one of the primary considerations of car movement.

Procedure

Orientation

Ask students if they like to drive or ride in cars. Discuss the different ways cars are used in today's society. What are the benefits of our current popular method of travel? What are some problems with the automobile? Lead students to a discussion of issues associated with gasoline consumption.

Hold up a solar panel that will be used on the cars. Ask if anyone knows what it is, what it is used for, and what makes it work. Point out the positive and negative wires and the alligator clips. Ask what role the panel could play in making an automobile work?

NOTE: This activity addresses one part of designing a solar-powered car. Involving students in the full activity of designing, building, and racing a solar car is a challenging and rewarding experience for students. It will help them understand many physical science concepts and also relates to social science topics such as transportation.

Conducting the full activity will take several weeks. Lesson plans and ideas are found on the KEEP website.

Steps

1. If enough PV panels are available, provide groups of students with a photovoltaic panel, wires, and a motor and challenge them to make the motor spin. Otherwise, show students how to use the photovoltaic panel to harness the sun's energy and make the motor spin.

2. Explain that this is a "direct drive" method of transmission. What do students think transmission means? Provide students with an overview of transmission (see **Background**).

3. Ask students if the cars they ride in have the motor directly attached to the wheel. They should know that this is not the case and some students will be able to share more extensive information (see **Background**).

4. Tell students they are going to experiment with different transmission models to see if they find one that enables wheels to move most efficiently. As a class, discuss the objectives for efficient movement, including speed, ease, and longest running time.

5. Hand out sets of ***Transmission Investigation Kits*** and copies of ***Transmission Technique Ideas*** (or have students experiment on their own).

6. Allow students much of the class period to see if they can get the motor to move a wheel using a transmission technique besides direct drive. While experimenting, students can use the batteries to make the motor operate and wheels move.

Closure

Have students share results, testing to see if the wheels run when the motor is hooked up to the battery, as well as to the solar panel. Ask each group to describe their transmission, including how energy is transferred throughout the system to make the wheels move. Discuss how this system relates to an actual car and what other components an actual car would need. Have students draw a picture of their transmission and design a model car that uses the system.

Assessment

Formative

- Can students describe the transmission of a vehicle?
- Can students illustrate how energy is transferred from a motor to a wheel?
- Can students explain how solar energy can be used to power a car?

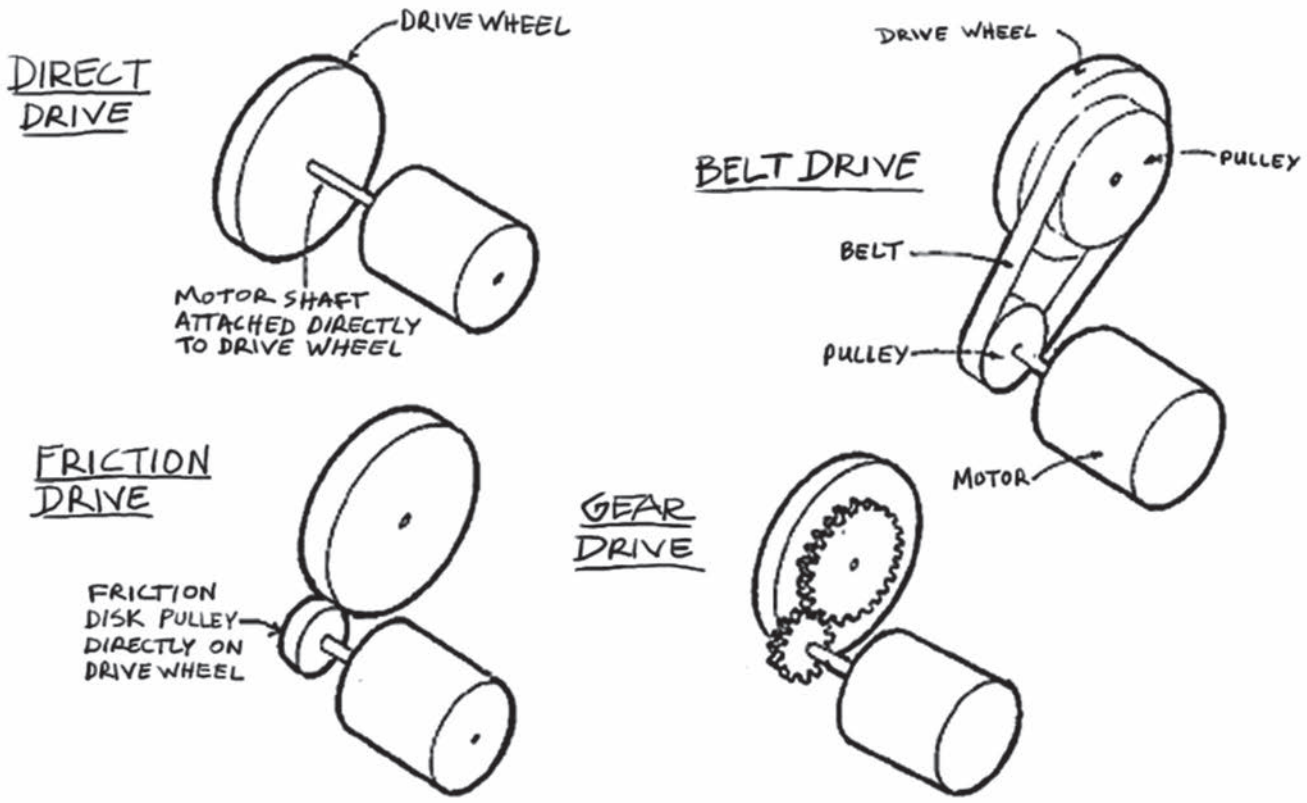
Summative

Have students research actual solar powered cars. Ask them to identify the transmission system used. Are there cars on the road today that use solar energy? What are the pros and cons of solar powered cars? Are there cars that use other forms of renewable energy?

Extension

Conduct the entire Junior Solar Sprint project with students. Visit the *Doable Renewables Support Page* on the KEEP website for links.

Transmission Technique Ideas



From National Renewable Energy Laboratory website, http://www.nrel.gov/docs/gen/fy01/30828.pdf, 2005