Energy Transformations

Objective
Students will understand energy conversions, the law of conservation of energy and be able to explain how energy conversions work in a vehicle.

Curriculum Focus
Science
Math
Social Studies

Materials
- Computer with internet access
- Copies of "Energy in an Electric Car" student worksheet
- Copies of "Energy Transformations" student worksheet

Key Vocabulary
Electrical energy
Kinetic energy
Light energy
Mechanical energy
Potential energy
Sound energy
Thermal energy

Next Generation Science Correlations
MS-PS2 – 3
MS-PS3.A
MS-ESS3 – 3
MS-ESS3.C
MS-ETS1 – 3
HS-PS3 – 2
HS-ESS3 – 4
HS-ETS1 – 3

Introduction

In this lesson, students explore the various forms of energy and the conversion of energy from one form to another. The law of conservation of energy states that energy can neither be created or destroyed. It can only be transformed.

In a traditional vehicle, gasoline containing chemical energy is pumped to the carburetor or from the fuel injectors where it is mixed with air. Next, it is fed into chambers known as cylinders, where it is compressed and ignited by a spark. Here the chemical energy in the gasoline is converted into heat (thermal energy), light, sound and the burning produces gases. These heated gases inside the chamber expand, causing the piston to move. Thus, the thermal energy is converted to mechanical energy.

In most cars, the up and down motion of the pistons is changed to rotary motion by the crankshaft. The mechanical energy is next transferred through shafts and gears to the transmission, then to the drive shaft, then to the universal joint and finally to the wheels, which propel the vehicle forward. The mechanical energy of the crankshaft also turns the alternator, which makes an electrical current. That electrical energy is used to run the car's electrical system, including the lights, the starter motor, the spark plugs and the stereo system. The excess electricity is converted to chemical energy in the battery.

Finally, exhaust gases and large quantities of heat are generated by the internal combustion engine; the gases are lost through the exhaust system while the heat is radiated by the engine block, the radiator and the exhaust system. This energy that is radiated away performs no useful work and is wasted.

An all electric vehicle (EV) has a different engine than a regular fuel vehicle. Not only do they run on electricity instead of gas but they also have a simple engine that requires fewer parts and less maintenance. Instead of an internal combustion engine, an EV has an electric motor that is powered by a battery pack. An EV owner charges the battery with a device similar to pumping gasoline.

The charging plug delivers alternate current (AC) voltage of various levels depending on the outlet. The current travels to the AC/DC converter, which changes the voltage, so the current is converted to direct current (DC). This device allows you to charge from outlets with various voltage levels, which can be saved in the car's battery pack. The battery pack is the source of power for the motor.

A controller sends energy from the battery to the electric motor at various rates based on the placement of the gas pedal under the driver's foot. If the pedal is pushed down all the way, the motor will receive maximum energy. If the car is stopped, the motor is not receiving energy. The motor converts electrical energy into mechanical energy. Torque to get the car moving is created by a moving rotor within coils generating a magnetic field. The radiator uses thermal energy to preserve the longevity of the battery range and lifespan by maintaining the proper operating temperature. The regenerative braking system converts the kinetic energy produced when the car is decelerated into stored battery energy. The brakes act as a generator by moving the engine coils backwards.

Procedure

1. Introduce students to EVs by showing "Energy 101: Electric Vehicle Basics" found at www.energy.gov/eere/videos/energy-101-electric-vehicles.
2. As a class, review energy transformation types by filling in the "Energy Transformations" student worksheet.
3. Discuss with the class how the motor works in a fuel powered car and an electric car.
4. Distribute the "Energy in an Electric Car" student worksheet. Instruct students to label as many different energy transformations as possible for each part of the electric car.

Discussion

What energy transformations occur within the electric motor?

How does energy flow to make the EV move?

To Know and Do More

1. Compare and contrast engine energy transformations between a fuel powered car and an all electric vehicle.
2. Research energy transformations occurring during the process of generating and transporting electricity.

Careers in Energy

Go to www.bls.gov/green/electric_vehicles/ to learn about careers in the up and coming EV industry.

Discuss careers available in scientific research, design and development, manufacturing, EV maintenance, infrastructure development and sales and support. Emphasize duties, credentials and wages for each career area.

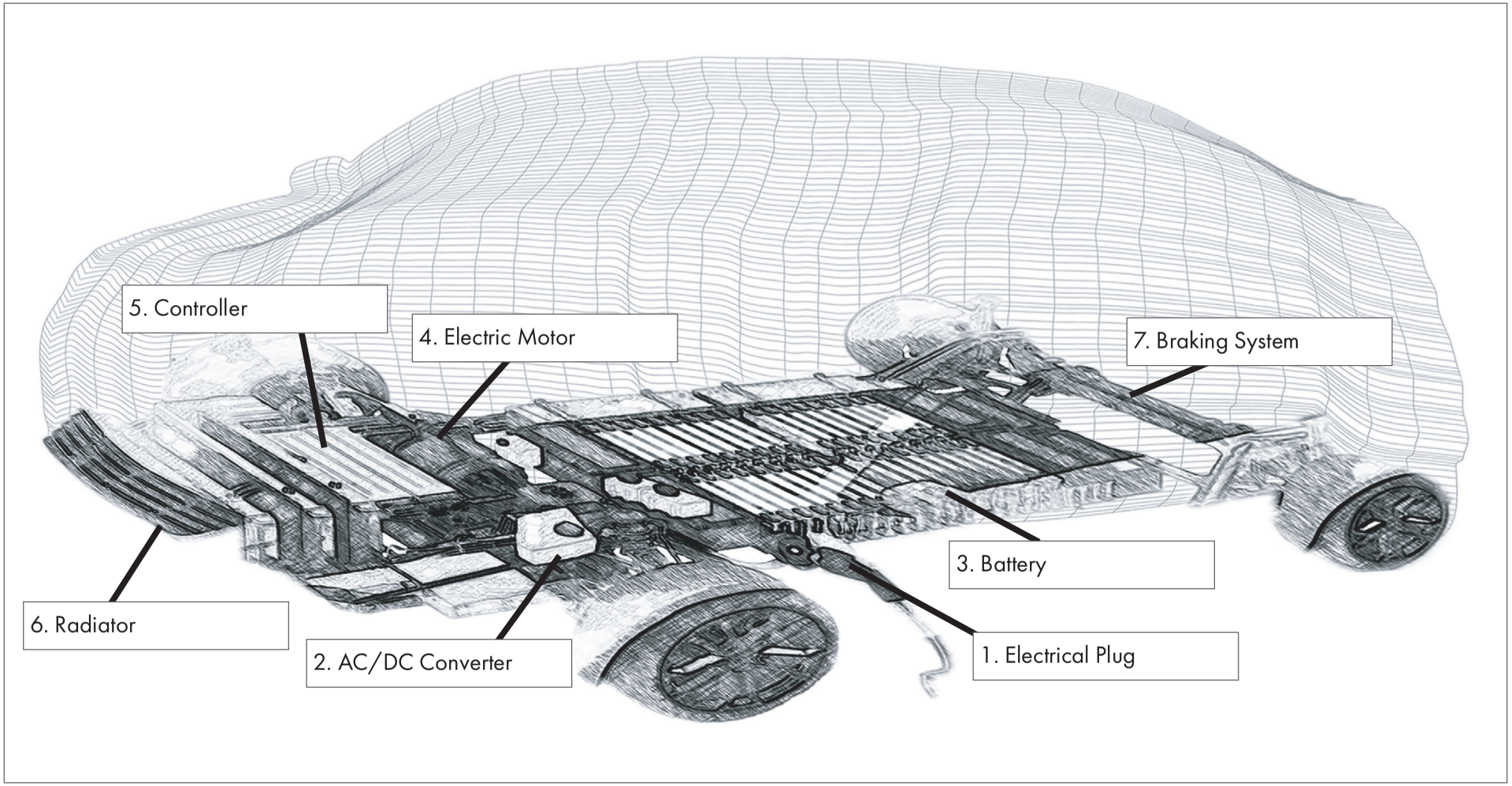
Energy Transformations

Fill out the chart below with a device that transforms one type of energy into another.

To/From	Mechanical	Electrical	Chemical	Thermal	Sound	Light
Mechanical						
Electrical						
Chemical						
Thermal						
Sound						
Light						

Energy in an Electric Car

Electric motors have fewer internal parts than an internal combustion engine.



List the energy transformation(s) occuring in each part of the engine.

1.	2.	3.	4.	5.	6.	7.