LESSON 3:
POWER

NEXT GENERATION SCIENCE STANDARDS

MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

Time: 1 50-60 minute class period

Start this lesson by asking students "What is power?"

The students should give some interesting answers. Tell them that average power is calculated by finding how much useful energy is produced in a certain amount of time. For example, let's say that a race car speeds up to a certain velocity in a given amount of time. The average power of the race car would be the kinetic energy achieved divided by the time it takes to get to that speed.

$$Average\ Power = \frac{Kinetic\ Energy}{time} = \frac{\frac{1}{2}mv^2}{t}$$

Example 1: Jeff's car (1000 kg) speeds up from rest to a velocity of 30 m/s in 3 s. Find the cars average power:

$$Average\ Power = \frac{\frac{1}{2}mv^2}{t} = \frac{\frac{1}{2}(1000\ kg)(30\ m/s)^2}{3\ s} = 150{,}000\ Watts$$

Many students are familiar with the unit horsepower. Let students know that the Watt is the same type of unit as the horsepower. They may also be familiar with electronic devices which are also measured in Watts. For example, a 60 Watt light bulb.

Sample Experiment

Now that your students have learned to calculate the average power of a race car speeding up from rest, have them use this information to calculate the power that can be produced individually. Students can design an experiment to collect data and use it to calculate average power. This sample experiment requires a lot of space. You will want to ensure that it's safe and allows for good data collection. Remind students to perform multiple trials.

Here is a Sample experiment:

You just learned how to calculate the average power of a race car speeding up from rest. Let's use this information to calculate the power that you can produce individually. Design an experiment that allows you to collect data and use it to find your average power. The experiment will need to be done where there is a lot of space. Make sure your experiment is safe and allows you to collect good data. Also remember to perform multiple trials. Get approval from your teacher before starting.

Sample Data

TRIAL	TIME
1	2.2s
2	2.4s
3	1.9s

Average tIme = 2.17 s

1) Measure the distance of 10 m.

2) Measure the time it takes to run 10 m, 3 different times.

3) Find the average velocity.

$$\text{average velocity} = \frac{\text{distance}}{\text{time}} = \frac{10\ \text{m}}{2.17\ \text{s}} = 4.61\ \text{m/s}$$

4) Calculate the power for a 120 lb student.

Mass = 120 lbs/2.2 kg = 54.5 kg

$$\text{average power} = \frac{\frac{1}{2}(54.5\ \text{kg})(4.61\ \text{m/s})^2}{(2.17\ \text{s})} = 267\ \text{Watts}$$

Students can use the provided worksheet.

Student Worksheet

You just learned how to calculate the average power of a race car speeding up from rest. Let's use this information to calculate the power that you can produce individually. Design an experiment that allows you to collect data and use it to find your average power. The experiment will need to be done where there is a lot of space. Make sure your experiment is safe and allows you to collect good data. Also remember to perform multiple trials. Get approval from your teacher before starting.

When finished, answer these questions.

1) An Olympic athlete can produce an average power of 2300 Watts. In your experiment, how close did you come to getting the same power? What could you have done differently to increase your power?

2) Jeff's car can produce 650,000 Watts of power. If a student can produce 300 W of power on their own, how many students would be required to create the same power as Jeff's car?

3) The Kia Stinger (1680 kg) can go from 0 to 60 mph (27 m/s) in 4.7 s. How much power does the car produce to make this happen?

Student Worksheet

ANSWER KEY

You just learned how to calculate the average power of a race car speeding up from rest. Let's use this information to calculate the power that you can produce individually. Design an experiment that allows you to collect data and use it to find your average power. The experiment will need to be done where there is a lot of space. Make sure your experiment is safe and allows you to collect good data. Also remember to perform multiple trials. Get approval from your teacher before starting.

When finished, answer these questions.

1) An Olympic athlete can produce an average power of 2300 Watts. In your experiment, how close did you come to getting the same power? What could you have done differently to increase your power?

Answers vary. Average students should have a power of about 200- 300 W.

2) Jeff's car can produce 650,000 Watts of power. If a student can produce 300 W of power on their own, how many students would be required to create the same power as Jeff's car?

(650,000 W)/(300W) = 2167 students

3) The Kia Stinger (1680 kg) can go from 0 to 60 mph (27 m/s) in 4.7 s. How much power does the car produce to make this happen?

$$Average\ Power = \frac{\frac{1}{2}(1680\ kg)(27\ m/s)^2}{4.7\ s} = 130{,}289\ W$$