Horsepower

Developed by Mary Beth Bennett, MBBennett@ mail.wvu.edu

Horses were a common source of power before machines were invented. In order to compare the new machines to the work that had been done by horses an inventor came up with a formula that is still being used today. That inventor was James Watt who lived in the 18th century. In the early 1780s, after making a vastly superior steam engine to the classic Newcomen steam engine, Watt was looking for a way to sell his invention. He did experiments to determine how much power a typical draft horse could generate. After doing the experiments, he figured that a typical draft horse could do about 32,400 foot-pounds of work in 60 seconds and maintain that power rate for a workday. He then rounded up, going to 33,000 foot-pounds per minute for 1 horsepower.

By his estimation a good draft horse could lift 33,000 pounds of material 1 foot in 1 minute or 3,3000 pounds of material 10 feet in one minute, etc.



Watt then used that formula to compare the power of his steam engine to the power of a horse in order to increase sales of his steam engine.

Watt's steam engine was revolutionary and played a big role in the Industrial Revolution. Today the term "horsepower" is still used to describe the strength of motors and engines.

Interesting also is the fact that a Watt as a unit is used to measure all power whether it is mechanical or electrical and it was named that to honor James Watt.

Power is the rate of doing work. It is a measure of how quickly a job can be done. You can calculate power by dividing the work done by the time it takes to do it. The unit is foot-lbs/second.

Horsepower is a unit of power. Power has units of energy per unit time (P=W/t), and is measured in watts. One watt is one joule of work done in one second. The joule measures energy in physics in meters/kilogram/sec. And one horsepower equals 746 watts. If you took a one horsepower horse and put it on a treadmill, it could power a generator and produce a continuous 746 watts.

Today we use a tool called a dynamometer to place a load on engines and measure the amount of power that the engine can produce against the load.

Procedure

1. Students should be familiar with the scientific units of force, work, and power.

2. Ask student to describe where they have heard the term horsepower used. (When describing engines such as those in a vehicle, lawnmower, chainsaw, or vacuum cleaner.)

3. Ask students to relate what they think horsepower is. (A unit of power: the rate at which work can be done.)

4. Share with students the story of how the unit of horsepower came to be:

In the 1770's, Scottish engineer James Watt developed a new kind of steam engine. He figured that the best way to sell it was to compare it to the power of the most familiar "engine" at the time-the horse. To quantify the rate at which a horse could do work, he set one up with a rope and pulley to lift a load. He calculated that a horse was strong enough to lift a weight of 33,000 pounds the height of 1 foot in 1 minute.

Using the above figures how many pounds could the horse lift in 1 second? Show your math.

33,000/60 = 550

Based on this calculation 1 horsepower = 55 foot-pounds/second or

1 horsepower = 33,000 foot-pounds per minute.

5. What does Watt have to do with power? Other than being named for the inventor James Watt. The watt, like horsepower, is a unit of power. One horsepower is equivalent to 746 watts. That means if a 1-horsepower horse walked on a treadmill, it could operate a generator to produce a continuous 746 watts (That is until it tired.). Where have you heard the term watt used? In light bulbs.

How many 40-watt light bulbs could that horse's power light up? Show your math.

746/40= 18.65

Several videos on Horsepower can be found at:

http://www.pbslearningmedia.org/resource/mapt-math-ee-animhorsepower/animation-horsepower/

http://www.amnh.org/exhibitions/past-exhibitions/horse/promos/for-educators-the-horse/calculate-horsepower

http://www.amnh.org/explore/ology/horse/?fid=29597

Working with Watts

There are many appliances on the market today. The following list is just a few of the appliances that can help make each of our lives a little easier. A watt is the standard unit of electrical power. Wattage requirements are listed with each appliance. Not all appliances will have the same watt usage. Use the list below if you are unable to locate the wattage on your own appliances.

APPLIANCE WATTAGE

Microwave 600

Percolator - 12 cups 800

Coffee pot - 4 cups 725

Toaster - 4 slice 1650

Toaster - 2 slice 900

Bread Maker 430

Toaster Oven 1400

Fry Daddy 1200

Crock Pot (small) 75-100

Iron 1000

Popcorn popper 1000

Hot plate 1100

Electric griddle 1500

Waffle iron 1000

Curling iron 38

Hair dryer 1600

Blender 350

Hand mixer 170

Sewing machine 90

Procedure

Given the formula - One (1) horsepower is equivalent to 746 watts.

How many appliances listed above could run on 1 horsepower? You can only use each appliance once.

Answer - Five at the most - 1 Sewing machines, Hand mixer, Blender & curling iron maybe the crock pot at 75 watts. .90+170+350+38+75=723 with 23 left over

Develop questions asking students to figure out how many horses it would take to power a variety of appliances listed above.

Have them show their math.

Light bulbs are used by everyone everyday. An incandescent light bulb uses more wattage than the new compact fluorescent light bulbs (CFLs). The size and shape of the CFL affects the wattage usage. Here is a comparison of light bulb wattage averages:

INCANDESCENT FLUORESCENT

40 watts 9-13 watts

60 watts 13-15 watts

75 watts 18-25 watts

100 watts 23-30 watts

150 watts 30-52 watts

Background;

The cost of operating appliances are calculated by multiplying kilowatt-hours by cost per kilowatt-hour. A kilowatt-hour is 1,000 watt-hours. A watt can be defined as the practical unit of electric power and is measured by multiplying volts by amps. The cost per kilowatt-hour can be determined using your electric bill. The wattage information for electrical appliances can be found on each appliance.

Introduction:

Electricity is not free. Someone has to pay for it. Today we're going to figure out how that price is determined. Can you guess?

Here is an example:

We are charged for electricity by the kilowatt-hour which is 1,000 watt-hours. So, if the cost for 1 kilowatt-hour of electricity is 8 cents, the cost of operating a 100-watt lamp for one hour is (kw x hr. x kwH cost = cost per hour) 0.1 kw x 1 hr x .08 cents = 0.8 cents or $0.008 (less than a penny).

For two hours the cost would be: 0.1 kw x 2 hrs x .08 cents - $0,016

Using the previous page with wattages for appliances have students calculate the cost to operate them for various times.

You could also have students calculate the costs for the light bulbs listed above and compare them.

Taken from the University of Florida, Power of Energy 4-H Leaders Guide.http://edis.ifas.ufl.edu/pdffiles/4H/4H12600.pdf