

CALCULATING YOUR "HORSEPOWER"

OBJECTIVE

This is a fun activity designed to allow participants to discover their "horsepower" by expending energy and then calculating the "horsepower." And, once you can compute your horsepower, you'll determine how much horsepower it takes to move your car, your plane, and your space shuttle.

BACKGROUND

Horsepower is a standard unit of power equal (in the United States) to 746 watts. This is nearly equivalent to the English gravitational unit (called one horsepower) of 550 foot-pounds of work per second.

James Watt devised this formula for computing horsepower:

$$\text{Horsepower} = \frac{\text{Foot-pounds}}{\text{Seconds} \times 550}$$

It is still used today for calculating the horsepower of engines.

Another way to calculate horsepower is:

$$\text{Horsepower} = \frac{\text{Distance (in feet)} \times \text{Weight (in pounds)}}{\text{Speed (in seconds)} \times \text{Constant (550)}}$$

Using either of these formulas, a horsepower-hour is equal to 1,980,000 foot-pounds, the amount of energy used to do one hour's worth of work at one horsepower.

The engine of a small motor-bike produces between 30 and 50 horsepower; a medium-sized car engine creates between 100 and 300 horsepower.

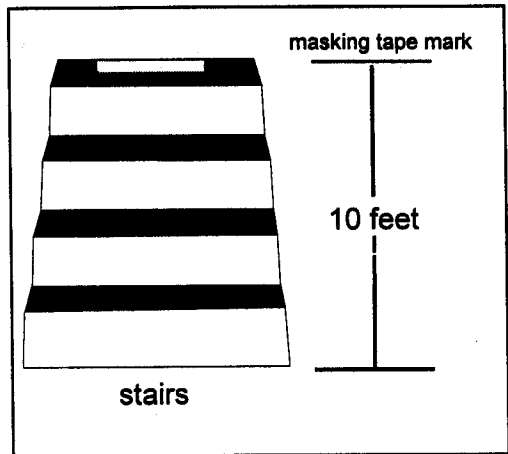
How many horsepower can you produce?

MATERIALS

1. This activity must be conducted on a stairway. A bathroom scale will be needed, or the participants need to know their weight.

PROCEDURE

1. Divide the group into teams of two.
2. Measure a vertical distance of ten feet up the staircase. Mark with masking tape.
3. One person is the stair climber; the other is the timer / recorder.
4. Each person weighs himself or herself and records their weight.



5. The stair climber, beginning at the bottom of the stairs, climbs up the stairs as fast as he or she can go. The timer / recorder times the climb from the start to the time the climber passes over the masking tape mark at the ten foot level. The time is recorded.
6. The team members change places, and the timer / recorder becomes the climber.
Complete the task as before; record the results.
7. Using the formula, calculate each person's horsepower.
(For foot-pounds, use your own weight, multiplied by 10 feet.)

Assuming a weight of 120 pounds, and a time of 3.5 seconds to climb 10 vertical feet:

$$\text{Horsepower} = \frac{120 \times 10}{3.5 \times 550} = \frac{1,200 \text{ foot-pounds}}{1,925} = 0.6233$$

DISCUSSION

Compare horsepower among the members of the group.

Would this be a good way to determine how much energy a person could expend in a work day? Why or why not?

How much horsepower does it take to move these objects?

Find out the weight of a four-door Saturn SL2 automobile, a Cessna 172, and the space shuttle. Calculate the horsepower needed to move the car 5,280 feet in one minute (sixty seconds). Calculate the horsepower needed for the Cessna to reach 5,000 feet altitude in ten minutes (600 seconds). Calculate the horsepower needed for the shuttle to reach 100 miles (528,000 feet) up (orbit) in five minutes (300 seconds).

For the instructor:

The fueled weight of a Saturn SL2 ----- 2,470 pounds
The fueled weight of a Cessna 172 Skyhawk ----- 1,678 pounds
The fueled weight of the space shuttle ----- 4,500,000 pounds (approximate)

FACTS:

The Saturn gas tank capacity is 12 gallons. Each gallon weighs 6.7 pounds.

The Cessna 172 gas tank capacity is 42 gallons. Each gallon weighs 6.7 pounds.

Fuel for the space shuttle is contained in two solid rocket boosters, each weighing about 181,000 pounds, and an external fuel tank with an approximate weight of 66,000 pounds. The approximate weight of the solid propellant is 1,111,000 pounds per booster; the liquid oxygen weight is about 1,361,936 pounds; and the liquid hydrogen weight is about 227,641 pounds.

Factoids:

A Saturn needs about .2 of a pound of fuel to travel one mile horizontally.

A Cessna uses about 12 pounds of fuel to reach 5,000 feet, about one mile up.

A Space Shuttle uses about 3,811,577 pounds of fuel to reach one hundred miles altitude, or 38,115 pounds to climb each mile.