Name: ______________________________ Date: __________ Skill and Practice

8A Power in Flowing Energy

Read:

Power is the rate of doing work. You do work if you lift a heavy box up a flight of stairs. You do the same amount of work whether you lift the box slowly or quickly. But your power is greater if you do the work in a shorter amount of time.

Power can also be used to describe the rate at which energy is converted from one form into another. A light bulb converts electrical energy into heat (thermal energy) and light (radiant energy). The power of a light bulb is the rate at which the electrical energy is converted into these other forms.

To calculate the power of a person, machine, or other device, you must know the work done or energy converted and the time. Work can be calculated using the following formula:

$$\text{Work (joules)} = \text{Force (newtons)} \times \text{distance (meters)}$$

$$W = F \times d$$

Both work and energy are measured in *joules*. A joule is actually another name for a newton·meter. If you push an object along the floor with a force of 1 newton for a distance of 1 meter, you have done 1 joule of work. A motor could be used to do this same task by converting 1 joule of electrical energy into mechanical energy.

Power is calculated by dividing the work or energy by the time. Power is measured in *watts*. One watt is equal to one joule of work or energy per second. In one second, a 60-watt light bulb converts 60 joules of electrical energy into heat and light. Power can also be measured in *horsepower*. One horsepower is equal to 746 watts.

$$\text{Power (watts)} = \frac{\text{Work or Energy (joules)}}{\text{Time (s)}}$$

$$P = W / t$$

Example:

A cat who cat weighs 40 newtons climbs 15 meters up a tree in 10 seconds. Calculate the work done by the cat and the cat's power.

Looking for	Solution
The work and power of the cat.	Work = 40 N × 15 m = 600 J
Given The force is 40 N. The distance is 15 m. The time is 10 s.	$\text{Power} = \frac{600\text{ J}}{10\text{ s}} = 60\text{ W}$
Relationships Work = Force × distance Power = Work/time	The work done by the cat is 600 joules. The power of the cat is 60 watts. In units of horsepower, the cat's power is (60 watts)(1 hp / 746 watts) = 0.12 horsepower.

Skill and Practice

Practice:

1. Complete the table below:

Force (N)	Distance (m)	Time (s)	Work (J)	Power (W)
100	2	5		
100	2	10		
100	4	10		
100		25	500	
	20	20	1000	
	30	10		60
9	20			60
3			75	5

2. Oliver weighs 600 newtons. He climbs a flight of stairs that is 3.0 meters tall in 4.0 seconds.
   a. How much work did he do?

   b. What was Oliver's power in watts?

3. An elevator weighing 6,000 newtons moves up a distance of 10.0 meters in 30.0 seconds.
   a. How much work did the elevator's motor do?

   b. What was the power of the elevator's motor in watt and in horsepower?

4. After a large snowstorm, you shovel 2,500 kilograms of snow off of your sidewalk in half an hour. You lift the shovel to an average height of 1.5 meters while you are piling the snow in your yard.

   a. How much work did you do? Hint: The force is the **weight** of the snow.

   b. What was your power in watts? Hint: You must always convert time to seconds when calculating power.

5. A television converts 12,000 joules of electrical energy into light and sound every minute. What is the power of the television?

6. The power of a typical adult's body over the course of a day is 100 watts. This means that 100 joules of energy from food are needed each second.

   a. An average apple contains 500,000 joules of energy. For how many seconds would an apple power a person?

   b. How many joules are needed each day?

   c. How many apples would a person need to eat to get enough energy for one day?

7. A mass of 1,000 kilograms of water drops 10.0 meters down a waterfall every second.

   a. How much potential energy is converted into kinetic energy every second?

   b. What is the power of the waterfall in watts and in horsepower

8. An alkaline AA battery stores approximately 12,000 joules of energy. A small flashlight uses two AA batteries and will produce light for 2.0 hours. What is the power of the flashlight bulb? Assume all of the energy in the batteries is used.