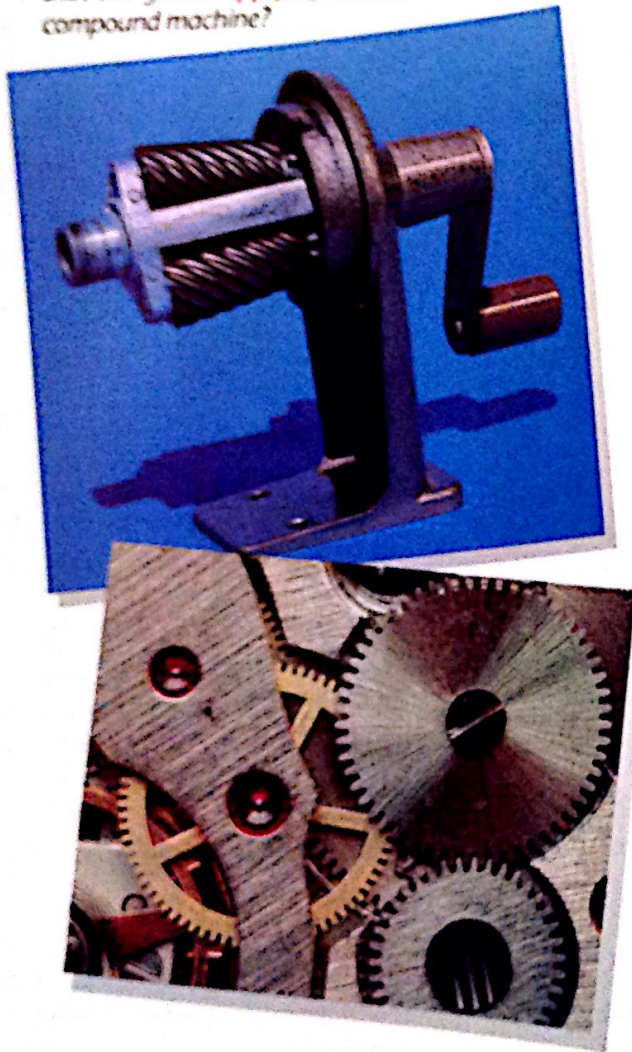


**Figure 19** Both a pencil sharpener and a clock are examples of compound machines that use gears. **Applying Concepts** What is a compound machine?



## Compound Machines

Many devices that you can observe around you do not resemble the six simple machines you just read about. That is because more complex machines consist of combinations of simple machines. A machine that utilizes two or more simple machines is called a **compound machine**. To calculate the ideal mechanical advantage of a compound machine, you need to know the mechanical advantage of each simple machine. The overall mechanical advantage is the product of the individual ideal mechanical advantages of the simple machines.

A mechanical pencil sharpener is a good example of a compound machine. When you turn the handle, you are using a wheel and axle to turn the mechanism inside the sharpener. The two cutting wheels inside are screws that whittle away at the end of the pencil until it is sharp.

Inside the pencil sharpener in Figure 19 is an axle that turns gears. The gears then turn the cutting wheels. A system of gears is a device with toothed wheels that fit into one another. Turning one wheel causes another to turn. Gears form a compound machine with one wheel and axle linked to another wheel and axle. Sometimes this link is direct, as in the gears shown in Figure 19. In other devices, such as a bicycle, this link is through a chain.