Wheel and Axle

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Learning Objectives

- Describe the simple machine known as a wheel and axle.
- Relate the mechanical advantage of a wheel and axle to how the machine is used.

Did you ever ride on a Ferris wheel like this one? If you did, then you know how thrilling the ride can be. The faster it goes, the more exciting it is. A Ferris wheel is an example of a machine called a wheel and axle.

Round and Round It Goes

A wheel and axle is a simple machine that consists of two connected rings or cylinders, one inside the other. Both rings or cylinders turn in the same direction around a single center point. The inner ring or cylinder is called the axle, and the outer one is called the wheel. Besides the Ferris wheel, the doorknob in the Figure 1.1 is another example of a wheel and axle.

In a wheel and axle, force may be applied either to the wheel or to the axle. This force is called the input force. A wheel and axle does not change the direction of the input force. However, the force put out by the machine, called the output force, is either greater than the input force or else applied over a greater distance.
Q: Where is the force applied in a Ferris wheel and a doorknob? Is it applied to the wheel or to the axle?

A: In a Ferris wheel, the force is applied to the axle by the Ferris wheel’s motor. In a doorknob, the force is applied to the wheel by a person’s hand.

Mechanical Advantage of a Wheel and Axle

The mechanical advantage of a machine is the factor by which the machine changes the input force. It equals the ratio of the output force to the input force. A wheel and axle may either increase or decrease the input force, depending on whether the input force is applied to the axle or the wheel.

• When the input force is applied to the axle, as it is with a Ferris wheel, the wheel turns with less force. Because the output force is less than the input force, the mechanical advantage is less than 1. However, the wheel turns over a greater distance, so it turns faster than the axle. The speed of the wheel is one reason that the Ferris wheel ride is so exciting.
• When the input force is applied to the wheel, as it is with a doorknob, the axle turns over a shorter distance but with greater force, so the mechanical advantage is greater than 1. This allows you to turn the doorknob with relatively little effort, while the axle of the doorknob applies enough force to slide the bar into or out of the doorframe.

Summary

• A wheel and axle is a simple machine that consists of two connected rings or cylinders, one inside the other, which both turn in the same direction around a single center point.
• A wheel and axle may either increase or decrease the input force, depending on whether the input force is applied to the axle or the wheel. Therefore, the mechanical advantage of a wheel and axle may be greater than 1 or less than 1.

Review

1. Describe a wheel and axle.
2. Give an example of a wheel and axle that isn’t mentioned in the article.
3. When you pedal a bicycle, you apply force to the back wheel and axle. Is the force applied to the wheel or to the axle? What is the mechanical advantage of the bicycle wheel and axle?

References

1. Zachary Wilson. CK-12 Foundation . CC BY-NC 3.0
2. James Lee (Flickr: jronaldlee); Robert Lopez and Laura Guerin; Zachary Wilson. http://www.flickr.com/photos/jronaldlee/4321420148/; CK-12 Foundation . CC BY 2.0; CC BY-NC 3.0