

# Work

## READ



In science, “work” is defined with an equation. Work is the amount of force applied to an object (in the same direction as the motion) over a distance. By measuring how much force you have used to move something over a certain distance, you can calculate how much work you have accomplished.

The formula for work is:

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

$$W = F \times d$$

A *joule* of work is actually a *newton-meter*; both units represent the same thing: work! In fact, one joule of work is defined as a force of one newton that is exerted on an object to it a distance of one meter.

$$1.0 \text{ joule} = 1.0 \text{ N} \times 1.0 \text{ meter} = 1.0 \text{ newton-meter}$$

## EXAMPLES



How much work is done on a 10-newton block that is lifted 5 meters off the ground by a pulley?

Looking for	Solution
The amount of work done by a pulley in unit of newtons and meters.	$\text{Work} = 10 \text{ N} \times 5 \text{ m}$ $\text{Work} = 50 \text{ newton-meters}$ <p>The pulley did 50 newton-meters or 50 joules of work.</p>
<b>Given</b> The lift force applied by the pulley = 10 N The distance the force was lifted = 5 meters.	
<b>Relationship</b> $\text{Work} = \text{Force} \times \text{distance}$ $1 \text{ newton-meter} = 1 \text{ joule}$	

## PRACTICE



- In your own words, define work in scientific terms. Be complete in your definition.
- How are work, force, and distance related?
- What are two different units that represent work?
- For the following situations, determine whether work was done. Write “work done” or “no work done” for each situation.
  - An ice skater glides for two meters across ice.
  - The ice skater’s partner lifts her up a distance of 1 meter.
  - The ice skater’s partner carries her across the ice a distance of 3 meters.
  - After setting her down, the ice skater’s partner pulls her across the ice a distance of 10 meters.
  - After skating practice, the ice skater lifts her 20-newton gym bag up 0.5 meter.



5. A woman lifts her 100-newton child up one meter and carries her for a distance of 50 meters to the child's bedroom. How much work does the woman do?
6. How much work does a mother do if she lifts each of her twin babies upward 1 meter? Each baby weighs 90 newtons.
7. You pull your sled through the snow a distance of 500 meters with a horizontal force of 200 newtons. How much work did you do?
8. Because the snow suddenly gets too slushy, you decide to carry your 100-newton sled the rest of the way home. How much work do you do when you pick up the sled, lifting it 0.5 meter upward? How much work do you do to carry the sled if your house is 800 meters away?
9. An ant sits on the back of a mouse. The mouse carries the ant across the floor for a distance of 10 meters. Was there work done by the mouse? Explain.
10. You decide to add up all the work you did yesterday. If you accomplished 10,000 newton·meters of work yesterday, how much work did you do in units of joules?
11. You did 150 joules of work lifting a 120-newton backpack.
  - a. How high did you lift the backpack?
  - b. How much did the backpack weigh in pounds? (Hint: There are 4.448 newtons in one pound.)
12. A crane does 62,500 joules of work to lift a boulder a distance of 25.0 meters. How much did the boulder weigh? (Hint: The weight of an object is considered to be a force in units of newtons.)
13. A bulldozer does 30,000 joules of work to push another boulder a distance of 20 meters. How much force is applied to push the boulder?
14. You lift a 45-newton bag of mulch 1.2 meters and carry it a distance of 10 meters to the garden. How much work was done?
15. A 450-newton gymnast jumps upward a distance of 0.50 meters to reach the uneven parallel bars. How much work did she do before she even began her routine?
16. It took a 500.0-newton ballerina a force of 250 joules to lift herself upward through the air. How high did she jump?
17. A people-moving conveyor-belt moves a 600-newton person a distance of 100 meters through the airport.
  - a. How much work was done?
  - b. The same 600-newton person lifts his 100-newton carry-on bag upward a distance of 1 meter. They travel another 10 meters by riding on the "people mover." How much work was done in this situation?
18. Which person did the most work?
  - a. John walks 1,000 meters to the store. He buys 4.448 newtons of candy and then carries it to his friend's house which is 500 meters away.
  - b. Sally lifts her 22-newton cat a distance of 0.5 meter.
  - c. Henry carries groceries from a car to his house. Each bag of groceries weighs 40 newtons. He has ten bags. He lifts each bag up one meter to carry it and then walks 10 meters from his car to his house.