

Work

Depends on _____ and the _____ the force moves the object

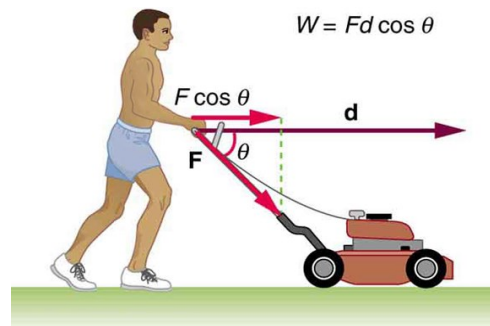
Want the force in the direction of the _____

$$W = Fd \cos \theta$$

Unit: N m = Joule (J)

_____ (but can be positive and negative)

Marcy pulls a backpack on wheels down the 100-m hall. The 60-N force is applied at an angle of 30° above the horizontal. How much work is done by Marcy?



Mark is carrying books (200 N) down the 100-m hall. How much work is Mark doing on the books?

You carry some books (200 N) while walking down stairs height 2 m and length 3 m. How much work do you do?

A suitcase is hanging straight down from your hand as you ride an escalator. Your hand exerts a force on the suitcase, and this force does work. Which one of the following is correct?

- a. The W is negative when you ride up and positive when you ride down
- b. The W is positive when you ride up and negative when you ride down
- c. The W is positive
- d. The W is negative

Power

Rate that _____ is _____: $P = \frac{W}{t}$

Unit: joule/s = watt (W)

Power is the _____ that _____ is _____

A 1000 kg car accelerates from 0 to 100 km/h in 3.2 s on a level road. Find the average power of the car.

Electrical Energy is often measured in _____ because $Pt = W$

If it costs \$0.10 per kWh, how much will it cost to run a 1000 W microwave for 2 minutes?

Practice Work

1. A box is being moved with a velocity v by a force P (parallel to v) along a level horizontal floor. The normal force is F_N , the kinetic frictional force is f_k , and the weight of the box is mg . Decide which forces do positive, zero, or negative work. Provide a reason for each of your answers.
2. A sailboat is moving at a constant velocity. (a) Is work being done by a net external force acting on the boat? Explain. (b) Recognizing that the wind propels the boat forward and the water resists the boat's motion, what does your answer in part (a) imply about the work done by the wind's force compared to the work done by the water's resistive force?
3. Work done on a system puts energy into it. Work done by a system removes energy from it. Give an example for each statement.
4. The brakes of a truck cause it to slow down by applying a retarding force of 3.0×10^3 N to the truck over a distance of 850 m. What is the work done by this force on the truck? Is the work positive or negative? Why? (Cutnell 6.1) **-2.6×10^6 J**
5. A person pulls a toboggan for a distance of 35.0 m along the snow with a rope directed 25.0° above the snow. The tension in the rope is 94.0 N. (a) How much is done on the toboggan by the tension force? (b) How much work is done if the same tension is directed parallel to the snow? (Cutnell 6.3) **2980 J, 3290 J**
6. A 75.0-kg man is riding an escalator in a shopping mall. The escalator moves the man at a constant velocity from ground level to the floor above, a vertical height of 4.60 m. What is the work done on the man by (a) the gravitational force and (b) the escalator? (Cutnell 6.4) **-3380 J, 3380 J**
7. Suppose in the picture that 1100 J of work are done by the force $F = 30.0$ N in moving the suitcase a distance of 50.0 m. At what angle θ is the force oriented with respect to the ground? (Cutnell 6.5) **42.8°**
8. A person pushes a 16.0-kg shopping cart at a constant velocity for a distance of 22.0 m. She pushes in a direction 29.0° below the horizontal. A 48.0-N frictional force opposes the motion of the cart. (a) What is the magnitude of the force that the shopper exerts? (review) Determine the work done by (b) the pushing force, (c) the frictional force, and (d) the gravitational force. (Cutnell 6.7) **54.9 N, 1060 J, -1060 J, 0 J**
9. (a) Calculate the work done on a 1500-kg elevator car by its cable to lift it 40.0 m at constant speed, assuming friction averages 100 N. (b) What is the work done on the lift by the gravitational force in this process? (c) What is the total work done on the lift? (OpenStax 7.3) **5.92×10^5 J, -5.88×10^5 J, 0 J**
10. How much work is done by the boy pulling his sister 30.0 m in a wagon as shown in Figure 7.36? Assume no friction acts on the wagon. (OpenStax 7.6) **1.30×10^3 J**
11. Is it correct to conclude that one engine is doing twice the work of another just because it is generating twice the power? Explain.
12. Explain, in terms of the definition of power, why energy consumption is sometimes listed in kilowatt-hours rather than joules.
13. A spark of static electricity, such as that you might receive from a doorknob on a cold dry day, may carry a few hundred watts of power. Explain why you are not injured by such a spark.
14. A person is making homemade ice cream. She exerts a force of magnitude 22 N on the free end of the crank handle, and this end moves in a circular path of radius 0.28 m. The force is always applied parallel to the motion of the handle. If the handle is turned once every 1.3 s, what is the average power being expended? (Cutnell 6.56) **30 W**
15. What is the cost of operating a 3.00-W electric clock for a year if the cost of electricity is \$0.0900 per kWh? (OpenStax 7.33) **\$2.37**
16. A large household air conditioner may consume 15.0 kW of power. What is the cost of operating this air conditioner 3.00 h per day for 30.0 d if the cost of electricity is \$0.110 per kWh? (OpenStax 7.34) **\$149**
17. A 500-kg dragster accelerates from rest to a final speed of 110 m/s in 400 m (about a quarter of a mile) and encounters an average frictional force of 1200 N. What is its average power output in watts and horsepower if this takes 7.30 s (1 hp = 746 W)? (OpenStax 7.37) **4.80×10^5 W, 643 hp**

