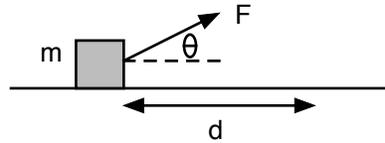


## Work

Normally, we would do a lab of some form to introduce a new idea or concept. While we will do a lab very soon, I want to introduce a new term to you that has a very specific definition: work. Tomorrow, we will get into why we care about work and what it does, but for today, let's just get used to doing some calculations based on the following initial definition of work:

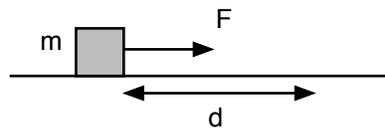


*The work  $W$  done by a force  $F$  that acts on an object for a distance  $d$  (as shown above) is*

$$W = Fd \cos \theta$$

- A. What are the units of work?
- B. Is work a vector or a scalar?
- C. Why is there a cosine in the equation?
- D. If the force  $F$  was parallel to the displacement ( $d$ ), what would be the work done by  $F$ ?
- E. If the force  $F$  was perpendicular to the displacement ( $d$ ), what would be the work done by  $F$ ?
- F. Can work be a negative number?

### Calculations



*The diagram above shows a block being pulled across a floor or table by a horizontal force  $F$ .*

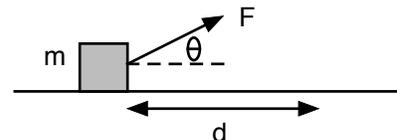
1. If the force was a constant 20 N, how much work was done by the force pulling the object 5 m?
2. If the force was a constant 20 N, how much work was done by the force pulling the object 15 m?
3. How far would a force of 15 N have to pull the object to do 100 J of work?
4. If the distance pulled was 8 meters and the total work done was 90 J, what was the force?

## Work

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5. If there was a friction force of 5 N, and the object was still pulled to the right 7 meters, how much work did friction do?
6. If friction did  $-75$  J of work, and the object was pulled 8 meters, what was the force of friction?
7. Can friction ever do positive work? Explain.
8. A 35 N force is pulling a box to the right. There is also a frictional force of 15 N acting on the box. The box is pulled a total of 5 meters.
  - a. How much work did the 35 N force do?
  - b. How much work did friction do?
  - c. How much total work was done on the box?
9. A 50 N force is pulling a box to the right a distance of 12 meters. Friction does  $-200$  J of work on the box.
  - a. How much work did the 50 N force do?
  - b. What was the force of friction?
  - c. How much total work was done on the box?

Now imagine a force is pulling up at an angle, as shown to the right. The object moves horizontally.



10. How much work does a constant force of 25 N at an angle of  $30^\circ$  do when the object moves 5 m?
11. How much work does a constant force of 25 N at an angle of  $60^\circ$  do when the object moves 5 m?
12. If the force was 75 N and the angle was  $40^\circ$ , how far was the box pulled if the work done by the force was 200 J?
13. Here's a tricky one! How much work did gravity do on the box in any of those problems?

Answers: 1) 100 J 2) 300 J 3) 6.7 m 4) 11.25 N 5)  $-35$  J 6)  $-9.4$  N  
 7) No! b/c always opposite the motion 8.a) 175 J b)  $-75$  J c) 100 J 9.a) 600 J b)  $-16.7$  N c) 400 J  
 10) 108.3 J 11) 62.5 J 12) 3.48 m 13) 0 J! Force of gravity perpendicular to motion in all these problems.