

Work

Objectives

- Define work.
- Calculate the work done by a force.

What is Work?

- You do work on an object when you move it.
- The rate at which you do work is your power output.
- When you do work on an object, you transfer energy from one object to another.
- **Work** is the process of moving an object by applying a force in the direction of the motion.

Examples of Work

- A stuntman in a jet pack blasts through the atmosphere, accelerating to higher and higher speeds.
- The jet pack is applying a force causing it to move.
- Hot expanding gases are pushed backward out of the jet pack.
- The reactionary force of the gas pushing the jet pack forward causes a displacement.
- The expanding exhaust gas is doing work on the jet pack.



Examples of Work

- A girl struggles to push her stalled car, but can't make it move.
- She expends significant effort, but car doesn't move.
- Since car isn't moving, no work is done.

Examples of Work

- A child in a ghost costume carries a bag of Halloween candy across the yard.
- The child applies a force upward on the bag, but the bag moves horizontally.
- Was there work being done by the child?



Calculating Work

- $W = Fd$
- W is the work done in Joules ($N \cdot M$)
- F is the force applied in Newtons
- d is the object's displacement in meters

Calculating Work

- Only the force in the direction of the displacement counts.
- When force and displacement aren't in the same direction, you must take component of force in the direction of displacement.
- $W = Fd \cos\theta$

Sample Problem 1

- An appliance salesman pushes a refrigerator 2 meters across the floor by applying a force of 200N. Find the work done.

Sample Problem 2

- A friend's car is stuck on the ice. You push down on the car to provide more friction for the tires (by way of increasing the normal force), allowing the car's tires to propel it forward 5 meters onto less slippery ground. How much work did you do?

Sample Problem 3

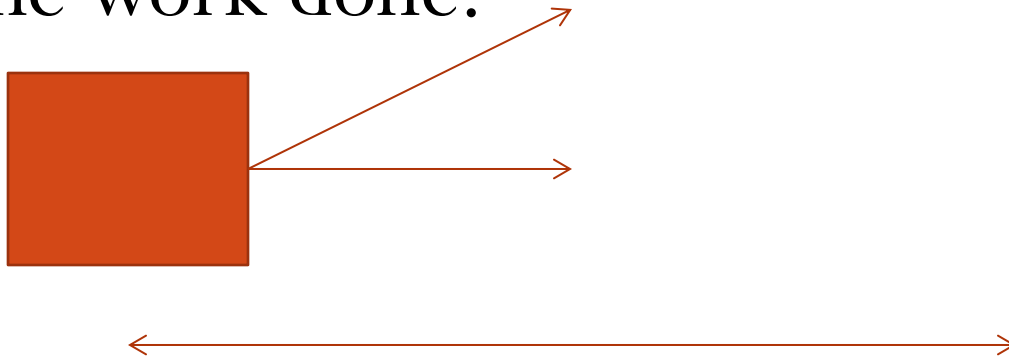
- You push a crate up a ramp with a force of 10N. Despite your pushing, however, the crate slides down the ramp a distance of 4m. How much work did you do?

Sample Problem 4

- How much work is done in lifting an 8-kg box from the floor to a height of 2m above the floor?

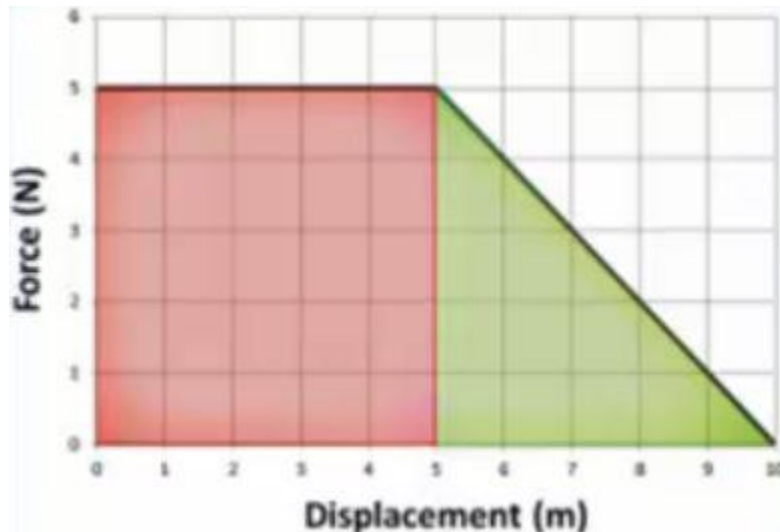
Sample Problem 5

- Barry and Sidney pull a 30 kg wagon with a force of 500N a distance of 20m. The force acts a 30° angle to the horizontal. Calculate the work done.



Force vs. Displacement Graphs

- The area under a force vs displacement graph is the work done by the force. Consider the situation of a block being pulled across a table with a constant force of 5 Newtons over a displacement of 5 meters, then the force gradually tapers off over the next 5 meters. Find the work done.



Sample Problem 7

- A box is wheeled to the right with a varying horizontal force. The graph represents the relationship between the applied force and the distance the box moves. What is the total work done in moving the box 6 meters?

