Work, Force, and Motion

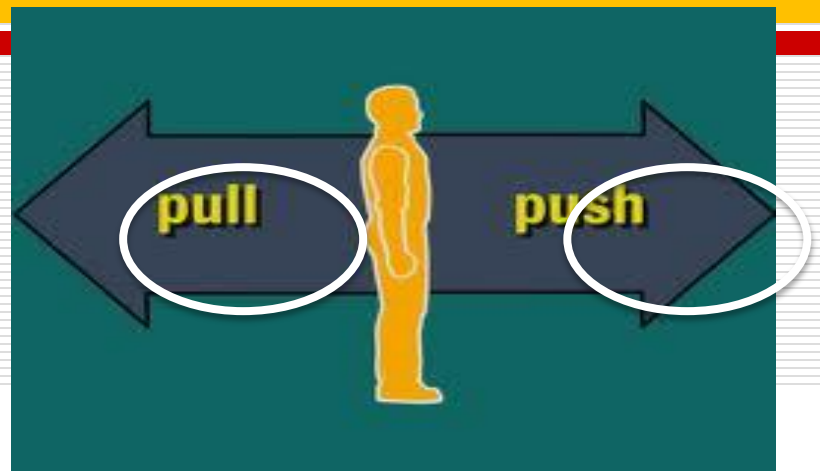
SOL Standard

- PS.10 The student will investigate and understand the scientific principles of work, force and motion. Key concepts include
  - Speed, velocity and acceleration
  - Newton's laws of motion
  - Work, force

Guiding Questions

- What is the difference between work, force and motion?
- How is the speed, velocity, and acceleration of an object measured and calculated?
- How does speed, velocity, and acceleration describe motion?
- What is the difference between mass and weight?
- What is an example of each of Newton's three Laws of Motion?
- What is the relationship between force, mass and acceleration?

What is a force?



A force is a push or a pull on matter

Motion

- a change in position, or location of a place or object, over a certain amount of time
- relies on a frame of reference or something assumed to be stationary
- Frame of reference is a stationary location or object to which you compare other locations or objects

How does Frame of Reference relate to motion?

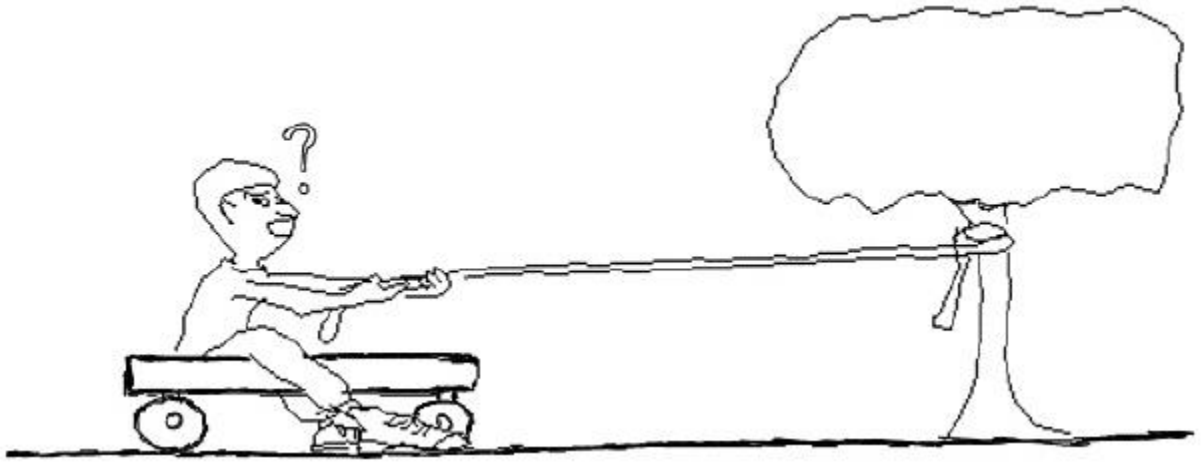
- Motion is relative to a frame of reference
- Something that is not moving in one point of reference can be moving in a different point of reference

Understanding frame of reference

- Nothing is truly stationary when relative to all other objects
- If you sit perfectly still, are you moving?

What Is Work?

- **Work** is a transfer of energy
- In science, **work** is done when a force causes an object to move in the direction of the force.
- If there is no movement in the direction of the force. no work is done



How to Calculate Work

We use the equation **W = F x D** "Work equals Force times Distance"

$W = 80\ N \times 1\ m = 80\ J$

The force needed to lift an object is equal to the gravitational force on the object—in other words, the object's weight.

$W = 160\ N \times 1\ m = 160\ J$

If you increase the weight, an increased force is needed to lift the object. This increases the amount of work done.

$W = 80\ N \times 2\ m = 160\ J$

Increasing the distance also increases the amount of work done.

Do forces always cause work?

Example	Direction of force	Direction of motion	Doing work?
	→	→	Yes
	↑	→	No
	↑	↑	Yes
	↑	→	No

Speed

- the rate at which an object moves
- a measure of how fast something moves, or the distance it moves, in a given amount of time
  - **Formula:** $S = \frac{d}{t}$
- typically expressed in units of m/s
- is considered ***average*** when taking into account the total distance covered and the total time of travel
- is considered ***constant*** when it does not change
- is considered ***instantaneous*** when it represents a specific instant in time

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What is the ball's speed?

6 meters

Interesting Speeds

	meters/second	miles/hour
Cockroach	1.25	2.8
Kangaroo	15	34
Cheetah	27	60
Sound *(in 20°C air)*	343	767
Space Shuttle *(getting into orbit)*	7,823	17,500
Light	300,000,000	671,080,888

Practice Problems - Speed

1. If you walk for 1.5 hours and travel 7.5 km, what is your average speed?

$$S = \frac{d}{t} \qquad S = \frac{7.5\ km}{1.5\ hr} = 5\ \frac{km}{hr}$$

2. Calculate the speed of a bee that flies 22 meters in 2 seconds.

$$S = \frac{d}{t} \qquad S = \frac{22\ m}{2\ sec} = 11\ \frac{m}{sec}$$

The Speed Triangle

$$d = S \cdot t$$