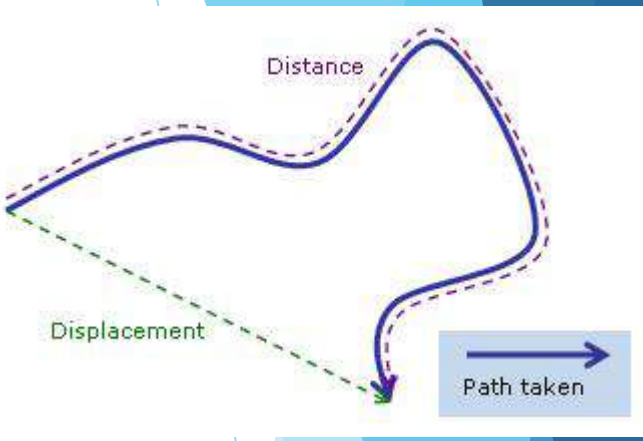
Physical Science Unit 1 Crash Course

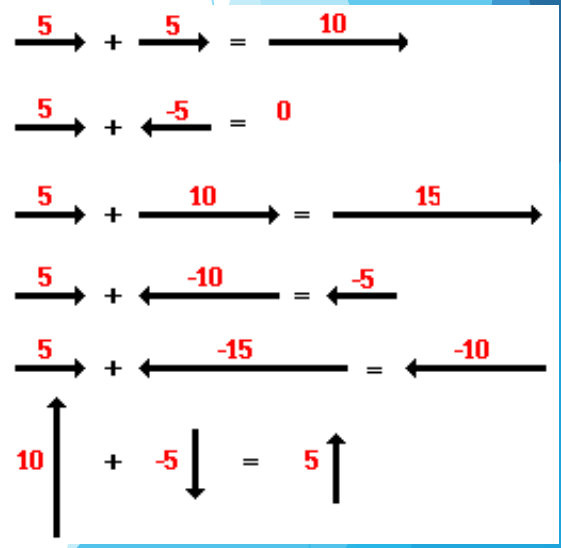
Chapter 11, 12, and 14

(Motion, Forces, and Machines)

Chapter 11 - Motion

- Distance is the length of a path between two points.
- Displacement is the direction from the starting point and the length of a straight line from the starting point to the ending point.
- When two displacements, represented by two vectors, have the same direction, you can add their magnitudes.
- If two displacements have opposite directions, the magnitudes subtract from each other.





Chapter 11 - Motion

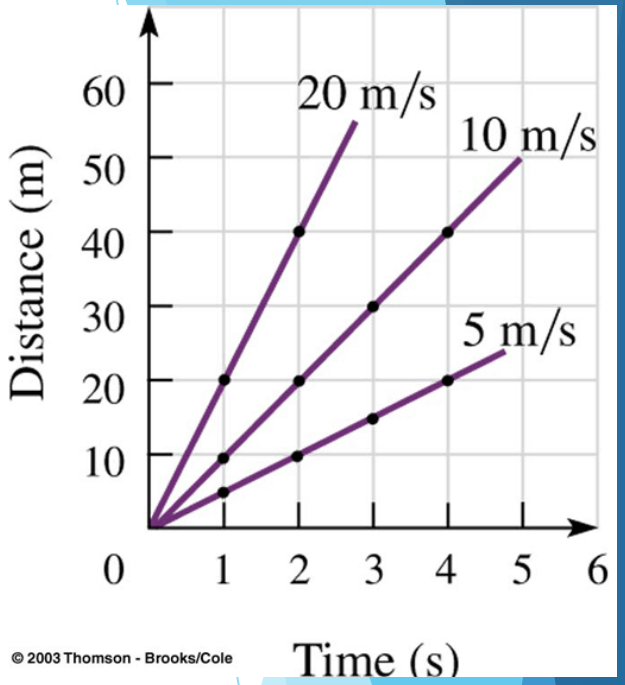
- Speed is the ratio of the distance an object moves to the amount of time the object moves.
- Velocity is a description of both speed and direction. Velocity is a vector.
- A change in velocity can be a result of a change in speed, direction, or both.

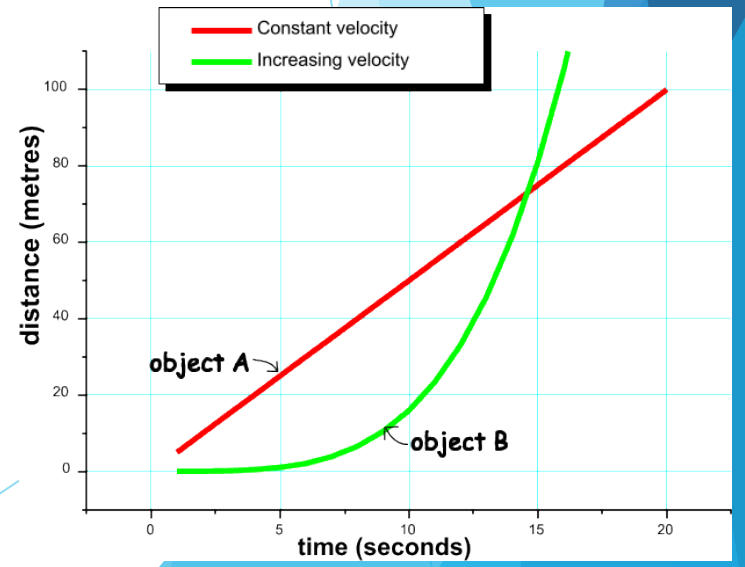
$$\text{Velocity} = \frac{\text{distance}}{\text{time}}$$

- The SI unit of speed and velocity is meters per second (m/s).

Chapter 11 - Motion

- The slope of a line on a distance-time graph is speed.
- The steeper the slope of the line, the faster the speed.
- Straight lines represent constant speed.





Chapter 11 - Motion

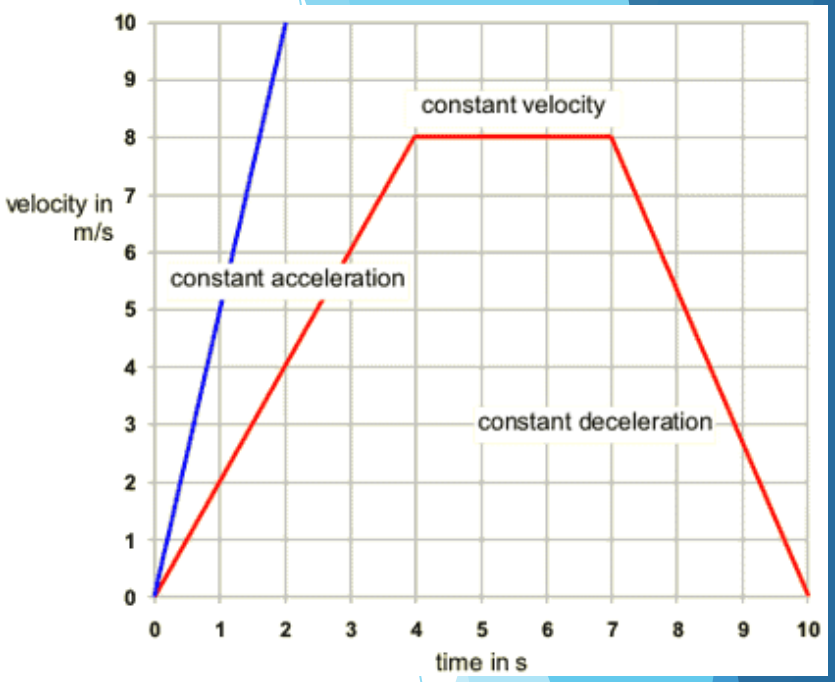
- The rate at which velocity changes is called acceleration.
- Acceleration can be described as changes in speed, changes in direction, or changes in both.
- Free fall is the movement of an object toward the Earth solely because of gravity.
- Objects falling near Earth's surface accelerate downward at a rate of $9.8 m/s^2$.

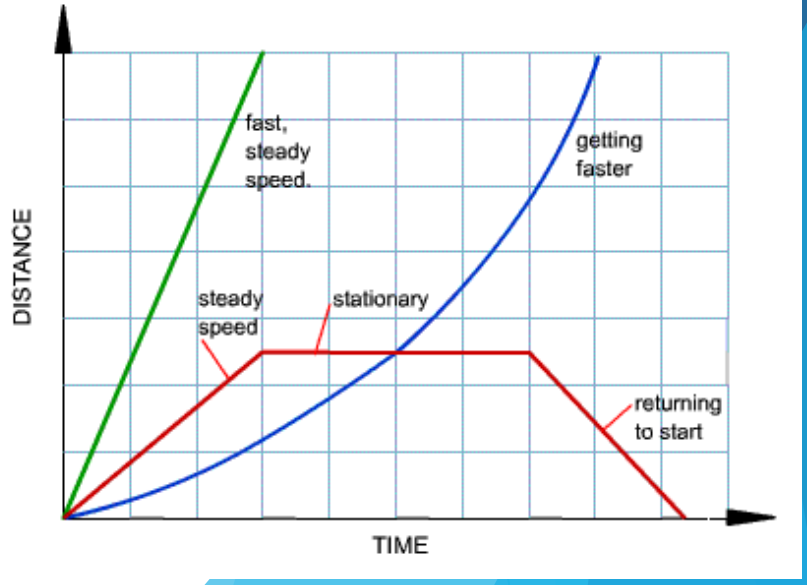
Chapter 11 - Motion

- The SI unit for acceleration is m/s^2.

$$a = \frac{v_f - v_i}{t}$$

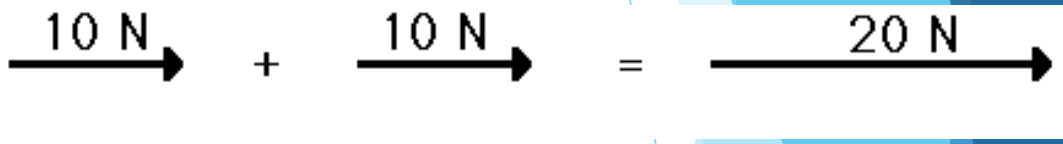
- The slope of a speed-time graph is acceleration.
- Constant acceleration is represented by a straight line.
- On a distance-time graph, acceleration is represented by a curved line.



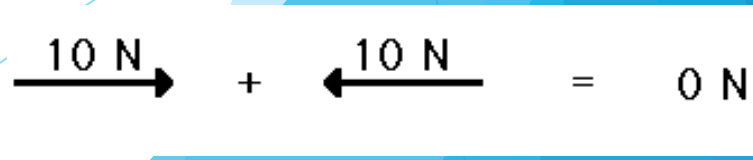


Chapter 12 - Forces

- A force is a push or pull that acts on an object.
- A force can cause a resting object to move, or can accelerate a moving object by changing the object's speed or direction.
- Force is measured in newtons (N).



- Forces combine by vector addition.
- When the forces on an object are balanced, the net force is zero and there is no change in the object's motion.
- An unbalanced force is a force that results when the net force acting on an object is not equal to zero.



Chapter 12 - Forces

- All moving objects are subject to friction, a force that opposes the motion of objects that touch as they move past each other.
- Static friction is the friction force that acts on objects that are not moving.
- Sliding friction is a force that opposes the direction of motion of an object as it slides over a surface.
- The change in shape when something rolls is the cause of rolling friction, the friction force that acts on rolling objects.
- The force of fluid friction opposes the motion of an object through a fluid.
- Fluid friction acting on an object moving through air is known as air resistance.

Chapter 12 - Forces

- Gravity is an attractive force that acts between any two masses.
- Gravity does not require objects to be in contact for it to act on them.
- As the speed of a falling object increases, so does the air resistance.

Chapter 12 - Forces

- According to Newton's first law of motion, the state of motion of an object does not change as long as the net force acing on the object is zero.
- Inertia is the tendency of an object to resist change in its motion.
- According to Newton's second law of motion, the acceleration of an object is equal to the net force acting on it divided by the object's mass.

$$a = F/m$$

- According to Newton's third law of motion, for every force there is an equal and opposite force.

Chapter 12 - Forces

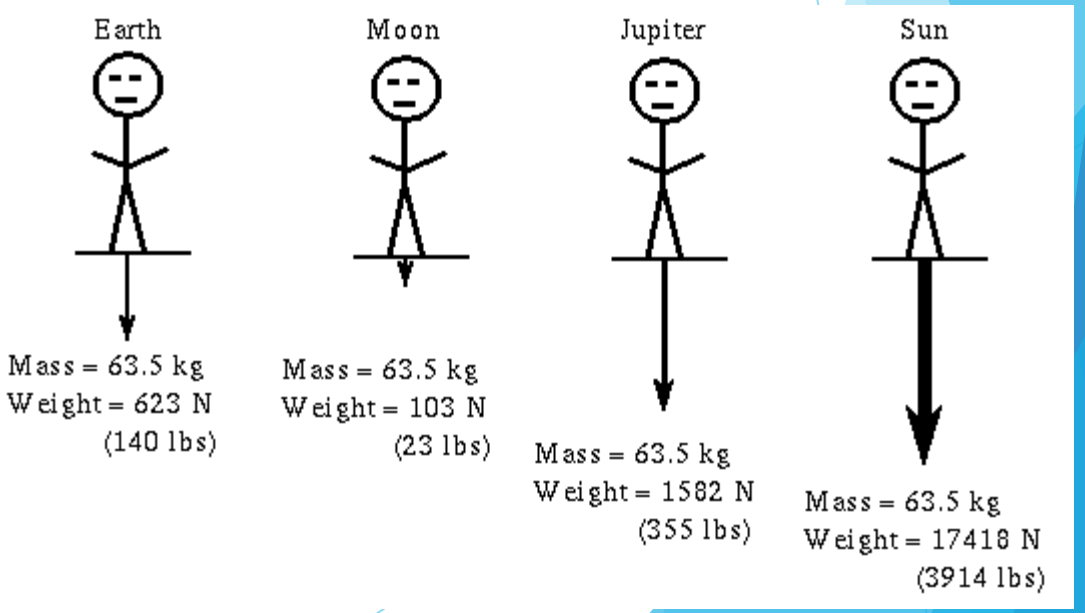
- Mass is the amount of matter an object contains.
- Weight is the force of gravity acting on an object.

$$W = m \times g$$

Weight (W) = N

mass (m) = kg

gravity (g) = 9.8 m/s^2



Chapter 12 - Forces

- All the universal forces act over a distance between particles of matter, which means that the particles do not need to be in contact with one another.
- Electromagnetic force is associated with charged particles.
- Two forces, the strong nuclear and the weak nuclear force, act within the nucleus to hold it together.
- Gravitational force is an attractive force that acts between any two masses.
- Newton's law of universal gravitation states that every object in the universe attracts every other object.

Chapter 12 - Forces

- Newton's law of universal gravitation states that every object in the universe attracts every other object.
- The gravitational force between two objects is proportional to their masses and decreases as the distance between them increases.
- Gravity is the weakest universal force, but it is the most effective over long distances.

Chapter 14 - Machines

- In science, work is the product of force and distance. Work is done when a force acts on an object in the direction the object moves.

$$W = F \times d$$

- The unit of force is newtons.
- The unit of distance is meters.
- The unit of work is the joule.

Chapter 14 - Machines

- Machines make work easier to do. They change the size of the force needed, the direction of a force, or the distance over which a force acts.
- If a machine increases the distance over which you exert a force, then it decreases the amount of force you need to exert.
- A machine that decreases the distance through which you exert a force increases the amount of force required.
- Because of friction, the work done by a machine is always less than the work done on the machine.

Chapter 14 - Machines

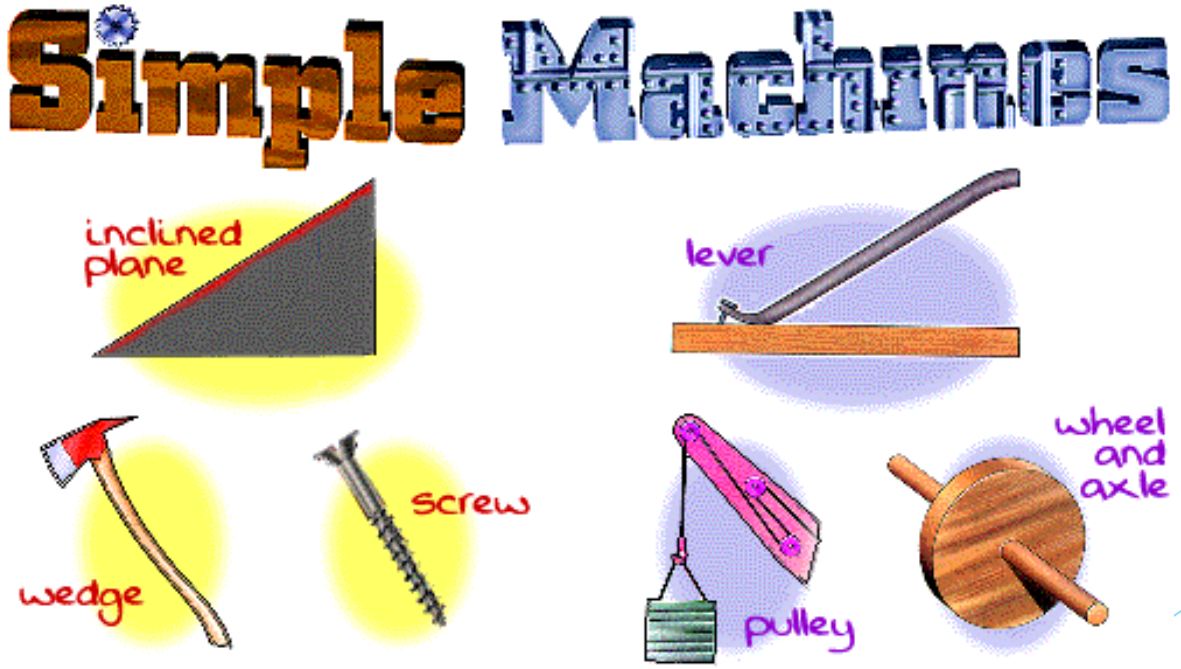
- The work done by the effort force acting through the effort distance is called the work input.
- The work output of a machine is the resistance force multiplied by the resistance distance.
- You cannot get more work out of a machine than you put into it.
- The mechanical advantage of a machine is the number of times that the machine increases the effort force.

$$\text{AMA} = \frac{\text{resistance force}}{\text{effort force}}$$

$$\text{IMA} = \frac{\text{effort distance}}{\text{resistance distance}}$$

Chapter 14 - Machines

- Some resistance force is lost due to friction.
- No machine has 100 percent efficiency due to friction.
- The six simple machines are:



Chapter 14 - Machines

- A lever is a rigid bar that rotates around a fixed point called the fulcrum.
- The wheel and axle is a simple machine consisting of a large disk (wheel) rigidly secured to a smaller disk (axle).
- An inclined plane is a slanted surface along which a force moves an object to a different elevation.
- The wedge is a V-shaped object whose sides are two inclined planes. Narrow wedges have a greater IMA.
- Screws with threads that are closer together have a greater IMA since it takes less force.
- A pulley is a simple machine that consists of a rope that fits into a groove in a wheel.