

AIM: Force and Motion Ideas

a. An object's position can be described by locating the object relative to other objects or a background.

- To locate one object relative to another (reference) object, one must give the distance between them and specify the direction from the reference object.

b. An object is in motion when its position is changing; an object's motion can be described by its speed and the direction in which it is moving.

- The distance an object travels is the length of the actual path it takes from its starting position to its ending position. Objects may travel different distances between the same starting and ending points.
- The average speed of an object (as opposed to its speed at a particular instant) is defined by the distance it travels divided by the amount of time it took to travel that far.
- Instantaneous velocity and speed are different kinds of quantities. Instantaneous speed is a measure of how quickly an object is moving without regard for its direction. Instantaneous velocity includes information about the direction of motion also. An object that changes its direction of motion, while keeping a constant speed, also changes its velocity.
- The description of an object's motion from one observer's view may be different from that reported from a different observer's view.
 - The description of an object's motion depends on the reference point chosen.
 - Different observers may be in different positions and may choose different reference points.
 - An observer will report an object as being in motion when its position measured relative to the observer or the observer's chosen reference point is changing. When an object and an observer have the same motion, the observer will report the object as being at rest with respect to him/her, while other observers may report both the object and the first observer as being in motion.

c. A change in motion, or acceleration, is a change in an object's velocity (speed, direction of motion, or both).

- Acceleration measures the rate of change of an object's velocity per unit time.

d. The motion of an object can be represented using graphs of its position versus time and speed versus time.

- An object's speed and/or acceleration can be determined from a graph of its position vs. time or speed vs. time.
 - The slope of a position-time graph represents how quickly an object's position is changing and so is equivalent to the speed of an object. A straight horizontal line on a position-time graph indicates the object is not moving. A straight line on a position-time graph that slopes upward or downward indicates that an object's speed is constant. A curved line on a position-time graph indicates that an object's speed is changing.
 - The slope of a speed-time graph represents how quickly an object's speed is changing and so represents its acceleration. A straight horizontal line on a speed-time graph indicates the object's speed is not changing; if this line is zero then the object is not moving. A line that slopes upward or downward on a speed-time graph indicates that an object's speed is changing.
- A graph of position versus time (or speed versus time) from measured points only approximates the relationship between position and time (or speed and time), because no information is provided about position (or speed) between the successive times of measurement.

e. A force is a push or pull exerted on one object by another object when they interact with one another.

- Forces have magnitude and direction. To be completely specified, both the magnitude and direction of a force must be stated.

- Some types of force, typically those caused by everyday pushes and pulls (such as when people push or pull on other objects), only exist when the objects involved are in direct contact with each other. When contact is broken these forces no longer exist. Some types of force, such as gravity and magnetic forces, always exist, whether or not the interacting objects are in contact with each other.
- Earth pulls on all objects with a force called gravity.
- Supporting objects, such as hands, tables, and shelves, exert an upward force on objects on top of them.
- The force of friction acts to oppose the relative motion of two objects in contact
- Air exerts a weak upward force on all objects. For some very light but large objects this force may be equal to or stronger than the gravitational force and so they will not fall to the ground when released and may even move upward.

f. Forces can be added. The net force on an object is the sum of all the forces acting on the object.

g. A net force of zero on an object does not change the object's motion.

- When an object does not move in response to a push or a pull, it is because another push or pull is being applied by the environment.

h. A non-zero net force on an object changes the object's motion; that is, the object's speed and/or direction of motion changes. The size of the change is related to the size of the force (push or pull) and the weight (mass) of the object on which the force is exerted.

- The change in an object's motion (speed and direction) is proportional to the size of the net force acting on it and inversely proportional to the object's mass.
- A net force acting in the same direction as an object's motion will cause its speed to increase. A net force acting in the opposite direction as an object's motion will cause its speed to decrease. A non-zero net force acting in a direction perpendicular to an object's motion will change the object's direction (and possibly its speed).