Motion and Momentum

Section 1   What is motion?

> Underlined words and phrases are to be filled in by students on the Note-taking Worksheet.

A. All matter is constantly in <u>motion</u>.

B. Motion involves a <u>change</u> in position.

   1. An object changes position relative to a <u>reference</u> point.

   2. <u>Distance</u> is the total length of the route an object travels when it moves.

   3. <u>Displacement</u> includes distance and direction of the stopping point from the starting point.

C. Distance traveled divided by the time taken to travel the distance is called **speed**.

   1. The formula for <u>speed</u> can be written as: speed = distance/time.

   2. The units of speed are units of distance divided by units of time; in SI units, speed is given as <u>meters per second</u> (m/s).

   3. An object in motion can change <u>speeds</u> many times as it moves from one point to another, speeding up or slowing down.

      a. **Average speed** is the total distance traveled divided by total time taken.

      b. An object's speed at a particular moment in time is called **instantaneous speed**.

      c. <u>Constant</u> speed occurs when an object travels at a steady rate with the same instantaneous speed for some period of time.

D. Motion can be <u>graphed</u> on a distance-time graph with time plotted on the horizontal axis and distance plotted on the vertical axis.

   1. The steeper the line on a distance-time graph, the greater the <u>speed</u>.

   2. A horizontal line on a distance-time graph indicates that no change in <u>position</u> is occurring, and the speed is <u>zero</u>.

E. <u>Velocity</u>—speed of an object and its direction of motion; velocity changes if either, or both, of these changes.

DISCUSSION QUESTION:

What is instantaneous speed? *The speed of an object at a particular moment in time*

Teacher Support & Planning

Section 2 Acceleration

A. <u>Acceleration</u>—change in velocity divided by the time for the change to occur; it can include an object's speeding up, slowing down, and/or changing direction

B. Acceleration can be <u>calculated</u> if you know how an object's velocity has changed during a given time period.

    1. The formula for calculating <u>acceleration</u> is: acceleration = final speed – initial speed/time or $a = (s_f - s_i)/t$.

        a. The unit of acceleration is distance divided by time squared; in SI units, acceleration is given as <u>meters per second squared</u> (m/s^2).

        b. Acceleration is <u>positive</u> when an object speeds up and <u>negative</u> when an object slows down.

    2. Accelerated motion can be <u>graphed</u> with speed on the vertical axis and time on the horizontal axis.

        a. An object that is speeding up will have a line on a speed-time graph that slopes <u>upward</u>.

        b. An object that is slowing down will have a line on a speed-time graph that slopes <u>downward</u>.

        c. A horizontal line would indicate acceleration of <u>zero</u>, or constant speed.

DISCUSSION QUESTION:
Acceleration includes what three ways an object's motion can change? *Speeding up, slowing down, or changing direction*

Section 3 Momentum

A. The amount of matter in an object is its **mass**; <u>inertia</u> is the tendency of an object to resist a change in its motion.

B. <u>Momentum</u>—measure of how hard it is to stop an object; calculated as mass times velocity

    1. With <u>momentum</u> expressed as p, the equation can be written as: $p = mv$.

    2. Momentum <u>increases</u> if the mass or velocity of the object increases.

    3. Momentum has direction that is the same direction as its velocity.

C. <u>**Law of conservation of momentum**</u>—the total momentum of objects that collide with each other does not change.

  1. There are <u>many</u> ways collisions can occur.

    a. In one type, objects stick together and <u>move</u> still stuck together, although possibly at different speeds.

    b. In another type, two objects bounce off each other when they collide, and may transfer <u>momentum</u> from one to the other.

  2. In both cases, the <u>total</u> momentum of the objects that collide is the same before and after the collision.

DISCUSSION QUESTION:

How is momentum calculated? *Momentum equals mass times velocity.*