Distance, Speed, and Time

1. The speed of an object is a measure of how fast it is going.
    a. We need to measure distance and time in order to know the **speed** of an object.
    b. To find the speed of a car in units of kilometres per hour (km/h), we divide the distance (in kilometres) by the time (in hours).
    c. Therefore speed *v* is distance *d* divided by the time *t*
    d. Often the words speed and **velocity** are used interchangeably, but in truth, velocity is actually speed with an indication of direction (*e.g.*, an arrow, '+' or '-' sign).
    e. **Distance** (d) is the amount of space between two objects or points.
        i. It is commonly measured in millimeters (mm), centimeters (cm), meters (m), or kilometers (km).
    f. **Time** (t) is the duration between two events.
        i. It is commonly measured in seconds (s), minutes (min), hours (h), or years (a).
    g. The **average speed** (v_{av}) of an object can be calculated by dividing the total distance traveled by the total time taken.

$$v_{av} = \frac{\Delta d}{\Delta t} = \frac{d_2 - d_1}{t_2 - t_1} = \frac{d}{t}$$

where, **Δ** = "delta". Means "the change in".

d_1 is one distance measurement and d_2 is a later distance measurement
Likewise, t_1 is one time measurement and t_2 is a later time measurement
d_1 and t_1 are usually equal to zero.

    h. The units for speed are always a distance measurement per time measurement. (*e.g.*, km/h, m/s)
    i. The **instantaneous speed** of an object is its speed at a particular moment in time.
        i. **Instantaneous speed** is the speed at which an object is travelling at a particular instant. It is not affected by its previous speed, or by how long it has been moving.
        ii. When something is traveling at a **constant speed**, also known as **uniform motion**, the speed simply remains the same over a period of time.
        iii. **Non-uniform motion** occurs when speed is NOT constant - it is changing.

2. Solving problems involving distance, speed, and time
    a. Steps
        i. Write down given information.
        ii. Write down the unknown variable (the one you are solving for).
        iii. If necessary, rearrange the speed equation for the unknown variable.
        iv. Plug in the known values, and their units, into the equation and solve for the unknown.
    b. Important reminders
        i. Only round off at the very end of the calculations.
        ii. Watch significant figures.
        iii. Include the correct units.

3. Working with graphs.
    a. Graphs are used to visually communicate quantitative information. They can most often be understood more quickly and easily than a table or paragraph of information.
    b. The **independent variable** is plotted on the **x-axis**. It is the variable that is either purposely manipulated in an experiment or it naturally changes on its own.
    c. The **dependent variable** is plotted on the **y-axis**. This variable is directly changed because of changes in the independent variable.

4. **Distance-time graphs** are handy because they allow us to see how the distance (dependent variable) changes with time (independent variable).
    a. We can determine the average speed of an object by simply finding the **slope** of the **line of best fit** (a straight line that best represents the data).
        i. The greater the slope, the greater the speed (and vise versa).
        ii. If a broken-line graph is used, you can not only see that the motion is non-uniform, but you can calculate the individual speeds by calculating the slopes of each individual line segment.
    b. Calculating slope
        i. Start by selecting two points on the line of best fit. Label the points 1 and 2.
        ii. Find the coordinates (x and y values) for these points and plug them into the equation:

$$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{\Delta y}{\Delta x}$$

$$= \frac{d}{t}$$