INTRODUCTION TO TIME, DISTANCE & SPEED

TIME

All the time 'units' that appear natural to us are caused by astronomical phenomena:

- the **YEAR** by Earth's orbit around the Sun and the resulting flow of the seasons (*Fig. 1*)
- the **MONTH** by the Moon's movement around the Earth and the change of the Moon phases (*Fig. 2*)
- the **DAY** by Earth's rotation and the succession of brightness and darkness (*Fig. 3*)

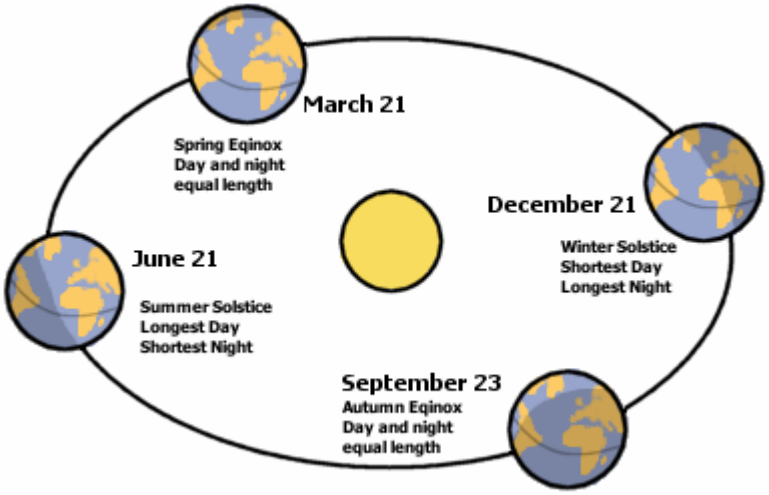


Fig. 1 Earth orbiting around the Sun (yearly cycle)

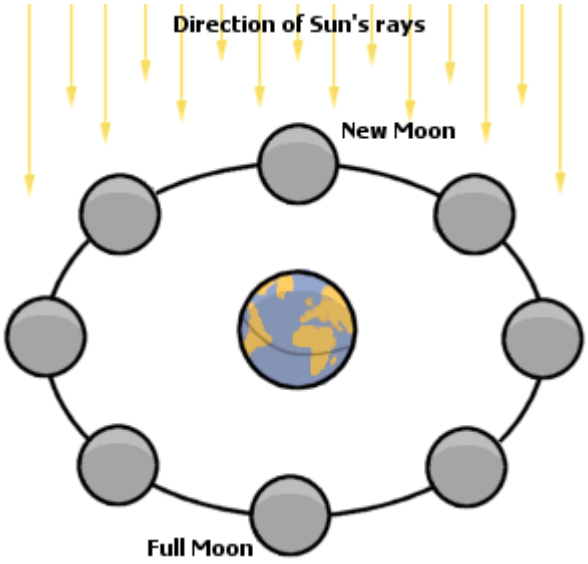


Fig. 2 Moon orbiting around the Earth (monthly cycle)

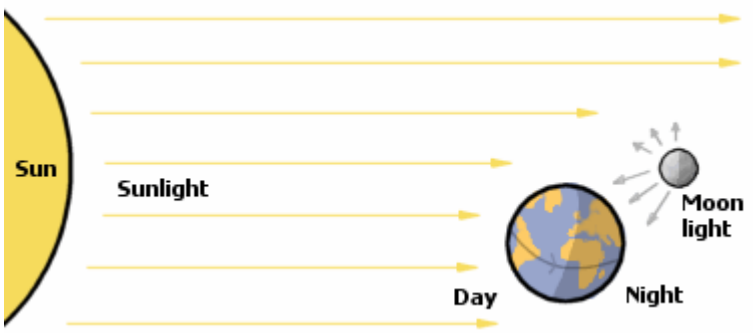


Fig. 3 Earth rotating on its axis (day/night cycle)

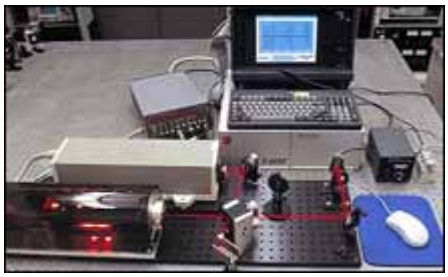
These measurements involve a long length of time. To understand speed, we need something a lot shorter. So, we define the basic unit of time as the *second*.

DISTANCE

Distance is a measure of how far an object has travelled or how far away it is. It is the same as length and is measured in *metres*.

The origins of the metre go back to at least the 18th century. In 1791, soon after the French Revolution, the French Academy of Sciences defined the metre as being equal to one ten-millionth of the length of the meridian through Paris from pole to the equator.

Today, the metre is defined by the distance covered by a laser beam travelling through a vacuum in a given time.



A special laser used in the calculation of a standard metre

SPEED

Speed describes how fast something is moving. When you're in a moving car, the speedometer tells you the speed at which you are travelling. A speedometer does not tell you the direction in which you are travelling. To indicate the speed **AND** the direction in which something is moving, we use the term *velocity*.

Average speed is measured by comparing the distance travelled and the time taken for the journey. This is written as:

$$\text{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time}}$$

If an object is stationary (not moving), then its speed is zero. The rate of change of distance is zero.

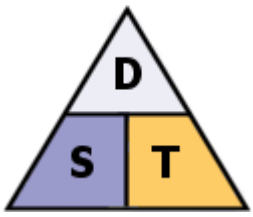
Remember, the difference between velocity and speed is that velocity is speed in a certain direction. If an object is moving in a straight line, then its speed and velocity will be the same. If the moving object stays at the same speed but changes direction, the velocity has changed (because the direction has changed) but the speed has stayed the same.

Speed Rules

The following graphic may help you remember how to calculate the different terms associated with speed. Take the equation Speed = Distance ÷ Time as an example. If S is down on the bottom left, you can see that D is over T in the other parts of the triangle. This tells you that to calculate S, D is divided by T. Now, see if you can work out what the equations for Distance or Time would be using the triangle.

Distance = Speed X Time
D = S X T

Time = Distance ÷ Speed
T = D / S

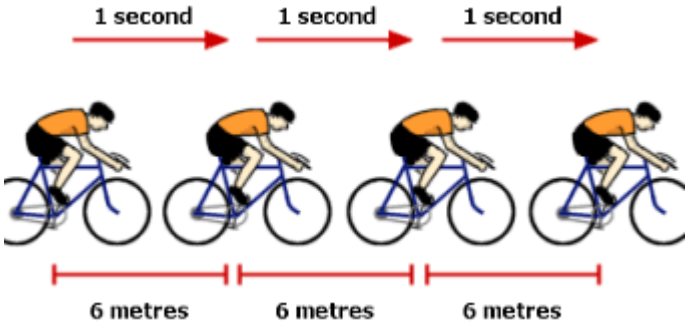


The speed of sound in air is **331.45 m/s**, at normal temperatures at sea level. This means that sound waves travel over 330 metres in 1 second. Air travel records this speed as Mach 1. Fighter jets travel at speeds of up to Mach 4 or 5.

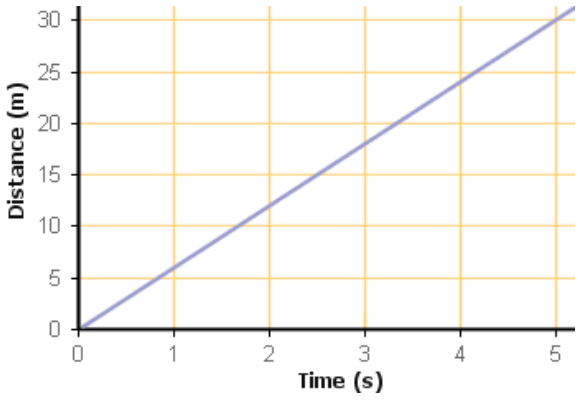
The speed of light is **299,792,458 m/s** and is denoted by the abbreviation *c*.

Distance-Time Graphs (1)

Simple distance-time graphs can describe the motion of an object. Consider a cyclist travelling at a rate of 6 m/s. Every second the cyclist travels 6m.

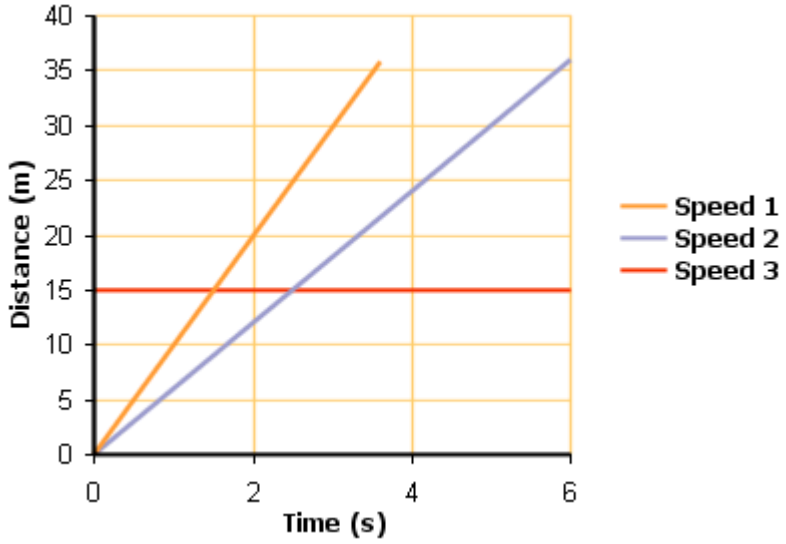


Plotting a graph of the cyclist's motion would look like the one here. The cyclist is travelling at a steady speed and the slope of the line remains the same as time passes. What do you think the line on the graph would look like if the cyclist was cycling at a faster speed?



DISTANCE-TIME GRAPHS (2)

The graph below gives some idea of different speeds would be plotted on a graph. There are 3 speeds represented here with an orange line, a pale blue line and a red line. You can see that the blue line reaches 30m after 3 seconds, the green line reaches 30m after 5 seconds and the red line remains at 15 metres after 5 seconds.



The orange line represents the fastest speed. The distance travelled every second is bigger; the rate is greater, therefore the speed is greater. The slope of the line gives a measure of the speed.

How would you describe the movement of the object represented by the red line? After 0 seconds it is at a distance of 15 metres from the starting point. After 3 seconds it is 15 metres from the starting point. After 6 seconds it is 15 metres from the starting point. Has it moved? The red line describes a stationary object — there is no movement, therefore there is no speed.

SPEED FACTS

Inertia is the tendency of a stationary object to remain at rest or the tendency of a moving object to continue at the same speed. The heavier the object, the greater the inertia. It takes longer to stop a truck than a car when travelling at the same speed because the truck is heavier.

When a car brakes suddenly, the driver and passengers tend to keep going in the same direction and at the same speed as before braking. Seatbelts are therefore needed to stop them going through the windscreen.