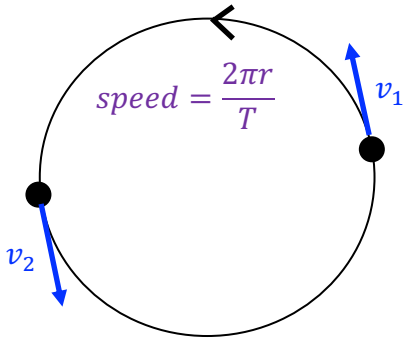
4.3.1 Speed and velocity

videos

Speed and velocity are often used interchangeably. However, speed is a scalar quantity (has a size only), whereas velocity is a vector quantity (it has a direction as well as a size).

Consider an object moving around a circle. The speed of the object is just the distance divided by time. If the object is moving around the circle in regular time intervals (T), then the speed will be constant. However, the velocity changes (see v_1, v_2), because the instantaneous direction of movement changes.



Velocity is defined as displacement divided by time. Displacement is a vector quantity showing the distance and direction of a movement. For example, if you want to move from one location on a map to another (as the crow flies), you could specify a displacement. You might say something like "Go 3.2 kilometers north-east", giving a size and direction to the displacement.

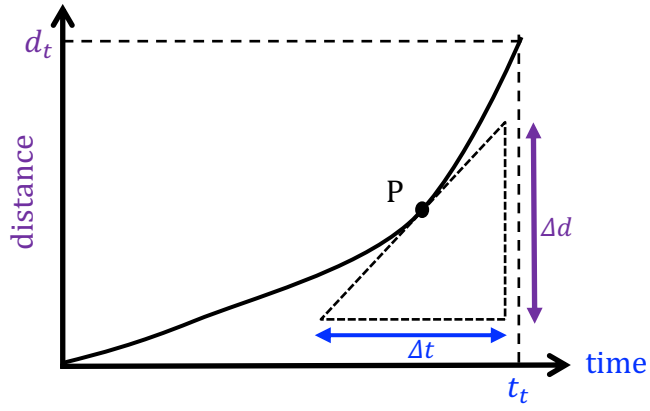
(1) Imagine you are on the London Eye. It has a radius of 60m and a period of rotation of 30mins. Calculate your speed.

(2) Calculate your displacement from the start to a point 15mins into the ride.

(3) Calculate your average velocity for the first 15mins.

Average and instantaneous speeds

Consider the following distance-time graph:



The graph shows that the speed increases as time progresses. If we want the average speed for the whole journey:

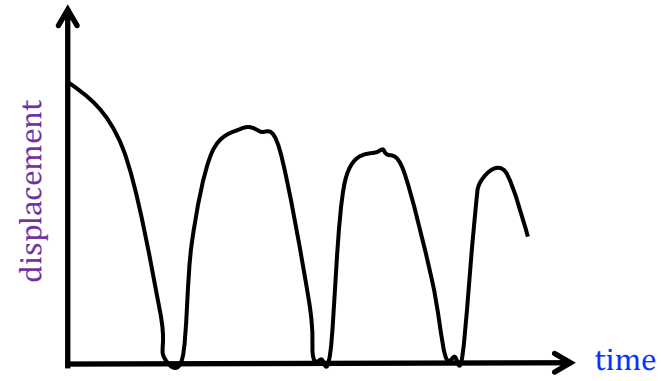
$$average\ speed = \frac{total\ distance}{total\ time} = \frac{d_t}{t_t}$$

However, if we want to find the speed at any particular instance, we need to take the gradient of the distance-time graph at that point. For example, at point P:

$$instantaneous\ speed = \frac{\Delta d}{\Delta t}$$

Distance-time graphs are always increasing. It is like the milometer in your car – it just records the total distance the car has covered.

Consider the following displacement-time graph for a bouncing ball:



(4) Indicate on the graph where the ball is in contact with the floor.

(5) Indicate on the graph where the ball is moving with greatest downward velocity.

(6) Sketch a graph to show what a velocity-time graph of this motion would look like.