S3 Transport Need to Know Sheet

1.6 I can perform calculations involving the relationship between speed, distance and time (d=vt)

Speed is the distance travelled in unit time (distance travelled per second)

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

1.8 I can determine average and instantaneous speed.

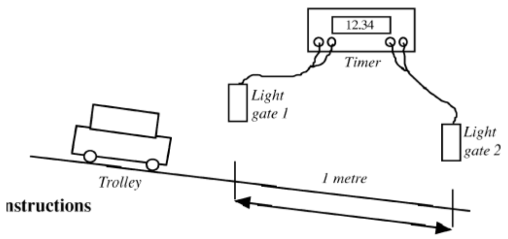
The **instantaneous** speed of a vehicle at a given point can be measured by finding the average speed during a **very short time** as the vehicle passes that point.

$$v = \frac{\Delta d}{\Delta t} = \frac{l}{t}$$

The instantaneous speed of an object is defined as the length of the vehicle divide by the time to pass a point.

1.9 I can describe experiments to measure average and instantaneous speed.

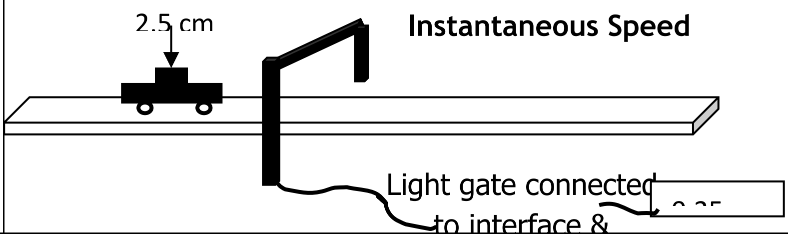
Average Speed



To measure the average speed you need to **measure the distance for the whole journey** and measure **the time taken for the whole journey**. The distance can be measured with a trundle wheel, tape measure etc., and the time can be measured with a stop watch. Use the formula:

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

Instantaneous Speed



1.1 I can define the terms scalars and vectors

a scalar quantity is completely described by stating its magnitude (size) & unit.

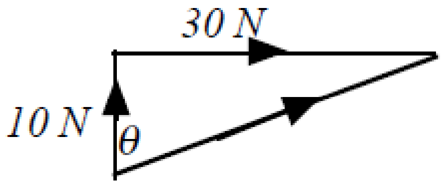
a vector quantity is completely described by stating its magnitude, unit and direction

1.2 I can identify vector and scalar quantities such as: force, speed, velocity, distance, displacement, acceleration, mass, time and energy.

Scalars	Vectors
Energy	Velocity
Temperature	Acceleration
Speed	Displacement
Time	Force
Mass	(Weight/ friction etc)
Distance	Gravitational field strength

1.3 I can calculate the resultant of two vector quantities in one dimension or at right angles.

Using Pythagoras



$$R^2 = a^2 + b^2$$

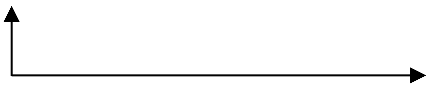
$$R^2 = 30^2 + 10^2$$

$$R = 31.6\ N$$

$$tan\theta = \frac{opp}{adj}, tan\theta = \frac{30}{10}$$

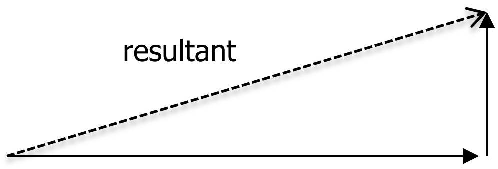
$$tan^{-1}\theta = 3, \theta \quad = 72°$$

In some cases that means that the two vectors have to be redrawn so that they are being added "head to tail". See example below.



becomes

Then join a line from the tail of the first vector to the head of the second vector. This is the resultant vector.

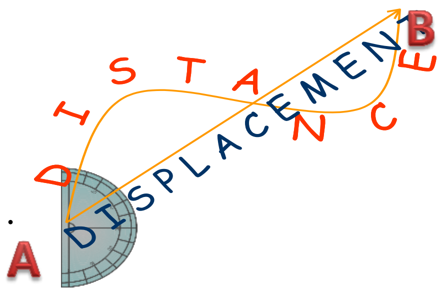


1.4 I can determine displacement and/or distance using scale diagram or calculation.

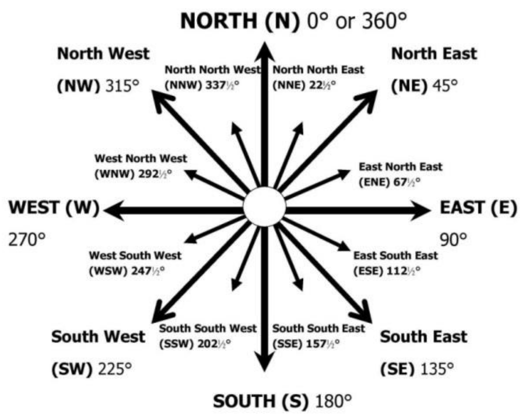
Distance is a measure of how far a body has actually travelled in any direction.
Distance is a scalar as it only requires a magnitude and unit.

Displacement is the measurement of how far an object has travelled in a straight line from the start to the finish of its journey.

1.6 I can make use of appropriate relationships to calculate velocity in one dimension (s=vt)



$$speed = \frac{distance}{time}\ but\ velocity = \frac{displacment}{time}$$



distance = 50 m

quantity magnitude unit

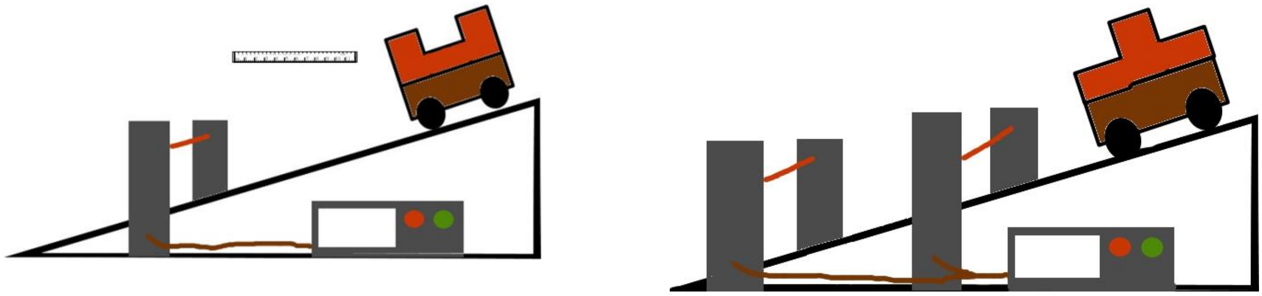
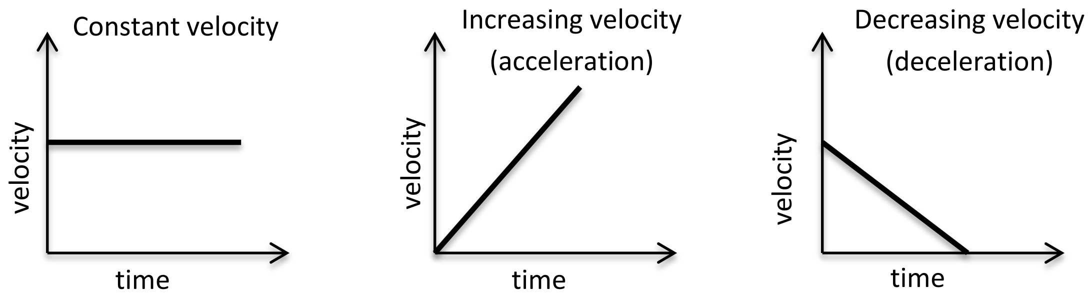
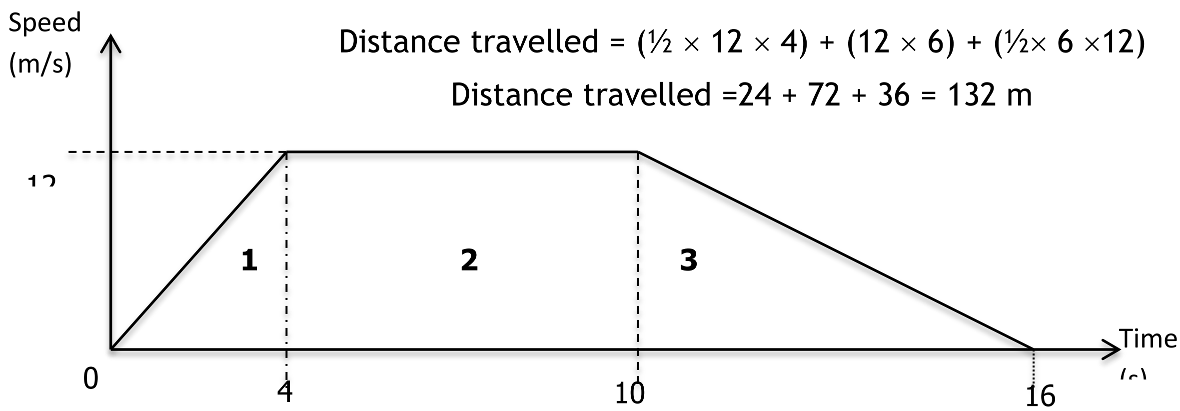
Displacement = 50 m South

Speed = 50 ms^{-1}

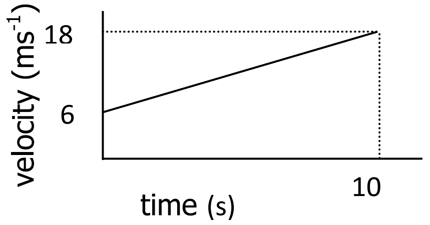
quantity magnitude unit direction

Velocity = 50 ms^{-1} East

3.1	**I can define acceleration as the final velocity subtract the initial velocity divided by the time for the change, or change in velocity divide by the time for the change.**
	$a = \frac{v-u}{t} = \frac{\Delta v}{t}$
3.1	**I can define the acceleration as rate of change of velocity.**
	Acceleration is the **rate of change of velocity.** Acceleration is the change in velocity per unit time. An acceleration of 2 ms^{-2} means the velocity increases by 2 ms^{-1} every second
3.2	**I can use the relationship involving acceleration, change in speed and time (a = Δv/t).**
	$a = \frac{v-u}{t} = \frac{\Delta v}{t}$ $\Delta v = v - u$
3.3	I can use appropriate relationships to solve problems involving acceleration, initial velocity (or speed) final velocity (or speed) and time of change $\left(a = \frac{v-u}{t}\right)$.
	A girl is riding a bicycle. She starts at rest, and accelerates to 20 ms^{-1} in 8.0 seconds, calculate her acceleration. $\boldsymbol{\Delta v = v - u = 20 - 0 = 20}$ $\boldsymbol{a = \frac{\Delta v}{t} = \frac{20}{8} = 2.5\ ms^{-2}}$
	A car increases its velocity from 30 ms^{-1} to 80 ms^{-1} in 20 seconds. Calculate its acceleration. $\boldsymbol{a = \frac{v-u}{t}}$ $\boldsymbol{a = \frac{80-30}{20} = 2.5\ ms^{-2}}$
3.5	**I can describe an experiment to measure acceleration**
	Instructions for double mask method. 1. Measure the length of the two parts of the double mask, 2. Set the computer to measure acceleration, and input 3. Release the trolley and record the acceleration, 4. The computer measures the time for each part of the double mask to pass through 5. the light gate, and the time between the two parts. It then uses these to calculate acceleration $a = \frac{(v-u)}{t}$ 6. Repeat several times and calculate an average.
	Instructions for single mask method 1. Measure the length of the mask, d. 2. Set the computer to measure acceleration, and input d. 3. Release the trolley and record the acceleration, a. 4. The computer measures the time for each for the mask to pass through each light gate 5. the light gate, and the time between the two light gates. It then uses these to calculate acceleration $a = \frac{(v-u)}{t}$ 6. Repeat several times and calculate an average.

	
2.1	I can draw velocity-time graphs for objects from recorded or experimental data.
	
2.2	I can interpret velocity-time graphs to describe the motion of an object.
	***The steeper the gradient the greater the acceleration*.** **A flat line indicates constant velocity, zero acceleration**
2.3	I can find displacement from a velocity-time graph.
	Displacement is the area under a speed time graph. It is best to split the area under the graph into rectangles and triangles. Calculate the area of each and then add them together. [Area of a triangle is ½ base x height] Distance travelled = area 1 + area 2 + area 3 Distance travelled = (½ × 12 × 4) + (12 × 6) + (½× 6 ×12) Distance travelled =24 + 72 + 36 = 132 m 
3.4	I can find the acceleration as the gradient of a velocity-time graph.
	Example 1-

Calculate the acceleration shown in the graph below:



Solution using gradient

$$m = \frac{y_2 - y_1}{x_2 - x_2}$$

$$\mathrm{m} = \mathrm{a} = \frac{18-6}{10-0} = 1.2\ \mathrm{m}s^{-2}$$

Solution

v=18; u=6; t=10

$$a = \frac{v-u}{t}$$

$$a = \frac{18-6}{10} = 1.2\ ms^{-2}$$

4.1 I can give applications and use Newton's laws and balanced forces to explain constant velocity (or speed), making reference to the frictional forces of the object.

Newton's First Law : A body will remain at rest or travel at a constant speed in a straight line, unless acted upon by an unbalanced force.

Newton's Second Law *we normally write as a formula:*

$$F_{un} = ma$$

$$\text{Unbalanced Force} = \text{mass} \times \text{acceleration}$$

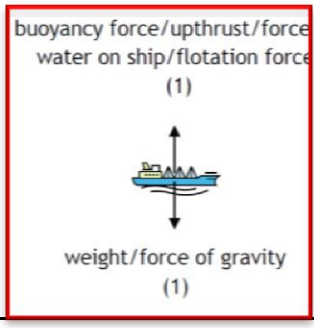
$$\text{(Newtons)} = \text{(Kilogram)} \times \text{(metres per second squared)}$$

Newton's Third Law states: *For every action there is an equal but opposite reaction.*

Or If A exerts a force on B, B exerts an equal but opposite force on A.

Difference between N1 and N3 Laws

4.2 I can give applications of Newton's laws and balanced forces to explain and or determine acceleration for situations where more than one force is acting, (F=ma)

A force can change an object's:	Why a boat floats
➢ direction of motion (an acceleration)	
➢ shape	
➢ speed (cause an acceleration)	
➢ start a mass moving (cause an acceleration)	
If none of these occur the forces on an object are either balanced or zero.	

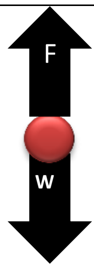
A car is travelling at a constant speed along a flat level road.

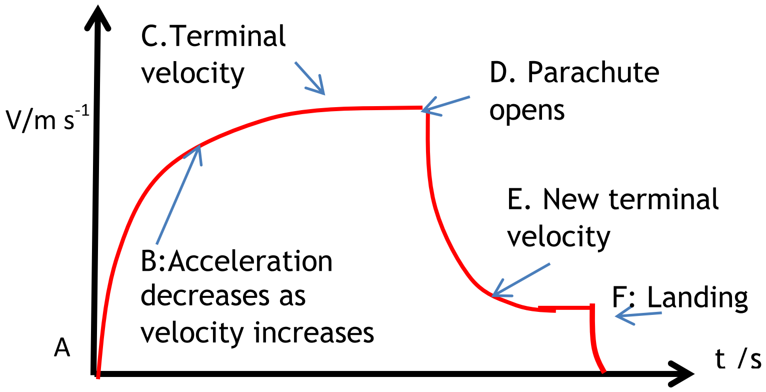
The forces on the car are balanced as the car is travelling at constant speed.

If an unbalanced force is added to the car will accelerate.

A hot air balloon is falling at constant velocity to the ground.

(i) A free body diagram with the forces labelled on the balloon.

	W= weight, F= frictional forces. (ii) The forces on the balloon **are equal in size and opposite in direction** (iii) A balloonist throws a sandbag over the side of the balloon basket, state what happens to the forces on the balloon. **The weight decreases, the frictional forces remains constant for an instant** (iv) Describe the motion of the balloon when the sandbag is thrown overboard. **The balloon will accelerate upwards as there is an unbalanced upwards force until a new terminal velocity is reached** 
4.3	I can use F=ma to solve problems involving unbalanced force, mass and acceleration for situations where more than one force is acting, in one dimension.
	A boat has a mass of 700 kg, and can accelerate at 3.0 ms^{-2}. If the engines produce a force of 7000 N, what is the size of (i) the unbalanced force on the boat, and (ii) the drag force of the water on the boat? ***(i) F = ma = 700kg × 3ms^{-2} = 2100 N*** ***(II) DRAG FORCE = 7000N - 2100N = 5800N***
4.4	I can use W=mg to solve problems involving weight mass and gravitational field strength, including on different planets (where g is given on page 2 of section1)
	$Force = mass \times acceleration$ the same so a and g must be the equivalent $Weight = mass \times gravitational\ field\ strength$
4.5	I can use Newton's 3rd law and its application to explain motion resulting from a 'reaction' force.
	 *If I sit on a chair I am exerting a force (equal to my weight) on the chair (if my legs are off the ground). I am not accelerating so the forces on me must be balanced. So there must be a reaction force equal in size and opposite in direction to my weight. This is the reaction force from the chair.*
4.6	I can use Newton's laws to explain free-fall and terminal velocity.



point	Forces and Motion
A	Newton's 2nd Law F=ma *F=weight, m = mass of the skydiver and kit, a=acceleration.* Initial velocity in the vertical direction is zero, the object accelerates under the force of gravity at 9.8ms^{-2}. Initially no drag force.
B	Newton's 2nd Law F=ma *F_{un} =weight+drag (which is in the opposite direction), m = mass of the skydiver and kit, a=acceleration.* As vertical speed increases air resistance acting against the parachutist increases. At B weight is greater than drag so the skydiver accelerates with a reduced acceleration than at the start.
C	Newton's 1st Law *An object will move at constant velocity unless acted upon by an unbalanced force. The forces are balanced.* At C Weight = drag so the skydiver falls at constant speed, terminal velocity.
D	Newton's 2nd Law F=ma *Fun=weight+ frictional forces (which are much greater than weight so F is negative), m = mass of the skydiver and kit, a=acceleration.* The parachute is opened At D drag forces are much greater than the weight (the parachute has been opened) so there is a high deceleration (or negative acceleration)
E	Newton's 1st Law *An object will move at constant velocity unless acted upon by an unbalanced force. The forces are balanced.* At E Weight = drag so the skydiver falls at constant speed, terminal velocity
F	Newton's 2nd Law F=ma and Newton's 3rd Law *For every action there is an equal but opposite reaction.* *Fun=weight+ forces from the ground, m = mass of the skydiver and kit, a=acceleration.* The skydiver touches the ground creating a large force on the ground (slowing down) The ground produced an equal but opposite force on the skydiver which cause a great negative acceleration