LOCKERBIE ACADEMY

acceleration

S1-S3 Road Safety & PHYSICS

MINDMAP OF ROAD TRANSPORT MATERIAL

Practicals
Fun &Games

Momentum
(advanced only)

Velocity
Displacement
Distance

ACCELERATION

REVIEW

Measuring 'a'

The Physics
behind
Acceleration

F=ma

INVESTIGATION

Newtons
2nd Law

ANALYSIS

calculations

Studying Accidents

Practicals

Measure

S1 Physics Transport

REVIEW

Back to mind map

REVIEW

WHAT ARE DISTANCE AND DISPLACEMENT?

- Distance is length. How far you've travelled (e.g. 100 metres)
- Displacement is direct distance in a particular direction (e.g. 100 metres to the right)

- *WHAT ARE SPEED AND VELOCITY?*
- Speed is the rate of covering a distance (e.g. 50km/h)
- Velocity is rate of displacement in a particular direction (e.g. 50 km/h north)

We might not have covered this it depends on the order that your teacher chooses

- Force
- A force is a push or a pull. Forces are measured in units called Newtons. A force is always present if an object does at least one of the following
- ✓ change speed
- ✓ change direction
- ✓ change shape.

What is a force? What does it do?

In the back of your jotter try to:

- give 5 examples of a force.
- as best you can to write a definition of what a force is.

- The instrument for measuring forces is the Newton Balance or Forcemeter. Forces are measured in units of NEWTONS (N)

DYNAMIC WORD BINGO- REVISION

Distance	Acceleration	Mechanics
Displacement	At rest	Vehicle
Average Speed	Velocity	Time
Inst. Speed	stationary	Speed
kinematics	uniform speed	Instantaneous speed
dynamics	m/s	metres
second		

acceleration

Putting your foot down

- Have you ever looked closely at advertisements for cars? Most of them will say something like this:
-
  - **0 – 60 mph in 8 seconds**
-
- **What does this tell you?**
- It's not how fast the car can go – cars can manage more than 60 miles per hour.

What does this tell you?

- It's not how fast the car can go – cars can manage more than 60 miles per hour.

- It's how quickly the car gains speed – the car's **acceleration**. The less time a car takes to gain speed, the greater its acceleration.

Vauxhall Nippy:

Top speed: 115 mph
Engine size: 1.2 litres
0 – 60 mph: 10 seconds

Ferrari Flyer:
Top speed: 130 mph
Engine size: 2.4 litres
0 – 60 mph: 5 seconds

Ford Speeda:

Top speed: 125 mph
Engine size: 1.6 litres
0 – 60 mph: 7.5 seconds

Mazda Vroom:

Top speed: 135 mph
Engine size: 2.0 litres
0 – 60 mph: 6 seconds

- 1. Which car has the highest top speed?
- 2. Which car has the greatest acceleration?
- 3. Which car would you prefer to drive? Why?

ACCELERATION

When a driver of a car puts her foot down on the accelerator (throttle or right pedal), the car goes faster - it accelerates!

ACCELERATION

- Imagine two drivers side by side at a set of traffic lights, the lights are on red. Angus is in a very fast sports car, and Caitlin is sitting in her lorry. The lights turn green and both vehicles set off. Both vehicles accelerate, the speed of both vehicles increases.

After a while both vehicles reach the same speed. But we can tell that the sports car will accelerate faster than the lorry. Acceleration is not just about the increase in your speed, it takes account of how quickly your speed changes. The time it takes your speed to change must be in the equation.

Acceleration

- When your velocity is changing you are accelerating.

Acceleration is the rate of change of velocity. (how quickly you change your velocity).
If you change your velocity quickly you have a high acceleration.

- Acceleration is given by:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time for the change}}$$

$$a = \frac{\Delta v}{t}$$

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

a	acceleration
Δ	change in
v	velocity
v	final velocity
u	initial velocity
t	time

Physics Transport

WORDBANK

Copy the following words into your jotter and literacy logs

Back to mind map

Acceleration

Acceleration is the rate of change of velocity.
(how quickly you change your velocity).

Or
change of velocity per second

If you change your velocity quickly you have a high acceleration.


STOP
100 yds

ACCELERATION

- If the change in velocity is measured in metres per second (m/s) and the time is measured in seconds, then the acceleration is measured in metres per second per second (m/s^2).

- For example, if a car accelerates at 2 m/s^2,then its speed increases by 2 metres per second every second.

- If it was stationary when the clock is started, then after the first second it will be going at 2 m/s, after the second second it will be travelling at 4m/s, and after ten seconds the car will be travelling at 20m/s. what will be the speed of the car after sixty seconds?

ACCELERATION

- When you buy a new car, figures are given to indicate the acceleration car companies often only quote the time it takes for vehicles to speed up from 0 mph to 60 mph. From this information the customer can work out whether it is a sporty or slow car. As a customer, wanting to purchase a new sporty car, would you want a long time or a short time for the change in speed to occur?
- If a car is slowing down then it is said to be decelerating or has a negative acceleration.

Acceleration

1. A Jaguar can reach 27 m/s from rest in 9.0 s. What is its acceleration?
2. The space shuttle reaches 1000 m/s, 45 s after launch. What is its acceleration?
3. A car reach 30 m/s from a speed of 18 m/s in 6 s. What is its acceleration?
4. A train moving at 10 m/s increases its speed to 45 m/s in 10 s. What is its acceleration?
5. A bullet travelling at 240 m/s hits a wall and stops in 0.2 s. What is its acceleration?
6. A car travelling at 20 m/s brakes and slows to a halt in 8 s. What is the deceleration?

7. Describe how you would measure the acceleration of a small vehicle as it runs down a slope in the laboratory.
8. On approaching the speed limit signs, a car slows from 30 m/s to 12 m/s in 5 s. What is its deceleration?
9. A bowling ball is accelerated from rest at 3 m/s^2 for 1.2 s. What final speed will it reach?

10. How long will it take a car to increase its speed from 8 m/s to 20 m/s if it accelerates at 3 m/s^2?

11. A cyclist can accelerate at 0.5 m/s^2 when cycling at 4 m/s. How long will she take to reach 5.5 m/s ?

12. The maximum deceleration a car's brakes can safely produce is 8 m/s^2. What will be the minimum stopping time if the driver applies the brakes when travelling at 60 mph (27 m/s).

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time for the change}}$$

The proper unit for acceleration is
metres per second per second,
metres per second squared.
(miles per hour per second).
m/s^2
mph/s

WORDBANK

- At rest- in Physics we use this term to mean not moving. We can also say the object is stationary.

- *It is not the same word as pens and pencils which are stationery!*

Acceleration

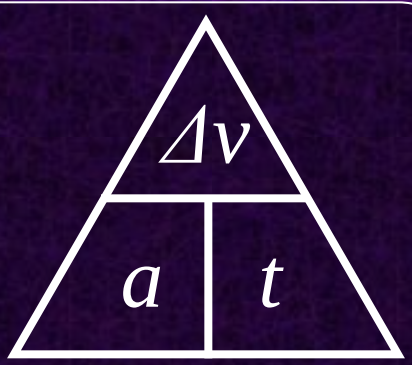
Acceleration is a way of saying that an objects velocity is changing. It is a measure of the change in velocity every second.

a = acceleration (m/s^2)

Δv = change in velocity (m/s)

t = time taken (s)

$$a = \frac{\Delta v}{t}$$



a = acceleration (m/s^2)

v = final velocity (m/s)

u = initial velocity (m/s)

t = time taken (s)

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

$$v = u + at$$

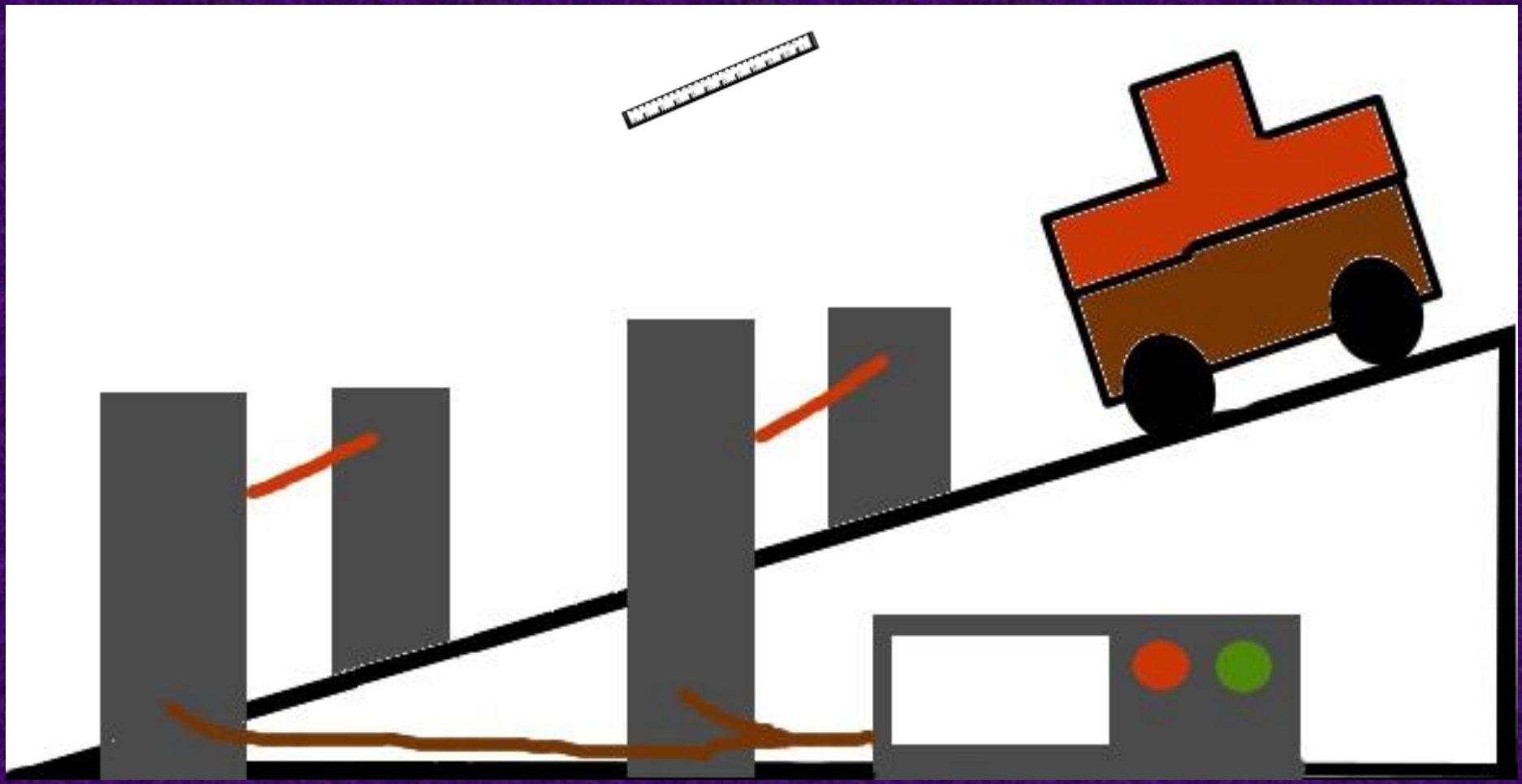
MEASURING acceleration

Practical

Measuring Acceleration

- You can measure acceleration in the lab with EITHER one single mask and two light gates or a double mask and one light gate.
- Whichever way the experiment is conducted the measurements that need to be made are:
  - Width of the mask or masks.
  - Time for first light beam to be broken.
  - Time for second light beam to be broken.
  - Time between the breaks in the light beam to be measured.

Measuring acceleration with two light gates



We don't measure v and u we calculate them from

- u=s/t
  - Where
    - s = length of the card
    - t= time for the vehicle to pass through the top light gates.
  - v=s/t
  - Where
    - s = length of the card
    - t= time for the vehicle to pass through the bottom light gates.

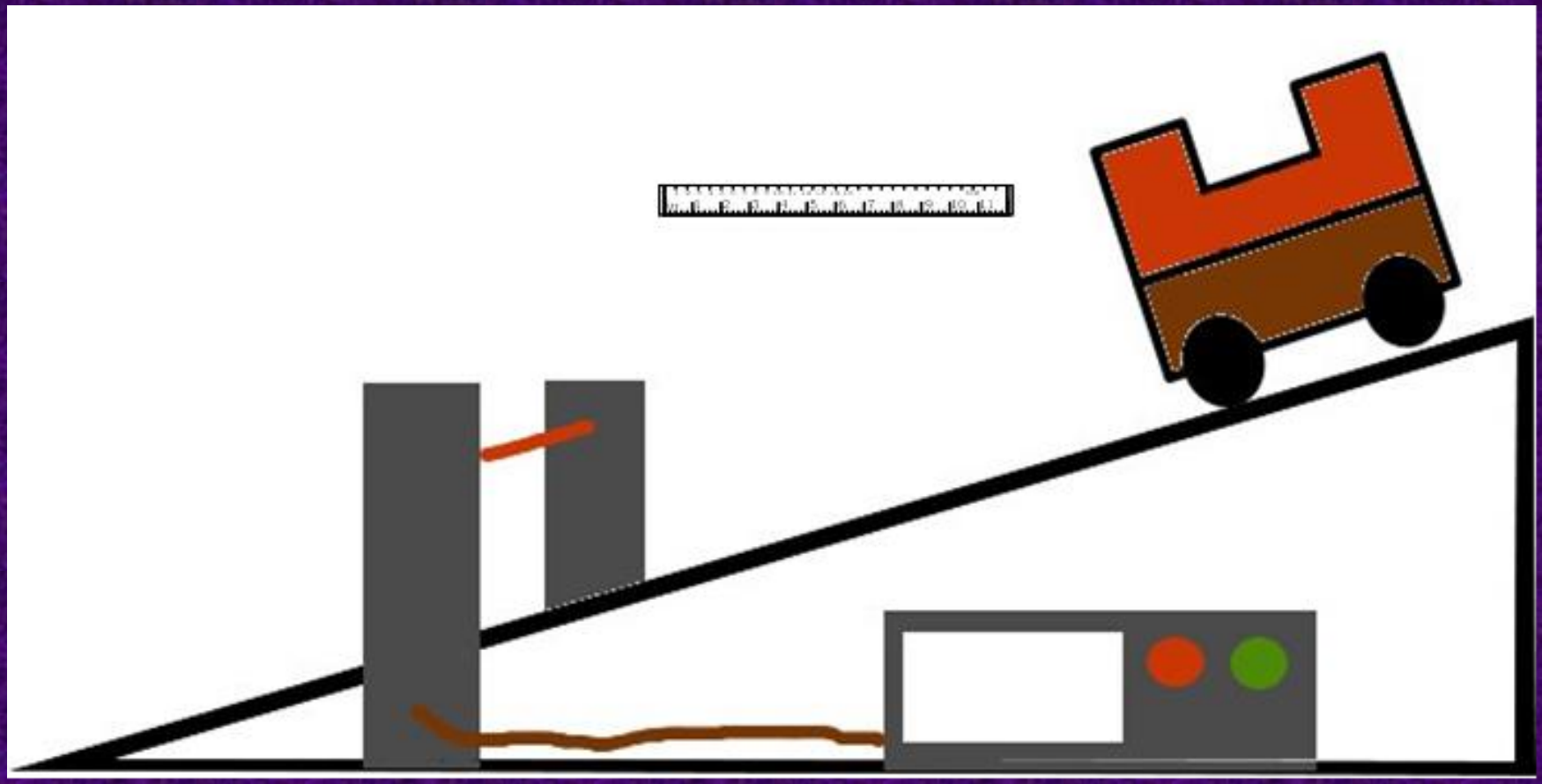
We also need to know the time it took the car to go between the light gates.

Does it matter how far apart the light gates are?

Surely the further apart the light gates the greater the value of v.

Yes the further apart the light gates the greater the value of v but the longer it takes to go between the light gates. If a=v-u/t then v is greater but also t so these two cancel and a remains constant

Measuring acceleration with only one light gate



How can we only use 1 light gate to find acceleration?

Yes the vehicle has a double MASK. u and v are still taken from the time it takes the mask to pass through the light gate and we need to measure the length of the mask

Measurements	Calculations
t_1 time to pass first light gate	$u = \frac{l}{t_1}$
t_2 time to pass second light gate	$v = \frac{l}{t_2}$
t_3 time between light gate	$a = \frac{v-u}{t_3}$
Length of mask	l


The ALBA Ranger

Measuring acceleration with the ALBA RANGER

Here the Ranger sends out pulses of ultrasound. The waves reflect off the object and returns them to the ranger.

If the pulses are returning after a longer time what does this tell you about the vehicle?

What about the pulses reflecting in a sorter time?

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{time for change}}$$

$$a = \frac{\Delta v}{t}$$

where Δ is the change

$$\Delta v = v - u$$

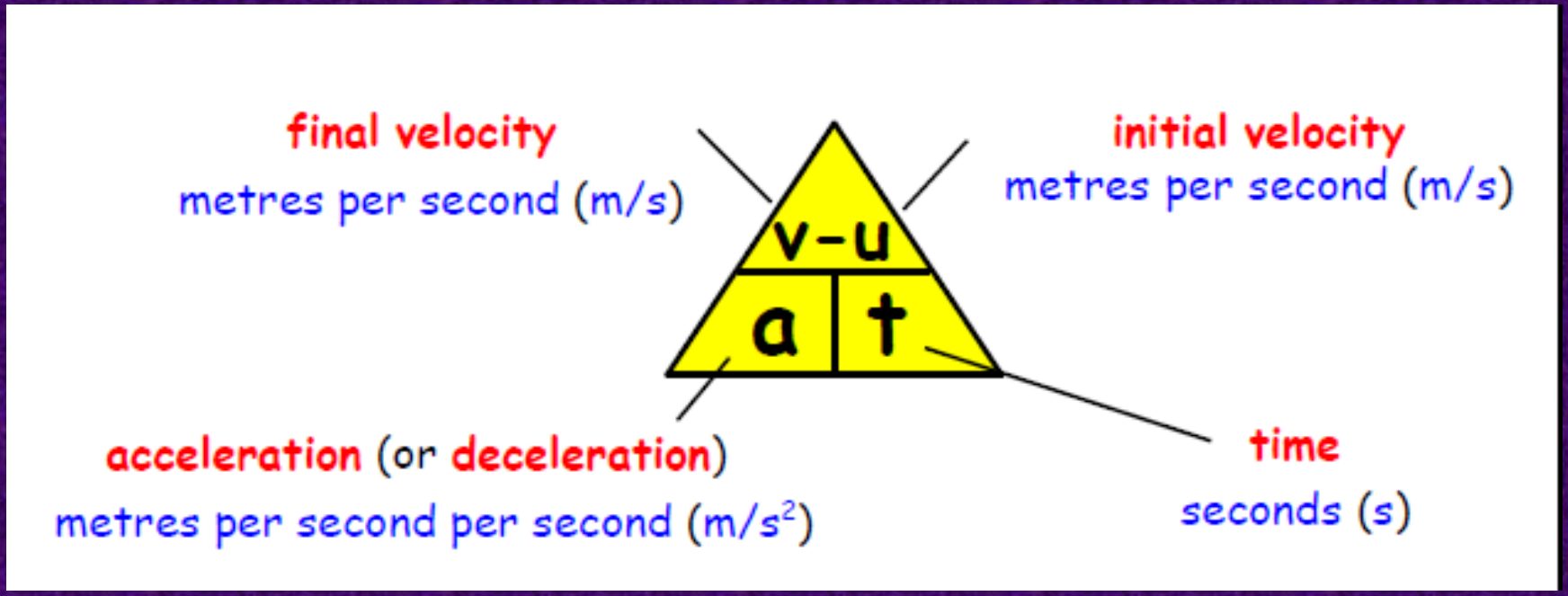
change in velocity=final velocity- starting velocity

so

$$\text{acceleration} = \frac{\text{final velocity- starting velocity}}{\text{time for change}}$$

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

Calculating Acceleration



TASK

Using equipment of your choice investigate the effect of the angle of a slope on acceleration.

In each case, calculate the **acceleration** of the vehicle:

(a) Farmer Jones' tractor starts from rest and increases its velocity to 8 m/s to the right in 10 s.

(b) In their go-kart, Jill and her Mum increase their velocity from rest to 6 m/s to the right in 12 s.

(c) On her motor scooter, Dominique takes 5 s to increase her velocity from 3 m/s to 13 m/s to the right.

(d) Mike's motorbike takes 5 s to increase in velocity from 10 m/s to 30 m/s to the right.

19) In each case, calculate the **acceleration** of the vehicle:

(a) Farmer Jones' tractor starts from rest and increases its velocity to 8 m/s to the right in 10 s.

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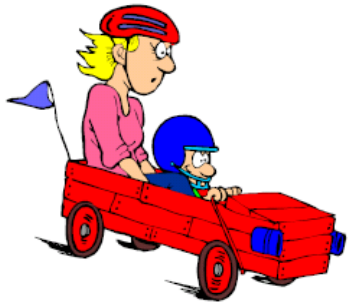


(c) On her motor scooter, Dominique takes 5 s to increase her velocity from 3 m/s to 13 m/s to the right.

(d) Mike's motorbike takes 5 s to increase in velocity from 10 m/s to 30 m/s to the right.

20) As a bobsleigh reaches a steep part of track, its velocity increases from 24 m/s to 36 m/s down the slope. This happens in 0.4 s.

Calculate the acceleration of the bobsleigh during this time.

21) An arrow hits a stationary target with a velocity of 50 m/s to the right and comes to rest in 0.1 s.

Calculate the deceleration of the arrow once it hits the target.

22) Starting from rest, a fireman slides down a pole with an acceleration of 1.2 m/s^2 downwards. His velocity at the bottom of the pole is 3.6 m/s downwards.

Calculate the time taken to slide down the pole.

23) A bee, decelerating at 0.7 m/s^2 to the right, decreases its velocity from 6.7 m/s to 2.5 m/s to the right.

What time does this take?

24) When a stationary rugby ball is kicked, it is in contact with a player's boot for 0.05 s. During this short time, the ball accelerates at 600 m/s^2 at 45° above the horizontal ground.

Calculate the velocity with which the ball leaves the player's boot.

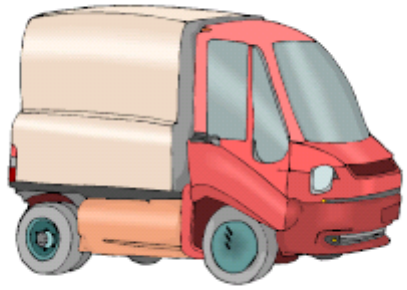
25) A helicopter is flying at 35 m/s to the right. It then decelerates at 2.5 m/s^2 to the right for 12 s.

Calculate the velocity of the helicopter after the 12 s.

26) The velocity of a conveyor belt which is moving to the right is increased to 2.8 m/s by accelerating it at 0.3 m/s^2 to the right for 4 s.

Calculate the initial velocity of the conveyor belt.

27) A van decelerates at 1.4 m/s^2 to the right for 5 s. This reduces its velocity to 24 m/s to the right.

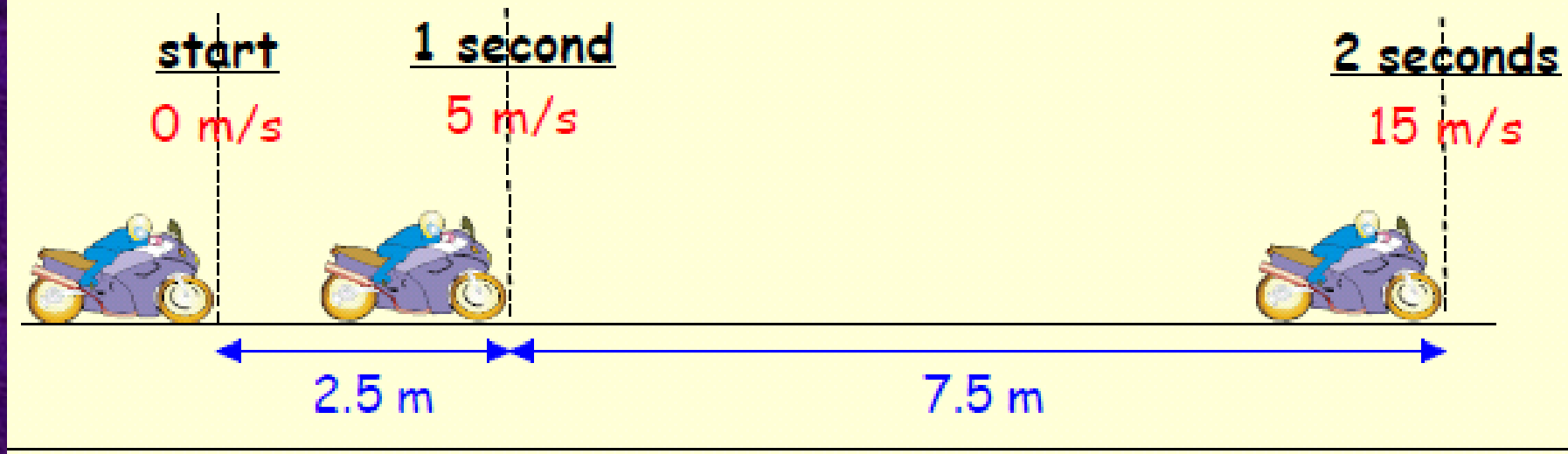


Calculate the van's initial velocity.

This diagram shows a motorbike **accelerating** from a **stationary start (rest, 0 m/s)** to a **velocity** of **15 m/s to the right.**

After each second:

- Its **velocity** has **increased.**
- It has travelled **further** than it travelled the second before.



Acceleration linked to Force

We will find out later that the acceleration of an object is related to the FORCE applied to it.

Any unbalanced force causes an object to change velocity or accelerate.

The size of the acceleration will depend on the force and the mass of the object.

F_{un} = unbalanced Force (N)

m = mass (kg)

a = acceleration (m/s^2)

$$F_{un} = ma$$