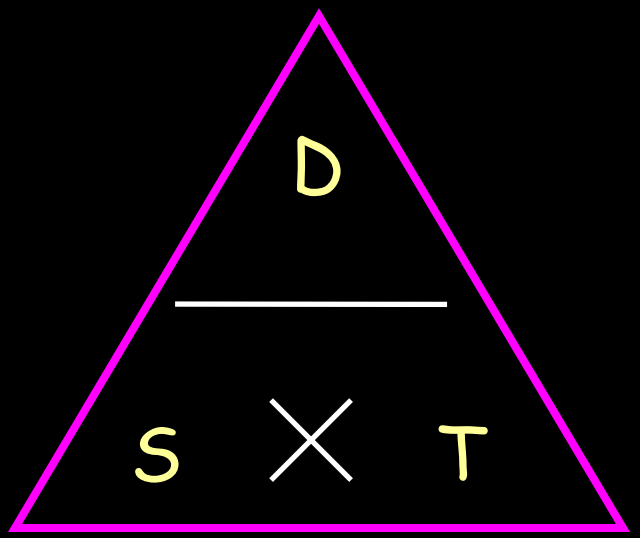
Explaining Motion

Distance, Speed and Time

$$\text{Speed} = \frac{\text{distance (in metres)}}{\text{time (in seconds)}}$$

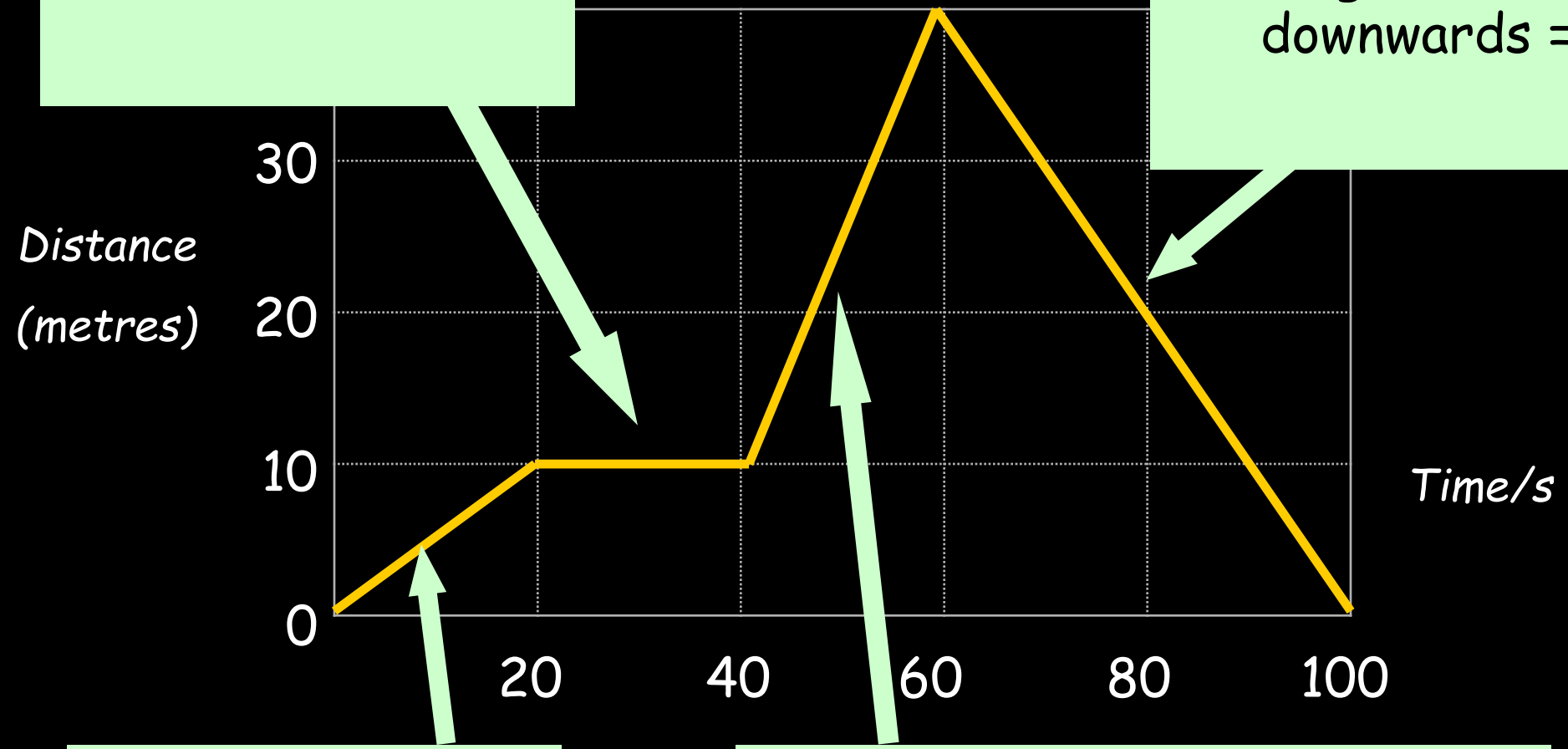


1) Seb walks 200 metres in 40 seconds. What is his speed?
2) Lucy covers 2km in 1,000 seconds. What is her speed?
3) How long would it take Freddie to run 100 metres if he runs at 10m/s?
4) Sue travels at 50m/s for 20s. How far does he go?
5) Hannah drives her car at 85mph (about 40m/s). How long does it take her to drive 20km?

Distance-time graphs

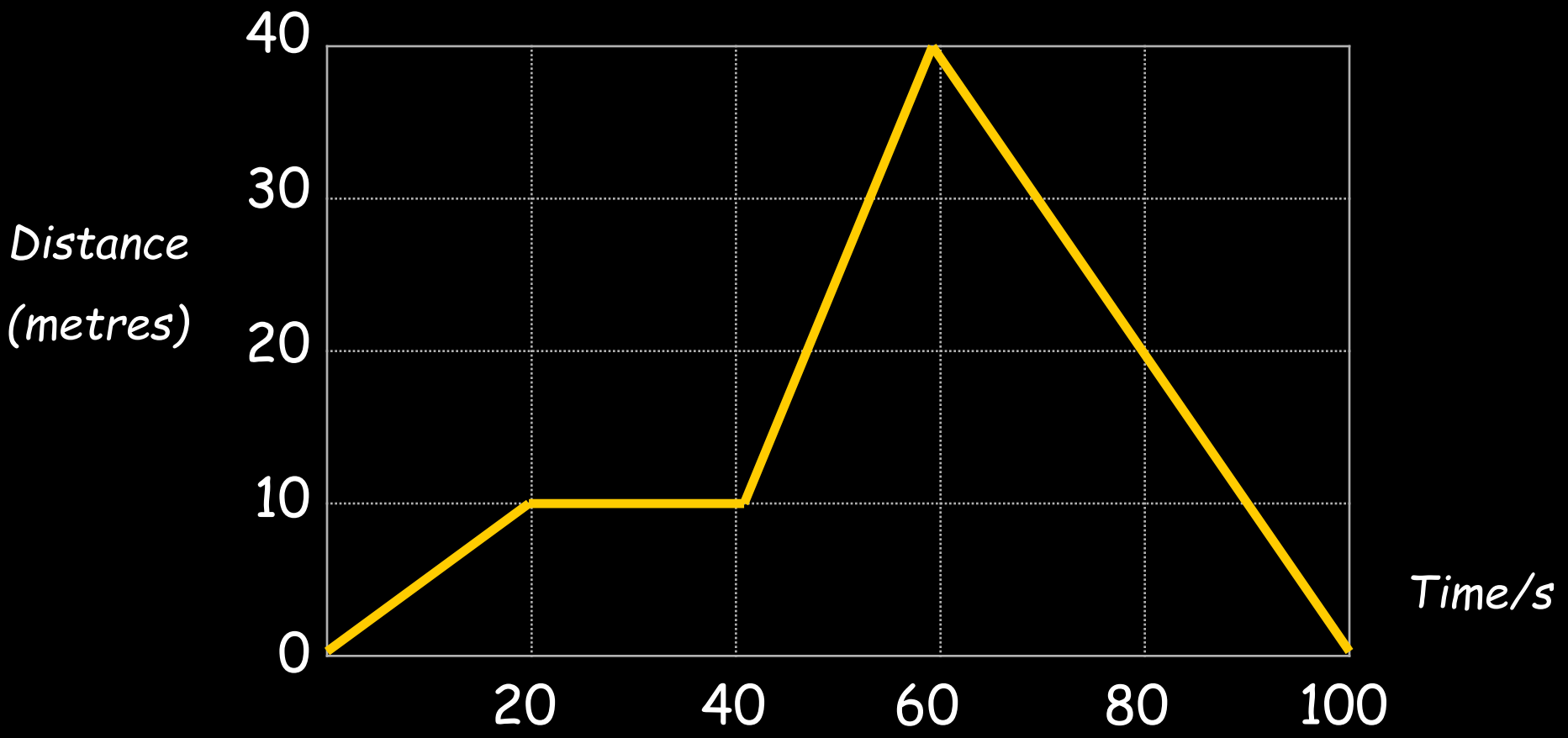
2) Horizontal line =

4) Diagonal line downwards =



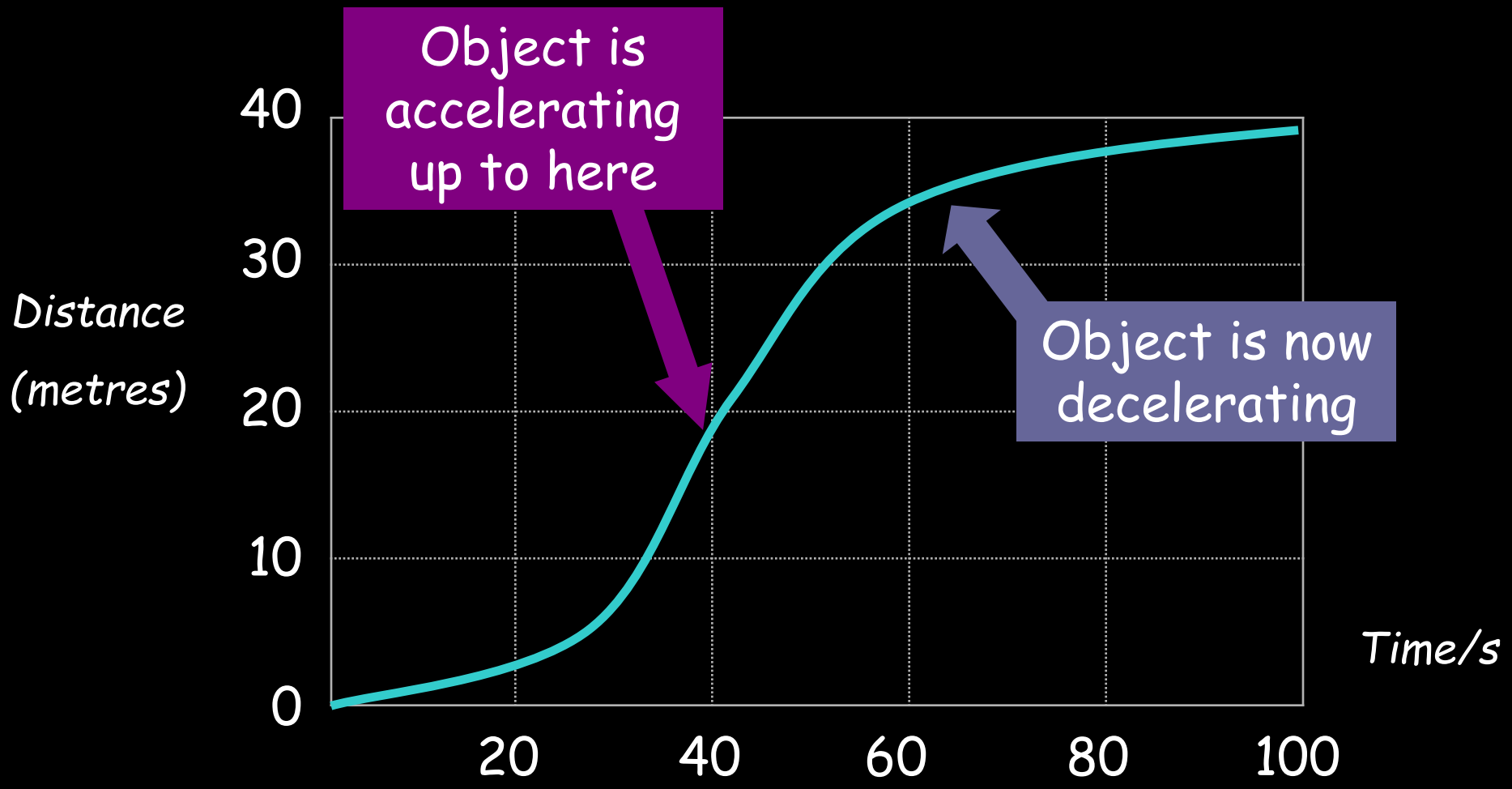
1) Diagonal line =

3) Steeper diagonal line =



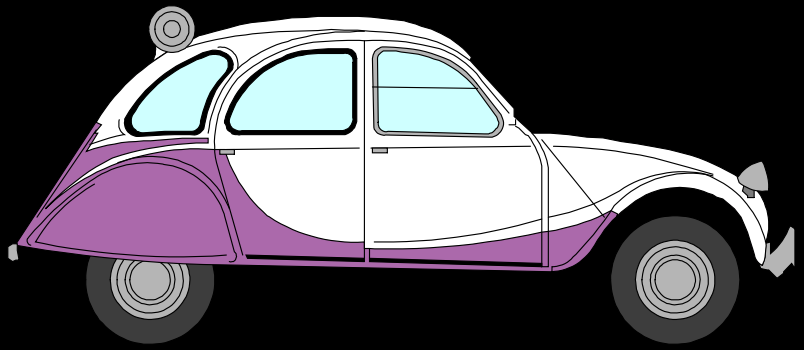
1) What is the speed during the first 20 seconds?
2) How far is the object from the start after 60 seconds?
3) What is the speed during the last 40 seconds?
4) When was the object travelling the fastest?

Distance-time graph for non-uniform motion



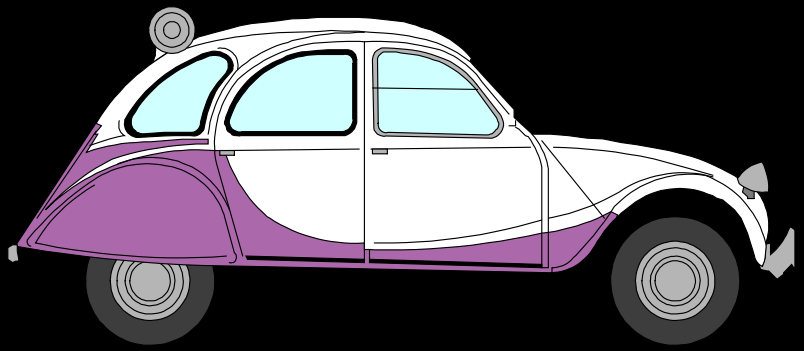
Speed vs. Velocity

Speed is simply how fast you are travelling…



This car is travelling at a speed of 20m/s

Velocity is "speed in a given direction" (a "vector quantity")…

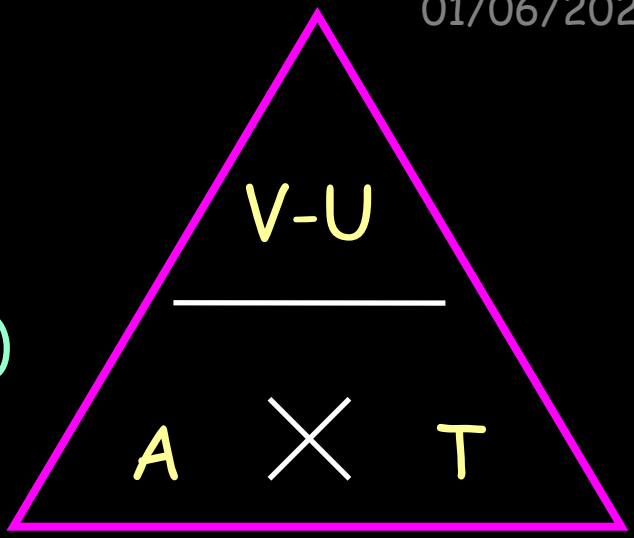


This car is travelling at a velocity of 20m/s east

Acceleration

$$\text{Acceleration} = \frac{\text{change in velocity (in m/s)}}{\text{time taken (in s)}}$$

(in m/s^2)

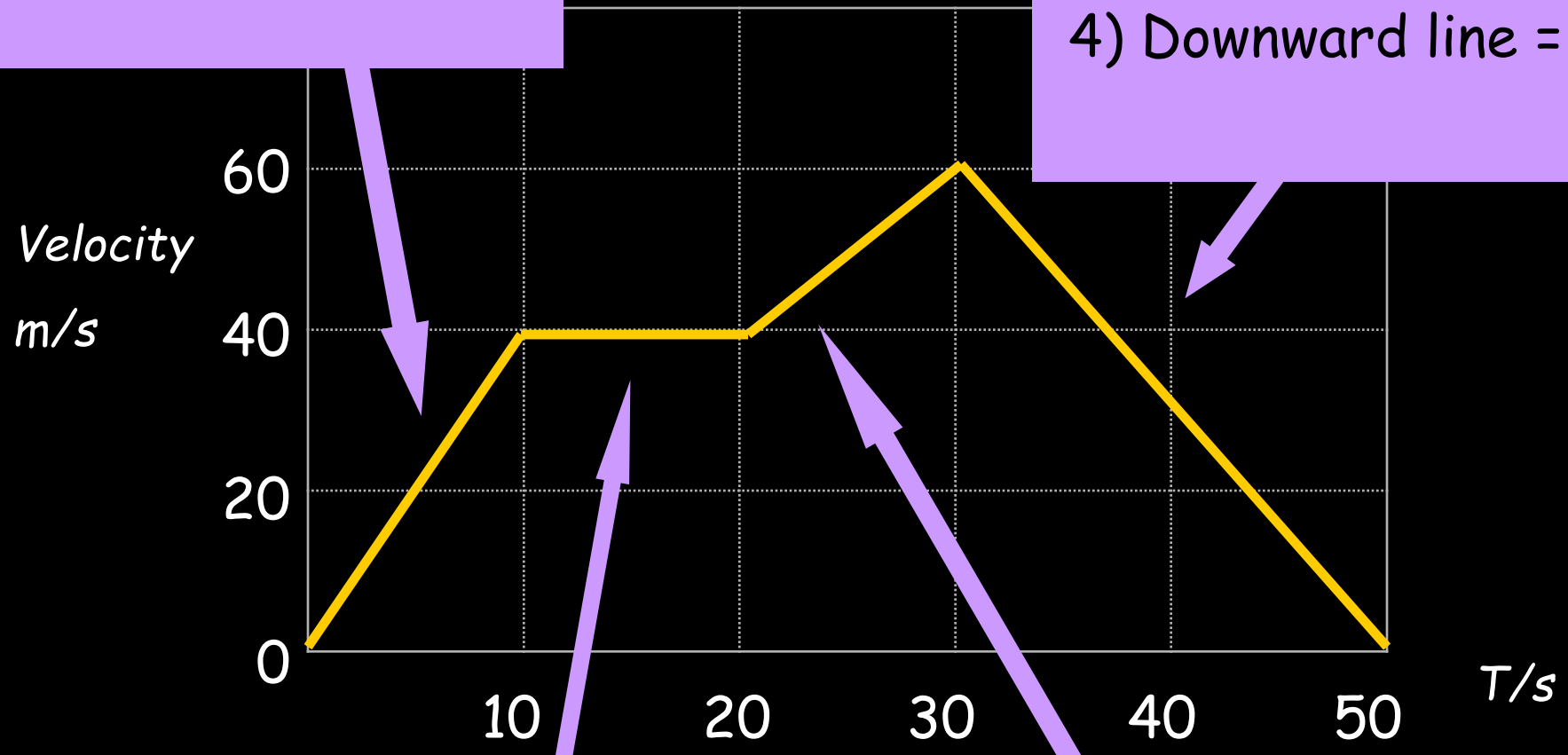


1) A cyclist accelerates from 0 to 10m/s in 5 seconds. What is her acceleration?
2) A ball is dropped and accelerates downwards at a rate of $10m/s^2$ for 12 seconds. How much will the ball's velocity increase by?
3) A car accelerates from 10 to 20m/s with an acceleration of $2m/s^2$. How long did this take?
4) A rocket accelerates from 1,000m/s to 5,000m/s in 2 seconds. What is its acceleration?

Velocity-time graphs

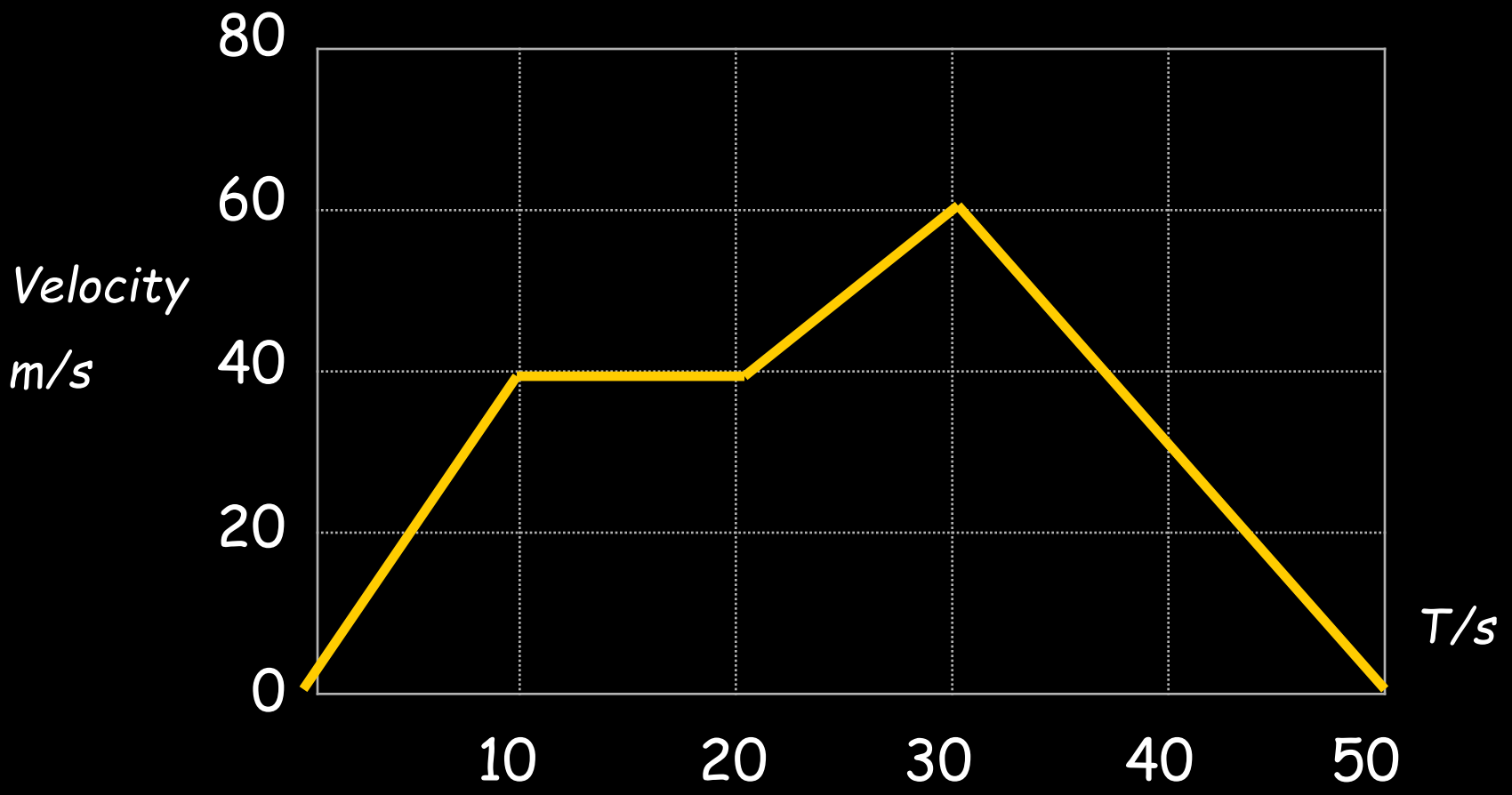
1) Upwards line =

4) Downward line =



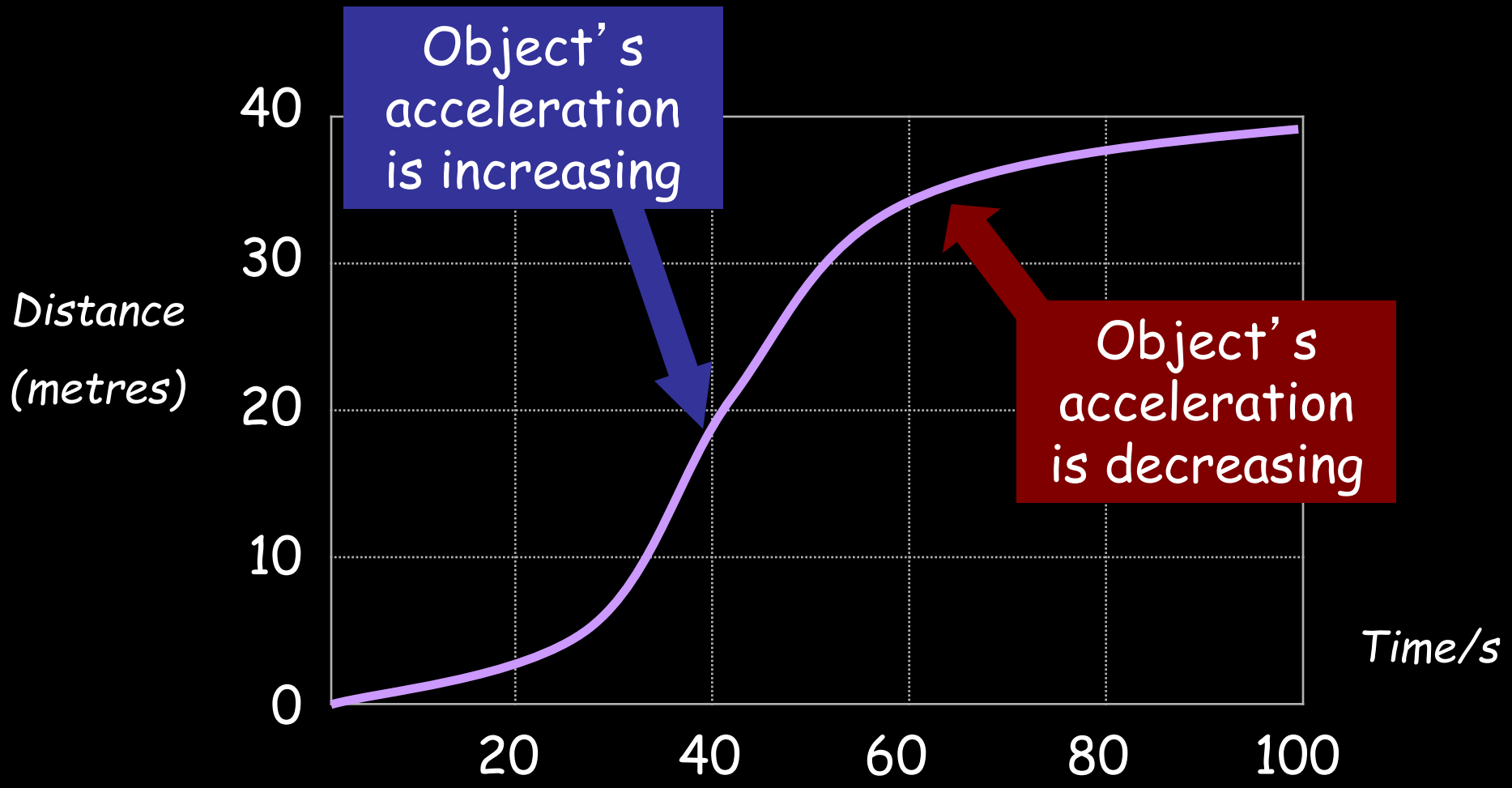
2) Horizontal line =

3) Upwards line =



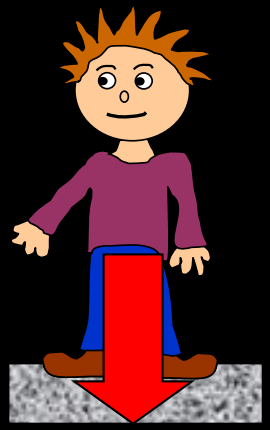
1) How fast was the object going after 10 seconds?
2) What is the acceleration from 20 to 30 seconds?
3) What was the deceleration from 30 to 50s?
4) How far did the object travel altogether?

Speed-time graph for non-uniform motion



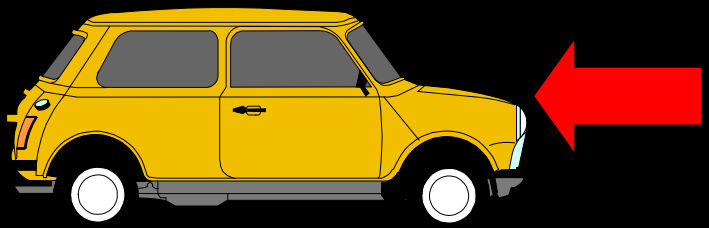
Introduction to Forces

A force is a "push" or a "pull". Some common examples:

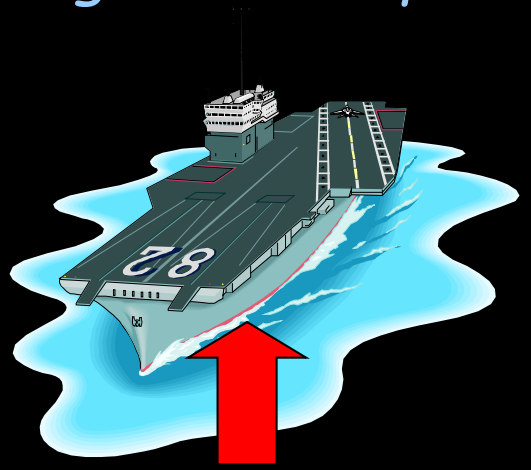


Weight (mg) – *pulls things towards the centre of the Earth*

Air resistance/drag – *a contact force that acts against anything moving through air or liquid*



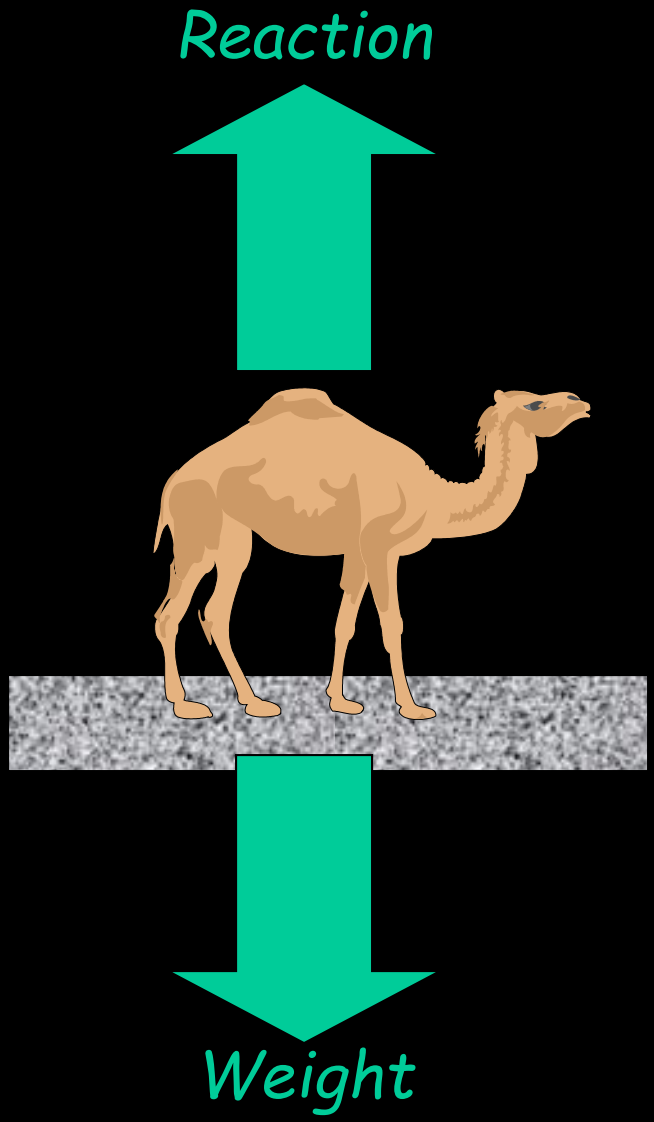
Friction – *a contact force that acts against anything moving*



Upthrust – *keeps things afloat*

Balanced and unbalanced forces

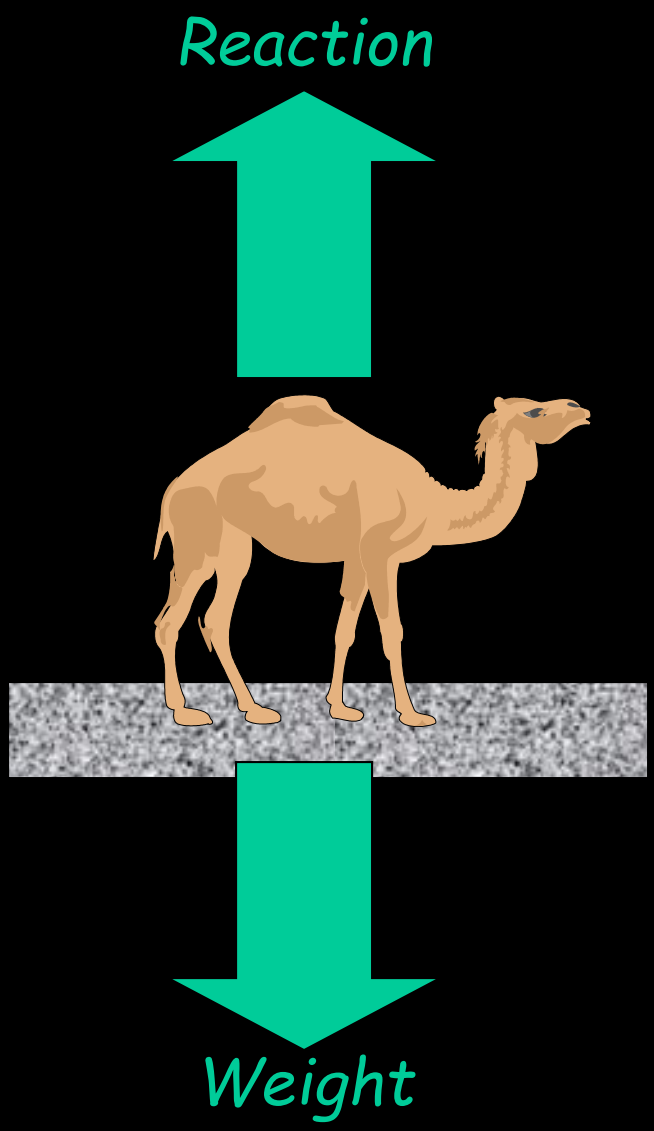
Consider a camel standing on a road.
What forces are acting on it?



These two forces would be equal – we say that they are BALANCED. The camel doesn't move anywhere.

Balanced and unbalanced forces

What would happen if we took the road away?



The camel's weight is no longer balanced by anything, so the camel falls downwards…

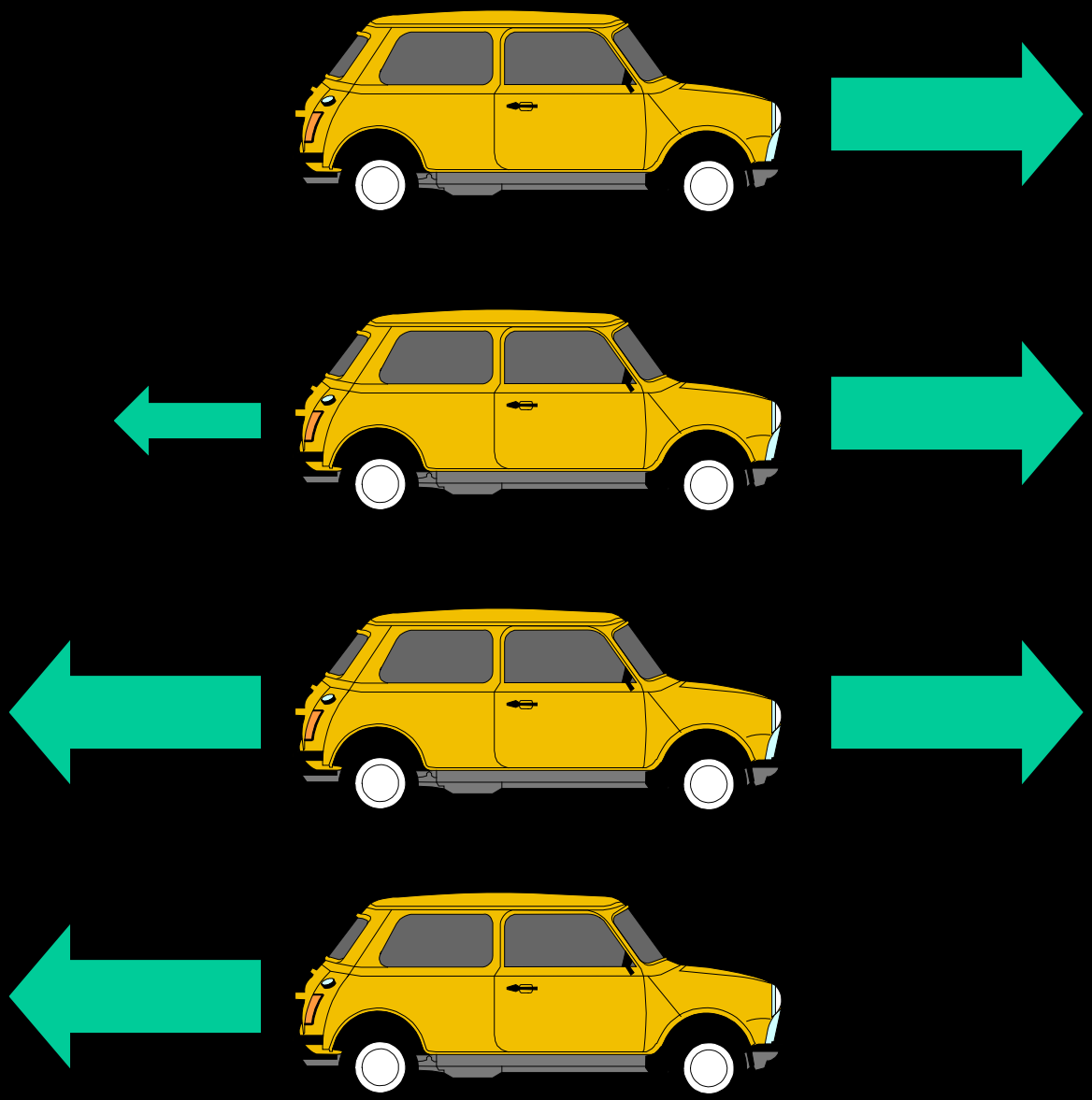
Air Resistance

Air resistance is a force that opposes motion through air. The quicker you travel, the bigger the air resistance:

The same applies to a body falling through a liquid (called "drag" or "upthrust").

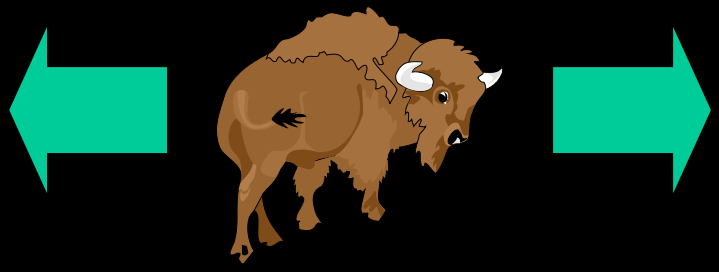
Balanced and unbalanced forces

01/06/2020

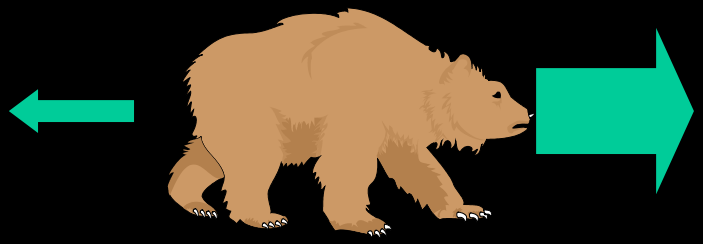


Balanced and unbalanced forces

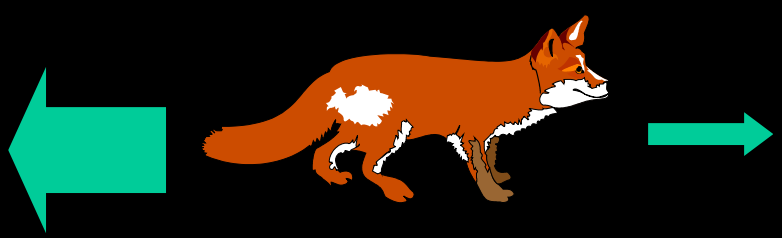
1) This animal is either _____ or moving with _____ _____…



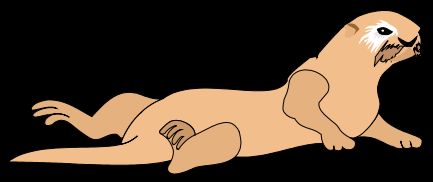
2) This animal is getting _____…



3) This animal is getting _____….

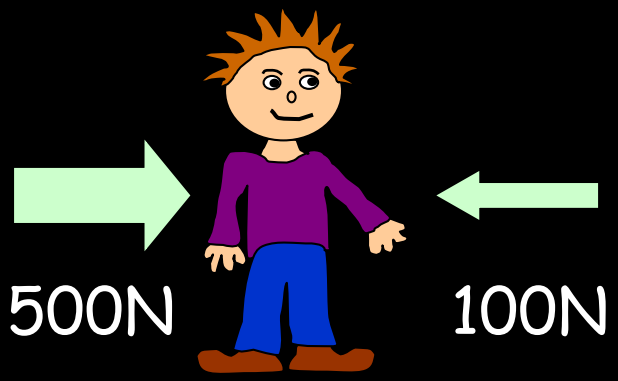


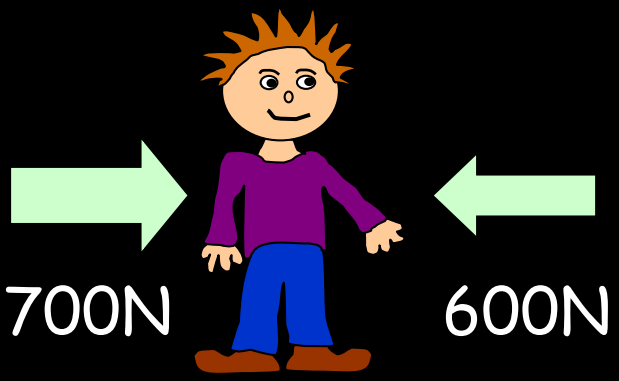
4) This animal is…

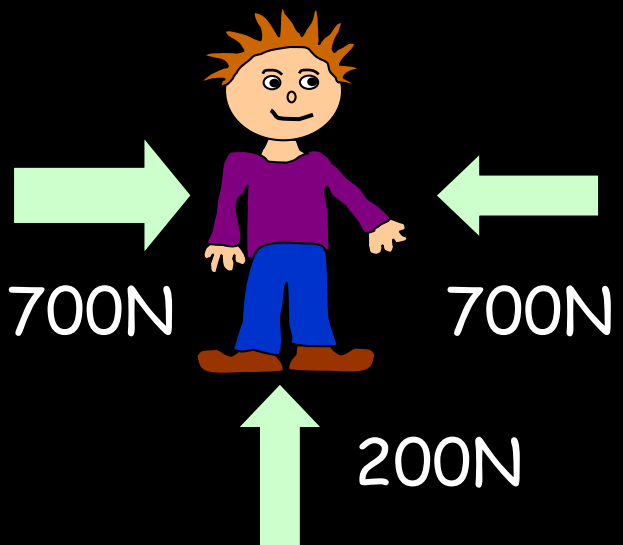


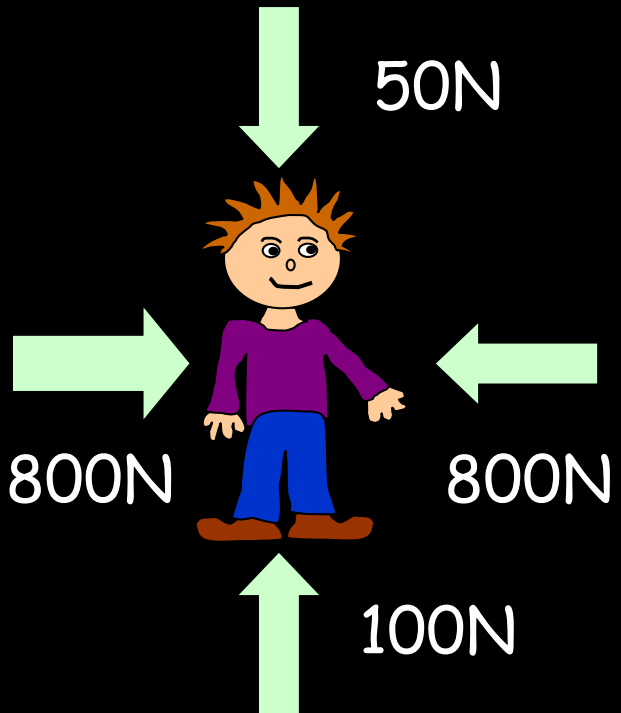
Resultant Force

Calculate the resultant force of the following:







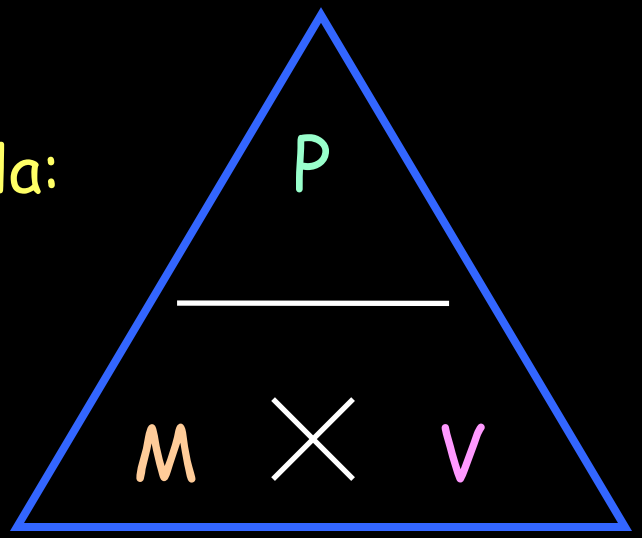


Momentum

Any object that has both mass and velocity has MOMENTUM. Momentum (symbol "p") is simply given by the formula:

$$\text{Momentum} = \text{Mass} \times \text{Velocity}$$

(in $kgms^{-1}$) *(in kg)* *(in ms^{-1})*



What is the momentum of the following?

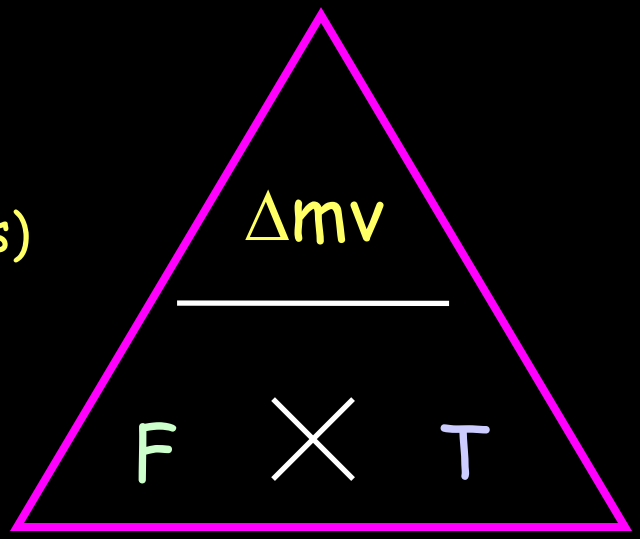
1) A 1kg football travelling at $10ms^{-1}$
2) A 1000kg Ford Capri travelling at $30ms^{-1}$
3) A 20g pen being thrown across the room at $5ms^{-1}$
4) A 70kg bungi-jumper falling at $40ms^{-1}$

Force and momentum

Newton's second law of motion says that the force acting on an object is that object's rate of change of momentum. In other words…

$$\text{Force (in N)} = \frac{\text{Change in momentum}}{\text{Time (in s)}} \quad \text{(in kgm/s)}$$

Also called "impulse"



For example, David Beckham takes a free kick by kicking a stationary football with a force of 40N. If the ball has a mass of 0.5kg and his foot is in contact with the ball for 0.1s calculate:

1) The change in momentum of the ball (its impulse),
2) The speed the ball moves away with

Example questions

1) Ben likes playing golf. He strikes a golf ball with a force of 80N. If the ball has a mass of 200g and the club is in contact with it for 0.2s calculate a) the change in momentum of the golf ball, b) its speed.

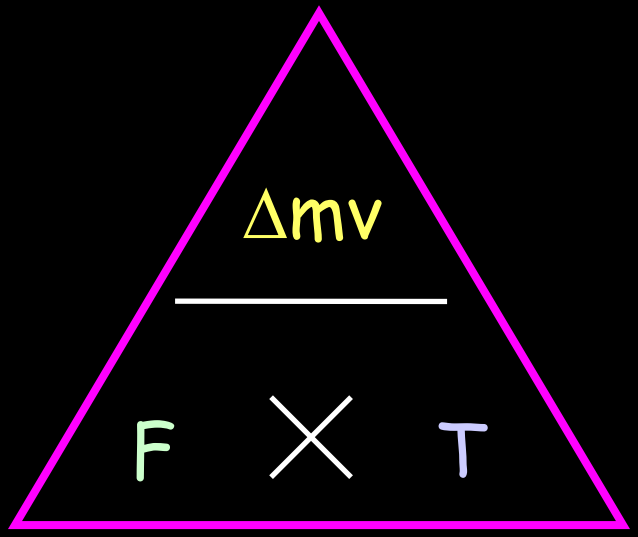
2) Nick thinks it's funny to hit tennis balls at Tom. He strikes a serve with a force of 30N. If the ball has a mass of 250g and the racket is in contact with it for 0.15s calculate the ball's change in momentum and its speed.

3) Dan takes a dropkick by kicking a 0.4kg rugby ball away at 10m/s. If his foot was in contact with the ball for 0.1 seconds calculate the force he applied to the ball.

4) Simon strikes a 200g golf ball away at 50m/s. If he applied a force of 50N calculate how long his club was in contact with the ball for.

Safety features

Let's use Newton's Second Law to explain how airbags work:



Basically:

1) The change in momentum is the same with or without an airbag
2) But having an airbag increases the time of the collision
3) Therefore the force is reduced

Kinetic energy

Any object that moves will have kinetic energy.

The amount of kinetic energy an object has can be found using the formula:

Kinetic energy = $\frac{1}{2}$ x mass x velocity squared

in J *in kg* *in m/s*

$$KE = \frac{1}{2} mv^2$$

Example questions

1) Nicole drives her car at a speed of 30m/s. If the combined mass of her and the car is 1000kg what is her kinetic energy?

2) Shanie rides her bike at a speed of 10m/s. If the combined mass of Shanie and her bike is 80kg what is her kinetic energy?

3) Dan is running and has a kinetic energy of 750J. If his mass is 60kg how fast is he running?

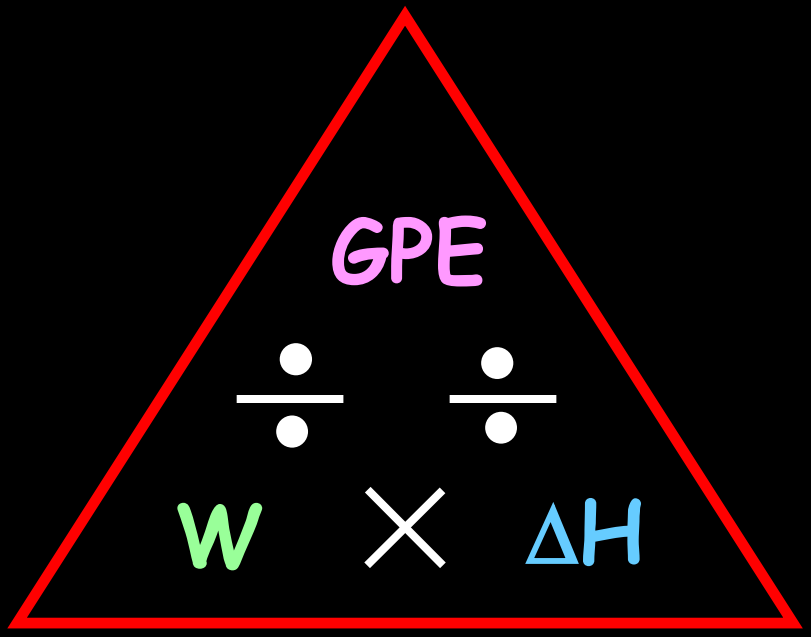
4) George is walking to town. If he has a kinetic energy of 150J and he's walking at a pace of 2m/s what is his mass?

Gravitational Potential Energy

To work out how much gravitational potential energy (GPE) an object gains when it is lifted up we would use the simple equation...

GPE = Weight x Change in height

(Joules) *(newtons)* *(metres)*



Some example questions…

How much gravitational potential energy have the following objects gained?:

1. A brick that weighs 10N lifted to the top of a house (10m),
2. A 10,000N car lifted by a ramp up to a height of 2m,
3. A 700N person lifted up 50m by a ski lift.

How much GPE have the following objects lost?:

1. A 2N football dropping out of the air after being kicked up 30m,
2. A 0.5N egg falling 10m out of a bird nest,
3. A 10,000N car falling off its 2m ramp.
4. Nathan when falling 1.5m to the ground after being hit by a van (Nathan's weight is around 800N).

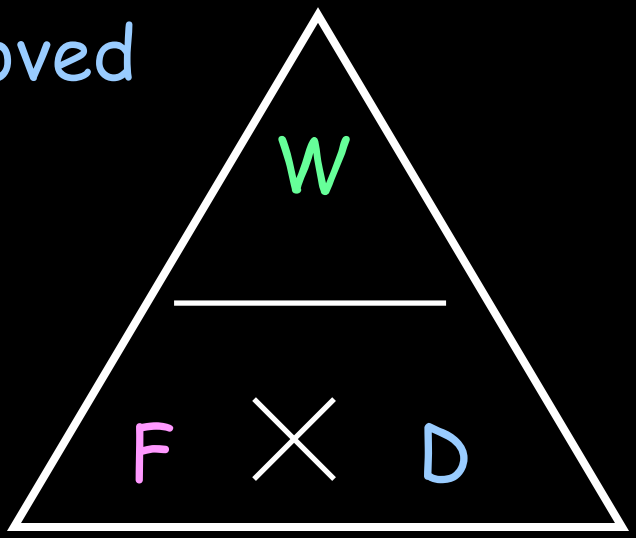
Work done

When any object is moved around work will need to be done on it to get it to move (obviously).

We can work out the amount of work done in moving an object using the formula:

Work done = Force x distance moved

in J *in N* *in m*



Example questions

1. Bori pushes a book 5m along the table with a force of 5N. He gets tired and decides to call it a day. How much work did he do?

2. Alicia lifts a laptop 2m into the air with a force of 10N. How much work does she do?

3. Martin does 200J of work by pushing a wheelbarrow with a force of 50N. How far did he push it?

4. Chris cuddles his cat and lifts it 1.5m in the air. If he did 75J of work how much force did he use?

5. Carl drives his car 1000m. If the engine was producing a driving force of 2000N how much work did the car do?