Physics Paper 2 Revision

Monday, 25 September 2023

Forces

Revision Session

Physics Paper 2 Revision

5.1.1 Scalar and Vector Quantities

Think

Pair

Share

What are scalar and vector quantities?

Key Term	Definition
Scalar Quantity	
Vector Quantity	

5.1.1 Scalar and Vector Quantities

Think
Pair
Share

How can we model vector quantities?

A vector quantity may be represented by an arrow.

→

The length of the arrow represents the magnitude.

The direction of the arrow represents the direction of the vector quantity.

Key Term	Definition
Scalar Quantity	A quantity with magnitude (size) only.
Vector Quantity	A quantity with both magnitude (size) and direction.

5.1.1 Scalar and Vector Quantities

Momentum | Acceleration

Force | Mass | Displacement | Density | Temperature

Energy | Weight | Distance | Velocity | Speed

Scalar Quantities	Vector Quantities

5.1.2 Contact and Non-Contact

Think

Pair

Share

What are contact and non contact forces?

Key Term	Definition
Forces	
Contact Forces	
Non-Contact Forces	

5.1.2 Contact and Non-Contact

Gravitational Force | Friction

Air Resistance | Electromagnetic Force | Magnetic Force

Water Resistance | Tension | Normal Contact Force

Contact Force	Non-Contact Force

6.5.1.1 Scalar and vector quantities

Content
Scalar quantities have magnitude only. Vector quantities have magnitude and an associated direction. A vector quantity may be represented by an arrow. The length of the arrow represents the magnitude, and the direction of the arrow the direction of the vector quantity.

6.5.1.2 Contact and non-contact forces

Content
A force is a push or pull that acts on an object due to the interaction with another object. All forces between objects are either: • contact forces – the objects are physically touching • non-contact forces – the objects are physically separated. Examples of contact forces include friction, air resistance, tension and normal contact force. Examples of non-contact forces are gravitational force, electrostatic force and magnetic force. Force is a vector quantity. Students should be able to describe the interaction between pairs of objects which produce a force on each object. The forces to be represented as vectors.

5.1.3 Gravity

Think Pair Share

What is the equation that you would use to calculate weight?

Weight = Mass x Gravitational Field Strength

$$W = m \times g$$

Newtons
N

Kilograms
kg

Newtons per kilogram
N/kg

Key Term	**Definition**
Weight	

5.1.3 Gravity

A book has a mass of 138g and gravitational field strength is 9.8N/kg. Calculate its weight. (4)

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Show each step that you do. 1 mark available here.

Answer to 3 s.f which is the same as the values in the qu.

6.5.1.3 Gravity

Content

Weight is the force acting on an object due to gravity. The force of gravity close to the Earth is due to the gravitational field around the Earth.

The weight of an object depends on the gravitational field strength at the point where the object is.

Content

The weight of an object can be calculated using the equation:

weight = mass × gravitational field strength

$$[\ W = m\ g\ ]$$

weight, W, in newtons, N

mass, m, in kilograms, kg

gravitational field strength, g, in newtons per kilogram, N/kg (In any calculation the value of the gravitational field strength (g) will be given.)

The weight of an object may be considered to act at a single point referred to as the object's 'centre of mass'.

5.1.4 Resultant Forces

Think
Pair
Share

What is a resultant force and how are they calculated?

1000N
forward force
from engine.

750N

Key Term	Definition
Resultant Force	

5.1.4 Resultant Forces

Think Pair Share

What is a resultant force and how are they calculated?

1000N forward force from engine.

750N

Resultant force acting on this plane:

1000N - 750N = 250N

5.1.4 Resultant Forces

Think Pair Share

What is a resultant force and how are they calculated?

If the forces are acting in the same direction add them together.

If the forces are acting in opposite directions subtract one away from the other.

5.1.4 Resultant Forces

Scenario	Calculation	Resultant Force	Direction of Resultant Force
A parachutist has a weight of 70N and air resistance as they fall is 18N.			
A force of 18N and 12N both act to the right.			
A car has a forward force of 100N. Air resistance is 22N and friction between the car and road is 32N.			
A book is pushed to the left with a force of 8N. Friction is 2N.			

6.5.1.4 Resultant forces

Content
A number of forces acting on an object may be replaced by a single force that has the same effect as all the original forces acting together. This single force is called the resultant force. Students should be able to calculate the resultant of two forces that act in a straight line.

5.1.4 Resultant Forces

Think Pair Share

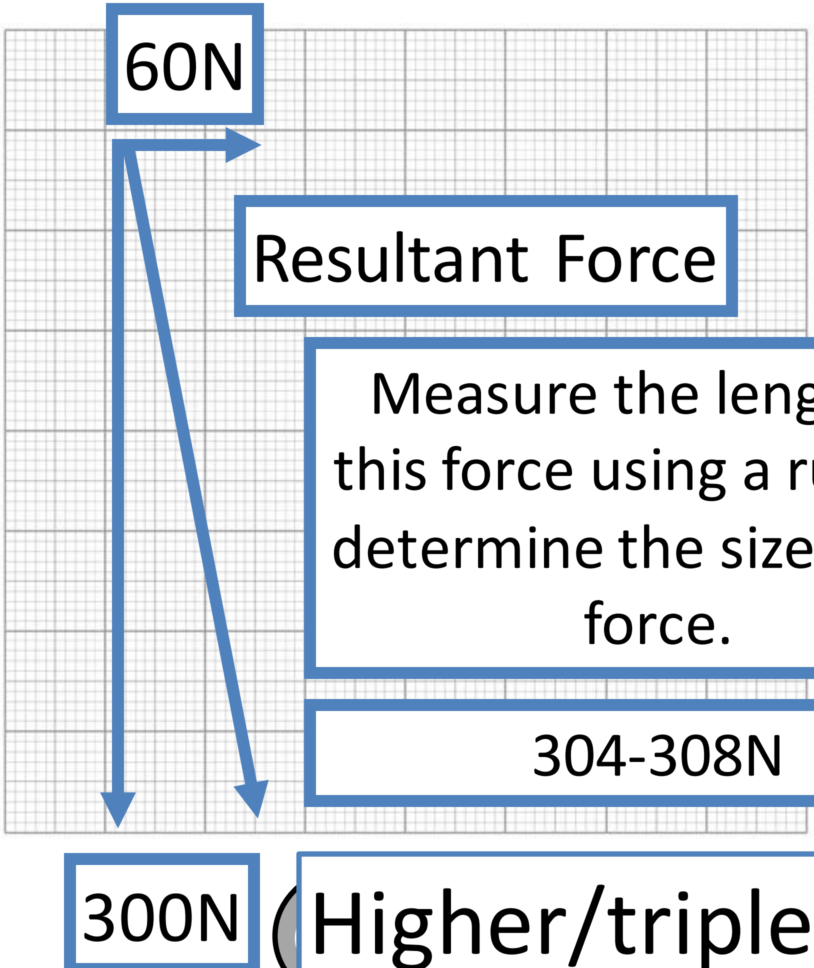
How do we calculate the resultant force if forces are not acting on a straight line?

You would draw a vector diagram to find the magnitude and direction of the force.

A skydiver jumps from an aeroplane.

There is a resultant vertical force of 300 N on the skydiver.

There is a horizontal force from the wind of 60 N.



Measure the length of this force using a ruler to determine the size of the force.

304-308N

Higher/triple

(HT only) Students should be able to:

- describe examples of the forces acting on an isolated object or system

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- use free body diagrams to describe qualitatively examples where several forces lead to a resultant force on an object, including balanced forces when the resultant force is zero.

(HT only) A single force can be resolved into two components acting at right angles to each other. The two component forces together have the same effect as the single force.

(HT only) Students should be able to use vector diagrams to illustrate resolution of forces, equilibrium situations and determine the resultant of two forces, to include both magnitude and direction (scale drawings only).

5.2 Work Done and Energy Transfer

Think
Pair
Share

What is work done?

When a force causes an object to move through a distance work is done on the object.

SO

A force does work on an object when the force causes a displacement of the object.

Key Term	Definition
Work Done	

5.2 Work Done and Energy Transfer

Think

Pair

Share

What is work done?

Newtons
N

Work Done = Force x Distance

W = F x s

Joules
J

Metres
m

You may need to convert units!

5.2 Work Done and Energy Transfer

Think

Pair

Share

What is work done?

One joule of work is done when a force of one newton causes displacement of one metre

1 Joule = 1 Newton-metre

Work done against the frictional forces acting on an object will cause a rise in the temperature of the object.

6.5.2 Work done and energy transfer

Content	Key opportunities for skills development
When a force causes an object to move through a distance work is done on the object. So a force does work on an object when the force causes a displacement of the object.	
The work done by a force on an object can be calculated using the equation: work done = force × distance (moved along the line of action of the force) [$W = F s$] work done, W, in joules, J force, F, in newtons, N distance, s, in metres	MS 3b, c Students should be able to recall and apply this equation.
One joule of work is done when a force of one newton causes a displacement of one metre. 1 joule = 1 newton-metre Students should be able to describe the energy transfer involved when work is done.	WS 4.5
Students should be able to convert between newton-metres and joules. Work done against the frictional forces acting on an object causes a rise in the temperature of the object.	MS 1c WS 4.5

5.3 Forces and Elasticity

Think
Pair
Share

If you applied a force to compress both a spring and a drinks can what differences would there be? Why do you think this is?

The spring is an example of an **elastic object**

The can is an example of an **inelastic object**

When a force is applied to either of these objects they will change shape. Depending on the force applied they may bend, stretch or compress. A change in shape is known as **deformation**.

5.3 Forces and Elasticity

Think Pair Share

If you applied a force to compress both a spring and a drinks can what differences would there be? Why do you think this is?

The spring is an example of an **elastic object**

The can is an example of an **inelastic object**

Elastic deformation is **reversed** when the force is removed. This means that spring will return back to its original shape.

Inelastic deformation is **not fully reversed** when the force is removed. This means that the can will not return back to its original shape.

5.3 Forces and Elasticity

Key Term	Definition
Deformation	
Elastic Deformation	
Inelastic Deformation	

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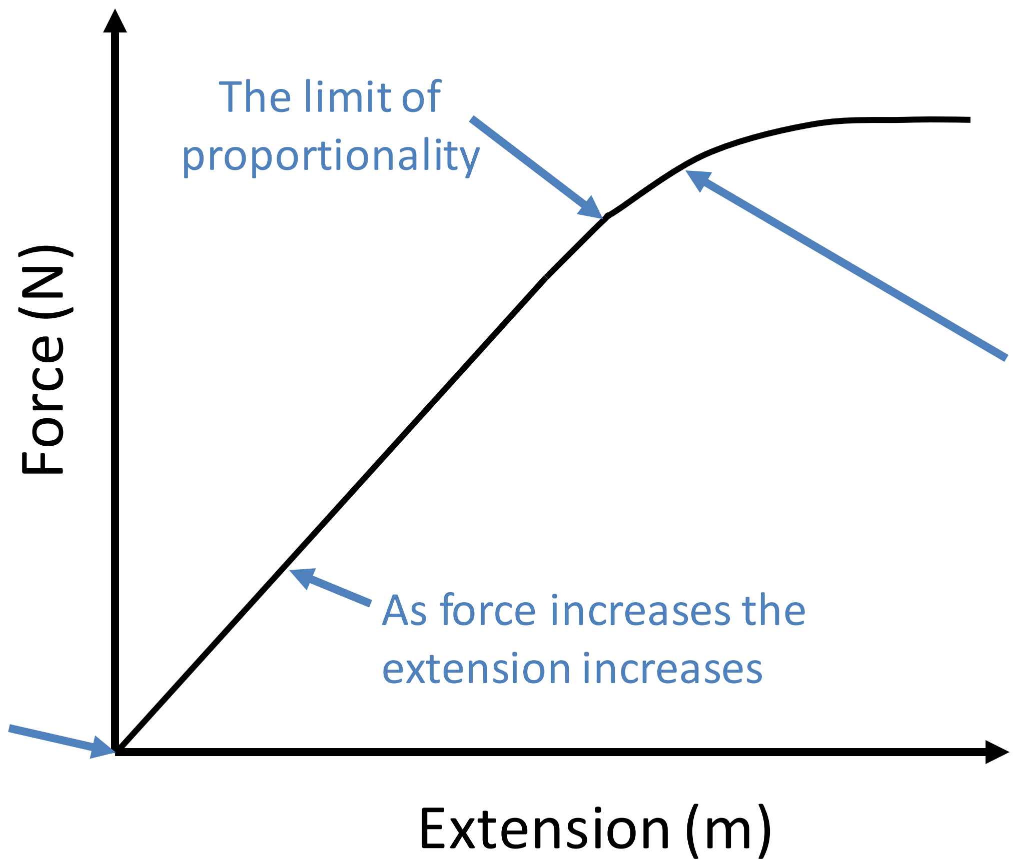
5.3 Forces and Elasticity

Think
Pair
Share

Below is a graph that shows the extension of a spring when a force is applied. What relationship does this graph show?

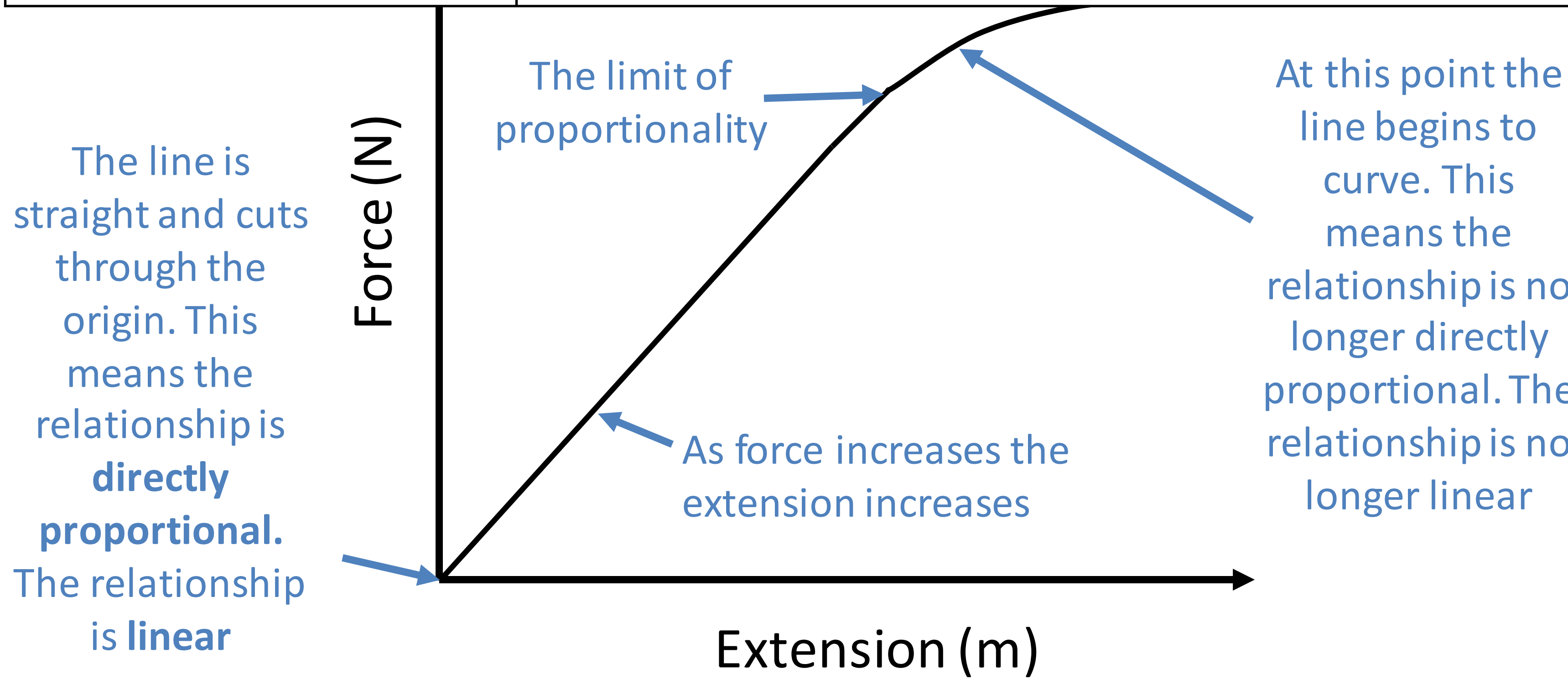


The line is straight and cuts through the the origin. This means the relationship is **directly proportional.** The relationship is **linear**

At this point the line begins to curve. This means the relationship is no longer directly proportional. The relationship is no longer linear

5.3 Forces and Elasticity

Key Term	Definition
Hooke's Law	The extension of a spring is directly proportional to the force applied as long as the limit of proportionality is not exceeded.



Exam Practice

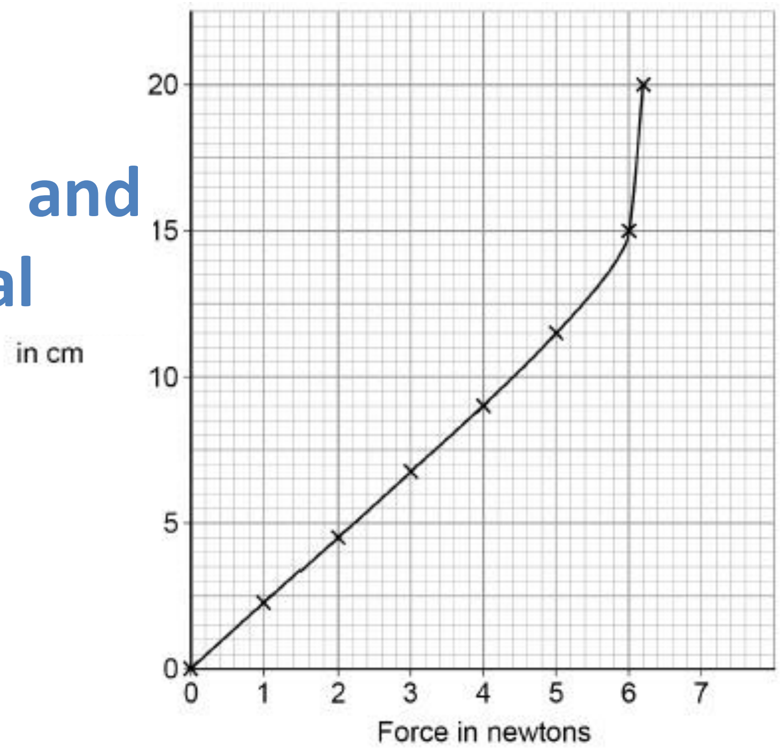
What is meant by elastic behaviour? (1)

The object returns to its original shape when the force is removed.

During an experiment the limit of proportionality was exceeded. What was this point? Give a reason for your choice (2)

5-5.8

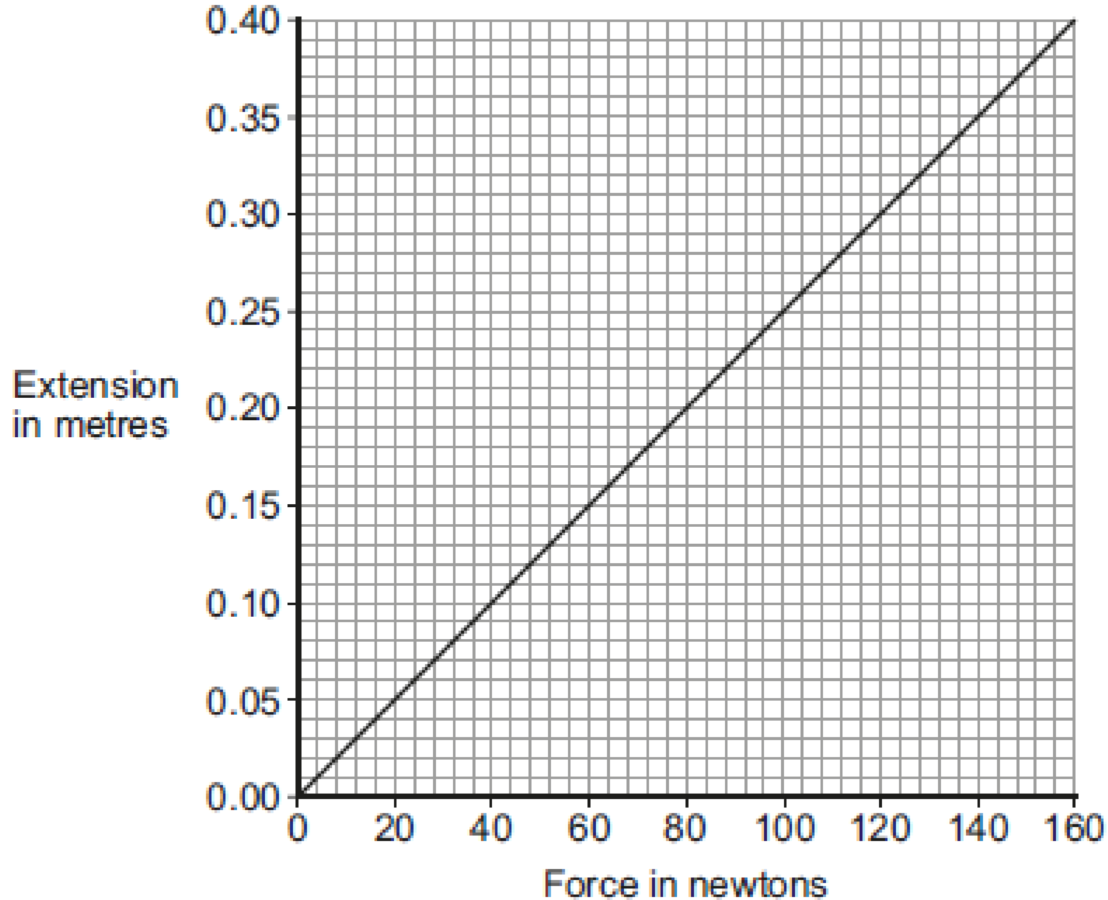
Up to this point force and extension are proportional



Exam Practice

How can you tell, from the graph below, that the limit of proportionality of the spring has not been exceeded? (1)

Line is straight



5.3 Forces and Elasticity

Think
Pair
Share

What is the equation that you would use to calculate extension of a spring?

Newtons per metre
N/m

Force = Spring Constant x Extension

F = k x e

Newtons
N

Metres
m

You may need to convert units!

5.3 Forces and Elasticity

A spring has a spring constant of 8N/m. Calculate the force needed to extend it 20cm

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Substitute the values into your equation

Units included.

5.3 Forces and Elasticity

Think Pair Share

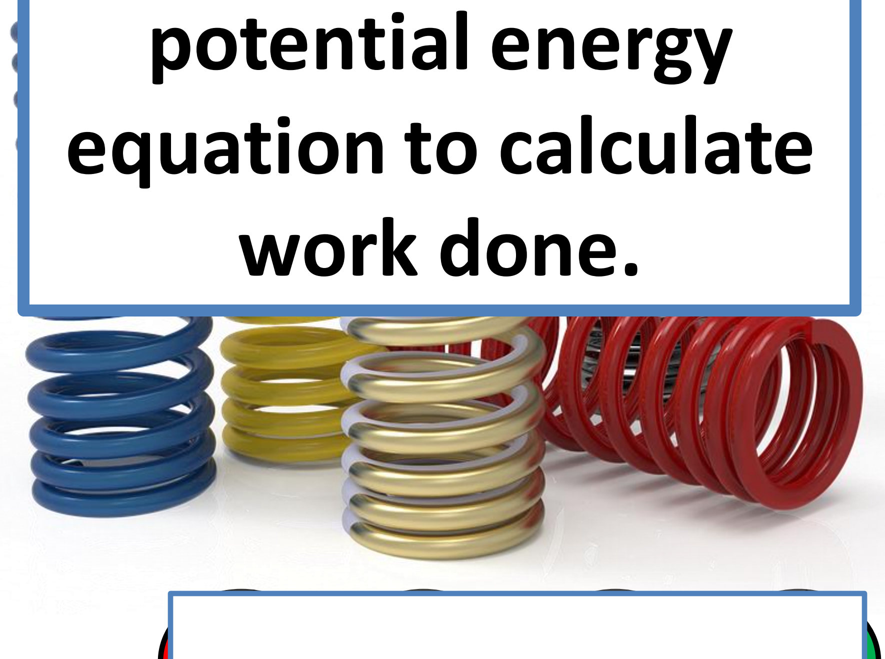
How can you find the work done when a spring is stretched or compressed?

A force that stretches or compresses a spring does work.

Elastic potential energy is stored in the spring.

Provided the spring is not inelastically deformed, the work done on the spring and the elastic potential energy stored are equal.

This means we can use the elastic potential energy equation to calculate work done.



5.3 Forces and Elasticity

Think Pair Share

What is the equation that you would use to calculate elastic potential energy?

You may need to convert units!

Newtons per metre
N/m

Elastic Potential Energy = 0.5 x Spring Constant x Extension^2

Joules
J

$$E_e = \frac{1}{2} \times k \times e^2$$

Metres
m

Key Term	Definition
Elastic Potential Energy	

5.3 Forces and Elasticity

A spring that has a spring constant of 1.2N/m is stretched 22cm. Calculate the work done.

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Substitute before you do any rearranging. 1 mark for doing this.

Show each step that you do. 1 mark available here.

Answer to 2 s.f which is the same as the values in the qu.

6.5.3 Forces and elasticity

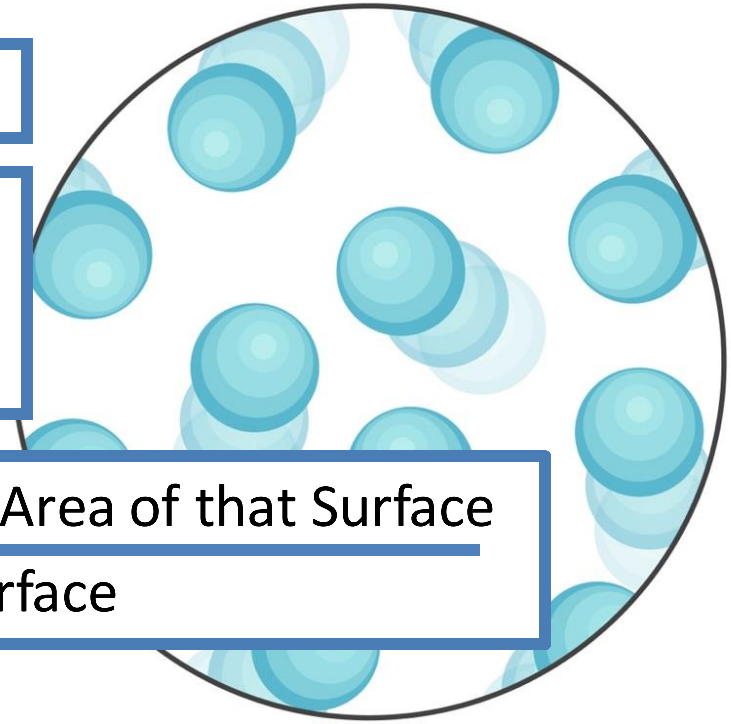
Content
Students should be able to: • give examples of the forces involved in stretching, bending or compressing an object • explain why, to change the shape of an object (by stretching, bending or compressing), more than one force has to be applied – this is limited to stationary objects only • describe the difference between elastic deformation and inelastic deformation caused by stretching forces. The extension of an elastic object, such as a spring, is directly proportional to the force applied, provided that the limit of proportionality is not exceeded.

Content	Key opportunities for skills development
force = *spring constant* × *extension* [$F = k\,e$] force, *F*, in newtons, N spring constant, *k*, in newtons per metre, N/m extension, *e*, in metres, m	MS 3b, c, 4a Students should be able to recall and apply this equation.
This relationship also applies to the compression of an elastic object, where '*e*' would be the compression of the object. A force that stretches (or compresses) a spring does work and elastic potential energy is stored in the spring. Provided the spring is not inelastically deformed, the work done on the spring and the elastic potential energy stored are equal. Students should be able to: • describe the difference between a linear and non-linear relationship between force and extension • calculate a spring constant in linear cases	MS 3b, c, 4a
• interpret data from an investigation of the relationship between force and extension	WS 3.5
• calculate work done in stretching (or compressing) a spring (up to the limit of proportionality) using the equation: *elastic potential energy* = 0.5 × *spring constant* × (*extension*)^2 [$E_e = \frac{1}{2}\,k\,e^2$]	MS 3c Students should be able to apply this equation which is given on the *Physics equation sheet*.

5.5.1 Pressure In A Fluid

Think
Pair
Share

What causes pressure in a fluid?



A fluid can be either a liquid or a gas.

The pressure in fluids causes a force normal (at right angles) to any surface.

Pressure = Force Normal to a Surface Area of that Surface

Area of that Surface

Newtons
N

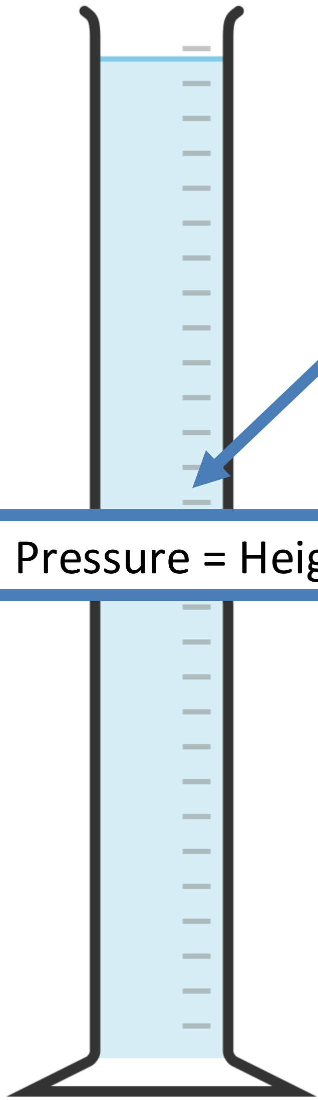
Pascals
Pa

$p = F / A$

Meters Squared m^2

Triple

5.5.1.2 Pressure In A Fluid 2



The pressure in a column can be calculated using the equation:

Pascals
Pa

Kilograms per metre cubed
kg/m^3

Pressure = Height of the Column × Density of the Liquid × Gravitational Field Strength

$$p = h \rho g$$

Metres
m

Newtons per kilogram
N/kg

Triple

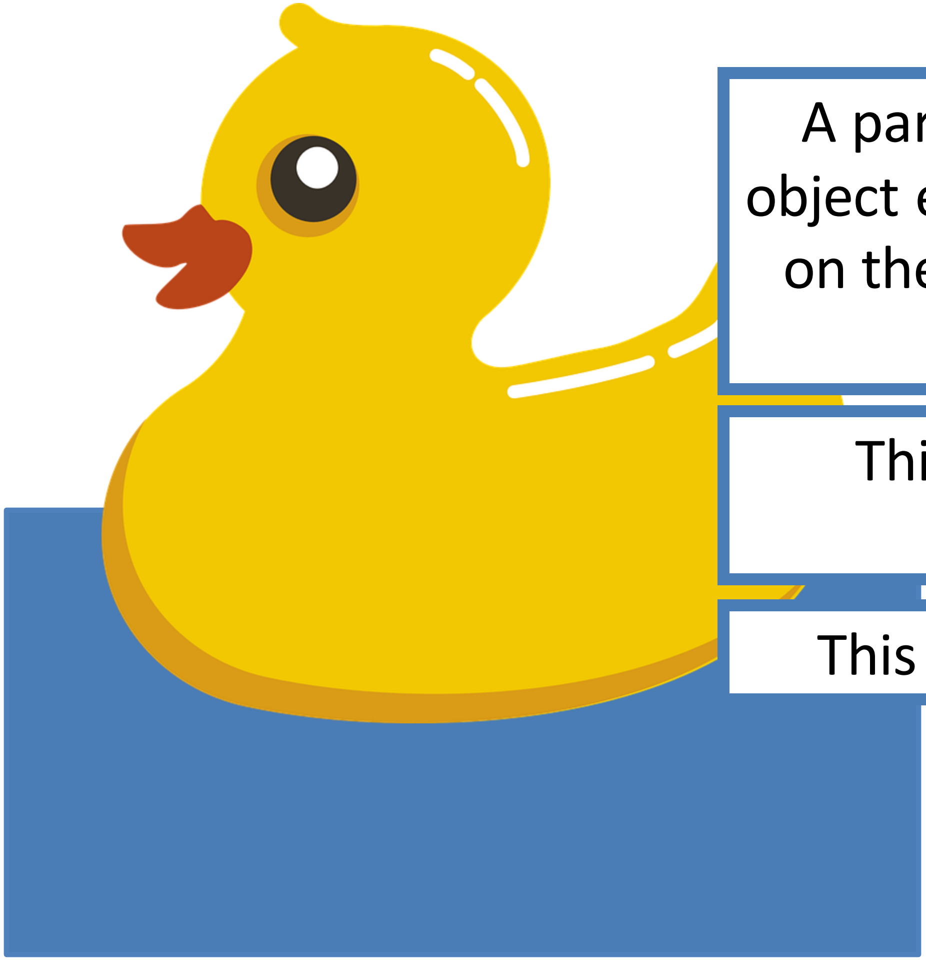
5.5.1.2 Pressure In A Fluid 2

Think

Pair

Share

What causes upthrust?



A partially (or totally) submerged object experiences a greater pressure on the bottom surface than on the top surface.

This creates a resultant force upwards.

This force is called the upthrust.

Triple

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5.5.2 Atmospheric Pressure

Think

Pair

Share

What is the atmosphere?

The atmosphere is a thin layer (relative to the size of the Earth) of air round the Earth.

The atmosphere gets less dense with increasing altitude.

Air molecules colliding with a surface create atmospheric pressure.

Triple

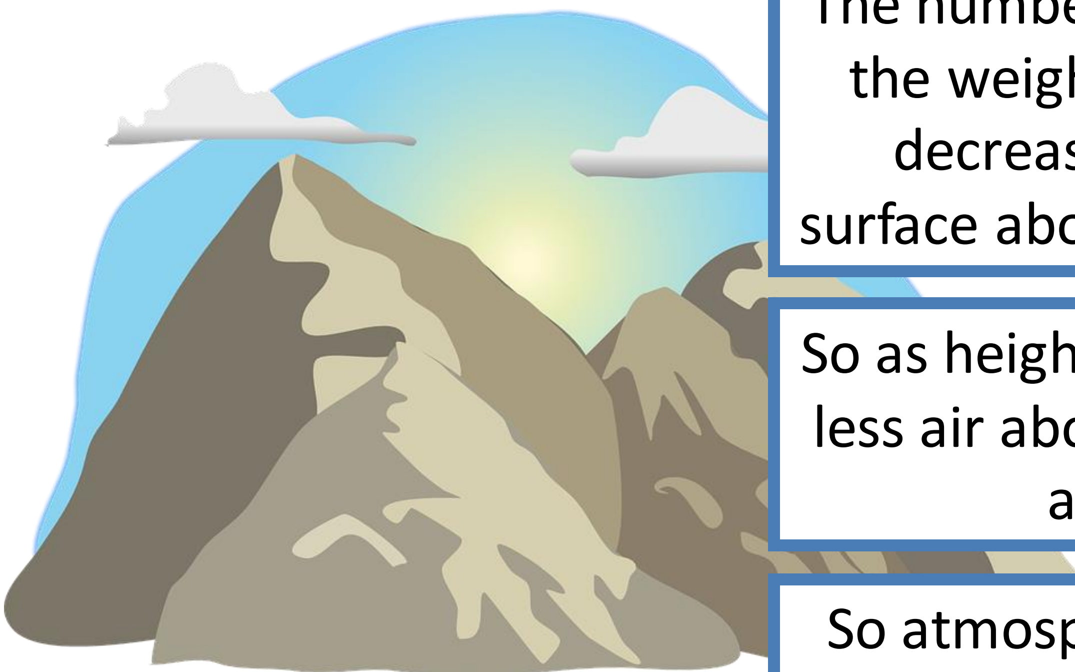
5.5.2 Atmospheric Pressure

Think

Pair

Share

What is the atmosphere?



The number of air molecules (and so the weight of air) above a surface decreases as the height of the surface above ground level increases.

So as height increases there is always less air above a surface than there is at a lower height.

So atmospheric pressure decreases with an increase in height.

Triple

5.6.1.1 Distance and Displacement

Think

Pair

Share

What are distance and displacement?

Key Term	Definition	Type of Quantity
Distance		
Displacement	.	
Speed		
Velocity		

6.5.4.1.1 Distance and displacement

Content
Distance is how far an object moves. Distance does not involve direction. Distance is a scalar quantity. Displacement includes both the distance an object moves, measured in a straight line from the start point to the finish point and the direction of that straight line. Displacement is a vector quantity. Students should be able to express a displacement in terms of both the magnitude and direction.

5.6.1.2 Speed

Think

Pair

Share

What are some typical values for speed?

Example	Typical Value of Speed
Walking	
Running	
Cycling	
Sound in Air	

The speed for each of these is rarely constant.

The speed someone walks runs or cycles at can depend on their age, the terrain, their fitness and the distance travelled.

6.5.4.1.2 Speed

Content

Speed does not involve direction. Speed is a scalar quantity.

The speed of a moving object is rarely constant. When people walk, run or travel in a car their speed is constantly changing.

The speed at which a person can walk, run or cycle depends on many factors including: age, terrain, fitness and distance travelled.

Typical values may be taken as:

walking ~ 1.5 m/s

running ~ 3 m/s

cycling ~ 6 m/s.

Students should be able to recall typical values of speed for a person walking, running and cycling as well as the typical values of speed for different types of transportation systems.

It is not only moving objects that have varying speed. The speed of sound and the speed of the wind also vary.

A typical value for the speed of sound in air is 330 m/s.

5.6.1.2 Speed

Think

Pair

Share

What is the equation that you would use to calculate speed?

You may need to convert units!

Distance Travelled = Speed x Time

$$s = v \times t$$

Metres

m

Seconds

s

Metres per second

m/s

5.6.1.2 Speed

Calculate the distance someone will travel if they are moving at 1.5m/s for 1 minute. (3)

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Show each step that you do. 1 mark available here.

Answer to 3 s.f which is the same as the values in the qu.

Content
$distance\ travelled = speed \times time$ [$s = v\,t$]   distance, *s*, in metres, m   speed, *v*, in metres per second, m/s   time, *t*, in seconds, s
Students should be able to calculate average speed for non-uniform motion

5.6.1.3 Velocity

Think
Pair
Share

What are speed and velocity?

Key Term	Definition	Type of Quantity
Distance	How far an object moves.	Scalar
Displacement	The distance an object moves measured in a straight line from the start point to the finish point.	Vector
Speed		
Velocity		

5.6.1.3 Velocity

Think Pair Share

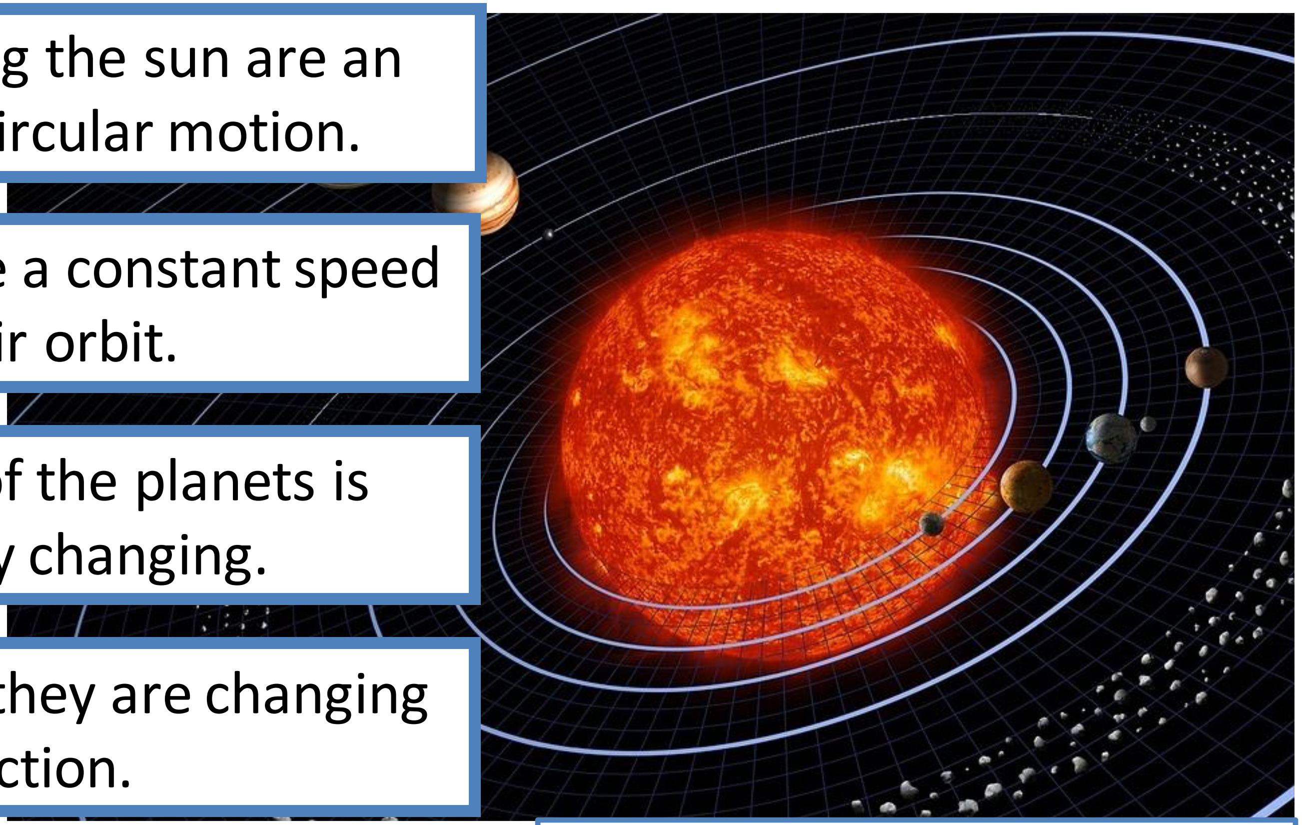
What happens to velocity and speed during circular motion?

Planets orbiting the sun are an example of circular motion.

The planets have a constant speed in their orbit.

The velocity of the planets is constantly changing.

This is because they are changing direction.



6.5.4.1.3 Velocity

Content
The velocity of an object is its speed in a given direction. Velocity is a vector quantity. Students should be able to explain the vector–scalar distinction as it applies to displacement, distance, velocity and speed. (HT only) Students should be able to explain qualitatively, with examples, that motion in a circle involves constant speed but changing velocity.

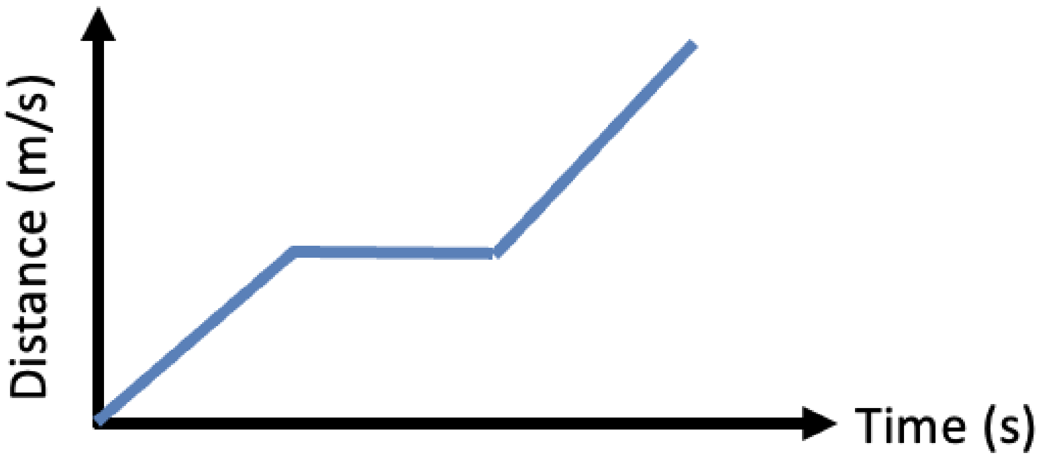
5.6.1.4 Distance-Time Relationship

Think

Pair

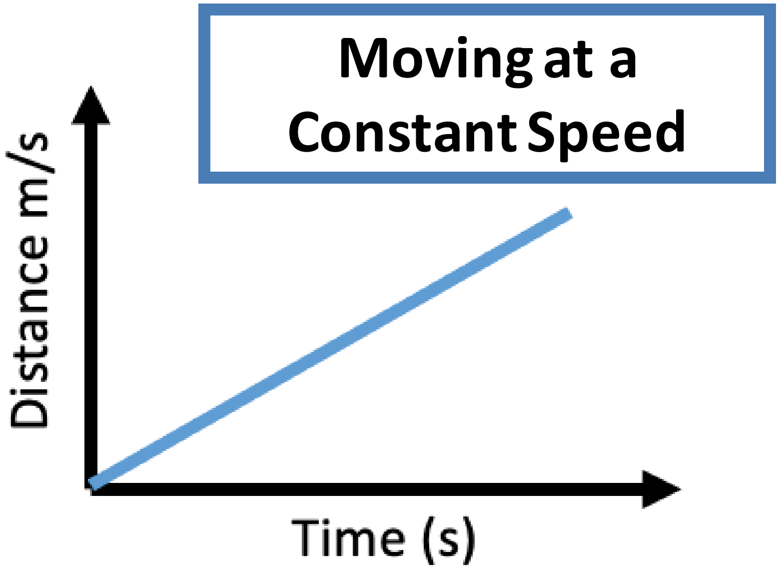
Share

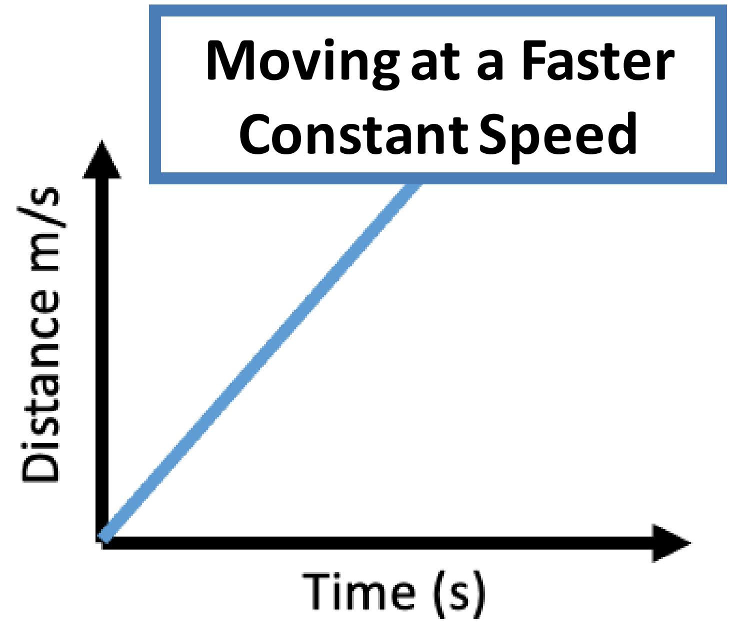
What are distance time graphs?

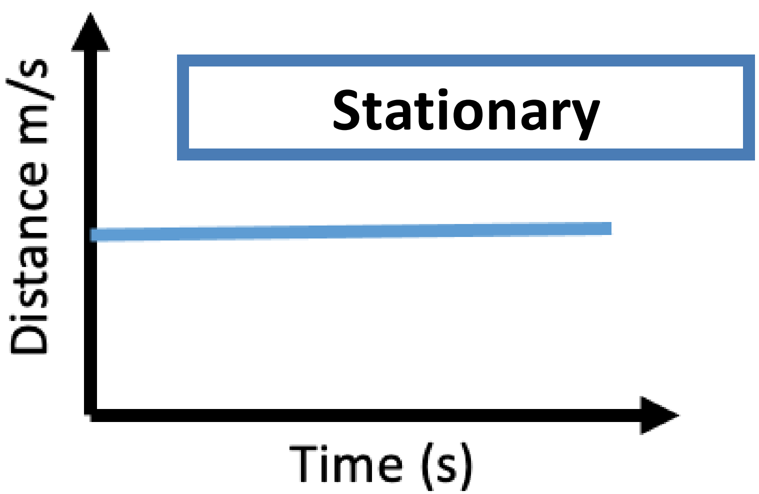


Key Term	Definition
Distance-Time Graph	

5.6.1.4 Distance-Time Relationship







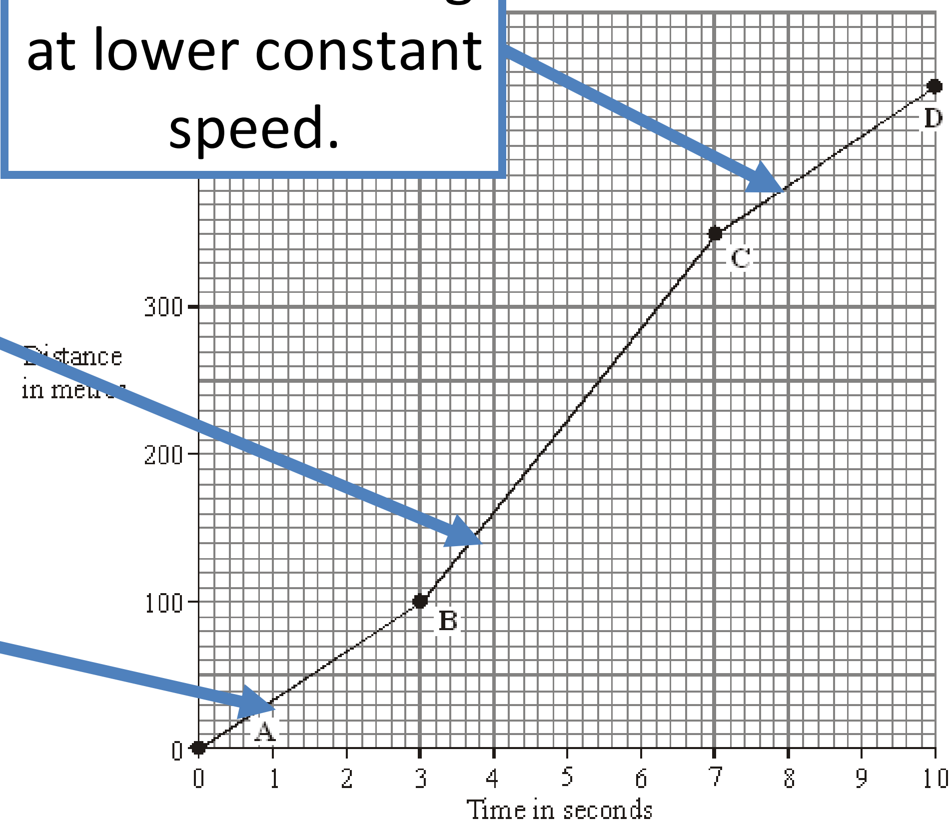
5.6.1.4 Distance-Time Relationship

Describe the journey between points A and D.

Back to travelling at lower constant speed.

Between B-C it is travelling at a faster constant speed.

Between A-B travelling at a constant speed.



5.6.1.4 Distance-Time Relationship

Think

Pair

Share

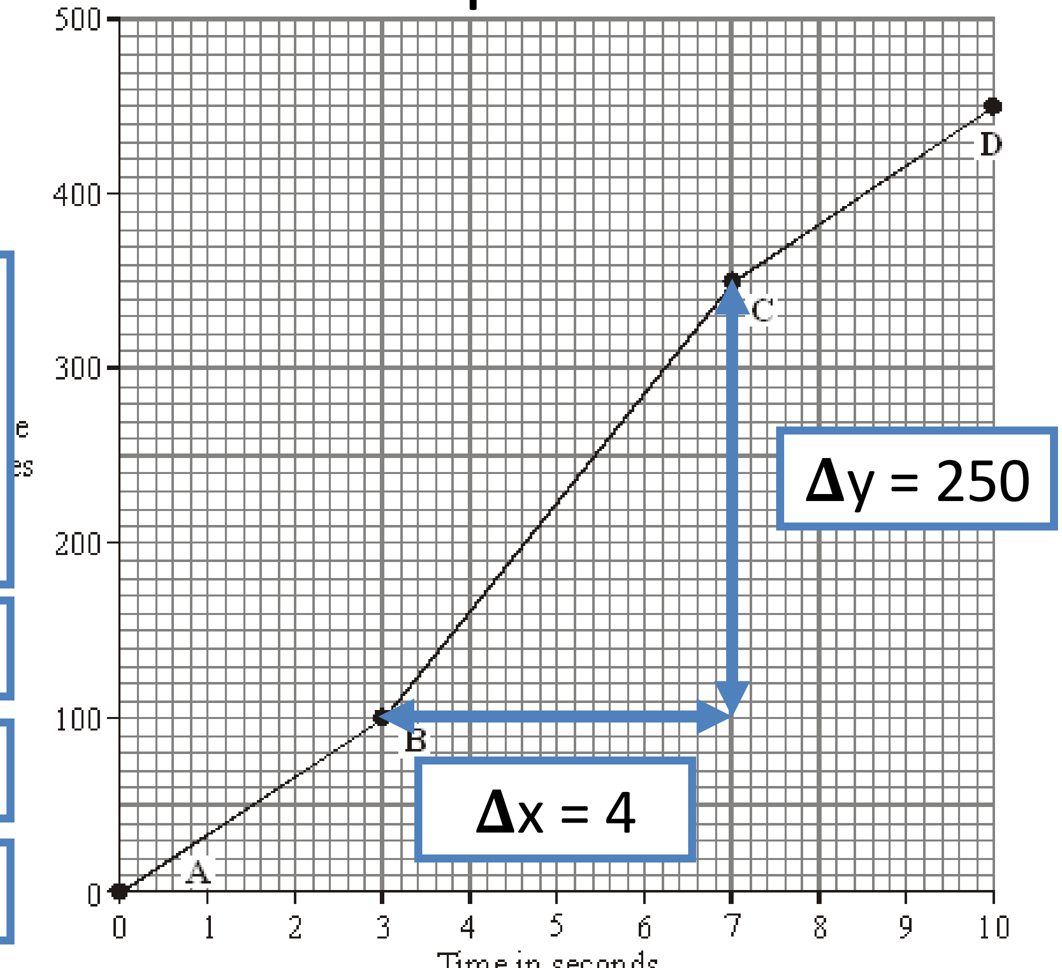
How could you determine speed between B and C?

To find the speed between points B and C you need to find the gradient of the line.

Gradient = **Δ**y / **Δ**x

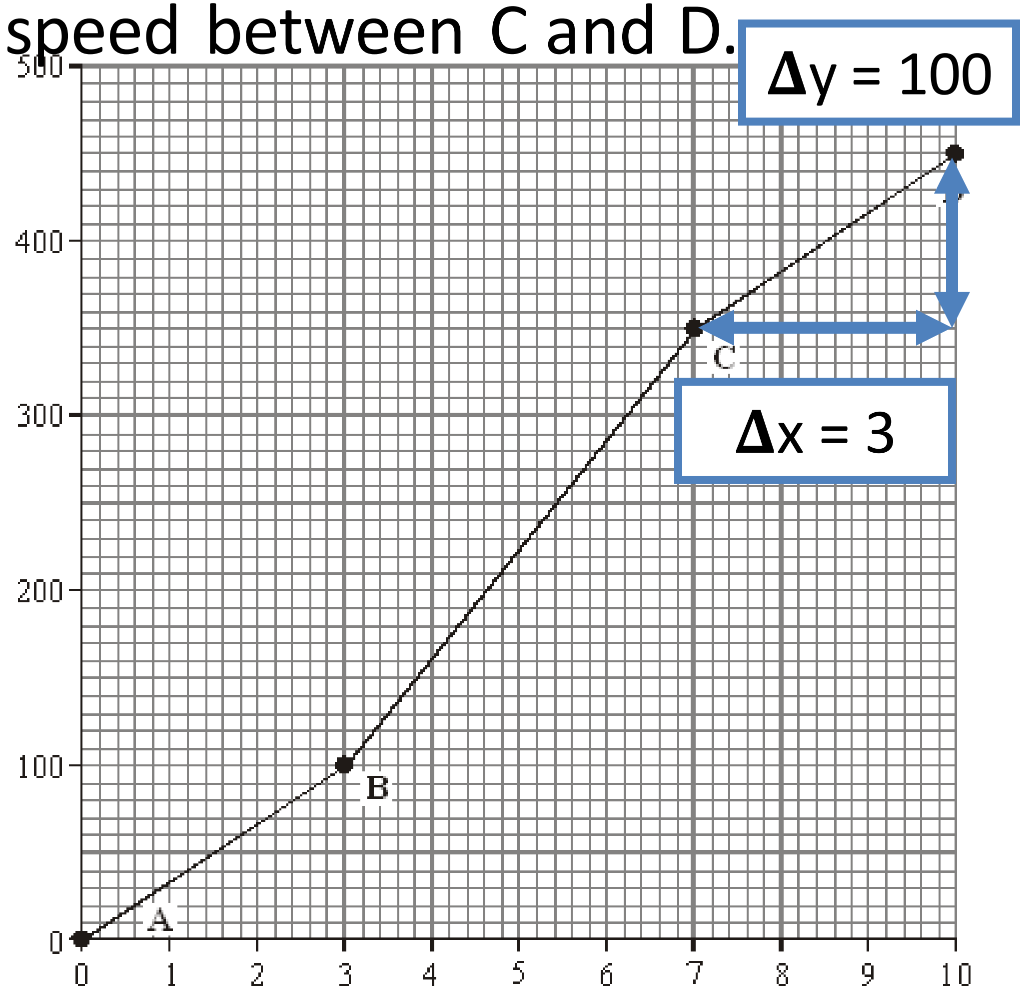
Gradient = 250 / 4

Gradient = 62.5m/s



5.6.1.4 Distance-Time Relationship

Task Determine the speed between C and D.



To find the speed between points C and D you need to find the gradient of the line.

Gradient = **Δ**y / **Δ**x

Gradient = 100 / 3

Gradient = 33.3m/s

6.5.4.1.4 The distance–time relationship

Content
If an object moves along a straight line, the distance travelled can be represented by a distance–time graph. The speed of an object can be calculated from the gradient of its distance–time graph. (HT only) If an object is accelerating, its speed at any particular time can be determined by drawing a tangent and measuring the gradient of the distance–time graph at that time. Students should be able to draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs, translating information between graphical and numerical form. Students should be able to determine speed from a distance–time graph.

5.6.1.5 Acceleration

Think

Pair

Share

How can acceleration be determined?

Metres per second
m/s

Acceleration = Change in Velocity / Time

$$a = \Delta v / t$$

Metres per second squared
m/s^2

Time
s

An object that is slowing down is **decelerating**.

5.6.1.5 Acceleration

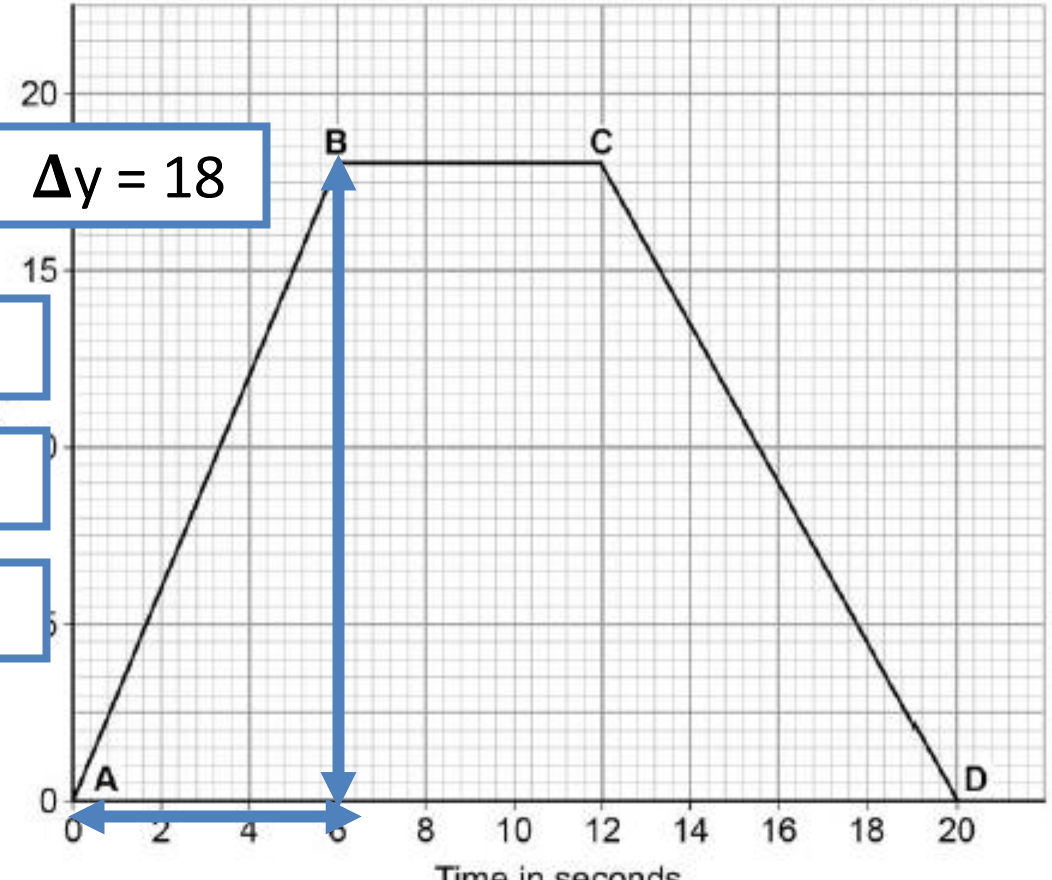
The acceleration of an object can also be calculated from the gradient of a velocity-time graph.

Between A and B

Gradient = Δy / Δx

Gradient = 18 / 6

Gradient = 3m/s^2



Δy = 18

Δx = 6

6.5.4.1.5 Acceleration

Content

The average acceleration of an object can be calculated using the equation:

$$acceleration = \frac{change\ in\ velocity}{time\ taken}$$

$$\left[\ a = \frac{\Delta v}{t}\ \right]$$

acceleration, a, in metres per second squared, m/s^2

change in velocity, Δv, in metres per second, m/s

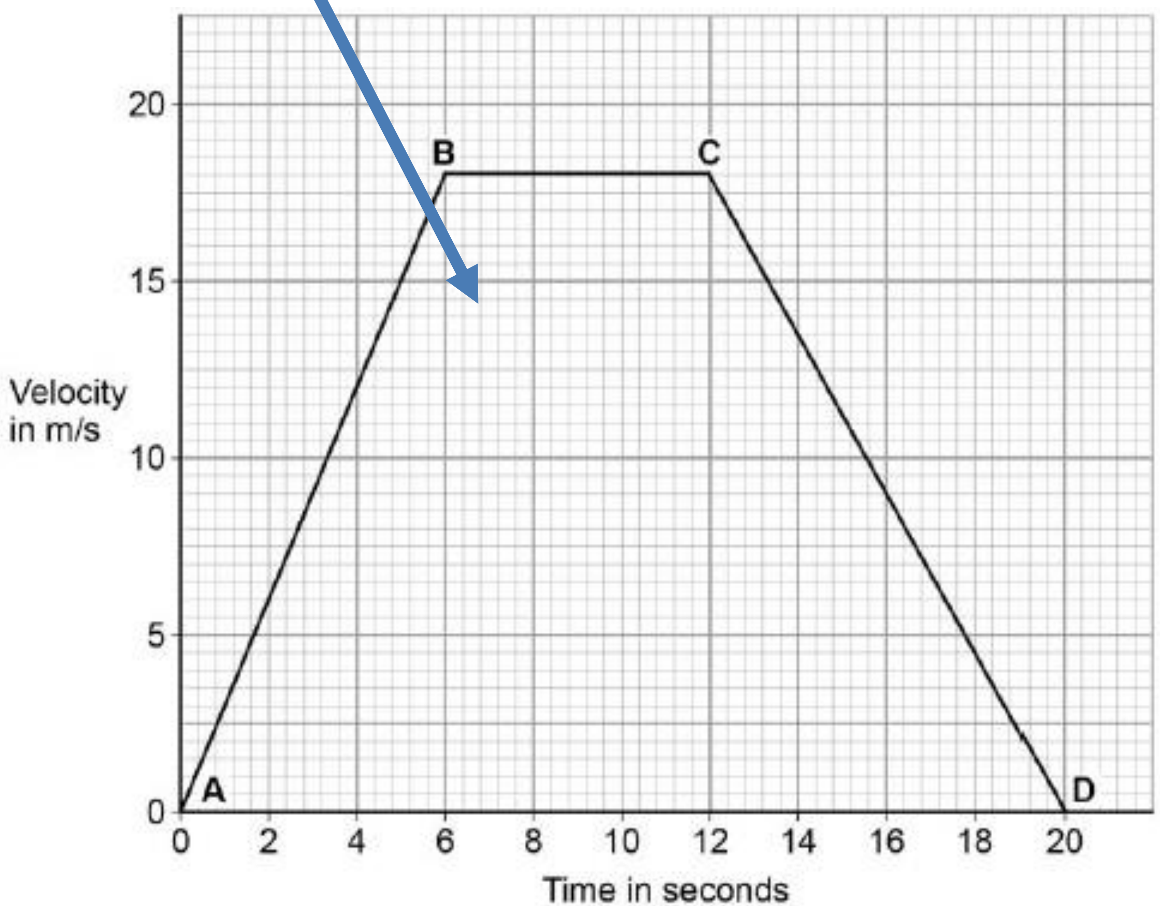
time, t, in seconds, s

An object that slows down is decelerating.

Students should be able to estimate the magnitude of everyday accelerations.

5.6.1.5 Acceleration

You can find the distance that an object moved by finding the area under the velocity-time graph.



Higher and triple

5.6.1.5 Acceleration

Think

Pair

Share

What is uniform acceleration?

Metres per second

m/s

Metres per second squared

m/s^2

(Final Velocity)^2 – (Initial Velocity)^2 = 2 x Acceleration x Distance

$$v^2 - u^2 = 2 \times a \times s$$

Metres m

Key Term	Definition
Uniform Acceleration	

Try this

(b) A small aircraft accelerated down a runway at 4.0 m/s^2

The aircraft started from rest and reached a speed of 34 m/s just before take-off.

Calculate the distance the aircraft travelled while accelerating.

Give your answer to 2 significant figures.

$$v^2 - u^2 = 2as$$

If you aren't given U (starting velocity) somewhere in the question, it must be 0

$34^2 - 0^2 = 2 \times 4 \times s$

Distance = ______ m

$1156 - 0 = 2 \times 4 \times s$

$1156 = 2 \times 4 \times s$

$1156 = 8 \times s$

$S = 1156 \div 8 = 144.5$ 140 to 2 sig figs

(HT only) The distance travelled by an object (or displacement of an object) can be calculated from the area under a velocity–time graph. Students should be able to:	
• draw velocity–time graphs from measurements and interpret lines and slopes to determine acceleration • (HT only) interpret enclosed areas in velocity–time graphs to determine distance travelled (or displacement)	W
• (HT only) measure, when appropriate, the area under a velocity–time graph by counting squares.	W
The following equation applies to uniform acceleration: $(final\ velocity)^2 - (initial\ velocity)^2 = 2 \times acceleration \times distance$ $[\ v^2 - u^2 = 2\ a\ s\ ]$ final velocity, *v*, in metres per second, m/s initial velocity, *u*, in metres per second, m/s acceleration, *a*, in metres per second squared, m/s^2	M S a gi e

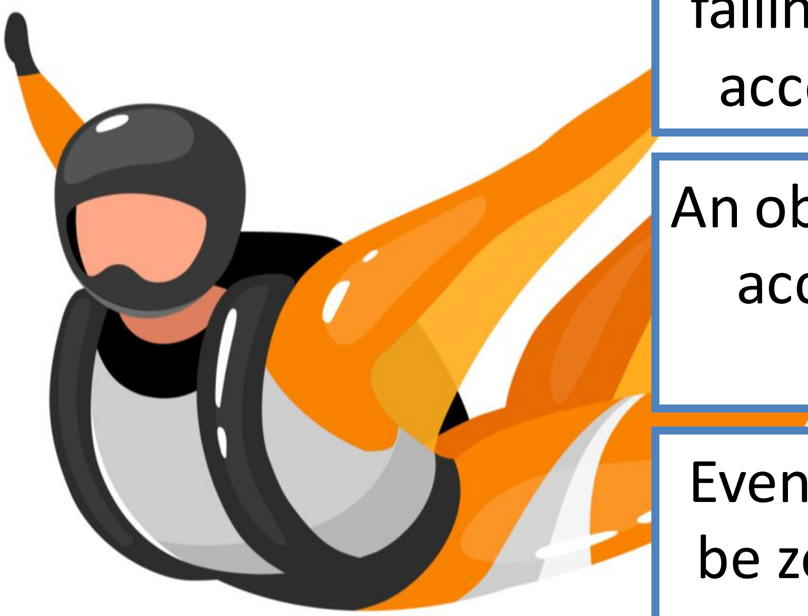
5.6.1.5 Acceleration

Think

Pair

Share

What is acceleration when an object falls under gravity?



Near the Earth's surface any object falling freely under gravity has an acceleration of around $9.8 m/s^2$

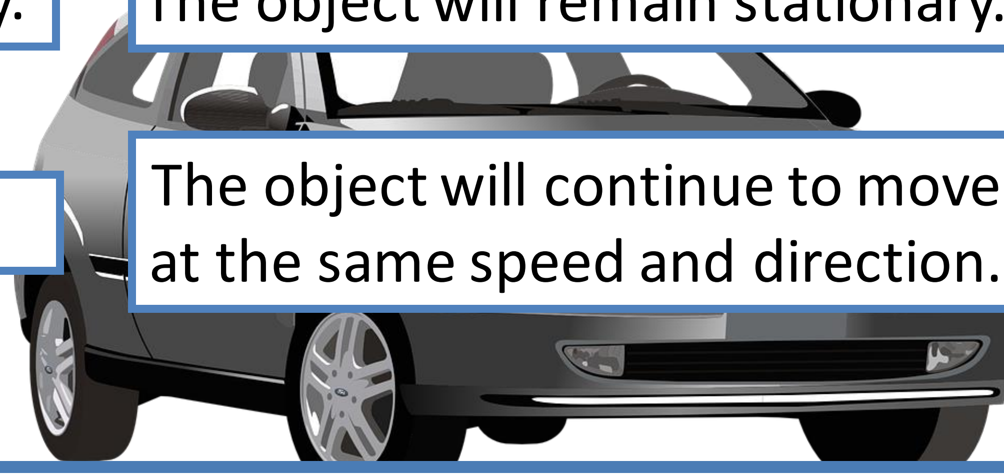
An object falling though a fluid will accelerate due to the force of gravity.

Eventually the resultant force will be zero and the object will move at its terminal velocity.

Content
An object falling through a fluid initially accelerates due to the force of gravity. Eventually the resultant force will be zero and the object will move at its terminal velocity.

5.6.2.1 Newtons 1st Law

If the resultant force acting on an object is zero and:



The object is stationary. → The object will remain stationary.

The object is moving. → The object will continue to move at the same speed and direction.

When a vehicle travels at a steady speed the resistive forces balance the driving force.

So, the velocity (speed and/or direction) of an object will only change if a resultant force is acting on the object.

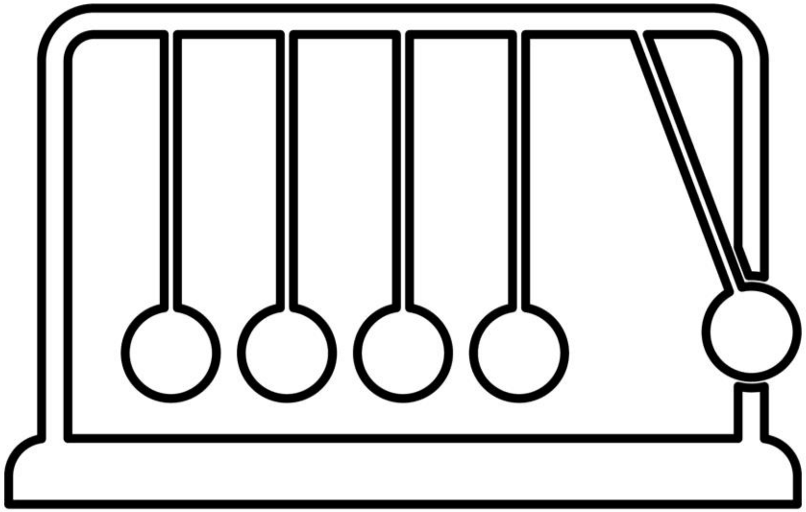
5.6.2.1 Newtons 1st Law

Think

Pair

Share

What is inertia?



Key Term	Definition
Inertia	

6.5.4.2.1 Newton's First Law

Content

Newton's First Law:

If the resultant force acting on an object is zero and:

- the object is stationary, the object remains stationary
- the object is moving, the object continues to move at the same speed and in the same direction. So the object continues to move at the same velocity.

So, when a vehicle travels at a steady speed the resistive forces balance the driving force.

So, the velocity (speed and/or direction) of an object will only change if a resultant force is acting on the object.

Students should be able to apply Newton's First Law to explain the motion of objects moving with a uniform velocity and objects where the speed and/or direction changes.

(HT only) The tendency of objects to continue in their state of rest or of uniform motion is called inertia.

5.6.2.2 Newtons 2nd Law

Think
Pair
Share

What is Newtons 2nd Law?

Kilograms
kg

Resultant Force = Mass x Acceleration

$$F = m \times a$$

Newtons
N

Metres per second squared
m/s^2

Key Term	Definition
Newtons Second Law	

5.6.2.2 Newtons 2nd Law

Think

Pair

Share

What is Newtons 2nd Law?

~

Symbol for an approximate value or answer.

5.6.2.2 Newtons 2nd Law

Think

Pair

Share

What is inertial mass?

Key Term	Definition
Inertial Mass	

6.5.4.2.2 Newton's Second Law

Content
Newton's Second Law:
The acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object. As an equation:

Content
$resultant\ force = mass \times acceleration$ $F = m\,a$ force, *F*, in newtons, N mass, *m*, in kilograms, kg acceleration, *a*, in metres per second squared, m/s^2
(HT only) Students should be able to explain that: • inertial mass is a measure of how difficult it is to change the velocity of an object • inertial mass is defined as the ratio of force over acceleration.
Students should be able to estimate the speed, accelerations and forces involved in large accelerations for everyday road transport. Students should recognise and be able to use the symbol that indicates an approximate value or approximate answer, ~

Physics Paper 2 Revision

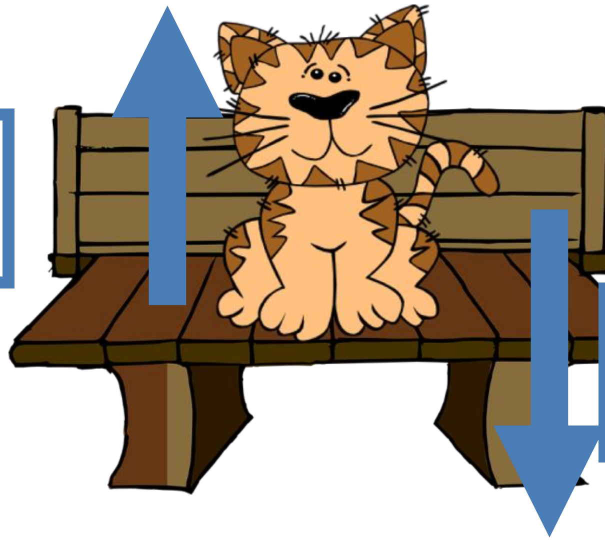
5.6.2.3 Newtons 3rd Law

Think
Pair
Share

What is Newtons 3rd Law?

These forces are equal in size and opposite in direction.

The cat pulls the Earth up



The Earth pulls the cat down.

Key Term	Definition
Newtons Third Law	

6.5.4.2.3 Newton's Third Law

Content
Newton's Third Law:
Whenever two objects interact, the forces they exert on each other are equal and opposite. Students should be able to apply Newton's Third Law to examples of equilibrium situations.

Physic

5.6.3.1 Stopping Distance

Think

Pair

Share

What is stopping distance?

For a given braking force the greater the speed of the vehicle, the greater the stopping distance.

Key Term	Definition
Stopping Distance	
Thinking Distance	
Braking Distance	

6.5.4.3.1 Stopping distance

Content
The stopping distance of a vehicle is the sum of the distance the vehicle travels during the driver's reaction time (thinking distance) and the distance it travels under the braking force (braking distance). For a given braking force the greater the speed of the vehicle, the greater the stopping distance.

Physics Pa

5.6.3.2 Reaction Time

Reaction times can vary from person to person.

Typical values range from 0.2 to 0.9s

A drivers reaction time can be affected by:

6.5.4.3.2 Reaction time

Content
Reaction times vary from person to person. Typical values range from 0.2 s to 0.9 s. A driver's reaction time can be affected by tiredness, drugs and alcohol. Distractions may also affect a driver's ability to react. Students should be able to: • explain methods used to measure human reaction times and recall typical results
• interpret and evaluate measurements from simple methods to measure the different reaction times of students
• evaluate the effect of various factors on thinking distance based on given data.

5.6.3.3 Factors Affecting Braking

The braking distance of a vehicle can be affected by:

Adverse road and weather conditions

e.g. wet of icy conditions

Poor condition of the vehicle.

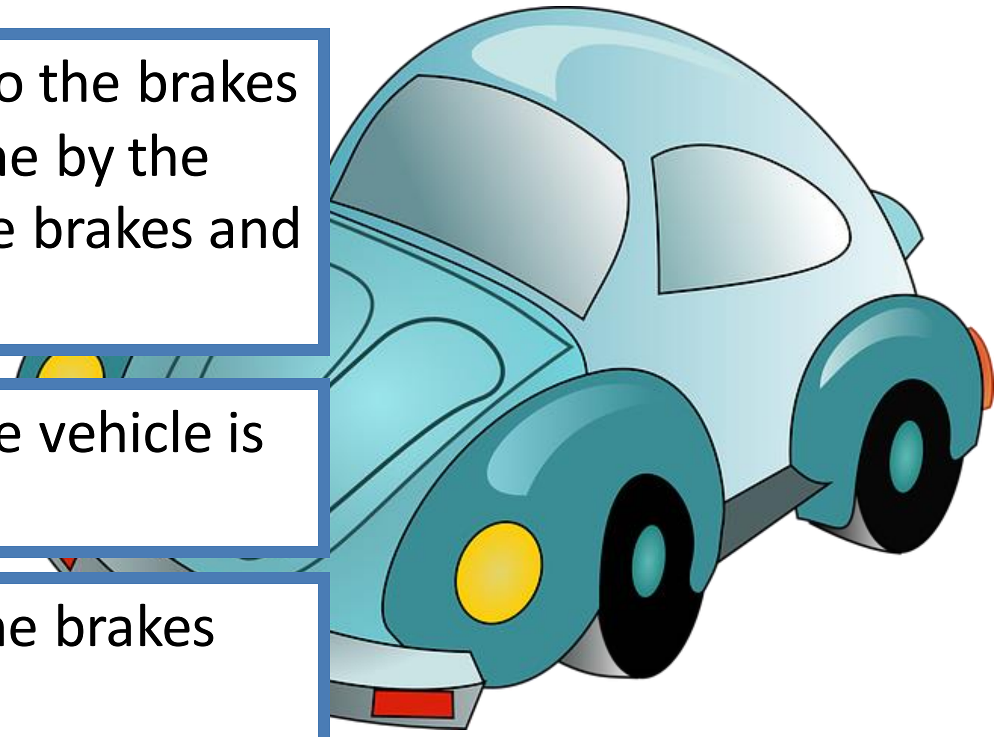
e.g. worn tyres or brakes

5.6.3.4 Factors Affecting Braking

When a force is applied to the brakes of a vehicle, work done by the friction force between the brakes and the wheel.

The kinetic energy of the vehicle is reduced.

The temperature of the brakes increases.

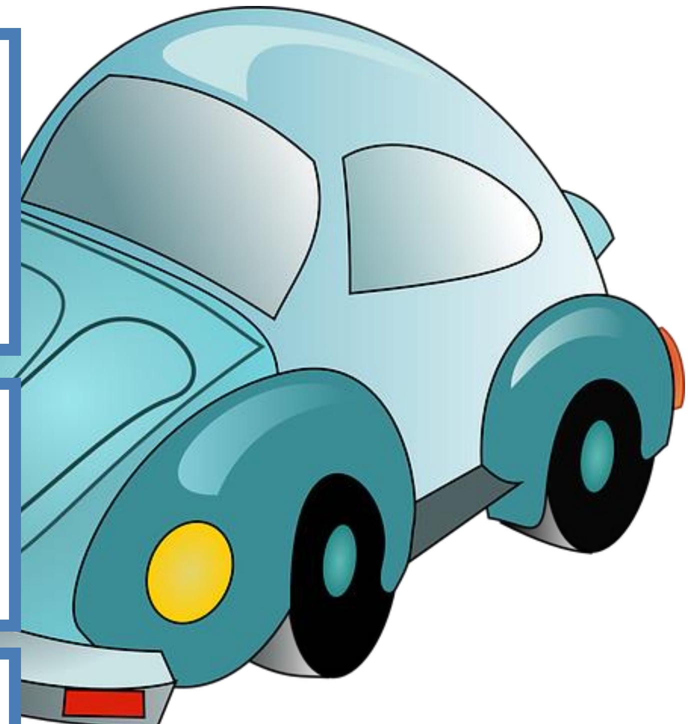


5.6.3.4 Factors Affecting Braking

The greater the speed of a vehicle the greater the braking force needed to stop the vehicle in a certain distance.

The greater the braking force the greater the deceleration of the vehicle.

Large decelerations may lead to brakes overheating and/or loss of control.



6.5.4.3.3 Factors affecting braking distance 1

Content
The braking distance of a vehicle can be affected by adverse road and weather conditions and poor condition of the vehicle. Adverse road conditions include wet or icy conditions. Poor condition of the vehicle is limited to the vehicle's brakes or tyres. Students should be able to: • explain the factors which affect the distance required for road transport vehicles to come to rest in emergencies, and the implications for safety

6.5.4.3.4 Factors affecting braking distance 2

Content
When a force is applied to the brakes of a vehicle, work done by the friction force between the brakes and the wheel reduces the kinetic energy of the vehicle and the temperature of the brakes increases. The greater the speed of a vehicle the greater the braking force needed to stop the vehicle in a certain distance. The greater the braking force the greater the deceleration of the vehicle. Large decelerations may lead to brakes overheating and/or loss of control. Students should be able to:
• explain the dangers caused by large decelerations
• (HT only) estimate the forces involved in the deceleration of road vehicles in typical situations on a public road.

Physics Paper 2 Revision

5.7.1 Momentum of Moving Objects

Think
Pair
Share

What is the equation that you would use to calculate momentum?

Kilograms
kg

Momentum = Mass x Velocity

$$\rho = m \times v$$

Kilograms metres per second
Kgm/s

Metres per second
m/s

Key Term	Definition
Momentum	

Higher/triple

5.7.1 Momentum of Moving Objects

A toy has a mass of 150g and moves forward with a velocity of 0.08 m/s. Calculate its momentum. (3)

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Substitute before you do any rearranging or calculations 1 mark for doing this.

Answer to 2 s.f which is the same as the values in the qu.

Higher/triple

6.5.5 Momentum (HT only)

6.5.5.1 Momentum is a property of moving objects

Content
Momentum is defined by the equation:
$momentum = mass \times velocity$
$p = m\ v$
momentum, *p*, in kilograms metre per second, kg m/s
mass, *m*, in kilograms, kg
velocity, *v*, in metres per second, m/s

5.7.2 Conservation of Momentum

Think
Pair
Share

What happens to momentum in the event of a collision?

For example, if 2 cars with equal momentum were travelling in opposite directions overall momentum would be 0kgm/s.

If the two cars were to collide they would both come to a stop. Momentum would still be 0.

Key Term	Definition
Conservation of Momentum	

Higher/triple

5.7.2 Conservation of Momentum

Think
Pair
Share

What would happen when a standing ice skater throws a bag forwards.

Momentum before bag is thrown is 0.

Momentum after the bag is thrown must also be 0 due to conservation of momentum.

The skater will have equal momentum in the opposite direction.

The bag will now have forward momentum.

The skater will move backwards.

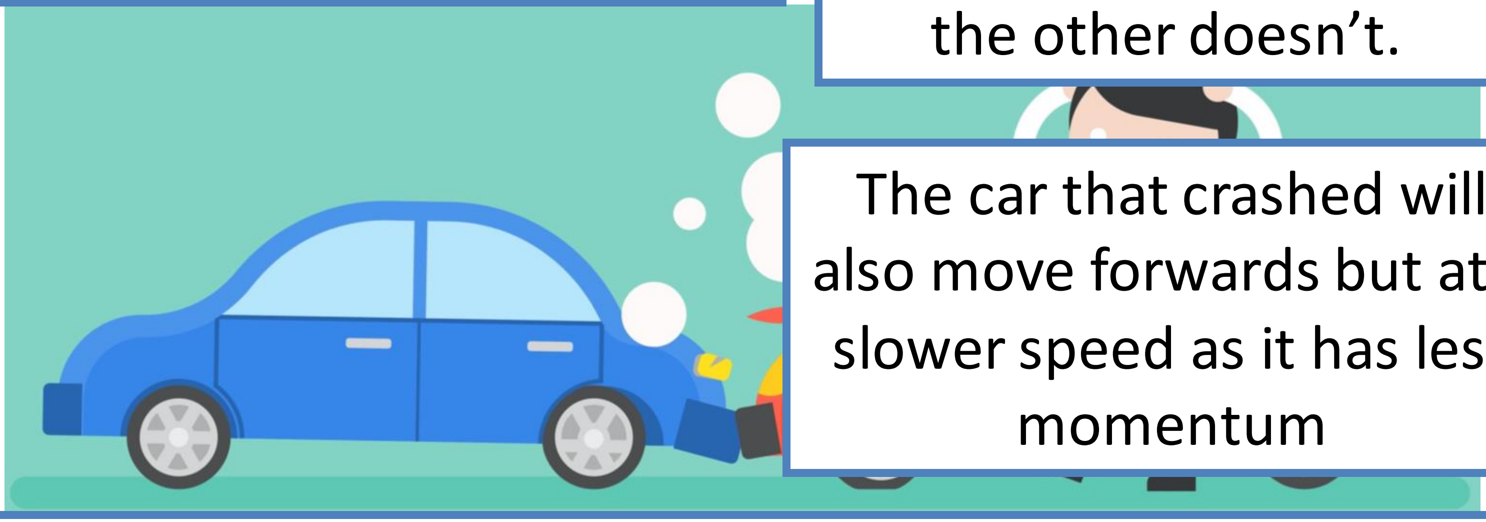
Higher/triple

5.7.2 Conservation of Momentum

Predict what would happen if a car crashes into the back of a stationary car.

The stationary car will move forwards after the collision

Before the collision one car has momentum and the other doesn't.



The car that crashed will also move forwards but at a slower speed as it has less momentum

Momentum before the collision is the same after the collision due to the conservation of momentum.

Higher/triple

6.5.5.2 Conservation of momentum

Content
In a closed system, the total momentum before an event is equal to the total momentum after the event. This is called conservation of momentum. Students should be able to use the concept of momentum as a model to describe and explain examples of momentum in an event, such as a collision.

Phys

5.7.3 Changes in Momentum

Think

Pair

Share

When does a change in momentum occur?

A change in momentum occurs when a force acts on an object that is moving/able to move.

Kilogram metres per second
kgm/s

Seconds
s

Force = Change in Momentum / Change in Time

$$F = m\Delta v / \Delta t$$

Newtons
N

Triple

5.7.3 Changes in Momentum

A cricket ball has a change in momentum of 9.6kgm/s over 1ms when struck by a bat. Calculate the Force.

Convert Units	
Write down the formula.	
Substitute Values	
Do the Maths	
Round and add units.	

Usually 1 mark for this.

Substitute before you do any rearranging or calculations 1 mark for doing this.

Answer to 2 s.f which is the same as the values in the qu.

Triple

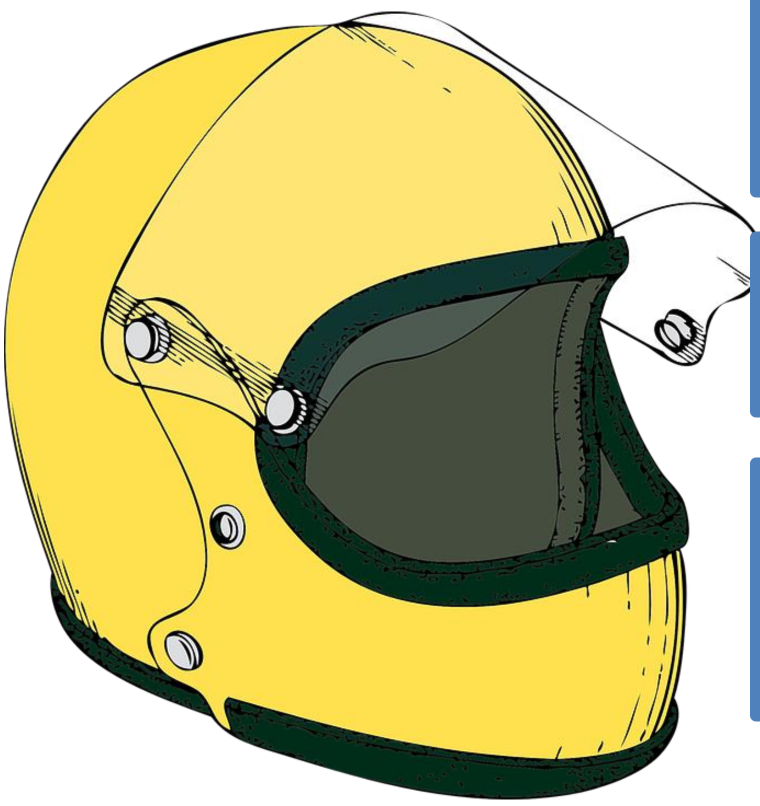
5.7.3 Changes in Momentum

Think

Pair

Share

How do safety features such as crash helmets work?



The helmet has a lining which is designed to crush in the event of an impact.

This increases the time taken for the head's momentum to reach 0.

Therefore, it reduces the forces acting on the head and so prevents injury.

Triple

Physics Paper 2 Revision

5.7.3 Changes in Momentum

Think
Pair
Share

What about some other safety features?

Airbags.

Seat belts

Gym mats.

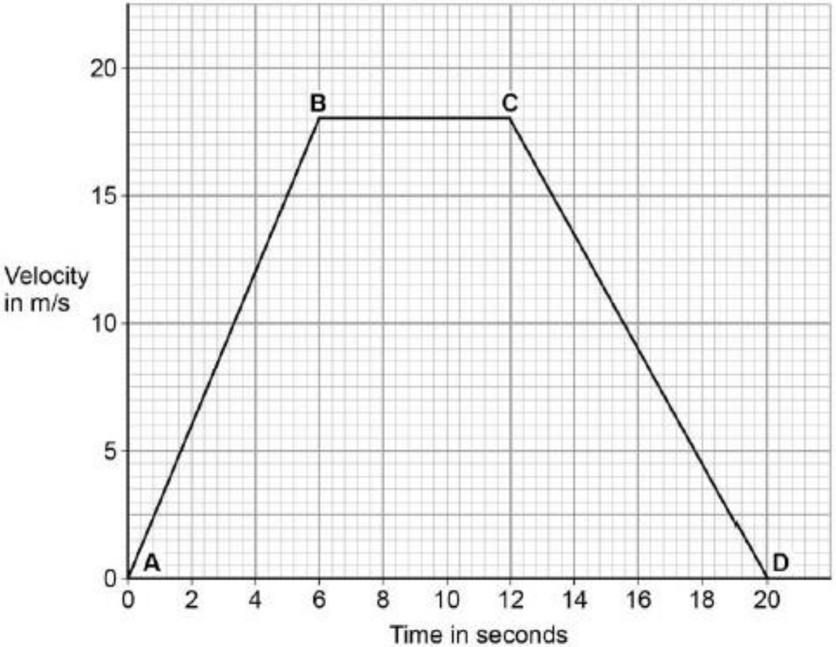
Playground floor

They all increase the time it takes for momentum to reach 0.

Which reduces the forces acting on the person.

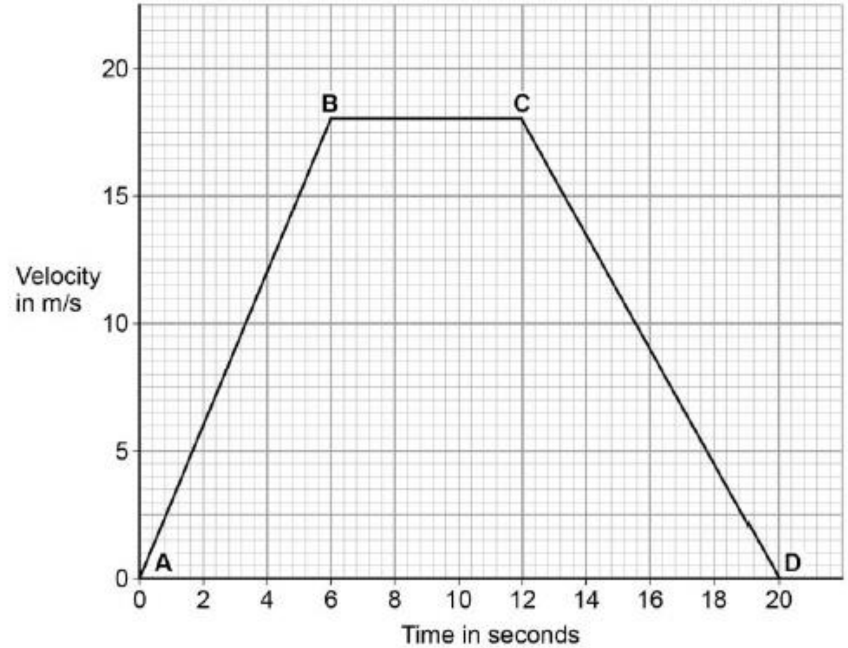
This reduces injuries.

Triple



Velocity in m/s
0
5
10
15
20
A
B
C
D
0 2 4 6 8 10 12 14 16 18 20
Time in seconds

per



Velocity in m/s
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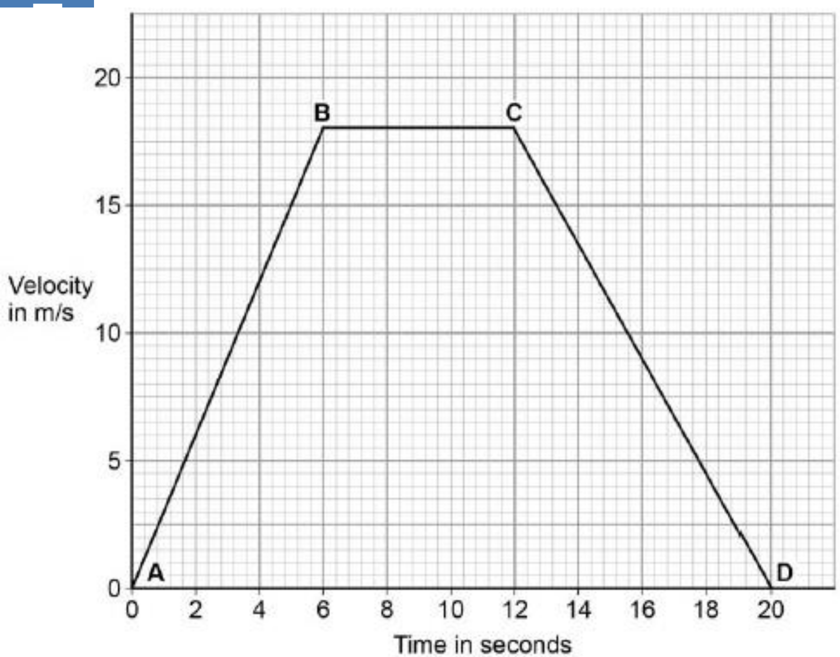
5
10
15
20
A
B
C
D
0 2 4 6 8 10 12 14 16 18 20
Time in seconds



Velocity in m/s
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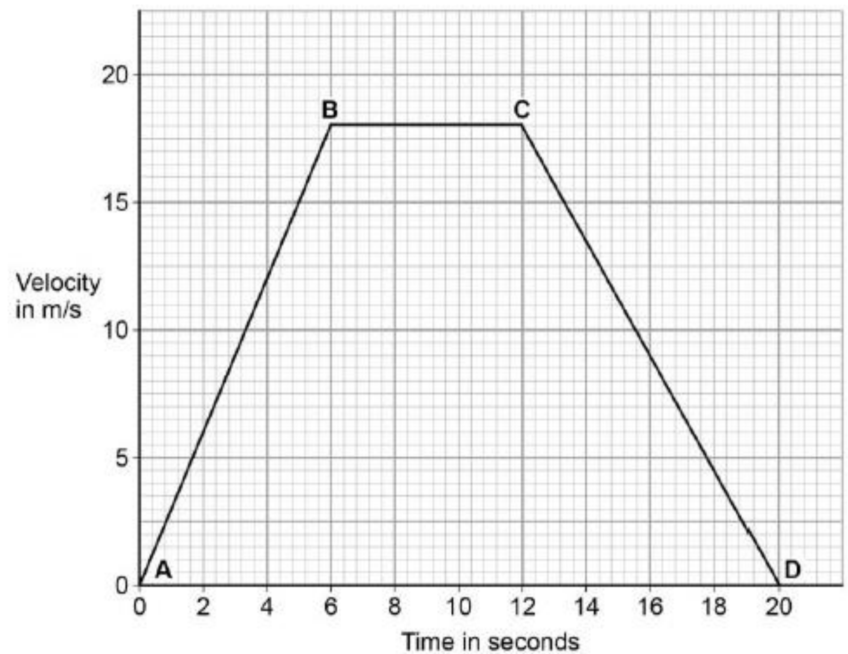
10
15
20
A
B
C
D
0 2 4 6 8 10 12 14 16 18 20
Time in seconds



Velocity in m/s
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5
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C
D
0 2 4 6 8 10 12 14 16 18 20
Time in seconds