Chestnut Grove Academy

Physics

5. Forces

Revisiting Booklet

Name:

Forces

1) Scalars and vectors
2) Contact and Non-contact forces
3) Gravity
4) Resultant forces
5) Work done and energy transfer
6) Forces and Elasticity
7) Moments levers and gears
8) Pressure in a fluid
9) Atmospheric pressure
10) Distance and displacement
11) Speed
12) Velocity
13) Distance-time relationship
14) Acceleration
15) Newtons first law
16) Newtons second law
17) Required practical – Newtons second law
18) Newtons third law
19) Stopping distances
20) Reaction time
21) Factors affecting breaking distance
22) Momentum

Scalars and vectors

A scaler is a physical quantity with _____

Examples of scalers:

-
-
-
-
-

A vector is a physical quantity with _____ and _____

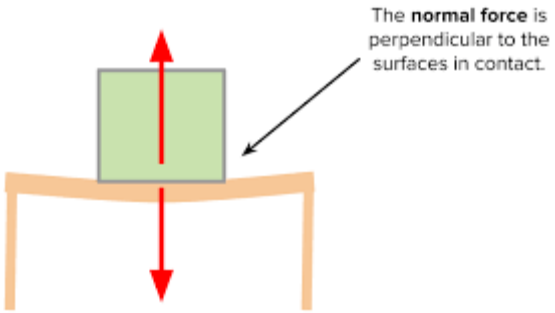
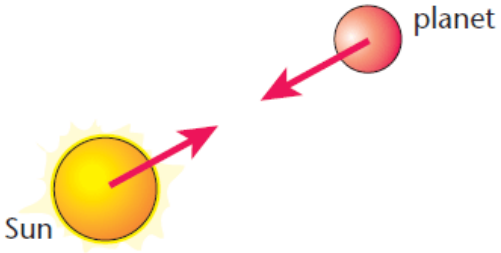
Examples of vectors:

-
-
-
-
-
-

What does the length of the arrow represent?

Contact and Non-contact forces

A force is a _____ or _____ that acts on an object due to the interaction with another object. All forces between objects are either:

contact forces	non-contact forces
Examples: 	Examples: 

Weight is the force acting on an object due to _____, so depends on the _____, which varies it is a lot less on the moon (0.6N/Kg) compared to Earth (10N/Kg). Weight is measured from an objects _____ _____

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

Word equation:
Symbol equation:
Units:

(c) An object has a weight of 6.4 N.

Calculate the mass of the object.

Use the equation

mass = weight ÷ gravitational field strength (g)

gravitational field strength = 9.8 N / kg

_____

_____

Mass = _____ kg

(1)

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

The weight of an object and the mass of an object are _____ _____

What is the resultant force?

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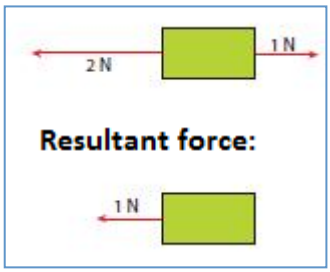


Forces are show by arrows. The longer the arrow, the greater the force.

Resultant force is the overall force; 2N -1N = 1N

How might a resultant force change an object?

.....

If the resultant force acting on a stationary object is _____ _____

If the resultant force acting on a moving object is:

Zero, then

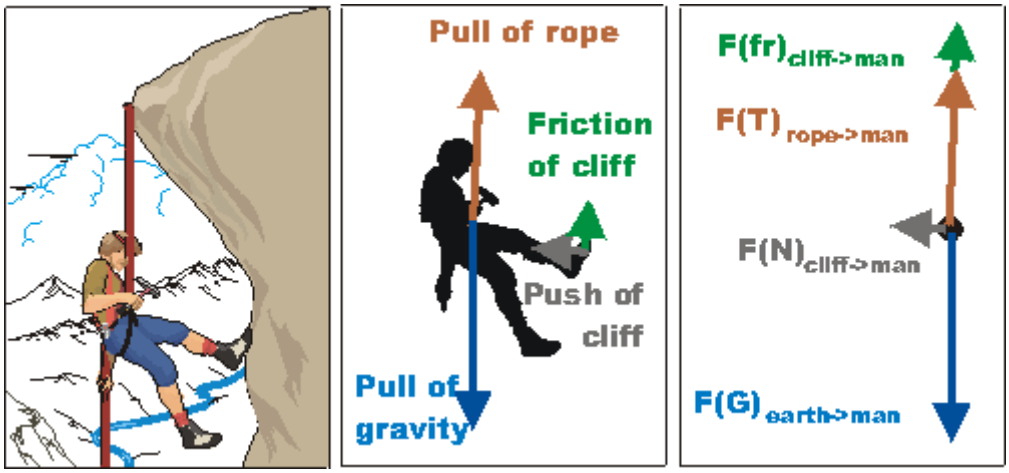
.....

Not zero, then

.....

Higher Tier:

A free body diagram can be used to show the forces acting on a person running or climbing



A scale diagram can be used to find the resultant force

Eg Draw a scale diagram to show that the resultant force on the man is 5N to the left.

F(fr) is 180N, F(T) = 520N and F(N) = 5N. The man's weight is 70Kg

(b) A fisherman pulls a boat towards land.

The forces acting on the boat are shown in **Diagram 1**.

The fisherman exerts a force of 300 N on the boat.
The sea exerts a resistive force of 250 N on the boat.

Diagram 1

(i) Describe the motion of the boat.

_____

_____

_____

_____

(2)

ipart 2)What is the resultant force?_____ (1)

Work done and energy transfer

Name the ten different types of energy:

What is work done?

.....

Work done against the frictional forces acting on an object causes a rise in the

_____ ____ of the object.

The work done by a force on an object can be calculated using the equation:

Word equation:

Symbol equation:

Units:

1 newton metre = 1 joule

What is the work done when Nazma moves an object 15cm by a force of 50N?

.....

..... units .....

What is the energy transfer occurred?

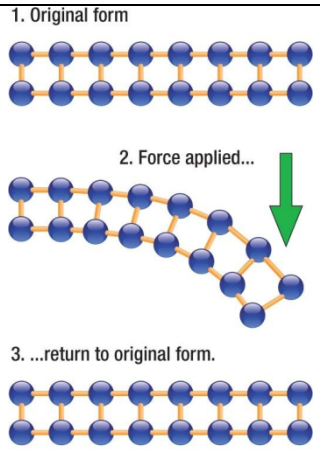
.....

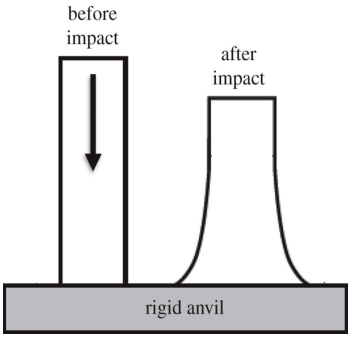
Forces and elasticity

When a force such as _____ ____, ____ _____ or _____ _____ is applied on an object it may stretch, compress or bend. To change its shape in this way more than one force must be applied in different directions otherwise it would simply _____

_____

Elastic deformation _____ _____	Inelastic deformation _____





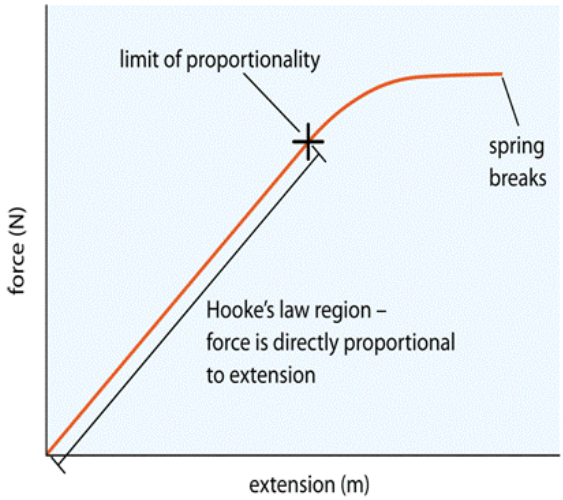
Force of an extension can be calculated using the equation:

Word equation: Symbol equation: Units:

A 12N force is used to compress a spring with a spring constant of 96 N/kg. Calculate the compression of the spring.

.....

..... units .....



What does this graph show?

.....

.....

What type of energy is stored by a spring when it is stretched? .....

What does this graph show?

.....

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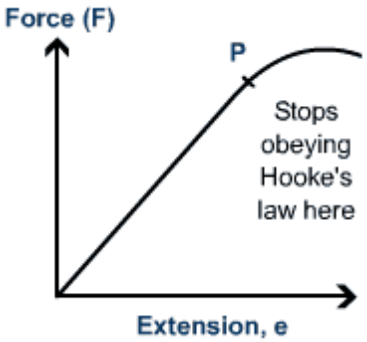
.....



What therefore is the relationship between work done & elastic potential energy stored?

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Calculate work done in stretching (or compressing) a spring (up to the limit of proportionality) using the equation:

Word equation: Symbol equation: Units:

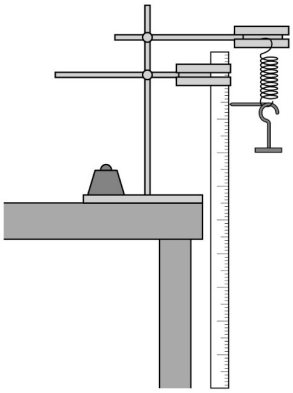
A spring has a constant of 1.2 N/m. Assuming that spring deforms elastically, calculate the total energy transferred to its elastic potential energy store when extended by 0.20m

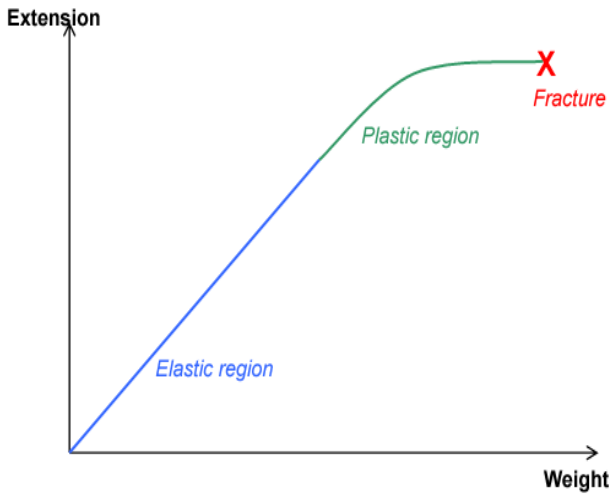
.....

..... units .....

Required practical activity 18: investigate the relationship between force and extension for a spring

Method:





How can the spring constant be calculated?

Hooke's law

- As the force on the spring is increased the extension of the spring _____ _____
- The extension is _____ _____ to the force added (as the force is _____, the extension is _____) up until a certain point 'the elastic limit'
- When further force is applied to the spring it continues to extend but it does not extend in _____. The spring will no longer _____

Forces and motion

Distance is _____ _____. Distance does not involve direction. Distance is a _____ ____ quantity.

Displacement is _____ _____ and _____ _____. Displacement is a _____ _____quantity.

Speed is _____ _____. Speed is a _____ _____ quantity. Speed is constantly changing due to a number of factors, such as a person's speed of walking is influenced by _____, _____, _____ and _____

Typical values of speed include:
walking ~_____
running ~_____
cycling ~_____
Car~_____
Train ~_____
Plane ~_____

You need to know these values approximately.

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.

For an object moving at constant speed the distance travelled in a specific time can be calculated using the equation:

Word equation:

Symbol equation:

Units:

A cat is walking at the speed of 0.4m/s. Calculate how far the cat walks in 50 s and how long it takes to walk 32m. How does this speed compare to a human?

.....

..... units .....

.....

..... units .....

.....

For an object moving at a varying speed you can calculate its average speed using the same equation: s=vt. You will need to add up the distance and time for each part to do this.

A lorry moves at a steady speed and travels 24m in 30s. The lorry than slows down and travels a further 45m in 70s before stopping, Calculate the average speed of the lorry for the whole time that it's moving

.....

.....

..... units .....

The velocity of an object is _____ _____.

Velocity is a _____ _____ quantity. E.g. 0.69m/s north.

The London Eye is one of the largest observation wheels in the world.

© Angelo

Ferraris/Shutterstock

The passengers ride in capsules. Each capsule moves in a circular path and accelerates.

(a) Explain how the wheel can move at a steady speed and the capsules accelerate at the same time.

_____

_____

_____

(2)

(b) In which direction is the resultant force on each capsule?

_____

(1)

(c) The designers of the London Eye had to consider **three** factors which affect the resultant force described in part (b).

Two factors that increase the resultant force are:

- an increase in the speed of rotation
- an increase in the total mass of the wheel, the capsules and the passengers.

Name the other factor that affects the resultant force and state what effect it has on the resultant force.

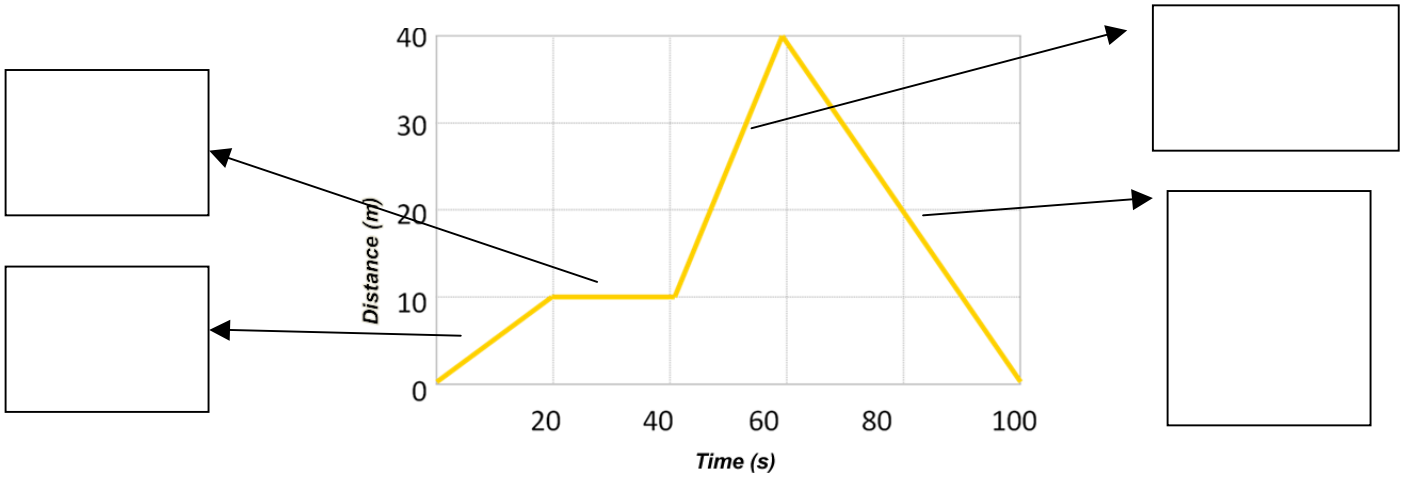
_____

_____

(1)

If an object moves along a straight line, the distance travelled can be represented by a distance–time graph.

Annotate this distance-time graph of a Mohammed walking to work and back again.



The speed of an object can be calculated from the gradient of its distance–time graph.

Calculate the speed of Mohamed walking to work in its first 20 seconds:

.....

..... units .....

Calculate the speed Mohamed walking home from work

.....

..... units .....

Acceleration is when an object is _____

Deceleration is when an object is _____

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

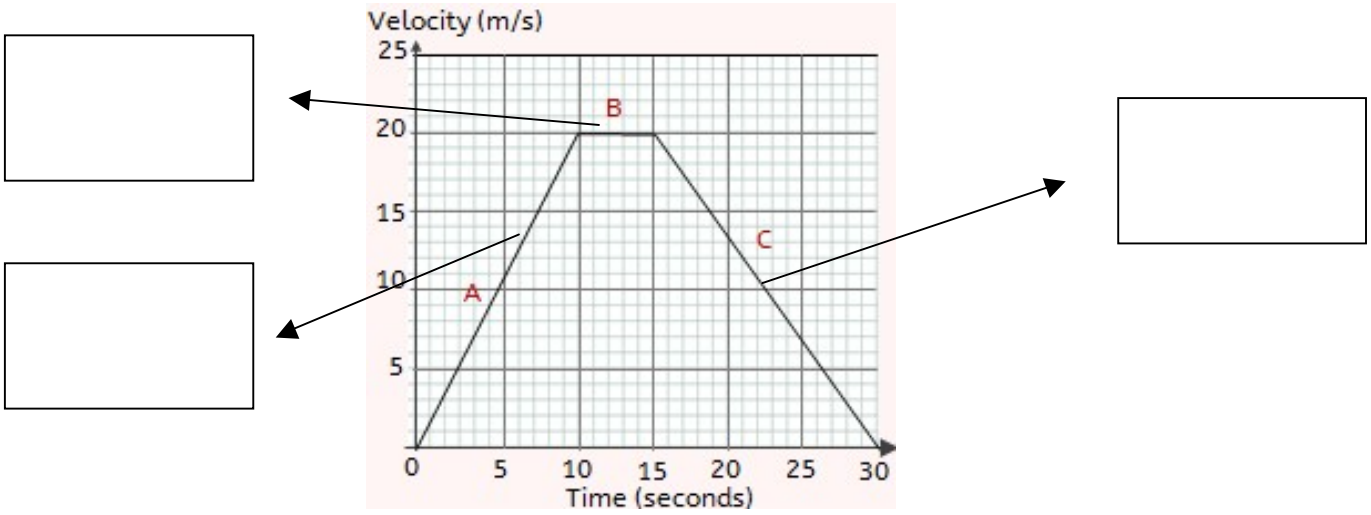
The average acceleration of an object can be calculated using the equation:

Word equation:

Symbol equation:

Units:

Annotate the velocity time graph:



Calculate the acceleration of William's bus during the first 10 second of his journey

.....

..... units .....

(HT) Calculate the total distance travelled by the bus?.....

.....

Estimating accelerations can be worked out from objects typical speed and suggesting a typical time it would take to stop.

A car comes to a stop when it collides with a tree. Estimate the deceleration of the car.

.....

..... units .....

Uniform acceleration is where _____ _____

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

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 _____ _____.

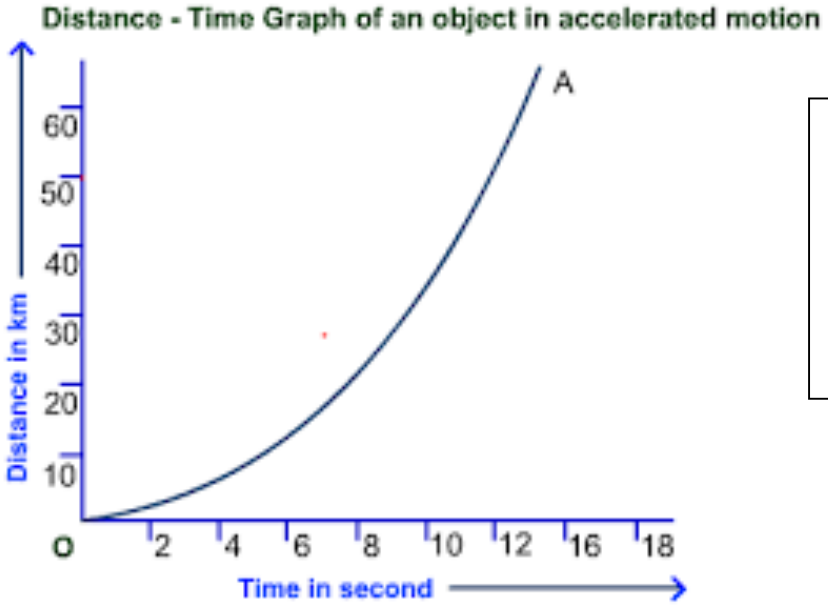
The following equation applies to uniform acceleration:

Word equation: Symbol equation: Units:

A ball has been dropped from the top of a building. The velocity of the ball when it is 2.25 m from the ground is 6 m/s. Near the Earth's surface any object falling freely under gravity has an acceleration of about 9.8 m/s^2.
Calculate the velocity of the ball when it reaches the ground. You can assume there is no air resistance.

.....

..... units .....



(HT only) This graph shows an object accelerating,
Calculate its speed at 10 seconds by drawing a tangent to the curve and measuring the gradient of the distance–time graph at that point.

Forces, accelerations and Newton's Laws of motion

Newton's First Law:

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

• The object is stationary, then the object remains _____

• The object is moving, the object _____

The velocity (speed and/or direction) of an object will only change if _____

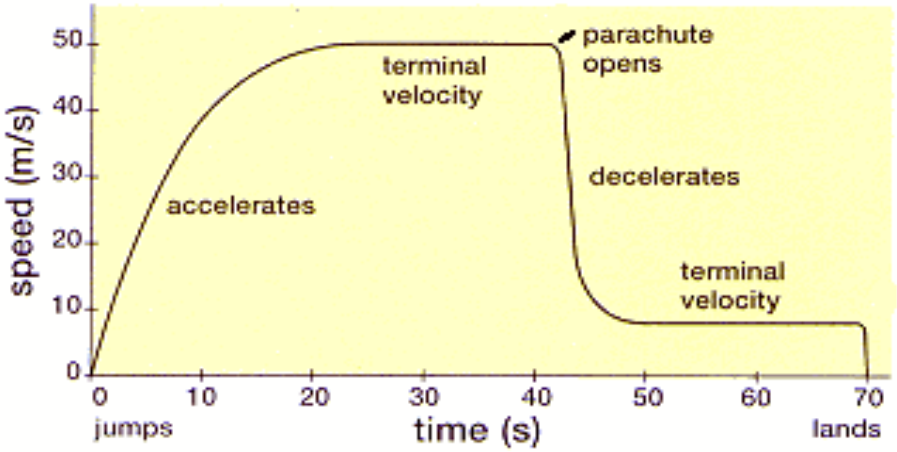
_____

If a rocket is moving through space at a steady velocity, what can you say about the resultant force acting on the rocket?

.....

.....

Annotate the graph with the words below.



Balanced forces, unbalanced forces, steady speed, acceleration, deceleration

What two forces are balanced when an object reaches terminal velocity?

.....

(HT only) What is the word used to describe the tendency of objects to continue in their state of rest or of uniform motion) _____

Newton's Second Law:

The acceleration of an object is _____ to the resultant force acting on the object, and _____ to the mass of the object.

As an equation:

Word equation:

Symbol equation:

Units:

A car with a mass of 900kg accelerates from rest with an initial acceleration of 2.5 m/s^2. Calculate the resultant force required to produce this acceleration.

.....

..... units .....

A car with a mass of 1250kg has an engine that provides a driving force of 5200N. At 70mph the drag force acting on the car is 5100N. Find its acceleration at 70 mph

.....

..... units .....

Estimate the resultant force on a car as it accelerates from rest to a typical speed in 10s

.....

..... units .....

What is the definition of inertial?

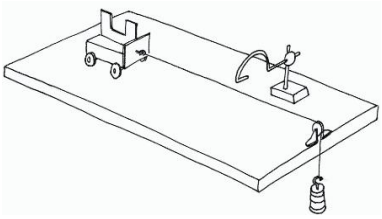
.....

.....

What ratio is used to define inertial mass? .....

Required practical activity19: investigate the effect of varying the force on the acceleration of an object of constant mass, and the effect of varying the mass of an object on the acceleration produced by a constant force.

Method:



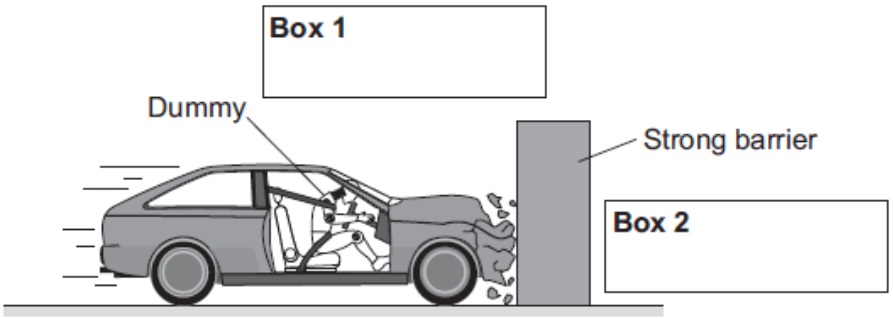
1.
2.
3.
4.

Newton's Third Law:

Whenever two objects interact, the forces they exert on each other are _____

An example of this is when a man pushes against a wall, there is a normal contact force acting back. This normal force is equal to the force the man is exerting on the wall.

The front crumple zone of a car is tested at a road traffic laboratory. This is done by using a remote control device to drive the car into a strong barrier. Electronic sensors are attached to a dummy inside the car.



(iii) Complete the following by drawing a ring around the correct line in the box.

The car exerts a force of 5000 N on the barrier. The barrier does not move. The force

exerted by the barrier on the car will be [more than / equal to / less than] 5000 N.

(1)

Forces and braking

What is the equation to work out stopping distance?

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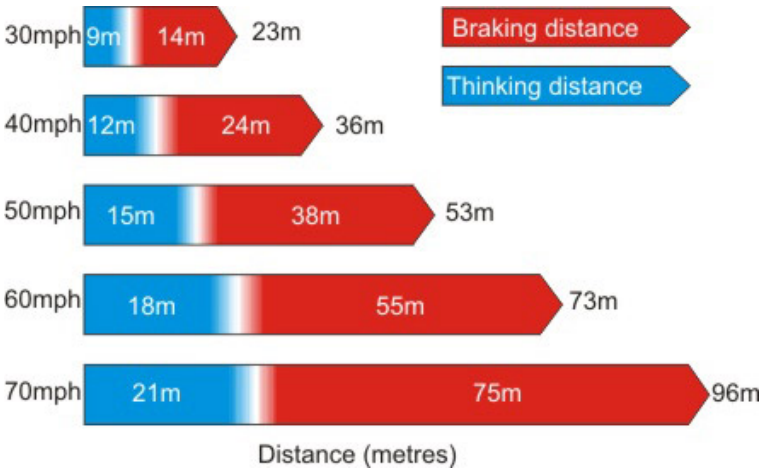
The greater the speed of the vehicle, the _____ the stopping distance.



Factors affecting braking distance	Factors affecting thinking distance

Reaction times vary from person to person. Typical values range from 0.2 s to 0.9 s

.A typical way to measure reaction time is _____

When a force is applied to the brakes of a vehicle, _____ by the friction force between the brakes and the wheel reduces the _____ of the vehicle and the temperature of the brakes _____

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 _____ of the vehicle. Large decelerations may lead to _____

Momentum

Momentum = Mass (in Kg) x velocity (in m/s)

1. Calculate the momentum of a toy train of mass 1.5 kg travelling at 0.2 m/s due west.
2. Which has greater momentum – a car of mass 1000 kg travelling at 32 m/s or a van of mass 1800 kg travelling at 20 m/s?
3. What is the momentum of a:
    a. boy of mass 60 kg running on a circular track at a steady speed of 12 m/s when he is running due north?
    b. What is his momentum when he is travelling at the same speed due east?
4. Calculate the momentum of a bullet of mass 15 g travelling north at 200 m/s.
5. What is the momentum of an oil tanker of mass 250 tonnes (250 000 kilograms) which is moving west at a speed of 20 m/s?

Conservation of momentum calculations

1. A dynamics trolley of mass 1.5 kg is travelling at 8 m/s towards a stationary trolley of mass 2.5 kg. After colliding, the trolleys stick together. What is their common velocity?
2. A model train of mass 3 kg moving at 5 m/s collides with a wagon of mass 7 kg moving at 1 m/s in the same direction. The two join together on impact. What is their common speed?
3. An air rifle fires a pellet of mass 0.004 kg at a speed of 100 m/s forwards.

a. Explain why the air rifle moves backwards.

b. Calculate the momentum of the pellet.

c. Write down the momentum of the rifle.

d. If the mass of the rifle is 2 kg, find its recoil velocity (velocity moving backwards).