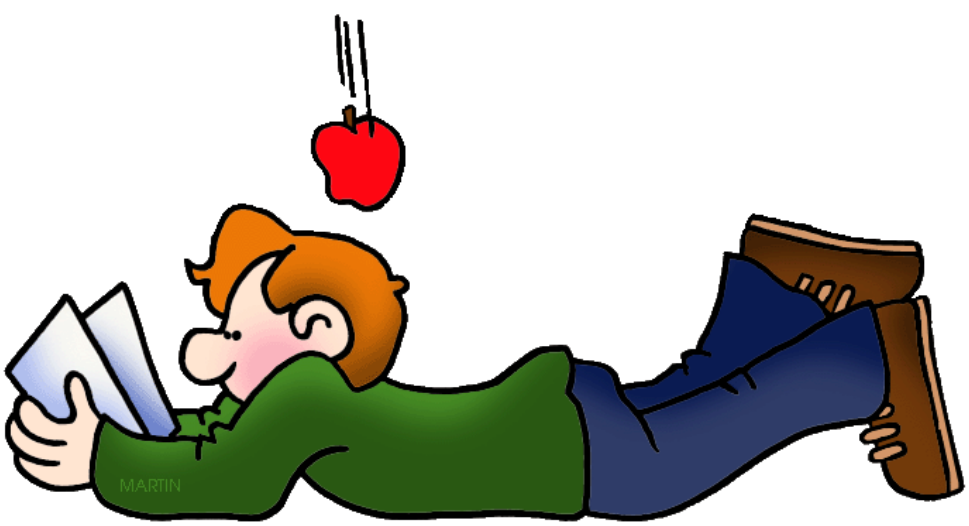
# Edexcel OL

# Physics

## (Code: 4PH1)

## Unit 1

## Forces and Motion

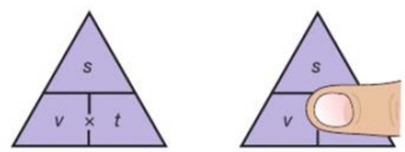


# 1.1 Movement and Position

## Average speed

| | | |
|---|---|---|
| Average speed = $\frac{\text{Distance moved}}{\text{time taken}}$ | Distance moved = Average speed x Time taken | Time taken = $\frac{\text{Distance moved}}{\text{Average speed}}$ |
| $v = \frac{s}{t}$ | $s = v \times t$ | $t = \frac{s}{v}$ |

Unit of speed: meter per second (m/s), kilometer per hour (km/h), centimeters per second (cm/s)



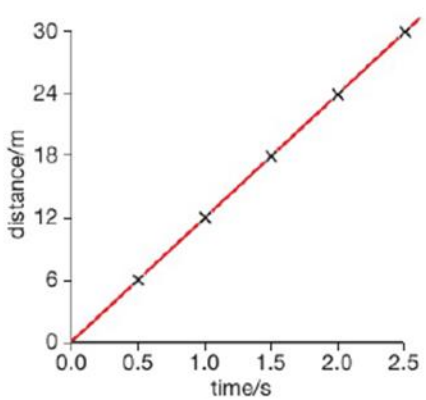

▲ Figure 1.2 You can use the triangle method for rearranging equations like $s = v \times t$.

**REMINDER**

To use the triangle method to rearrange an equation, cover up the part of the triangle that you want to find. For example, in Figure 1.2, if you want to work out how long ($t$) it takes to move a distance ($s$) at a given speed ($v$), covering $t$ in Figure 1.2 leaves $\frac{s}{v}$, or distance divided by speed. If an examination question asks you to write out the equation for calculating speed, distance or time, always give the actual equation (such as $s = v \times t$). You may not get the mark if you just draw the triangle.

## Distance – Time graph

| Time from start/s | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 |
|---|---|---|---|---|---|---|
| Distance travelled from start/m | 0.0 | 6.0 | 12.0 | 18.0 | 24.0 | 30.0 |




**KEY POINT**

You can convert a speed in m/s into a speed in km/h.

If the car travels 12.8 metres in one second it will travel

12.8 × 60 metres in 60 seconds (that is, one minute) and

12.8 × 60 × 60 metres in 60 minutes (that is, 1 hour), which is

46 080 metres in an hour or 46.1 km/h (to one decimal place).

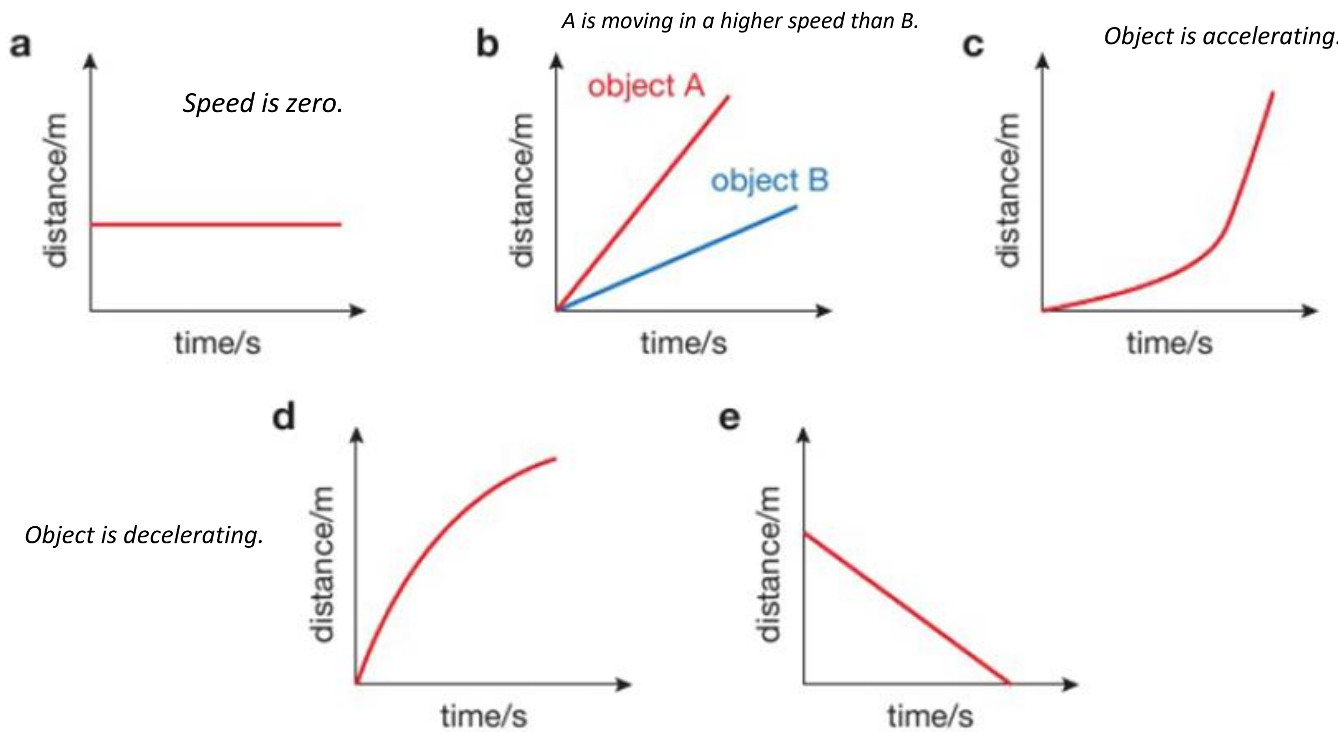
We have multiplied by 3600 (60 × 60) to convert from m/s to m/h, then divided by 1000 to convert from m/h to km/h (as there are 1000 m in 1 km).

*Rule*: to convert m/s to km/h simply multiply by 3.6.

**KEY POINT**

A curved line on distance–time graphs means that the speed or velocity of the object is changing. To find the speed at a particular instant of time we would draw a tangent to the curve at that instant and find the gradient of the tangent.

The car travels in equal distance in equal time intervals – it is moving at steady or constant speed. The slope or the gradient of the line tells us the speed of the car; steeper the line greater the speed of the car.




## Distance between Speed and Velocity

Displacement means distance traveled in a particular direction from a specific point. Displacement is an example of a vector. Vector quantities have a magnitude (size) and a specific direction. Velocity is also a vector.

Average velocity = $\frac{\text{Increase and displacement}}{\text{Time take}}$

## Acceleration

Acceleration is the rate at which the object changes their velocity.

Acceleration (a) = $\frac{\text{Change in velocity}}{\text{Time taken}}$ or $\frac{\text{final velocity (v) – initial velocity (u)}}{\text{Time taken}} = \frac{(v-u)}{t}$

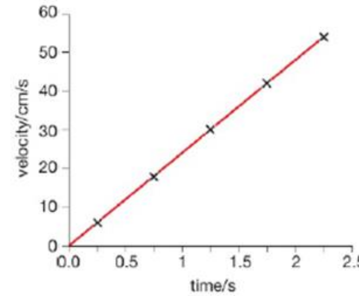
Acceleration, like velocity, is a vector because the direction in which the acceleration occurs is important as well as the size of the acceleration.

Units of acceleration: meter per square second ($m/s^2$), centimeter per square second ($cm/s^2$)

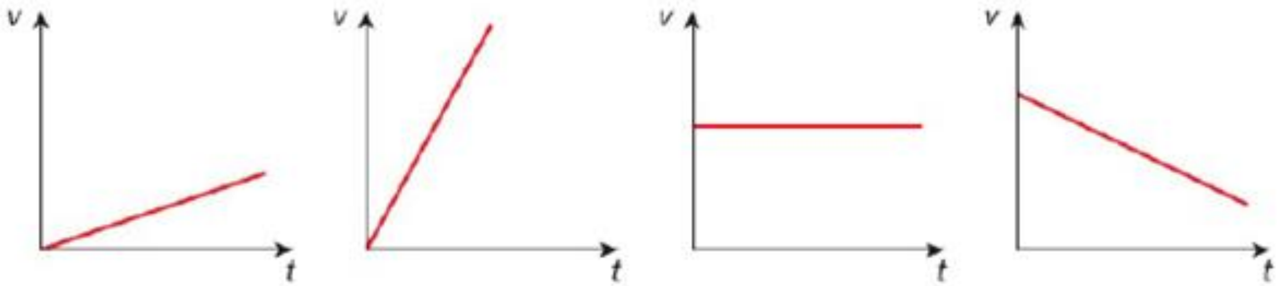
Deceleration means slowing down. This means that the final velocity will be lesser than the initial velocity. Simply a negative acceleration means a deceleration.

## Velocity – Time graph

| Time/s | 0.25 | 0.75 | 1.25 | 1.75 | 2.25 |
|---|---|---|---|---|---|
| Velocity/cm/s | 6 | 18 | 30 | 42 | 54 |




The gradient of the velocity – time graph is equal to the acceleration of the object.



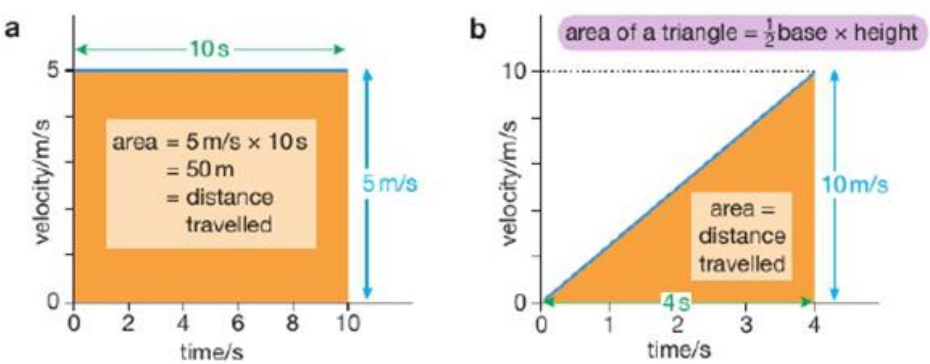

**a** shallow gradient – low acceleration

**b** steep gradient – high acceleration

**c** horizontal (zero gradient) – no acceleration

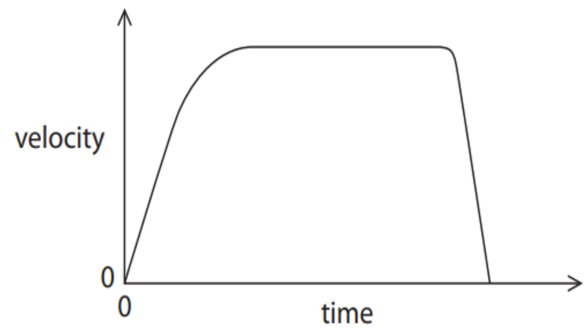
**d** negative gradient – negative acceleration (deceleration)

The area under the velocity – time graph is equal to the distance travelled by (displacement of) the object in that particular time interval.



1. A toy car rolls down a ramp and hits a cushion.

   The graph shows how its velocity changes with time.




   (a) Constant velocity on the graph is shown by

   **A**. the area under the line

   **B**. the horizontal part of the line

   **C**. the sloping line at the end

   **D**. the sloping line at the start

   (b) The distance travelled is shown by

   **A**. the area under the line

   **B**. the horizontal part of the line

   **C**. the sloping line at the end

   **D**. the sloping line at the star

   (c) The average velocity of the toy car is given by

   **A**. the change in velocity divided by the time taken

   **B**. the distance moved divided by the time taken

   **C**. the time taken divided by the change in velocity

   **D**. the time taken divided by the distance moved

2. A racing cyclist practices by riding around a track.
   A student wants to find the average speed of the cyclist.
   Describe a method that the student could use to find the average speed.

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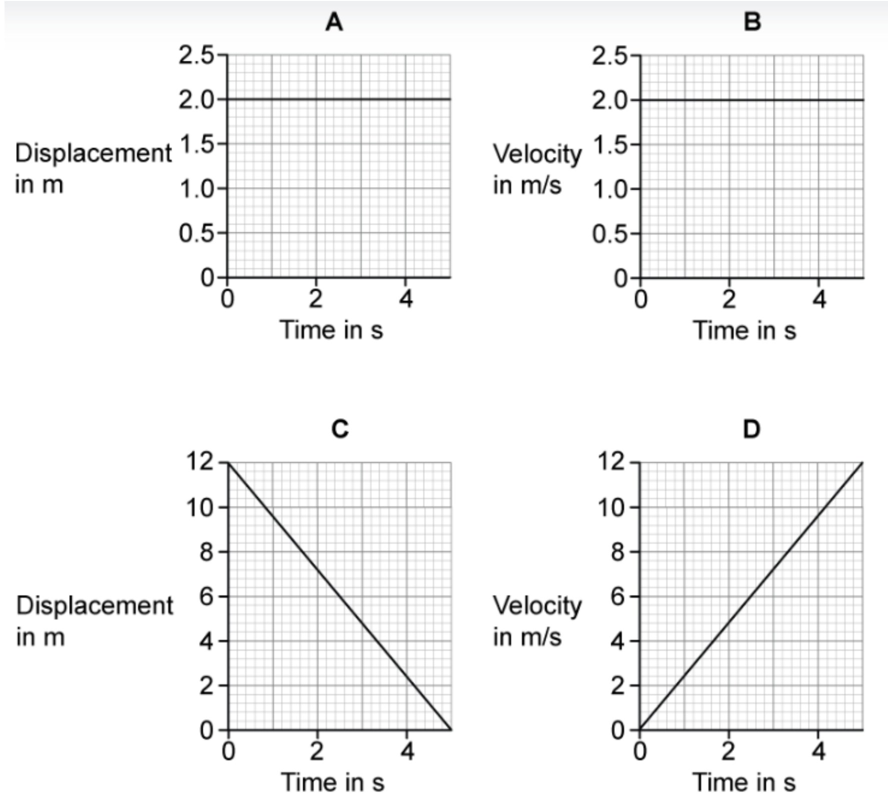
3. The following graphs A to D show the variation of displacement and velocity with time for different objects.




(a) Which of these graphs represents an object moving with constant velocity of 2m/s.
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(b) Which of the graphs represents and object which is not moving.
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(c) Which of the graphs represents an object moving with a velocity of 2.4m/s after two seconds.
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(d) Calculate the distance traveled by the object shown in graph D after 5 seconds.
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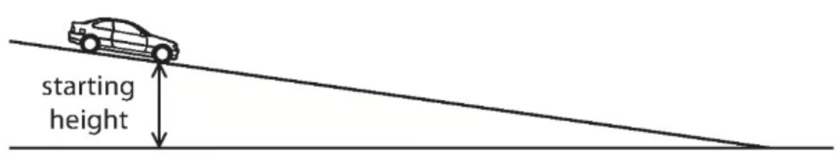
4.

(a) A student investigates the speed of different toy cars as they roll down a slope.




A student makes this prediction. 'The more weight a toy car has the faster it will roll down the slope.'

(i) What is the independent variable in the student's prediction?
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(ii) What is the dependent variable in the student's prediction?

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(b) State two factors that the students should keep constant in his investigations.

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(c) Put ticks in the boxes to show which pieces of apparatus the student needs for his investigation. One has been done for you.

| | |
|---|---|
| battery | |
| joulemeter | |
| micrometer | |
| newtonmeter | |
| ruler | ✓ |
| stopwatch | |
| thermometer | |

(d) Describe what the student should do to test his prediction that the more weight the toy car has, the faster it will roll down the slope.

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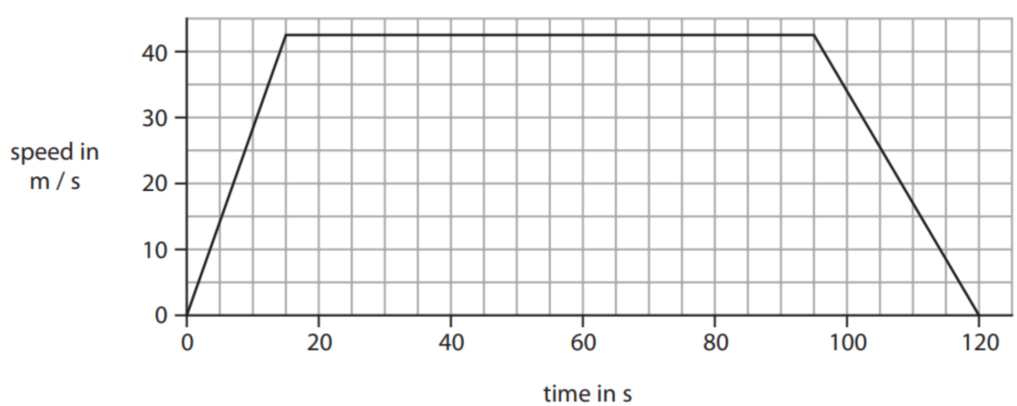
5. An airplane takes two minutes to travel the short the short distance between airports on two islands.

The graph shows how the speed of the airplane changes as it

- Take off
- Flies across the sea
- Lands on the other island

When it is flying across the sea, the airplane travels at a constant speed



(a) Use the graph and answer the following

(i) State the value of the constant speed

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(ii) Calculate the acceleration of the airplane at the start of the journey and give the unit

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(iii) Calculate the total distance that the airplane has traveled

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(b) Each airport has a runway that is about 500m long.
When it lands, the speed of the airplane is 40m/s.
Explain why the airplane that has more mass and needs a higher speed for landing.

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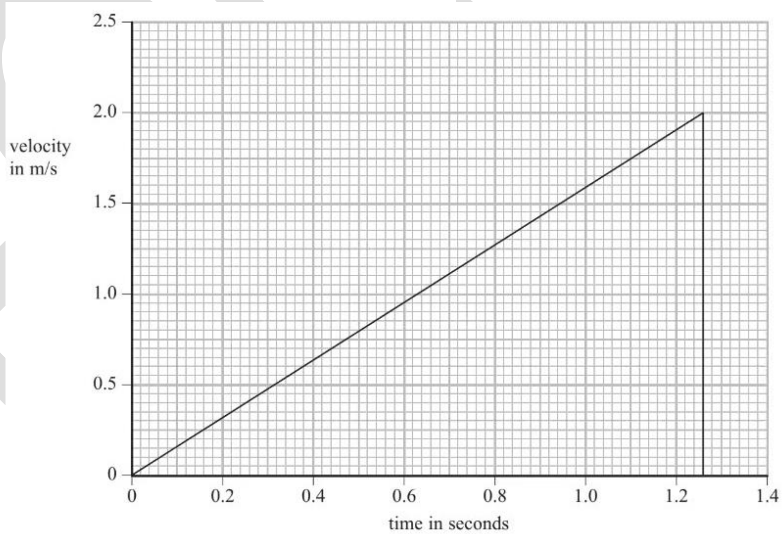
6. The Apollo 15 mission landed on the moon in 1971. The astronaut David Scott dropped a hammer and a feather. They were released from rest at the same time and from the same height. The hammer and the feather landed at the same time. The graph shows how the velocity of the hammer changed with time.




(a)

(i) Use the graph to calculate the acceleration due to gravity on the moon. Give unit.

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(ii) Use the graph to calculate the height the hammer was dropped from.

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(b) The gravitational field strength is smaller on the moon than on the earth. Suggest why.

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(c) If the same experiment carried out on earth, air resistance affects both objects. The feather reaches the ground after the hammer, even though the force of air resistance is smaller on the feather than on the hammer. Explain why the feather reaches the ground after the hammer.

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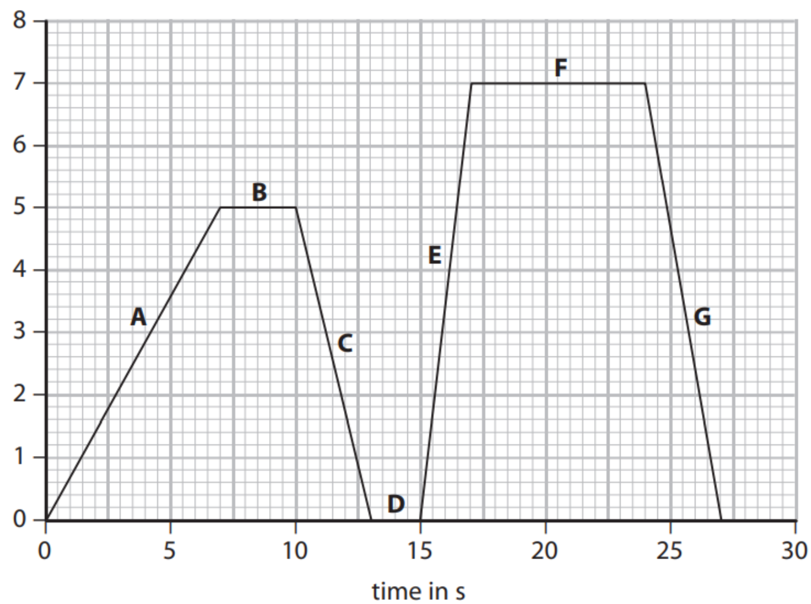
7. A student cycles to school. The graph shows the stage A to G of the journey




(a) Describe the motion of the student during stage B and D

| Stage | Description |
|---|---|
| B | |
| D | |

(b) State how the graph shows that the acceleration for stage E is greater than the acceleration for stage A.

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(c) Calculate the distance that the student travels in the last 10s of the journey

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(d) The total distance travelled 106.5 m.
Show that the average speed of the journey is about 4m/s

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8. Two students, jenny and Cho, are investigating motion. Jenny walks in a straight line. Cho measures the distance jenny has walked at 10s intervals.

(a) State two measuring instruments the students should use.

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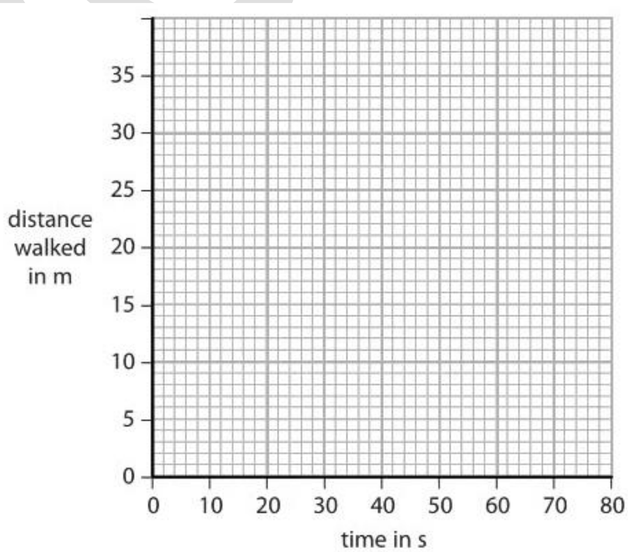
(b) The table shows their measurements.

| Time in s | Distance walked in m |
|---|---|
| 0 | 0 |
| 10 | 14 |
| 20 | 19 |
| 30 | 24 |
| 40 | 29 |
| 50 | 30 |
| 60 | 31 |

Draw a graph of distance against time for this data.



(c) How far had jenny walked after 35 seconds?

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(d)

(i) Describe how jenny's speed changed during the investigation.

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(ii) What feature of the graph shows this change?

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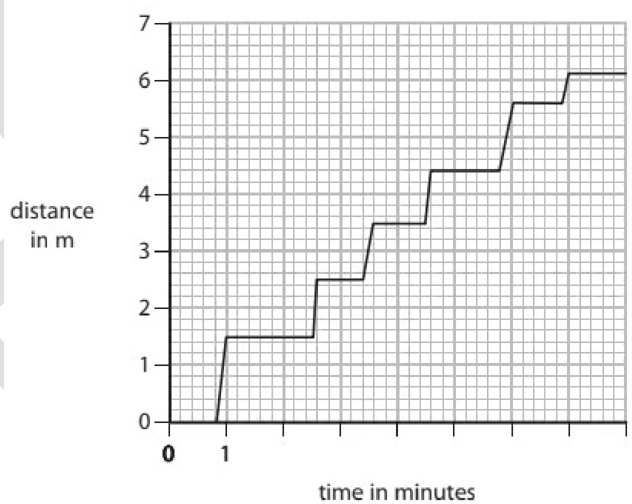
9.

(a) The diagram shows some people waiting in the queue at a supermarket.


The queue moves forward each time a person leaves the checkout. Person X spends seven minutes in the que before reaching the checkout. The graph shows how distance changes with time for a person X.




(i) Determine the initial length of the queue.

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(ii) Explain how you could use the graph to work out the number of times person X is stationary.

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(b)

(i) State the equation linking average speed, distance moved and time taken.

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(ii) Calculate the average speed of a person X in the queue. Give the unit.

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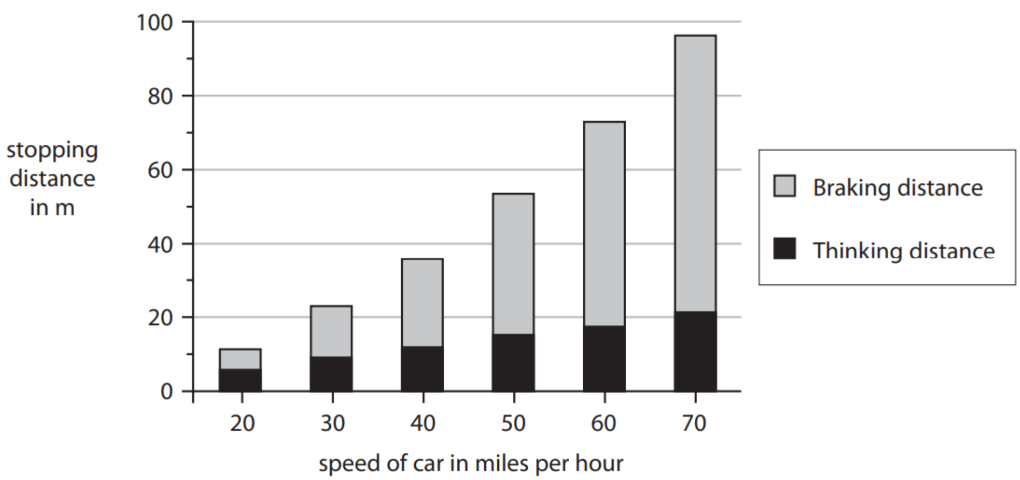
10. The graph shows the minimum stopping distances, in meters, for a car travelling at different speeds on a dry road.




(a) Complete the equation to show the link between stopping distance, thinking distance and braking distance.

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(b) Describe the patterns shown in the graph.

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(c) Use the graph to estimate the stopping distance for a car travelling at 35 miles per hour.

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(d) To find the minimum stopping distance, several different cars were tested. Suggest how the data from the different cars should be used to give the values in the graph.

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(e) The tests were carried out on a dry road. If the road is icy, describe and explain what change there would be, if any, to

(i) the thinking distance

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(ii) the braking distance

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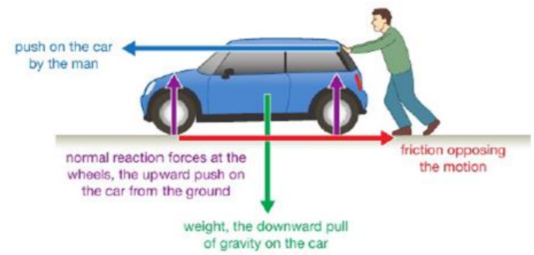
## 1.2 Forces and Shape

A force is simply a push or a pull. Other than a push or a pull, there are many other forces acting on an object.

> **KEY POINT**
>
> Like displacement, velocity and acceleration, force is a *vector quantity* because both its size and direction matter. Some quantities, such as temperature, have no direction connected with them. They are known as *scalar quantities*.




The direction of the force is important as much as the size of the force.

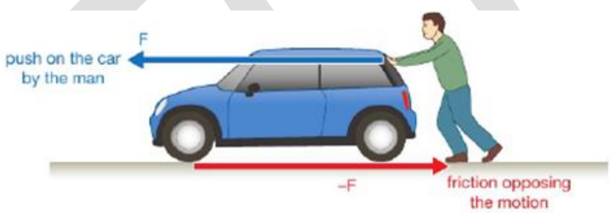
Unit of Force: Newton(N) [Named after Sir Isaac Newton.]

A force of 1 Newton will make a mass of 1 kilogram accelerated at one meter per second squared.

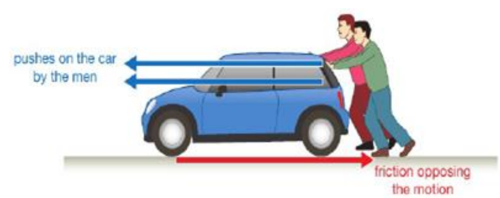
Some other examples for forces:

- Magnetic forces
- Electrostatic forces
- Upthrust
- Air resistance
- Nuclear forces

When more than one force is applied:




The resultant is zero because the two forces are balanced.




The total pushing force is the sum of the two individual forces.

### Balance and Unbalanced forces

When the forces acting on an object are balanced, the object does not change the way it's moving. When the forces acting on an object are unbalanced, the object changes the way it moves.

In a tug of war contest the two teams pull the rope to the opposite direction. And the rope stays steady for some time. This means that the two forces action are equal and that this is a balanced force.

Eventually when one of the teams get tired the force they apply would reduce. Then the rope moves towards the winning team as a result of an unbalanced force.

## Friction

Friction is the force that causes moving objects to slow down and finally stop. Kinetic Energy is the moving object is transferred to heat as work is done by the friction force.

In situations like ice skating the blade of the shoe is designed in a way that friction is minimized. And in tires friction is maximized in order to avoid skidding.

Objects in space keep moving straight at constant speed. This is because the objects in space are weightless and the air resistance acting on them are very small.

## Change in shape

Forces can change the shape of an object just like making an object move, accelerate and decelerate. A force can cause temporary changes or permanent changes.

### Temporary changes in shape

All materials will stretch when you put it under tension (that is pull them) or shorten when you compress or squash them. Some materials like glass does not change shape easily and are brittle. Elastic materials do not break easily and tend to return to their original shape when forces acting on them ae removed. Materials like putty and molding clay are not elastic, but plastic.

## Spring and Wires

Springs are coiled lengths of certain type of metal, which can be stretched or compressed by applying a force.

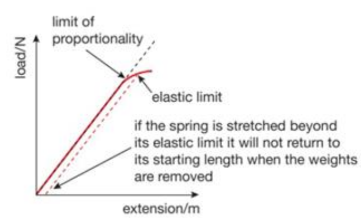
Uses of springs: Beds and chairs to make sitting and sleeping comfortable, in vehicles to absorb raised bumps, in doors to make them close automatically.

Springs change length when a force acts on them and they return to their original length when the force is removed. But, this is only true when the spring is not stretched too much. If is the spring I stretched beyond a point, it will not spring back to its original length.

### Hook's Law

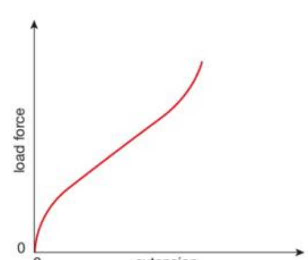
The extension of the spring is directly proportional to the force.

Hook's law only applies if you do not stretch the spring too far.




The point called limit of proportionality of the graph is the point where the spring stops obeying hook's law. If the force is increased more the point called the elastic limit is reached. Once the spring is stretched beyond the elastic limit, the spring does not spring back to its original length.

Hook's law applies to wires too. Wires made in different wires made of different metals will behave differently. Some will obey hook's law until the wire breaks and other type of metal will stretch elastically and then plastically before breaking.

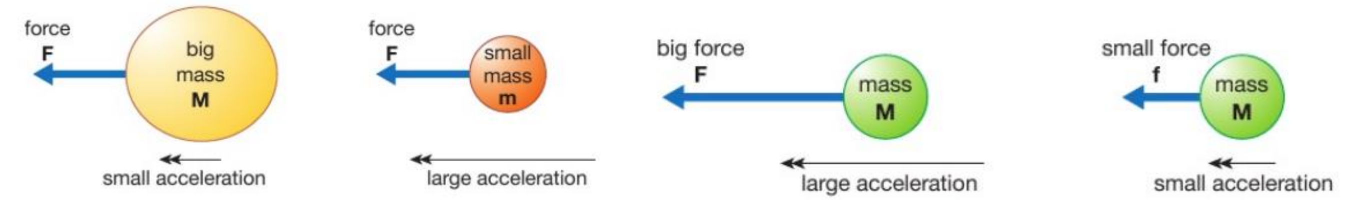



▲ Figure 2.16 Rubber bands do not obey Hooke's law – the extension is not directly proportional the force causing it.

# 1.3 Forces and movement

## Force, Mass and Acceleration

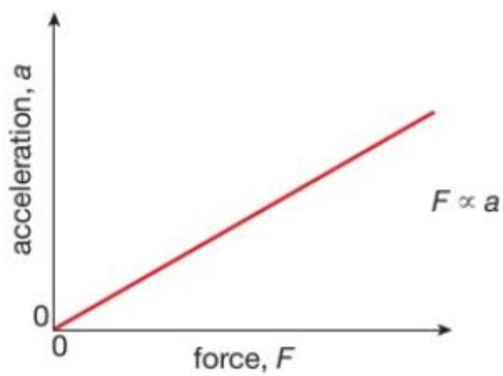
An object will not change its velocity(accelerate) unless there is an unbalanced force.

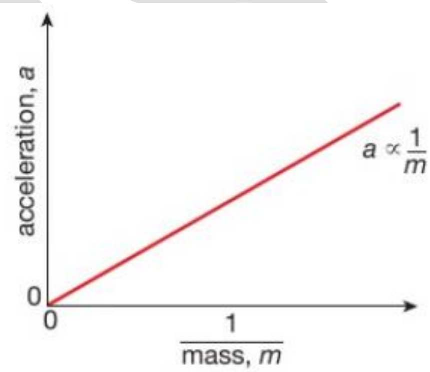



**a** When the same force is applied to objects with different mass, the smaller mass will experience a greater acceleration.

**b** Different-sized forces are applied to objects with the same mass. The small force produces a smaller acceleration than the large force.

### Investigating force, mass and acceleration




Force is proportional to acceleration :

$F \propto a$

Acceleration is inversely proportional to mass :

$a \propto \frac{1}{m}$

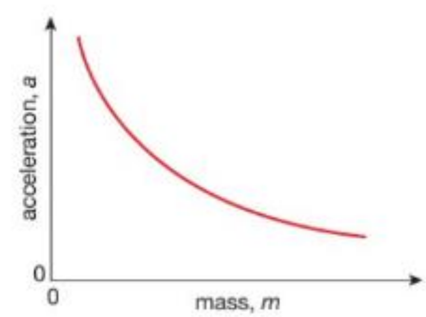
Combining these results : Force (F) = mass (m) × acceleration (a)

$$F = m \times a$$

One Newton is the force needed to make a mass of one kilogram accelerate at one meter per square second.

**HINT**

If an examination question asks you to write out the equation for calculating force, mass or acceleration, always give the actual equation (such as $F = m \times a$). You may not get the mark if you just draw the triangle.




▲ Figure 3.6 The graph of $a$ against $m$ is a curve. Plotting $a$ against $\frac{1}{m}$ (while keeping the force constant) gives a straight line. This makes it easier to spot the way that $a$ is affected by $m$.

## Deceleration in collision

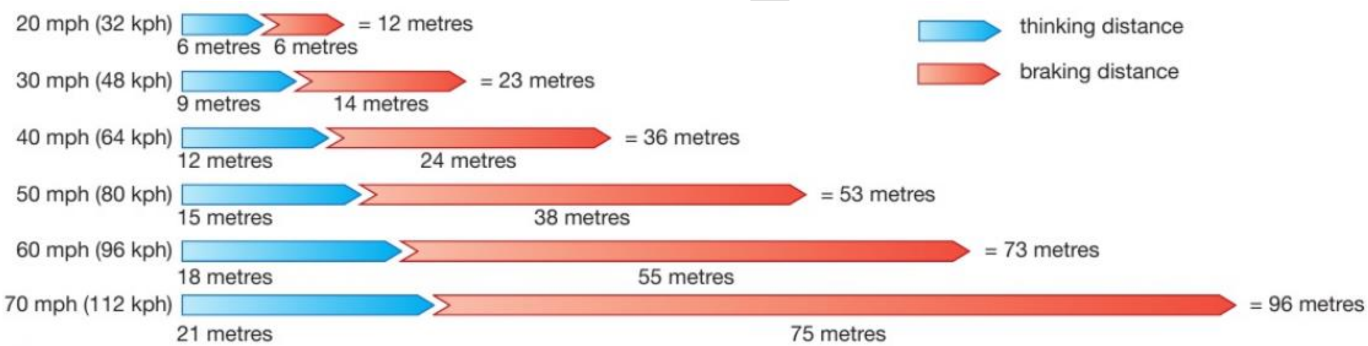
When a moving object is stopped it decelerates. A negative acceleration is a deceleration.

## Friction and braking

Brakes on cars and bicycles work by increasing the friction between the rotating wheels and the body of the vehicle.
Friction force between the tires depend on; condition of the tire, surface of the road, weight of the vehicle.

## Safe stopping distance

The stopping distance is the sum of the thinking distance and the braking distance. The faster the car is travelling the greater the stopping distance will be.




## Weight

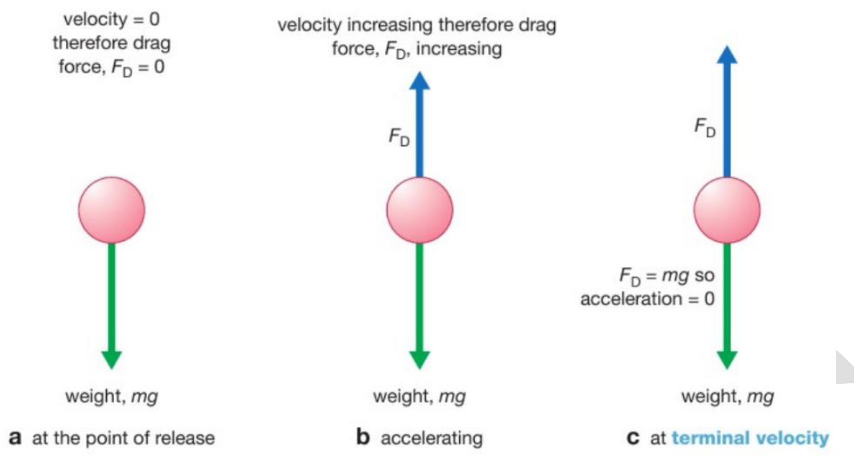
The weight of an object is the force that acts on it because of gravity. The weight(W) of an object depends on its mass(m) and the strength of gravity. The gravitational field strength (g) is the force that acts on each kilogram of mass.

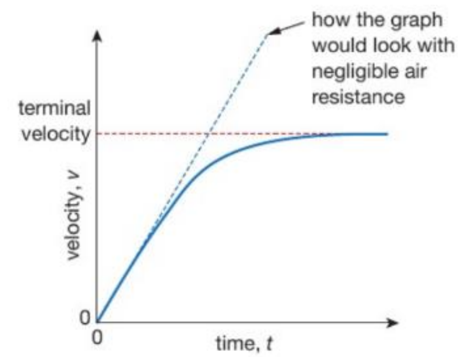
$$W = m \times g$$

Near and on the Earth's surface the gravitational field strength is approximately 9.8 N/kg, but we often use 10 N/kg to make calculations easier. The gravitational field strength on the Moon is about 1.6 N/kg, so an object taken from the Earth to the Moon will have less weight even though it has the same mass.

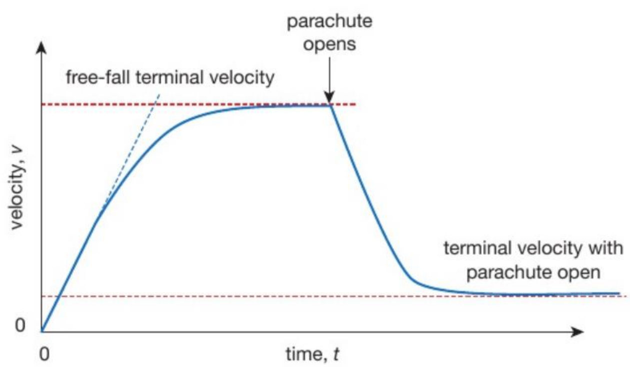
## Air resistance and terminal velocity

An object moving through air experiences a force that opposes its movement. This force is called air resistance or drag. The size of the drag force acting on an object depends on its shape and its speed. The drag coefficient is a measure of how easily an object moves through the air.  Objects falling through the air experience two significant forces: the weight force (that is, the pull of gravity on the object) and the opposing drag force.




## Parachutes




when sky diver jumps from a plane she will accelerate for a time and eventually reach terminal velocity. When she opens the parachute there will be a sudden increase in drag force. This means that the unbalanced force acting on the parachutist acts upwards and for a while she will decelerate. Then the drag force decreases and, eventually, a new terminal velocity is reached.

## Modelling terminal velocity

Objects have to accelerate to quite high speeds in air to reach terminal velocity. objects falling through liquids have a much lower terminal velocity than objects falling through air, and can be used to model terminal velocity.

You can use a tall measuring cylinder filled with water and drop small-diameter (1-2 mm) glass balls into it. Alternatively, use a much thicker liquid like oil and use small-diameter balls. As well as demonstrating terminal velocity this presents plenty of opportunities for investigations.

# 1.4 Momentum

## Momentum

Momentum is the measure of how difficult it is to stop something that's moving. It is a vector quantity.
Unit – kilogram meter per second

$$p = m \times v$$

## Momentum and acceleration

Rate of change of momentum of an object is proportional to the force applied to the object.

Initial momentum = $mu$

Final momentum = $mv$

Therefore, Increase in momentum = $mv - mu$

Rate of increase of momentum = $\frac{(mv-mu)}{t}$

As stated above, Newton identified a proportional relationship between the rate of increase of momentum and the force applied, but with the system of units we use the relationship appears as shown:

$$\text{Force} = \frac{\text{change in momentum}}{\text{time}}$$

$$F = \frac{(mv - mu)}{t}$$

## Momentum and Collision

The total momentum of objects that collide remains the same (momentum is conserved).

$$\text{Momentum before collision} = \text{Momentum after collision}$$

## Explosions

An explosion involves a release of energy causing things to fly apart. The momentum before and after the explosion is unchanged, though there will be a huge increase in movement energy.
produce a continuous, controlled explosion that forces large amounts of fast-moving gases (produced by the fuel burning) out of the back of the rocket. The spacecraft gains an equal amount of momentum in the opposite direction to that of the moving exhaust gases.

## Car safety

Cars are now designed with various safety features that increase the time over which the car's momentum changes in an accident. The car has a rigid passenger cell or compartment with crumple zones in front and behind. The crumple zones, as the name suggests, collapse during a collision and increase the time during which the car is decelerating.
Crumple zones are just one of the safety features now used in modern cars to protect the passengers in an accident. They only work if the passengers are wearing seat belts so that the reduced deceleration

applies to their bodies too. Without seat belts, the passengers will continue moving forward until they come into contact with some part of the car or with a passenger in front.

### Newton's laws of motion

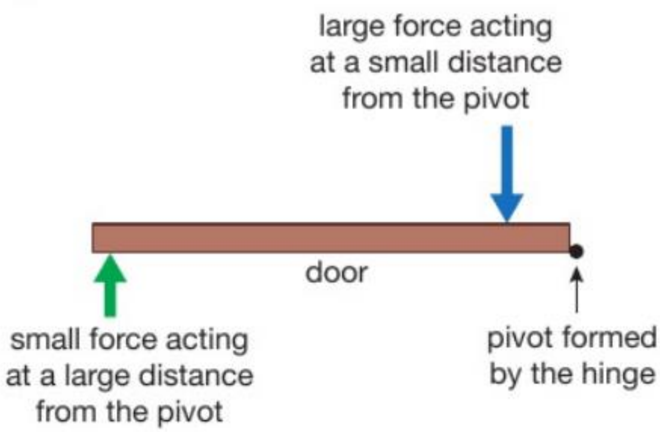
#### Newton's third law: Action and Reaction

For every action there is an equal and opposite reaction

Balanced forces act in opposite directions on the same object. Action and reaction forces also act in opposite directions, but are always acting on different objects.

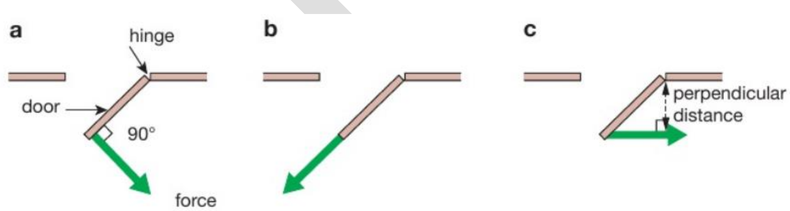
## 1.5 The turning effect of forces

### Opening a door




### Moment of a force

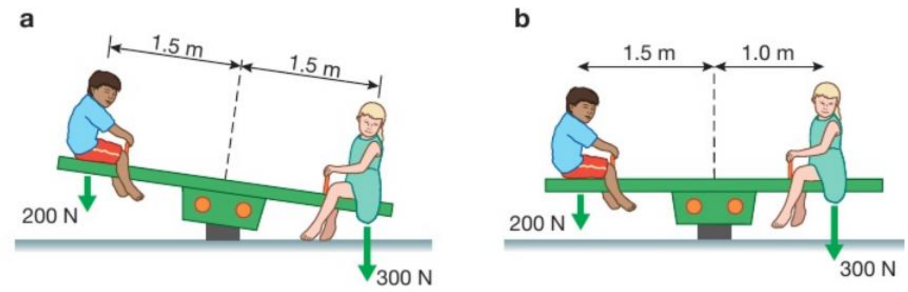
The turning effect of a force about a hinge or pivot is called its moment.
Moment of a force (Nm) = force, F (N) × perpendicular distance from pivot, d (m)

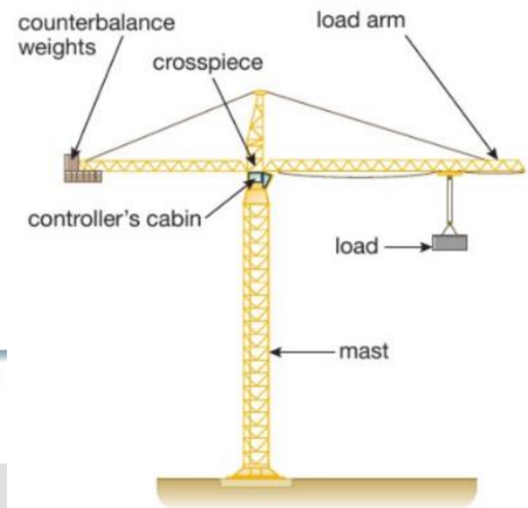



$$Moment = F \times d$$

### In balance

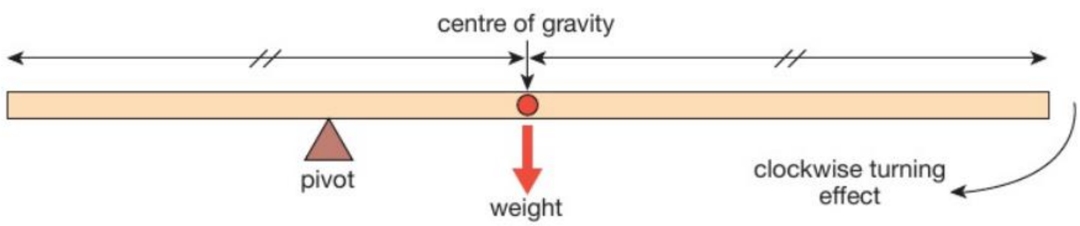
Sum of anticlockwise moment = sum of clockwise moment



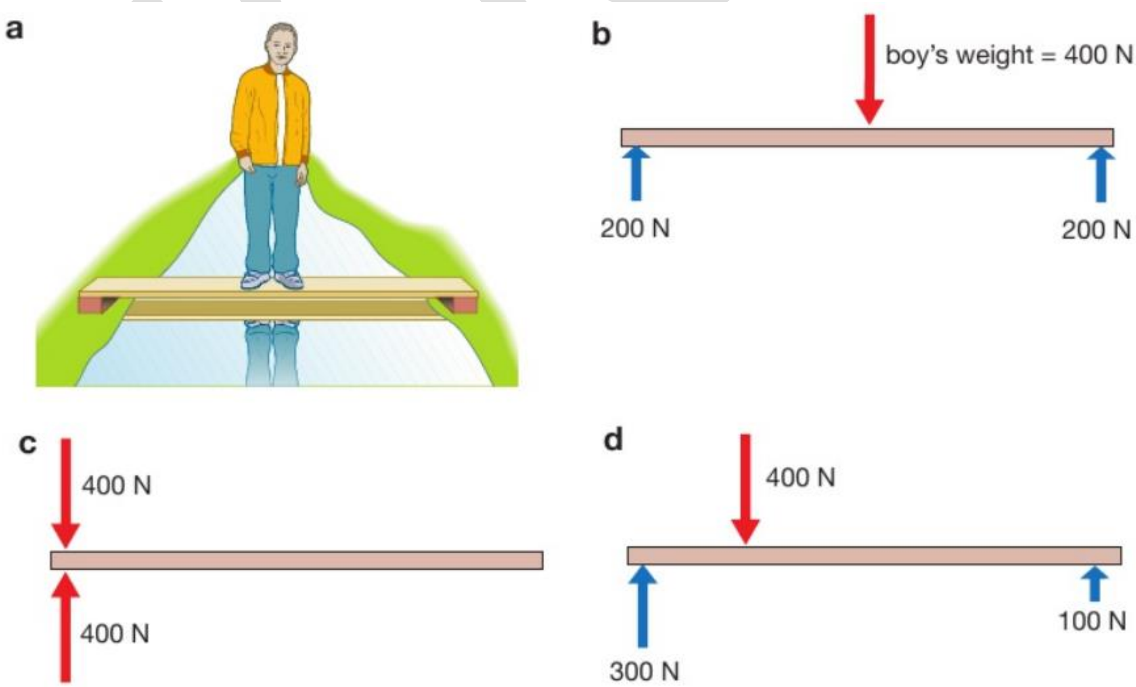




## Centre of gravity

### Objects not pivoted at the center of gravity




## Forces on a beam

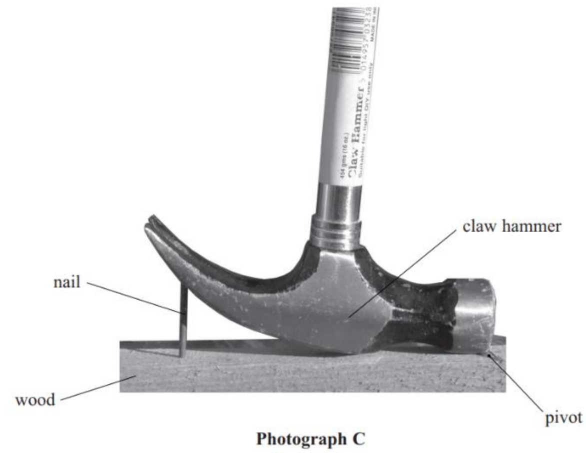


EXCERSISE

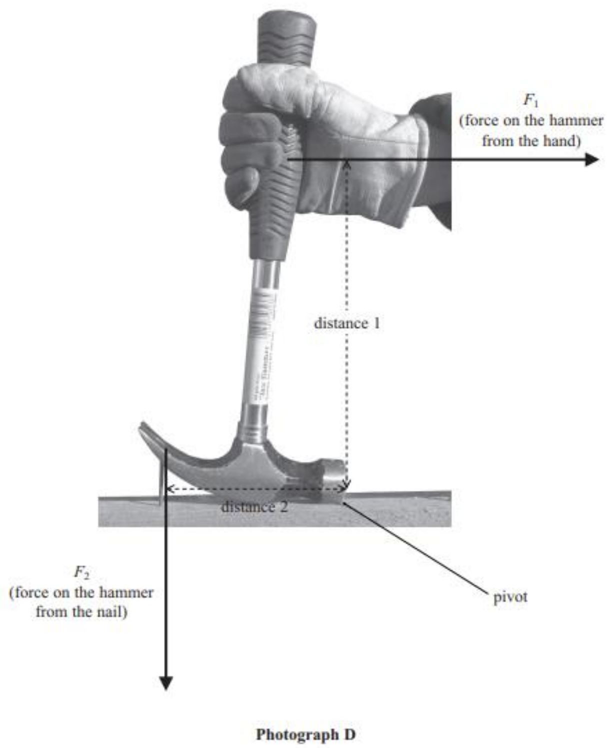
1. Photograph C shows how a student can use a claw hammer to pull a nail from a piece of wood.

   a. The mass of the hammer is 0.454 kg.
      i. Calculate the weight of the hammer.
      ii. From what point does this weight act?

   b. Photograph D shows the directions of two other forces on the hammer



Photograph C

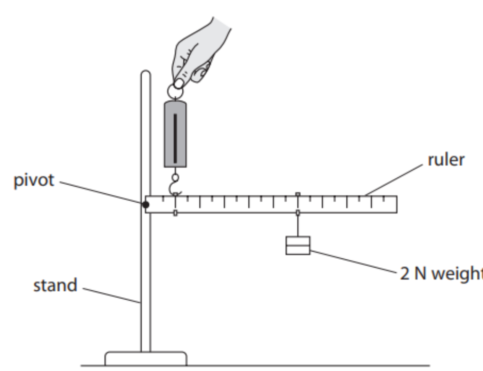


Photograph D

   i. Draw an arrow on photograph D to show the force on the nail from the hammer.

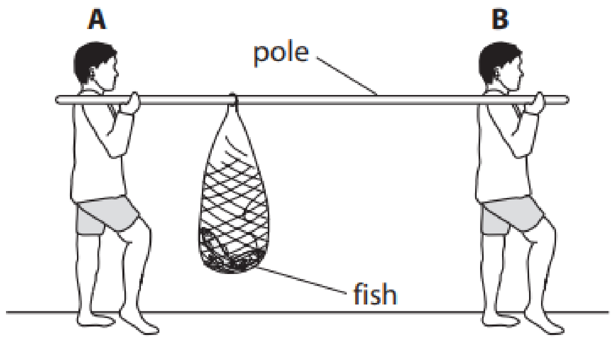
   ii. Suggest two ways that the student could increase the moment on the hammer.

2. A student investigates the principle of moments. He connects a ruler to a stand with a pivot. He hangs a 2 N weight from the 60 cm mark on the ruler. He uses a forcemeter to hold the ruler horizontal. The scale on the forcemeter reads from 0 N to 10 N.
   a. How could the student check that the ruler is horizontal?
   b.
      i. State the equation linking moment, force and distance from the pivot.
      ii. Calculate the moment of the 2 N weight. State the unit.



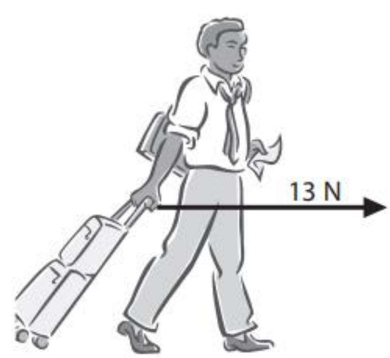
c. The student holds the ruler horizontal with the forcemeter at the 10 cm mark. He expects the reading on the forcemeter to be 12 N. The actual reading is 10 N.
   i. Explain why the correct reading should be larger than 12 N.
   ii. Explain why the actual reading is only 10 N.

d. A picture in the student's textbook shows two fishermen using a pole to carry some fish. Fisherman A and fisherman B feel different forces on their shoulders. Use ideas about moments to explain why fisherman A feels the larger force.

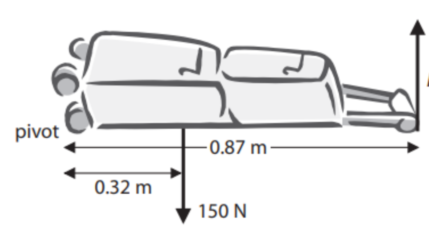



3.
   a. A boy of mass 43.2 kg runs and jumps onto a stationary skateboard. The boy lands on the skateboard with a horizontal velocity of 4.10 m/s.
   i. State the relationship between momentum, mass and velocity.
   ii. The skateboard has a mass of 2.50 kg. Using ideas about conservation of momentum, calculate the combined velocity of the boy and skateboard just after the boy lands on it.
   b. The boy holds a heavy ball as he stands on a stationary skateboard. The boy throws the ball forwards while still standing on the skateboard. Explain what happens to the boy and the skateboard.

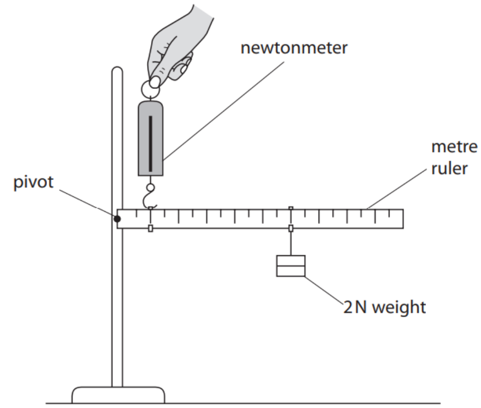
4. A person has a suitcase with wheels.



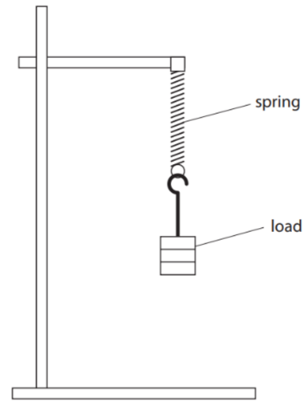

   a. The person pulls the suitcase with a horizontal force of 13 N for 110 m.
      i. State the equation linking work done, force and distance moved.
      ii. Calculate the work done on the suitcase by the person.
      iii. How much energy is transferred to the suitcase?
   b. The suitcase falls over. Explain why it loses gravitational potential energy when it falls.
   c. The person starts to raise the suitcase again by pulling on the handle with force F. The weight of the suitcase is 150 N.
      i. State the equation linking moment, force and perpendicular distance from the pivot.
      ii. Calculate the force F that the person must apply on the handle to start raising the suitcase.



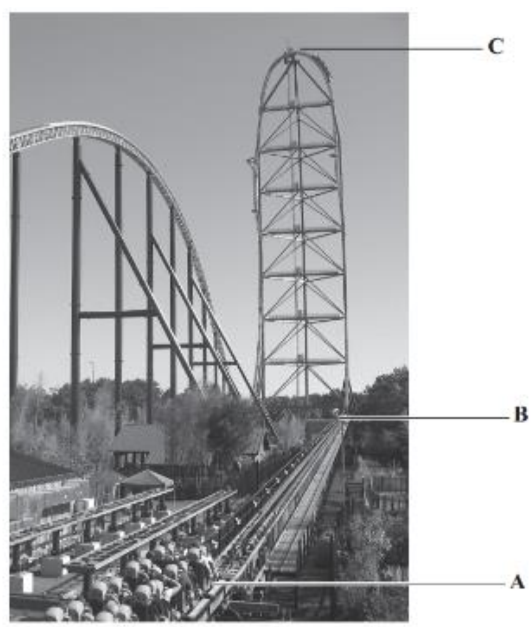
5. The diagram shows the apparatus used to investigate moments. The 2 N weight is placed 60 cm from the pivot. The newtonmeter is placed 10 cm from the pivot.
   a.
      i. State the equation linking moment, force and perpendicular distance from the pivot.
      ii. Calculate the reading on the newtonmeter. Ignore the weight of the ruler.
   b. The metre rule is replaced by an iron bar. The iron bar is 1 m long and has a weight of 10 N. The newtonmeter and the 2 N weight stay in their original position. Explain how this change affects the reading on the newtonmeter.




6. A student investigates how the extension of a spring varies when he hangs different loads from it.
   a. Write a plan for the student's investigation. Your plan should include details of how the student can make accurate measurements. You may add to the diagram to help your answer.
   b. The student finds that the spring obeys Hooke's law. Draw a graph on the axes to show the Hooke's law relationship. Label the axes.
   c. The student concludes that the spring shows elastic behaviour. Explain what is meant by the term elastic behaviour.




7. The photograph shows a type of rollercoaster. The car is launched from point A in the photograph, accelerates to point B and then rises over point C.
   a. Each loaded car has a mass of 2000 kg. C is 128 m above B.
      i. State the equation linking gravitational potential energy, mass, height and gravitational field strength.
      ii. Show that the gravitational potential energy gained by the car when it rises from B to C is about 2.6 MJ.
   b. The car gains kinetic energy when work is done on it by the launching system between A and B. Assume there are no energy losses.
      i. State the minimum kinetic energy that the car must have at B for it to reach C
      ii. How is the kinetic energy gained related to the work done?
      iii. Write down the equation linking work done, force and distance.

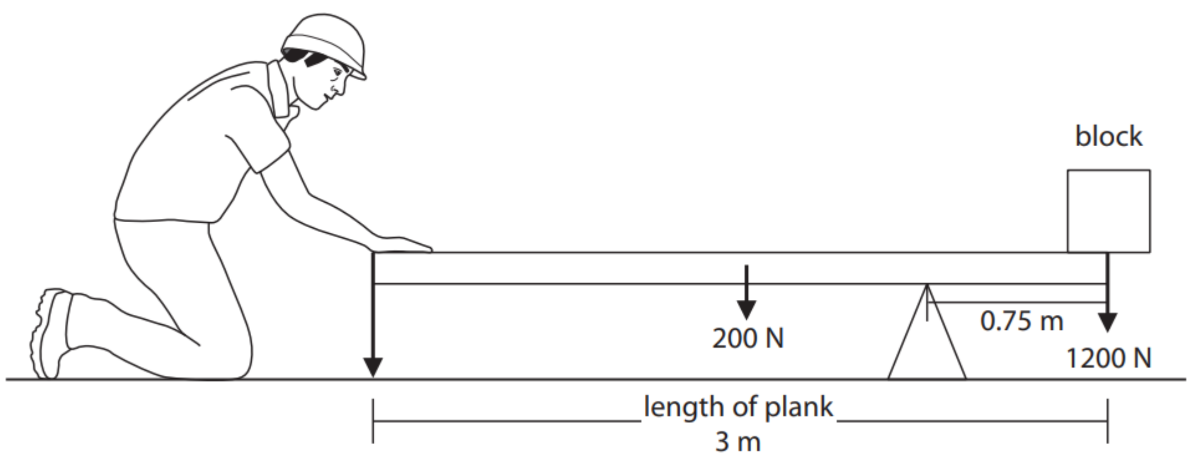


iv. The launching system provides a force of 32 kN. Calculate the minimum length of track needed between A and B for the car to reach C.

c. Sometimes the car does not reach C, but rolls backwards to the start. This can happen when it becomes windy or the track becomes wet. Explain why these conditions could cause the car to stop before it reaches C.

8. The Moon orbits the Earth.
   a. State a difference between the orbit of a moon and the orbit of a planet.
   b. The radius of the Moon's orbit is 385000 km. It takes 27 days for the Moon to complete one orbit. Calculate the orbital speed of the Moon. Give a suitable unit.
   c. in 1971, astronaut Alan Shepard hit a golf ball on the surface of the Moon. The golf ball had a mass of 50 g and he transferred 56 J of energy to it.
      i. State the equation linking kinetic energy, mass and velocity.
      ii. Calculate the initial velocity of the ball.
   d. At its highest point the ball had gained 12 J of gravitational potential energy.
      i. State the kinetic energy of the ball at its highest point.
      ii. State the equation linking gravitational potential energy, mass, g and height.
      iii. Calculate the maximum height that the ball reached. (gravitational field strength on the Moon, g = 1.6 N/kg)
   e. Suggest why the ball travelled further on the Moon than it would have done on Earth.

9. The arrows on the diagram represent three forces on the plank. A man uses a uniform plank to lift a block. He holds the plank horizontal.




   a. Complete the table to identify the missing force.

| Force | Name of force |
|---|---|
| F | force of man pushing down on the plank |
| 1200 N | weight of block |
| 200 N | |

b.
   i. State the equation linking moment, force and perpendicular distance from the pivot.
   ii. Calculate the clockwise moment of the block about the pivot.
c. Calculate the clockwise moment of the block about the pivot.

10. A student investigates the motion of a toy car as it moves freely down a slope. The student wants to find the link between the starting height of the car and the speed of the car at the bottom of the slope.
    a.
       i. State the independent variable in this investigation
       ii. Suggest a link between the starting height of the car and its speed at the bottom of the slope.
    b. Describe how the student should measure the starting height of the car.
    c. The student describes how she will find the speed of the car at the bottom of the slope. "I will start the timer when the car begins to move. I will stop the timer when the car reaches the bottom. I will find the speed at the bottom by dividing the distance moved by the time taken."
       i. Explain why the student will not be able to calculate the correct speed using this method.
       ii. Describe how the student should take the measurements needed to find the speed of the car at the bottom of the slope. You should name any additional equipment needed.
    d. The student repeats the experiment using the same equipment and the same starting height. She finds out that the time taken for the car to move down the slope is not exactly the same for each experiment. Suggest three reasons why the student gets different results when she repeats the experiment.

11)MOTION CONCEPTS

- Distance ...........................................................................................................
- Displacement ...........................................................................................................
- Speed ...........................................................................................................
- Velocity ...........................................................................................................
- Velocity ...........................................................................................................

2)Motion equations

| Quantity | Equation | Unit |
|---|---|---|
| Uniform speed | | |
| Mean speed | | |
| Uniform velocity | | |
| Mean velocity | | |
| Distance at uniform velocity | | |
| Distance mean velocity | | |
| Acceleration | | |
| Final velocity at acceleration with time | | |
| Final velocity at acceleration with distance | | |

QUESTIONS:

I. An object has moved 2750 m within 25 s. Find the speed of the object.

II. Find the velocity of an object moving 1500 m within 2.5 minutes.

III. An object moves at 30 $ms^{-1}$ for half an hour. What is the distance of the object?

IV. A motor car starts its motion from rest and acquires 80 $ms^{-1}$ within 20 s. Find the acceleration and the displacement of the motor car.

V. A trolley at rest has been accelerated at 25 ms-2 along a horizontal path for 20 s. Calculate its final velocity.

VI. A ball is projected vertically upwards at 40 $ms^{-1}$ Find the time taken to obtain the zero velocity and the maximum height. ($g=10ms^{-2}$)

VII. A bicycle moving at 80 ms-1 has stopped within 20 s. Find its deceleration and the distance during the time.

VIII. An object at rest has uniformly accelerated at 15 ms-2 and acquired 75 ms-1 velocity. Calculate the time taken.

IX. A ripen fruit has fallen from a branch and touches the ground within 5 s. Find the velocity when it touches the ground. ($g=10ms^{-2}$)

X. A person driving his car at 90 ms-1 has reduced the velocity down to 30 ms-1 within 30 s. Find his deceleration.

12)An object started its motion from rest and acquired 36ms-1 velocity within 6 seconds. Then it moved at the same velocity for another 4 seconds and ultimately came for rest within 4 seconds.

a) Sketch the velocity-time graph for this motion.

b) Calculate the acceleration of the object during the first 6 seconds.

c) Calculate the displacement of the object during the first 6 seconds.

d) Calculate the displacement of the object when it moves at uniform velocity.

e) Calculate the deceleration of the object during the last 3 seconds.

f) Calculate the total displacement of the object.

13)An object was vertically projected upward at 60 ms-1 ($g = 10\ ms^{-2}$)

a) Prepare the velocity-time data table for the object's motion until it reaches the maximum height.

b) Sketch the v-t graph.

c) Calculate the maximum displacement using the graph.