PHYSICS
Intermediate 1
Movement

ACTIVITY 1

Title: The Newton balance.

Aim: To use a Newton balance to measure some applied forces.

Apparatus: Some Newton balances with different ranges.

Instructions

- Measure the value of each force mentioned in the table below. Use the Newton balance which gives the largest reading without being pulled to its limit.

- Take a reading only when the pointer on the balance is steady.

- Copy and complete the table below.

Force being measured	Force (newtons)
Close door; pulling on handle	
Close door; pulling near hinge	
Weight of steel nut	
Drag book along desktop	
Weight of pen	

- Comment on any difficulties when taking readings.

ACTIVITY 2

Title: The weight to mass ratio.

Aim: To use a Newton balance to show that if you divide a weight in newtons by its mass in kilograms it is always 10.

Apparatus: A selection of known masses, a Newton balance.

Instructions

- Use the balance to find the weight of a range of masses.

- Copy and complete this table.

Mass (kilograms)	Weight (newtons)	Weight/Mass Ratio

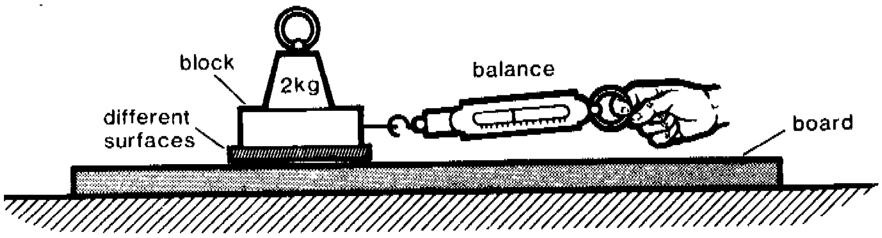
- Is the ratio always 10? Are there any sources of error in your experiment?

ACTIVITY 3

Title: Investigating Friction.

Aim: To investigate how the force of friction varies for different surfaces.

Apparatus: Block of wood, 2 kg mass, rough sandpaper, smooth sandpaper, rubber, linoleum, rough wood, smooth wood, Newton balance.



Instructions

- Assemble the apparatus as shown.
- Pull the block along at a steady speed.
- Copy and compete this table for the different surfaces.

Surface Material	Force applied (newtons)

- What type of material required the least force to move?
- Draw a bar chart of applied force for each surface material.
- Describe any pattern to your results.
- Were there any unexpected results? Try to find out why they happened.

ACTIVITY 4

Title: Reducing Friction.

Aim: To describe how friction is reduced between surfaces.

Apparatus: Air pucks, tray with polystyrene beads and puck, linear air track and vehicle, mass and rollers, two hinges.

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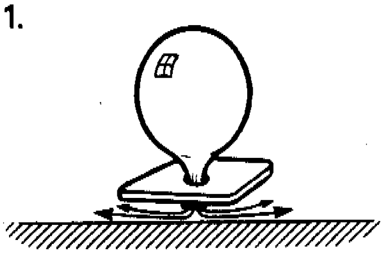

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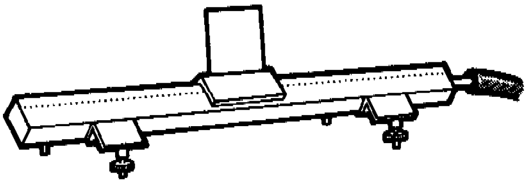

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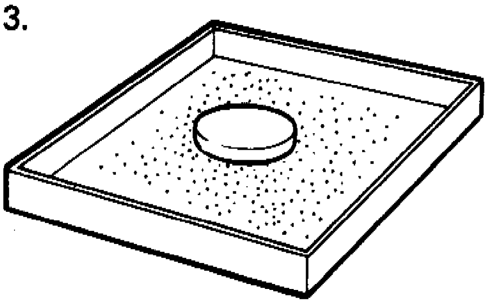

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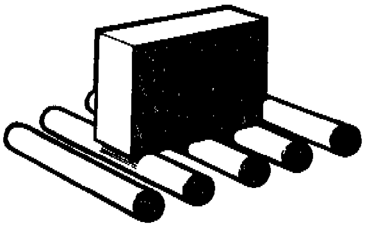

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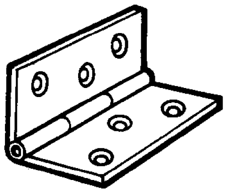


Instructions

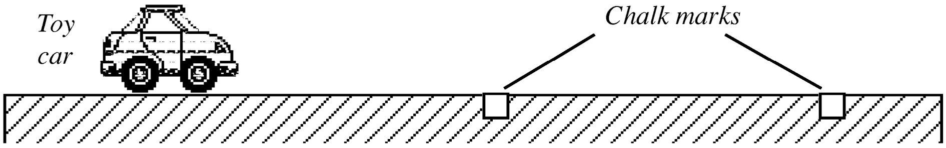
- Try moving each of the above examples without friction being reduced.
- Try again with friction reduced.
- In each case write a few lines describing the difference made by reducing friction.
- For each case draw a simple diagram to show how friction was reduced.

ACTIVITY 5

Title: Measuring Average Speed.

Aim: To measure the average speed of a toy car.

Apparatus: Metre stick, stopwatch, toy car, chalk.



Instructions

- Use your chalk to draw lines 50 cm apart on the bench.
- Give the car a gentle push so that it will run across the two lines.
- Start the stopwatch when the car crosses the first line and stop it when the car crosses the second line.
- Use the measured distance and the time on the stopwatch to calculate average speed.
- Does the speed of the car change between the two chalk lines? Explain your answer.
- Are there any improvements you could make to this experiment?

ACTIVITY 6

Title: Measuring Average Speed.

Aim: To measure the average speed of a student.

Apparatus: Measuring tape, stopwatch, 2 markers.

Instructions

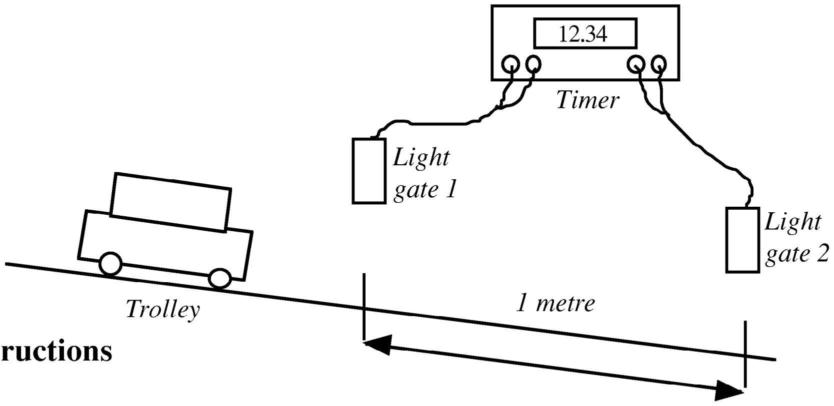
- Measure out a distance of 10 m and mark a start and finish.
- Ask your partner to wait at the start until you wave.
- Start timing and wave to start your partner running/walking.
- Stop timing when they finish, use this time and the distance you have measured to calculate their average speed.
- Repeat for other runners or different speeds and record the results in a table.
- Are there any improvements you could make to this experiment?

ACTIVITY 7

Title: Measuring the average speed of a trolley on a slope.

Aim: To measure the average speed of a trolley.

Apparatus: Trolley with light mask, two light gates, electronic timer, slope.



Instructions

- Adjust the slope so that the trolley speeds up noticeably as it goes down.
- Place light gate 1 and light gate 2 one metre apart.
- Reset the timer. Release the trolley so the mask cuts through both beams.
- Record the time, reset and repeat twice more noting each time. Copy the table below and enter the readings in your table.
- Move the light gates so that they are 0.25 m apart and repeat as above.
- Calculate the average speed for each of these distances.
- Compare the average speed over 1.00 m and over 0.25 m. Explain any difference.

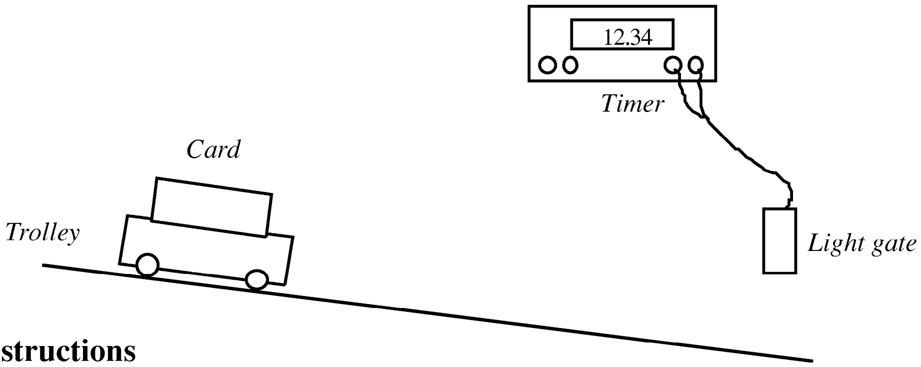
	1st Try	2nd Try	3rd Try	Average time (s)	Average speed (m/s)
Time (s) for 1.00 m					
Time (s) for 0.25 m					

ACTIVITY 8

Title: Measuring Instantaneous Speed.

Aim: To measure the instantaneous speed of a toy car as it moves down a track.

Apparatus: Trolley and card, slope, light gate and electronic timer.



Instructions

- Tilt the slope so that the speed of the trolley changes as it moves down it.
- Position the light gate so that the card cuts through it.
- Release the trolley and record the time taken for the card to pass through the light gate. Use a table like the one below to record your results.

	1st Try	2nd Try	3rd Try	Average time (s)	Speed (m/s)
Time (s) on timer					

- Repeat for two more times and find the average (release the trolley from the same point each time).
- Use the length of card and the time measured to calculate the speed of the trolley at the instant it passed through the light gate (instantaneous speed).

ACTIVITY 9

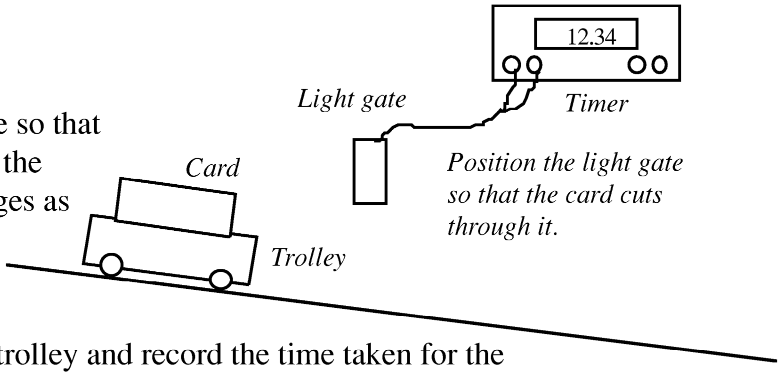
Title: Acceleration.

Aim: To find out how the speed of a moving object changes when it is accelerating.

Apparatus: Trolley and card, light gate and electronic timer, slope.

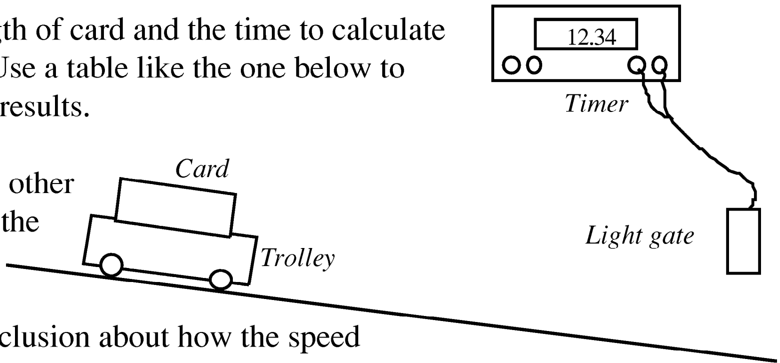
Instructions

- Tilt the slope so that the speed of the trolley changes as it moves down it.



Position the light gate so that the card cuts through it.

- Release the trolley and record the time taken for the card to pass through the light gate (repeat for three readings and find the average).
- Use the length of card and the time to calculate the speed. Use a table like the one below to record your results.
- Repeat for 2 other positions of the light gate.



- Draw a conclusion about how the speed of an object changes when it is accelerating.

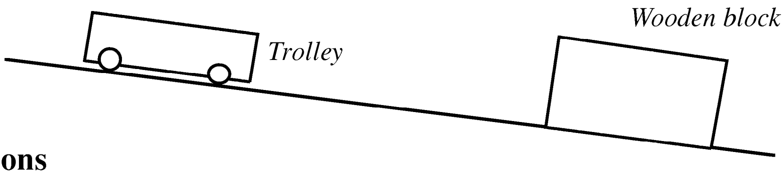
Position of Trolley	1st Try (s)	2nd Try (s)	3rd Try (s)	Average time (s)	Speed (m/s)
1st					
2nd					
3rd					

ACTIVITY 10

Outcome 3 ✓

Title: Investigating crashes and speed.

Apparatus: Trolley, slope, wooden block, metre stick.



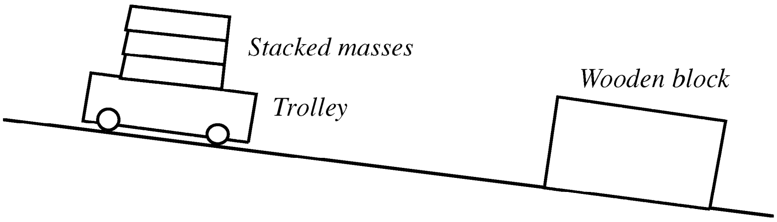
Instructions

- Tilt the slope so that the trolley gets faster as it runs down.
- Mark a start line for the trolley. You must always release the trolley from this point.
- Place the wooden block near the trolley so that the trolley is travelling quite slowly when it collides with the block. Mark the block position.
- Release the trolley and let it hit the block, moving it down the slope a little. Measure the distance moved by the block.
- Replace the block and repeat the measurement.
- Move the block to the middle of the slope. The trolley will now move faster when it collides. Measure the distance moved by the block.
- Now move the block to the bottom of the slope so that the trolley moves much faster when it collides. Measure the distance moved by the block.
- Display your results on a bar chart.

ACTIVITY 11 **Outcome 3** ✓

Title: Investigating crashes and mass.

Apparatus: Trolley, slope, stackable masses, wooden block, metre stick.



Instructions

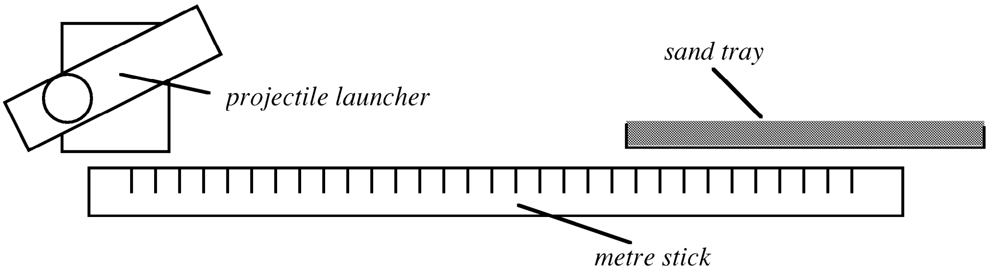
- Tilt the slope so that the trolley gets faster as it runs down.
- Mark a start line for the trolley.
- Place the wooden block in the middle of the slope. Mark the block position.
- Make sure you always start with the trolley and block in these positions.
- Release the trolley and let it hit the block, moving it down the slope a little. Measure the distance moved by the block.
- Replace the block and trolley and repeat the measurement.
- Add 0.5 kg to the trolley and release it again. Measure the distance moved by the block.
- Now add 1 kg to the trolley and release the trolley again. Measure the distance moved by the block this time.
- Display your results on a bar chart.

ACTIVITY 12

Outcome 3	✓

Title: The range of a thrown ball.

Apparatus: Ball, projectile launcher, protractor, metre stick, sand tray.



Instructions

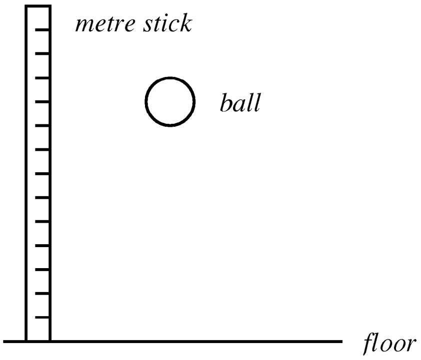
- Set up the apparatus as shown in the diagram above.
- Set the projectile launcher at an angle of 10° to the horizontal.
- Fire the ball from the launcher. Adjust the position of the sand tray so that the ball lands in the sand and leaves a clear mark.
- Measure the range of the ball (the distance from the launcher to the mark in the sand tray).
- Fire the ball a second time from 10° and repeat the measurement.
- Set the projectile launcher to larger angles in steps of 10° and measure the range of the ball for each angle.
- Plot a graph of the range of the ball against angle.

ACTIVITY 13

Outcome 3	✓

Title: The rebound height of a ball.

Apparatus: Ball, hard floor surface, 2 metre sticks.



Instructions

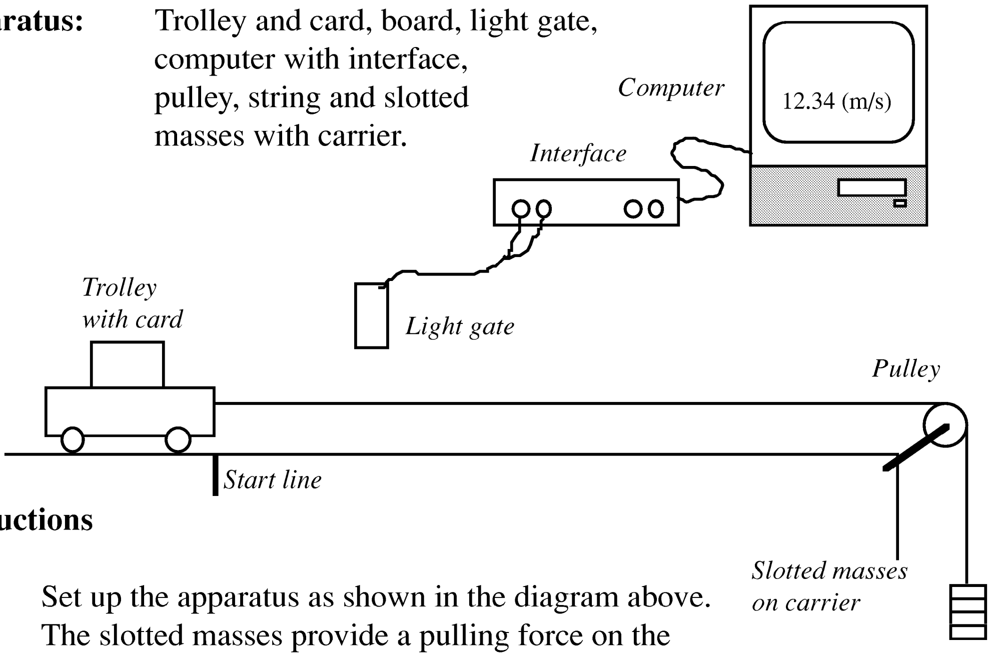
- Drop the ball from a height of 2 m.
- Measure the rebound height of the ball.
- Drop the ball a second time from 2 m and repeat the measurement.
- Reduce the drop height in steps of 0.25 m and measure the rebound height for each drop height.
- Plot a graph of rebound height of the ball against drop height.

ACTIVITY 14

Title: The effect of a force.

Aim: To investigate how the increase in speed changes with the size of the force acting.

Apparatus: Trolley and card, board, light gate, computer with interface, pulley, string and slotted masses with carrier.



Instructions

- Set up the apparatus as shown in the diagram above. The slotted masses provide a pulling force on the trolley.
- Mark the starting point of the trolley. Always release the trolley from this mark.
- Set the computer to measure speed and release the trolley so that it passes through the light gate.

Mass	Force	Speed (m/s)		
		Try 1	Try 2	Ave.
0.1 kg	1 N			
0.2 kg	2 N			
0.3 kg	3 N			
0.4 kg	4 N			

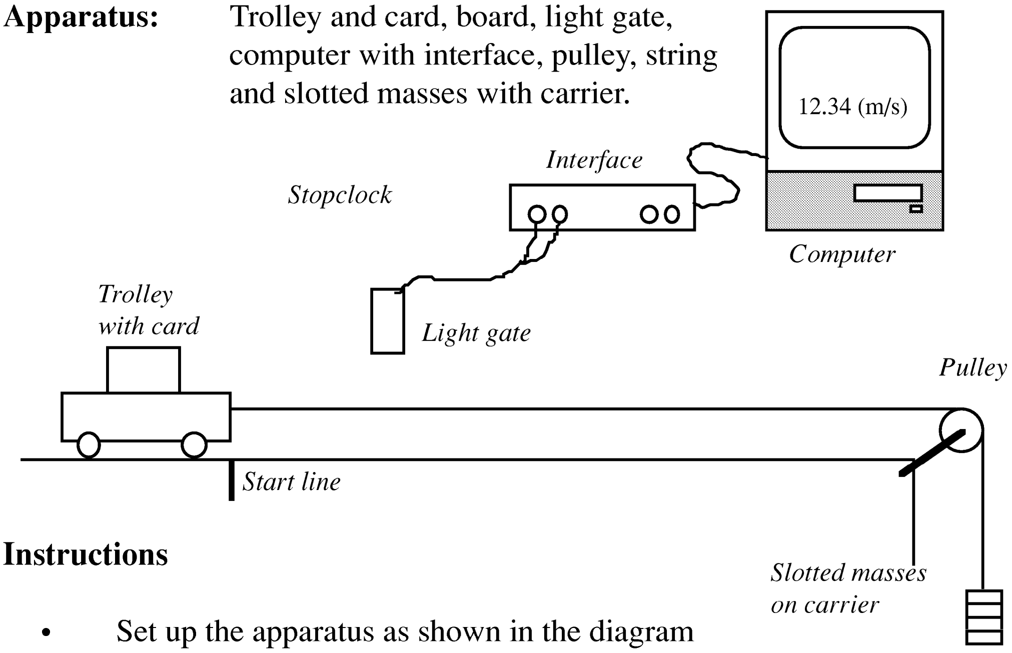
- Use a table like the one shown here to record the speed.
- Replace the trolley, reset the computer and repeat the measurement.
- Increase the mass on the carrier in steps of 0.1 kg and measure the speed in each case.
- Plot a graph of speed against pulling force.

ACTIVITY 15

Title: The effect of a force.

Aim: To investigate how the increase in speed changes with the time the force is acting.

Apparatus: Trolley and card, board, light gate, computer with interface, pulley, string and slotted masses with carrier.



Instructions

- Set up the apparatus as shown in the diagram above. Use a mass of 0.2 kg throughout the experiment to ensure the same pulling force.
- Place the light near the trolley so that the time the force is acting is short, and make sure that the trolley passes through it when released.
- Set the computer to measure speed and release the trolley. Record the speed on a table like the one shown here.

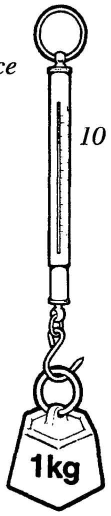
	Speed (m/s)		
Time force acts	Try 1	Try 2	Ave.
Short			
Medium			
Long			

- Replace the trolley, reset the computer and repeat the measurement.
- Adjust the position of light gate and trolley so that the force acting is a medium time and a long time. Measure the speed in each case.
- Display your results on a bar chart.

FORCES

Measuring Force

A newton balance is used to measure force

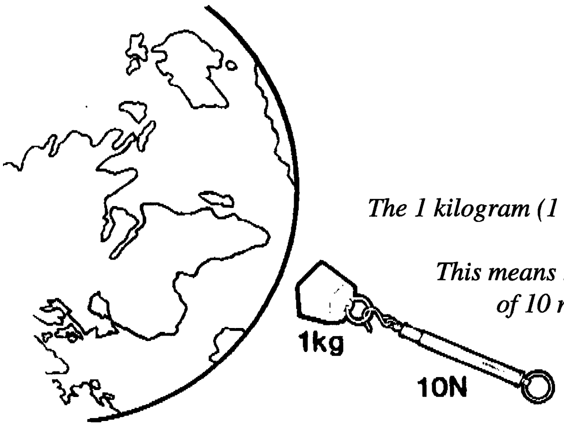


Forces can be measured using a newton balance. When a force acts on a spring balance, the spring inside it stretches. The position of the stretched spring on the scale tells you the size of the force.

The unit of force is the newton, symbol N.

Weight

Weight is a force. Weight is the pull of the Earth on an object.



The 1 kilogram (1 kg) mass has a weight of 10 newtons (10 N).

This means the Earth pulls the 1 kilogram mass with a force of 10 newtons.

Calculating Weight

For any object we can find its weight if we know the mass of the object in kilograms.

$$\boxed{\underset{\text{newtons (N)}}{\text{Weight}} = 10 \text{ x } \underset{\text{kilograms (kg)}}{\text{mass}}}$$

Example

Find the weight of a 2 kg bag of sugar.

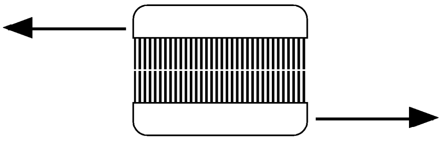
Weight $= 10 \text{ x } mass$
$= 10 \text{ x } 2$
$= 20\ N$

The weight of a 2 kg bag of sugar is 20 N.

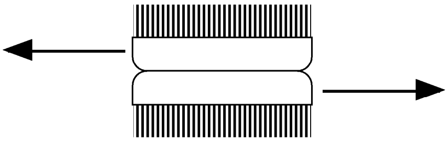
Friction

Friction causes a force that opposes the motion of a body. The force of friction can stop a moving object or slow it down. The force of friction can also keep objects from starting to move. Friction is caused by the contact of two surfaces. If objects do not slide across each other easily, the force of friction between the surfaces of two objects is large. If the objects slide easily, the force of friction is small.

When the force of friction between surfaces is high, we say they are rough, when the force of friction is low, we say they are smooth.



High Friction
Sliding rough surfaces is like sliding the bristles of two brushes - it is difficult.



Low Friction
Sliding smooth surfaces is like sliding the backs of two brushes - it is easy.

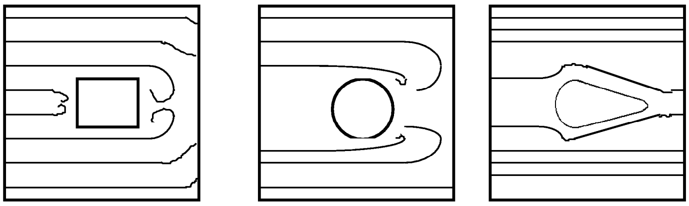
Changing Friction

The force of friction can be increased by making the surfaces rougher or by pressing the surfaces harder together.

The force of friction can be reduced by making the surfaces smoother or lifting the surfaces away from each other. Lubrication for example, uses oil which lifts two surfaces apart and reduces the force of friction. Air can also be used to lift surfaces apart e.g. in the hovercraft.

Streamlining

When an object moves through the air, the air rubs against the object causing friction; this air friction is called air resistance. Streamlining is when you change the shape of the object to reduce the air resistance.



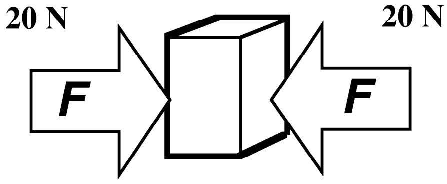
The lines in wind tunnel tests show the pattern of air flow. The smoother the air flow, the less the air resistance. The shape with the least air resistance is the teardrop shape - this is the most streamlined.

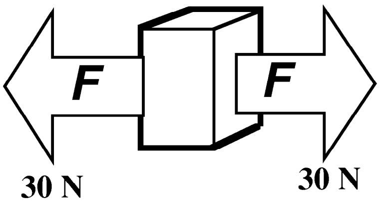
Cars and Streamlining

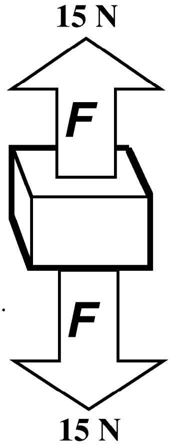
Wind tunnels are used to improve the streamlining of cars. The shape of a car can be made like a teardrop or like an aeroplane wing to reduce air resistance. Sometimes a spoiler is fitted at the back to improve the air flow making it more streamlined. Another way to reduce air resistance is to make the car closer to the ground.

Balanced Forces

When two forces are the same size as each other *and* act on the same object but in opposite directions, they balance each other. The forces are called **balanced forces**.

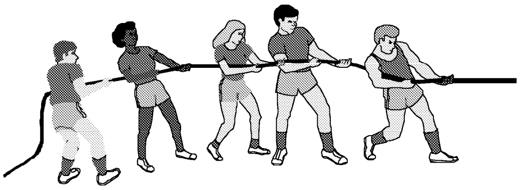






The forces that are acting on all of the objects above are balanced forces.

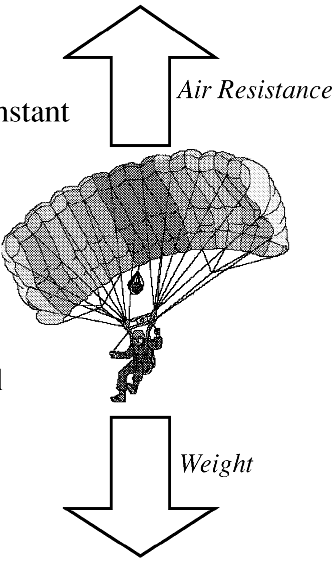
Examples of balanced forces

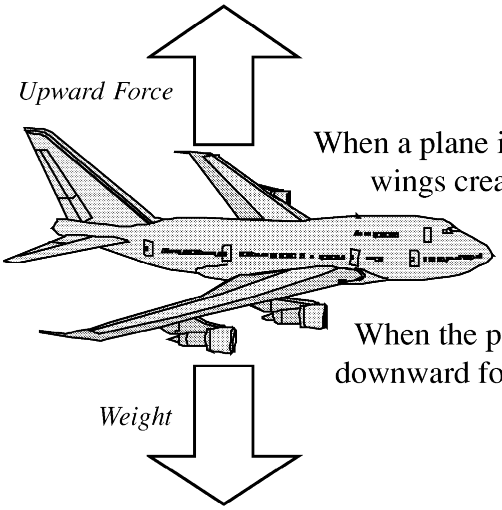


When two tug-of-war teams are pulling against each other but neither is making any progress, the forces applied by each team must be balanced.

Before skydivers open their parachute they fall with a constant speed called their terminal velocity. This is because their weight is balanced by the air resistance on their body.

When they open their parachute they still fall at a constant speed but much slower than before because the air resistance is greater with the parachute open. The air resistance is still equal to the weight so the forces are still balanced.





When a plane is travelling forwards, the air rushing over the wings creates an upward force. When the plane is flying level, this upward force balances the weight of the plane.

When the plane is taking off and landing, the upward and downward forces are not balanced.

SPEED AND ACCELERATION

Measuring average speed.

We can measure the average speed of any object by measuring the distance it travels and the time it takes to travel that distance. Average speeds are usually measured over large distances or long times.

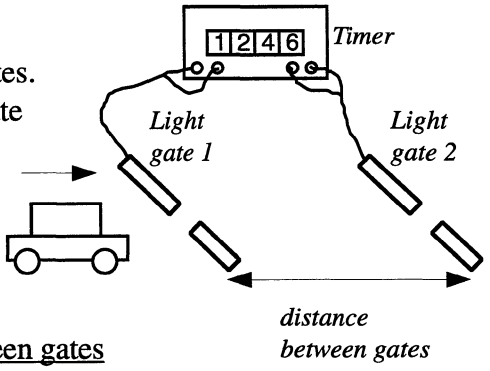
The average speed can then be found using the following equation:

$$\boxed{\text{Average speed} = \frac{\text{distance}}{\text{time}}}$$

metres per second (m/s)
metres (m)
seconds (s)

The distance can be measured using a tape or metre stick. Time is measured by a stopwatch or sometimes by a timer which starts and stops automatically.

Automatic timers are often operated by light gates. When a moving object cuts the beam of light gate 1, the timer starts timing. When the moving object cuts the beam of light gate 2, the timer stops timing.



In this case, the average speed = $\frac{\text{distance between gates}}{\text{time on timer}}$

Examples

1. A car travels a distance of 45 m in 30 s. Calculate its average speed.

$$\text{Average speed} = \frac{\text{distance}}{\text{time}} = \frac{45}{30} = 1.5\ \text{m/s}$$

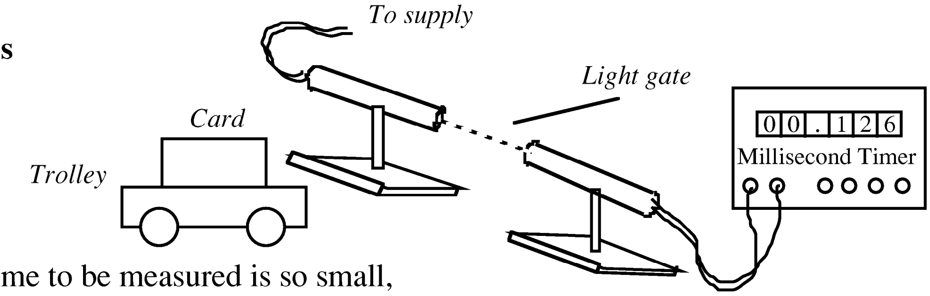
2. A trolley passes through two light gates which are 2.5 metres apart. The timer measures a time of 15 seconds. What is the average speed of the trolley?

$$\text{Average speed} = \frac{\text{distance}}{\text{time}} = \frac{2.5}{15} = 0.17\ \text{m/s}$$

Instantaneous Speed

Your speed at any particular point during a journey is called the instantaneous speed - the speed at an instant. Measuring this speed is the same as measuring the average speed but the time interval must be very small.

Measuring Instantaneous Speed



Because the time to be measured is so small, there is a problem with reaction time (the time taken by a person to start and stop a timer). To measure the speed of a moving trolley, it is better to use a light gate because there is no reaction time. The trolley is fitted with a card. The timer measures the time the card cuts off the beam of light. It starts when the card cuts the light gate beam and it stops again when the beam is remade. The instantaneous speed is calculated using the length of card as the distance and the timer reading as the time.

metres per second (m/s) *metres (m)* *seconds (s)*

$$\boxed{\text{Instantaneous speed} = \frac{\text{length of card}}{\text{time on timer}}}$$

Example

A trolley is fitted with a card 0.10 m in length. The trolley is set in motion and the card cuts a light gate. The time on the timer is 0.025 seconds. Calculate the speed of the trolley when it passes the light gate.

$$\textit{Instantaneous speed} = \frac{\textit{length of card}}{\textit{time on timer}}$$

$$= \frac{0.10}{0.025}$$

$$= 4\ m/s$$

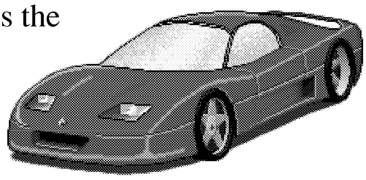
Acceleration

Acceleration is the change of speed of an object in one second. If an object is getting faster, it is accelerating - the speed of the object is increasing. If an object is getting slower, it is decelerating - the speed of the object is decreasing.

Do not confuse acceleration with speed. A car can be travelling at a high speed but have zero acceleration; also a car can have a high acceleration but be travelling at a low speed!

Car performance

Car manufacturers often state a value for their car's acceleration to indicate its performance. The usual performance figure quoted is the time in seconds it takes for the car to increase its speed from rest to 60 mph. The smaller the time, the higher the acceleration and the higher the performance.



A high performance car might be quoted as: 0-60 mph in 6.0 s

The table below shows performance figures for some makes of car.

Make of Car	Increase in Speed	Time for increase
Mini	0 —> 60 mph	10.5 seconds
Volvo	0 —> 60 mph	9.6 seconds
Ford	0 —> 60 mph	8.1 seconds
Jaguar	0 —> 60 mph	6.1 seconds

Example

a. Which car has the greatest acceleration? Explain your answer.
b. Which car has the smallest acceleration? Explain your answer.

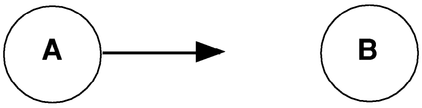
a. The car with the greatest acceleration is the Jaguar because it has the shortest time to make the same increase in speed as all the others.

b. The car with the smallest acceleration is the Mini because it has the longest time to make the same increase in speed as all the others.

MOVING BODIES

Collisions

When an object has its speed changed by another object, we say the two objects collide.



Suppose object A is moving and collides with object B.

The effect of the collision is to change the speeds of both the colliding objects.

The change in speed of the colliding objects is greater when:

(a) the objects are moving faster before collision
(b) the objects have a larger mass.

Change in Speed

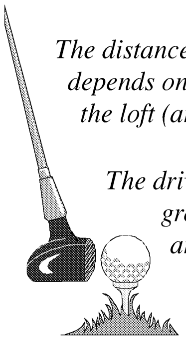
When an object has its speed changed, we say it has been acted on by a force. (Forces occur during collisions). The **larger** the force the greater the change in the speed. The **longer the time** a force is applied the greater is the change of speed.

The range of a ball

When an object is thrown or fired, it travels a distance horizontally before hitting the ground. Eventually even the fastest thrown or fired object hits the ground due to the force of gravity pulling it down. This horizontal distance travelled is called the range. The range of a ball thrown or hit is changed by:

a) the speed the ball is thrown or hit (the faster the speed the greater the range)

b) the angle the ball is thrown or hit.



The distance (range) a golf ball travels depends on the speed of the club and the loft (angle) of the club.

The driver is designed to give the greatest speed at the best angle for maximum distance.

Height of rebound

Whenever a ball bounces, it loses some of its energy so it never reaches the same height again. A ball dropped from a height of 80 cm might rebound to height of 50 cm. It will never rebound to a height of 80 cm.

When a ball hits a surface, it will rebound to a greater height if:

a) its speed on impact is large
b) the surface it hits is hard.

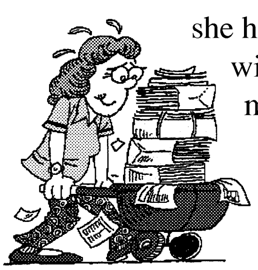
EMENT: PROBLEMS

1. Describe how to use a newton balance. Use a diagram in your answer.

2. Calculate the weights of the following objects:

   (a) 1 kg bag of sugar
   (b) a person of mass 75 kg
   (c) 0.1 kg apple
   (d) 420 g can of beans
   (e) 35 g packet of crisps

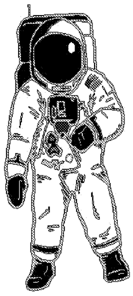
3. Susan feels she gets far too much homework. She decides to pile all her homework for a month into a barrow and weigh it. However, she finds that she has to stand on the weighing machine herself or else the barrow will tip over. The combined weight of Susan, the barrow and the month's homework is 670 newtons. Susan knows her own mass is 55 kg and the mass of the barrow is marked on it as 8 kg.



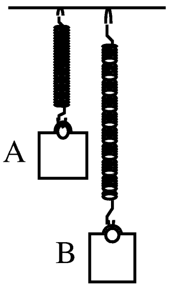
   Calculate the mass of homework Susan does in a month.

4. An astronaut has a mass of 70 kg. When far out in space the astronaut has no weight but is still 70 kg.

   Explain why it is possible for the astronaut to have no weight but still have mass.



5. The diagram below shows two identical boxes, A and B, suspended by identical springs. One box contains 50 pound coins, the other contains 50 pennies.



   Which box contains the £50? Explain your choice.

6. Copy and complete the following:

   Friction is a force caused by the ------- of two surfaces. Friction opposes the ------ of an object. Friction can also keep objects from starting to ----.

7. Friction is not always a bad thing. In many situations we want to use the force of friction. What role does the force of friction play in the following cases?

   (a) Opening a tight bottle top or jam jar lid
   (b) Sanding wood
   (c) Sports shoes on gym floors
   (d) Walking on icy pavements
   (e) Warming hands by rubbing
   (f) Striking a match
   (g) Car tyres for wet conditions

8. Often we want to reduce the force of friction. How is it reduced in the following cases?

   (a) Metal engine parts moving against each other
   (b) A hovercraft
   (c) Skates on ice
   (d) Door hinges
   (e) Air resistance of a racing cyclist

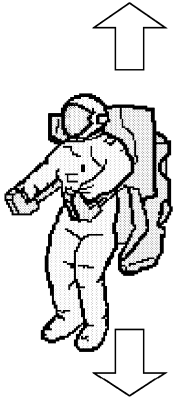
9. What force is streamlining designed to reduce?

10. Car manufacturers try to improve the streamlining of their cars.

    (a) Why is it useful for cars to be streamlined?
    (b) What are the two main things done to a car to improve streamlining?

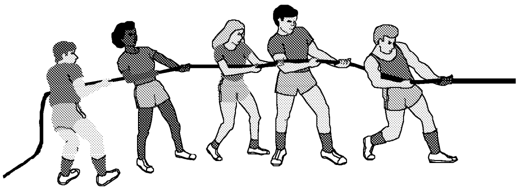
11. The picture shows an astronaut with a jet pack. The astronaut is on Earth during training for a space mission and is hovering in mid air.

    (a) Name the forces shown with arrows.
    (b) Compare the values of the forces.



Later, when far away in space, the astronaut fires his jet pack in the same way as on Earth training but finds that he moves away from the space craft.

    (c) Explain why he does not hover on this occasion.



12. In tug-of-war games both teams are often pulling. Explain why neither team moves.

13. A skydiver is falling at a very high constant speed - before she opens her parachute.

    (a) What force pulls her towards the ground?
    (b) What is the name of the force that is balancing this?
    (c) How does the sky diver use friction to reduce this high speed before reaching the ground?

14. What two measurements must be taken before you can calculate the average speed of a moving object?

15. You are asked to find the average speed of a car driving along a main road. You are given a measuring tape and a stopwatch.

    (a) Describe clearly your procedure and what measurements you would take.
    (b) A driver notices you with your stopwatch and brakes slightly. What effect will this have on the average speed?

16. A car travels 52 metres in 4 seconds. Calculate the average speed on the car in metres per second.

17. A trolley moves a distance of 10 metres in 2.5 seconds. What is the average speed of the trolley?

18. A girl on a train measures the time for the train to pass two stations as
    2 minutes and 30 seconds. From a map, she finds that the stations are
    6 kilometres apart. Calculate the average speed of the train between the two stations.

19. A student takes five minutes to walk from the playground to his class which is 200 m away. What is his average speed?

20. Do police radar guns measure average or instantaneous speeds? Why?

21. How can you tell that the speedometer in a car is measuring the instantaneous speed of the car?

22. How can you measure the instantaneous speed of a toy car at the bottom of a track?
    (a) Describe what equipment you need, what measurements are needed and how you calculate the instantaneous speed.
    (b) Describe the main differences in measuring the instantaneous speed and average speed of the car.

23. David measures the time taken for a mask on a trolley to pass through a light gate as 0.6 seconds. The length of the trolley is 15 centimetres.

    (a) What is the speed?
    (b) State whether David has measured the average speed or the instantaneous speed of the trolley.

24. Describe what is meant by the term acceleration.

25. Explain if it is possible for a bicycle have a greater acceleration away from lights than a car?

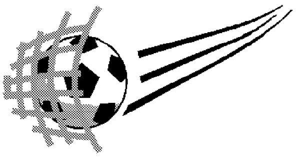
26. Car performance figures for "Feline Cars Ltd" are shown in the table.

    (a) Which model has the greatest acceleration?
    (b) After 5 seconds, approximately how fast will the Leopard be travelling?
    (c) The top speed of the Cheetah is 180 mph. At maximum acceleration, what time will it take to reach this speed?

Feline Cars: Model	Time in seconds (0-60 mph)
Cheetah	5.4
Leopard	6.2
Panther	6.8
Lion	8.1
Tiger	8.5

27. A football player is practising taking penalty kicks. Explain why the ball travels faster when the player is running when he strikes the ball than when he is standing still.

28. In the World Cup competition in France in 1998, a lighter ball was introduced. Explain why this ball travelled faster than the older ball even though it was kicked exactly the same way.



29. In a schools competition, called "Braking Without Breaking" competitors have to find a way of dropping an egg from the ceiling to the floor without breaking the egg. Devise a possible solution. Explain your solution.

30. John's father is a bricklayer. When John was watching his father at work, he noticed that his father's hand moved backwards when he caught a brick thrown to him by his workmate. John remembered that when his father caught the ball when playing table tennis, his hand did not move backwards. Explain this difference.

31. Why are golf balls made to be so hard and clubs made of iron or hard wood?

32. Padder Tennis is a popular indoor game using bats and sponge balls. What is the point of using a sponge ball?

33. A golf ball is dropped onto a concrete floor and another dropped into a sand tray.
Which rebounds higher and why?

34. Two tennis rackets are securely clamped. One is old and needs re-strung as the strings have stretched, the other is new. Tennis balls are dropped onto each from the same height. Explain which will bounce higher and why.

35. Two pupils want to find out if altering the speed of launch changes the range. The table below shows the results.

Speed of Launch (m/s)	Range (m)
10	8.6
20	34.6
30	58.5
40	138.6
50	216.5

(a) What conclusion can the students make?

(b) What would the students need to keep constant to make the experiment fair?