The Scottish Science and Technology Roadshow

SCI-FUN

Seniors' Booklet

Helpful Hints

Thank you for volunteering to be a guide for the visit of the SCI-FUN Roadshow. You will be required mostly for the hands-on exhibit part of the Roadshow session. During this time you will either be guiding a group of S1 or S2 pupils around the activities, or you will be stationed at a particular group of exhibits.

Guiding a group

- You will be allocated one group (usually of 4 or 5 pupils) and you can then begin guiding this group around the exhibits. You can start at any activity.
- It's important to get as many pupils in the group as possible to actually do the activities; it's easy to fall into the trap of just demonstrating the exhibits. Try to highlight the principal scientific ideas behind each item.
- If you need to check anything, you (or the pupils) can read the card beside most of the exhibits; alternatively, you can refer to this booklet.
- You should have about forty minutes in this session, so don't linger on any one activity for too long!

Stationed at exhibits

- If you don't have a group, then you will be assigned one or more exhibits, for which you will be the demonstrator.
- Groups of pupils will go around the activities and try them out. Your task is to ensure that the pupils have a reasonable understanding of the scientific idea behind each exhibit(s) to which you are assigned.
- Referring them to the accompanying card or poster for most of the exhibits could be the easiest way to do this, once you have explained the underlying ideas.

Make sure you refer to the Health and Safety section at the end of this booklet.

Contents

Viscosity Tubes

What to do

- **Turn the rack over so all the balls start to fall through the liquids.**
- **Which ball gets to the bottom first?**
- **Why?**

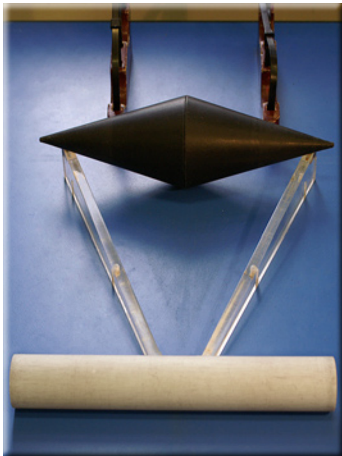
How does it work?

- We can explain this effect using the principle of viscosity.
- The viscosity of a liquid is a measure of how quickly it flows. For example, shower gel is more viscous than water: it flows more slowly. The more viscous a liquid, the more difficult it is for objects to move through it.
- The tubes contain: water, orange squash, cooking oil, shower gel and washing-up liquid.
- When you turn the tubes over, gravity causes the balls to begin falling. The more viscous the liquids are, the more they will resist the downward movement of the balls, thus increasing the time taken for the ball to reach the bottom.

Tip: Make sure the pupils realise that viscosity doesn't go hand in hand with transparency. Some S2s may expect that the orange juice will be the most viscous as they cannot see through it.

Uphill Gravity

What to do



- **Place the silver tube at the top of the slope and let it go... it will roll down, as you would expect.**
- **Place the black object at the top and it should stay there. Place it at the bottom and it will roll... up?!**

How does it work?

- This apparently odd behaviour can be explained using the idea of the *Centre of Mass* (or Centre of Gravity).
- Gravity acts on an object as if the entire object's mass was located at one point (the centre of mass). Gravity is the force by which all objects attract each other – in this example the Earth and the tubes are being attracted to each other. This means that the silver tube is pulled down and the Earth pulled up (although the Earth is so big you don't really notice the planet moving upwards...)
- The movement of the black object seems to go against common sense initially, but it doesn't... To see why, crouch down and look closely at the distance between the middle of the double coned black object and the board. You'll see that the bottom edge of the black object actually gets closer to the board as it travels "up" the slope, confirming it is indeed attracted by earth.

The Tippy Top exhibit seems to defy this rule: its centre of gravity moves upwards when it turns over... Check out its exhibit page to find out why.

Puzzles

These are mechanical puzzles – sets of mechanically interlinked pieces. Puzzles of this type came from Greece in about the third century B.C.

Warning: the following text will give you subtle hints on to how to complete the puzzles!!

Packing Squares

- **What to do: Try to fit all 11 blocks into the base.**
- **Tips**: Do not put all the blocks in so they look like squares from above. Instead, put the blocks in so they like squares and diamonds. You should be able to fit the blocks in now!

The Three Rings

- **What to do: Arrange the pieces so they look like 3 of the 5 interlocking Olympic rings by the end.**
- **Tips**: Start with the small central pieces. Arrange these so that they look like the picture to the right and the rest should fall into place.

Chinese puzzle

- **What to do: Use the pieces to make the star shape outlined on the board itself.**
- **Tips**: Start with the two larger pieces in opposite corners and keep them there.You should now find it easier to put the smaller pieces in around these to complete the task.

Spinning Chair

What to do

- **While the pupil holds the two weights, press the button of the seatbelt before you buckle the pupil in, otherwise the buckle won't engage.**
- **Place your foot on one corner of the base (this helps to keep the chair stable) and make sure the pupil's arms and legs are stretched out.**
- **Spin the chair only once for each pupil, clockwise (see below).**
- **After one complete rotation ask them to tuck their legs and arms in.**
- **Get the pupil to change the position of their limbs a couple of times, before asking the pupil to keep their arms and legs stretched so that you can stop the chair.**

They will rotate noticeably faster when their arms and legs are tucked in and will slow down when they stretch their legs.

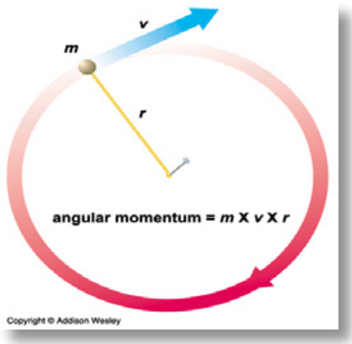
Safety Note: Make sure you secure the seat belt before starting.

Rotate the chair clockwise; rotating the chair anti-clockwise may loosen the bolts at the bottom of the chair, making it unsafe.

Keep one foot on a corner of the board to stop it moving. Keep an eye on the audience: make sure they are not too close, or they could be hit.

Spinning Chair

How does it work?



- It is all to do with *angular momentum*.

- Basically, angular momentum is related to the mass of the object, the velocity of the object, and its distance from the rotation axis (or radius), as shown by the equation below:

Angular momentum = mass × velocity × radius

- Angular momentum is a *conserved quantity* and therefore remains constant (unless acted on by an external *torque*, or twisting force). When you ask the students to bring their arms and legs in, the radius of the student's body overall is reduced but the mass remains the same. Therefore, in order to conserve angular momentum the speed has to increase.

- The basic rule is: *if one of the quantities above increases, one or both of the others must decrease.*

- The conservation of angular momentum explains many phenomena in sports:

- Figure skaters tuck their arms and legs in order to rotate faster. Later, they extend their limbs so they slow down and can skate away from the spin more easily.

- On the uneven parallel bars, gymnasts will carry out a spin with the body at full length on the top bar, and will then tuck themselves in to reduce the radius of rotation, and thus greatly increase their angular velocity (spin).

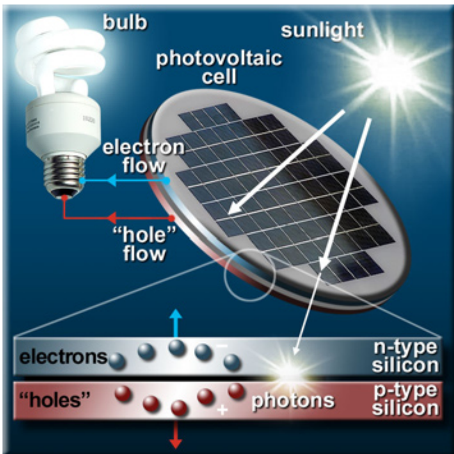
Solar Cells

What to do

- **Put the plug into sockets 1, 2, 3 and 4 in turn to select an increasing number of solar cells to be connected.**
- **What happens to the electrical output as you increase the number of cells?**
- **Try obscuring the light source – what happens to the electrical output now?**

How does it work?

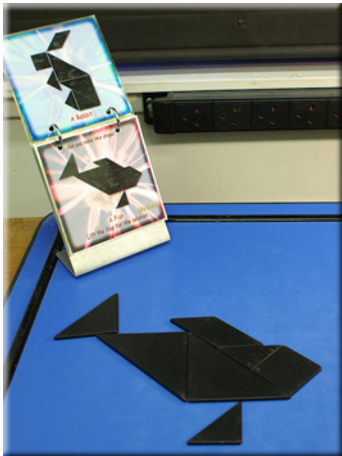
- This exhibit demonstrates the ability of photovoltaic (PV) cells to convert light directly into electrical energy via the photovoltaic effect.
- This effect shows how some materials absorb energy from the Sun, causing a current to flow between two oppositely charged layers.



- As the number of cells is increased the output increases. When the light is obscured the output will go down.
- Solar energy is one source of *renewable energy*. Traditional methods of power generation will only last as long as the raw materials will allow, and we now need long-term and sustainable energy generation methods.
- Renewable energy sources (such as solar, wave, wind, tidal and geothermal energy) are an increasingly promising option, but current technologies do not allow us to rely solely upon this method of generating energy.

Tangrams: The seven boards of cunning

What to do



- **Try to make each of the patterns on the board and some of the examples on the flip card.**
- **You must use all seven pieces, and none of them can overlap.**

History:

The tangram puzzle was invented in China, but nobody knows exactly when. The earliest known reference was in 1780 when an American ship owner brought a set back for his son. The Chinese word for "tangram" literally means "seven boards of cunning". Napoleon reputedly had a set during his imprisonment on St Helena.

You need logic and problem-solving abilities to complete these geometrical puzzles, both skills that are essential in science!

Seven Segment Display

What to do

- **Switch the display to COUNTER and look at the bulbs around the hands to see how the digits are formed by the segments.**
- **Then set it to MANUAL, and try making your own numbers and letters. Try writing the letters of your name, for example.**

How does it work?

- Digital displays are all around us. Each character in the simplest form of display is made up of seven pieces or segments (labelled from “a” to “g”). This technology is very common in basic calculator screens.
- The chip used for displaying numbers has a table built into its memory telling it which lines to activate for a particular number. In this exhibit, the pupil is taking the place of the chip and is feeding in the information by pressing the buttons.
- Seven segments displays are fine for representing the numbers 0 to 9, but they struggle with even the simple Latin alphabet used in most European languages, and they are completely overwhelmed by languages such as Japanese, with many thousands of highly complex characters. More advanced displays now use a dot-matrix approach, with each character being an array of perhaps 10 dots by 18.

Colour Box

What to do

- **Look through the hole into the box with the lid closed – what colour do you see?**
- **Keep looking through the hole as you lift the lid. What colour do see now?**

How does it work?

- When light hits an object, some is absorbed and some scattered. The scattered light from the object then enters our eyes, making it visible to us: we see the colours that are not absorbed.
- When looking into the colour box with the lid down it looks black, but when the lid is lifted it allows white light to shine in. White light is made up of lots of colours, which we are able to see in a rainbow: red, orange, yellow, green, blue and violet.
- Most of these colours in the white light are absorbed by the paint inside the box, but yellow light is reflected to our eyes.
- Another good example is the leaves of green plants which contain a pigment called chlorophyll. This pigment absorbs blue and red light but reflects green light.
- It's actually a bit more complicated than this: an object which reflects both red and green light will also look yellow to our eyes, because of the way the receptors in our eyes have evolved. We can detect red, green and blue light: yellow light activates both the red and the green receptors.
- By putting together various combinations of the primary colours red, green and blue we can fool our visual system into seeing most of the colours in the visible spectrum. We can even see colours such as magenta (red and blue), which don't actually exist in the spectrum as a pure colour!

The Coanda Effect

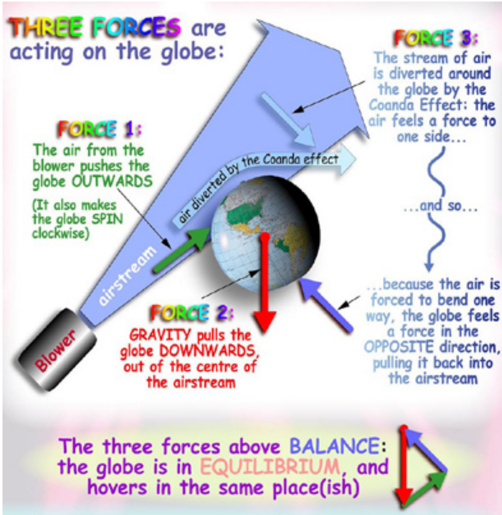
What to do

- **To start place the ball over the jet of air (for your information, the base unit has a red switch on top if the exhibit is not on). The ball is able to hover.**
- **Gently hold the end of the nozzle (not over the top!) and slowly move it sideways. If you are careful enough, the ball will remain levitating for longer than you might think it will...**

How does it work?

- In the starting position (pointing straight up), there are two main forces at work. Gravity tries to pull the ball down, but the jet of air balances this and levitates the ball. (The ball may "bounce" up and down to start with – this is just the gravitational and jet forces finding their equilibrium.)
- When you move the end of the nozzle, the ball will remain levitating since there is a third force acting upon it. If there were only the forces of gravity (pulling the ball down) and the jet of air (pushing the ball away), the ball would quickly fall.
- The extra force is caused by the *Coanda Effect*, which is the tendency of a stream of liquid or gas to stay attached to a convex (curved) surface, rather than following in its original direction of travel. You can easily demonstrate this by holding a spoon close to a stream of water coming from a tap. The water will be diverted and run down the surface of the spoon. And, because the water is diverted in one direction, the spoon will feel a force in the opposite direction: if you hold it lightly, it will be pulled into the flow.

The Coanda Effect



- When the jet of air reaches the ball, part of the jet stays attached to the ball, following it around part of its upper curved surface (as you can see opposite): this is known as *skin adhesion.* As the jet moves along this surface, friction acts just as it would between any two surfaces, and so the jet of air slows down here. The key point to understand is that the *direction* of the jet is changed.
- Newton's third law tells us what happens to the ball: the jet feels a force, caused by the ball (the skin adhesion effect) which bends the jet downwards. The ball therefore feels an *opposite* force from the jet, pulling it upwards.
- The Coanda effect is named after Henri Coanda (1886 – 1972), a Romanian inventor whose work in aerodynamics led to the development of the modern jet aircraft.

Safety Note: The jet of air for this exhibit travels at approximately sixty miles per hour, so it important that the pupils do not aim it at their own or anyone else's face. Although very unlikely, if a piece of grit gets caught in the jet of air it could potentially cause some significant eye damage.

Pangaea: Solving the Mystery

What to do

- **First arrange the continents to look like todays world map.**
- **You may notice several strange things. (These are described on the poster.)**
- **Now rearrange the continents to take the shape of Pangaea. (The red outline on the board should help you.)**

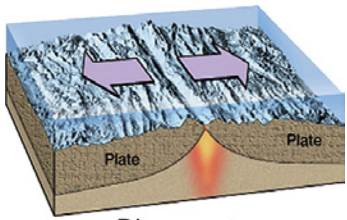
How can it be explained?

- These unusual findings can only make sense if we shift the continents across the globe from their current positions, going backwards in time, and using the lava compass directions, about 200 million years ago an amazing thing occurs: all of the continents come together in one supercontinent: Pangaea.
- This exhibit illustrates the process of *plate tectonics*.
- The surface of the earth is made of a thin layer of rock called the crust (or lithosphere) and a lower part called the mantle (or aethenosphere) which demonstrates a flowing motion over long periods of time: it is still a solid, but it can very slowly “creep”, under the right conditions. The lithosphere is made up of different tectonic plates which can be carried by the slow-moving lower mantle.
- This movement is extremely slow (it flows about the same rate as our fingernails grow), but over time has led to continents moving to the positions they occupy today.

Moving Continents

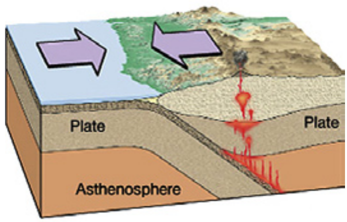
What happens at the plate boundaries?

- The plates move in different directions relative to each other leading to a variety of activities at the plate boundaries. There are three types of boundary: divergent, convergent and transform:
- **Divergent boundaries:** in areas where two plates slide apart from each other, the resultant space is taken up by molten material from the mantle which then cools to form a new part of the crust.



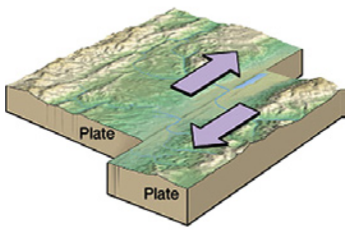
Divergent

- **Convergent boundaries:** where two plates slide towards each other, commonly forming either a subduction zone (if an oceanic plate dips underneath a continental plate) or a continental collision (if the two plates contain continental crust).



Convergent

- **Transform boundaries:** in areas where plates grind past each other along transform faults. Stress builds up which is eventually released by a sudden movement of the plates; we experience this as an earthquake.
- Volcanoes are always closely linked to subduction zones due to the friction and heating of the subducting slab. On the other hand, when continents collide they may give rise to new mountain ranges. (The Himalayas, for example, were formed when India collided with the Asian plate.)



Transform

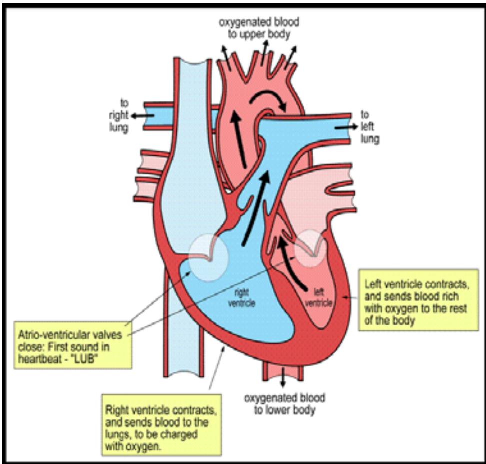
Heartbeat Monitor

What to do

- **Hold onto the copper handles and keep as still as possible. The display will update and you should be able to compare the shape of your pulse on the computer with the image on the poster.**

The Heart

- Consists of four chambers: left and right Atria and left and right Ventricles.
- The heart pumps blood to and from the lungs – where it is loaded with oxygen – and then around the body to deliver the oxygen needed for the many processes that keep us alive.
- The heart chambers are made of cardiac muscles which contract under the control of electrical signals.
- Unlike the skeletal muscle, this cardiac muscle can charge and discharge independently of the central nervous system.
- Hormones such as adrenaline (epinephrine) are also used to regulate heartbeat, for example to increase heart rate as part of the “fight or flight” response to danger.



Heartbeat Monitor

What do the peaks show?

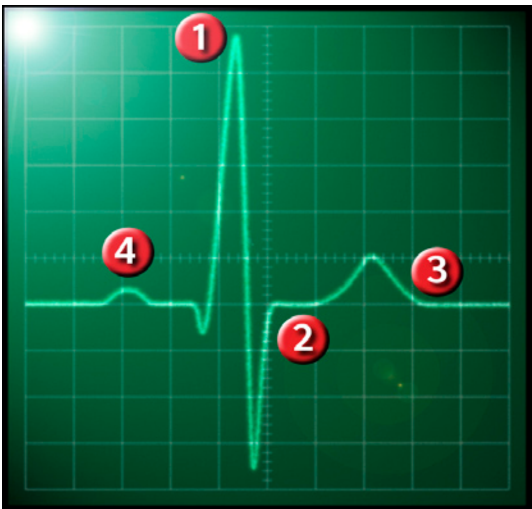
- Electrical signals from your cardiac muscles are detected by measuring the voltage differences between your hands whilst holding onto the handles, giving rise to these peaks on the computer screen.

1) Both ventricles contract.
   Right ventricle sends deoxygenated blood to the lungs.
   Left ventricle sends oxygenated blood around the body.

2) Atrioventricular valves close.

3) Aortic and pulmonary semilunar valves close.

4) The atria both contract, refilling ventricles with blood from the lungs and body respectively.



Human Circuit

What to do

- **Hold onto both of the metal handles: you will act as a conductor allowing the lamp to light.**
- **Try it with more than one person. Can your whole group form a human circuit with the people on the ends holding the handles – does the light still go on?**

How does it work?

- Circuits are closed paths for electricity. For the circuit to work, electrons (or other charged particles) must flow from the negative to the positive end to create a flow of electricity (electric current).
- Electricity needs a conductor in order for electrons (or negative charges) to flow. Conductors are materials in which it is easy to get electrons to move. (Mostly metals, such as gold, silver, copper, iron and lead. Humans can also act as conductors)
- By holding onto the handles you are acting as a conductor, completing the electric circuit and allowing the lamp to light.
- Currents are measured in milliAmps (mA), and a current as small as 50mA could be fatal. The headlamp on the exhibit needs about 700 mA to light up; if this were to pass through your body you would be killed. (A current of about 10 mA can be painful but not harmful, and at around 20 mA your muscles will contract sharply).
- This circuit uses transistors as a current amplifier. A transistor uses a small electrical current in one part of the circuit to control a large change in current in a separate circuit. (This makes the circuit safe to use: you only touch the first part.). The three transistors in our exhibit boost the tiny current by 70,000 times to light the lamp.

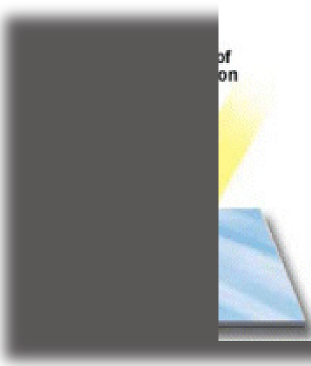
Mirror Box

What to do

- **Get the pupils to look down into the mirror box.**
- **They should observe a tunnel or shaft effect outlined and highlighted by the lights.**
- **The effect should continue down some distance, apparently through the table.**

How does it work?

- The mirror box works by using two mirrors: a normal mirror and a two-way mirror. A two-way mirror reflects some percentage of the light and lets most of the rest pass through.
- The two mirrors reflect the light between them. This continued reflection back and forth between the mirrors creates the tunnelling effect you can see.



- A two-way mirror can be used between a dark room and a room that is brightly lit. The difference in light level allows one side to be reflective while allowing the other side to be viewed through. People in the darkened room can easily see into the light room, but people in the light room would simply see an ordinary mirror. A two-way mirror does not work between equally lit rooms.
- Law of reflection: The beam of light before striking the mirror is called the incidence ray and the reflected beam is the reflected ray. The law of reflection states that the angle of incidence always equals the angle of reflection.

Life Through Time

What to do

- **Let the pupils lift up the various sections of the history box and read the appropriate text for the different eras.**
- **The main thing they should take away from this exhibit is the way in which scientists can work out what life was like in each era, and how it adapted to the different conditions.**

How does it work?

- This exhibit involves examining the various eras which are collected together under the Phanerozoic eon. (Phanerozoic means "visible animals.")
- This exhibit is based largely on information taken from fossils and from different types of drilling cores taken from the earth, such as ice cores.
- Using this information, scientists can work out what previous environmental conditions were like (including the temperature, rainfall and sea-level, as well as what life was present).
- Another idea which could be drawn into this discussion is evolution: how animal species have adapted or failed to adapt to changing environments and why certain characteristics are found in various species.

The Virtual Pig

What to do

- **Stand back from the box, and look through the slot on the front panel: your eyes will be at exactly the right height.**
- **Can you see the pig rotating on the top of the box?**
- **Try to pick it up...**

How does it work?

- When we see something we are detecting the light that has reflected or scattered from the surface of that object, and entered the pupils of our eyes, landing on our retina.
- When we look in a mirror, the light we detect doesn't travel straight to our eyes; it has reflected from the mirror, then into our eyes. The light comes from the direction of the mirror, so we see the image in front of us, seeming to be behind (or inside) the mirror.
- Since we are used to looking in mirrors, we know from experience that what we see is not really in front of us. However babies, cats and dogs tend to believe that the image is another animal.
- The mirage unit uses two curved mirrors to change the direction of the incoming light (there's an old unit that we've sliced in half, to show you the curved shape inside the box):

    a) Light reflects from the pig onto the upper mirror.
    b) The light reflects from the upper mirror onto the lower mirror.
    c) Finally, light reflects from the lower mirror back into our eyes.

• The result of this is that we can see an image of the pig, the right way up, floating just above the top mirror. The exhibit board has a cut-away diagram showing the light ray paths.

Match the Note

What to do

- **Two pupils take part: one is the listener (on the left with the headphones) and the other is the tester (the right).**
- **The tester makes sure that the switch is in *random* mode and then presses the button. The listener hears a random note and the tester should remember the numbers on the screen.**
- **The listener flicks the switch into *manual* mode and then uses the dial to try to reproduce the *exact* pitch of the random note using the frequency generator.**
- **The tester observes the accuracy of the listener and can confirm, once the listener has guessed, if the listener is correct or not. The aim is to get a good match, within 10 waves (Hertz or Hz) of the target frequency.**

How does it work?

- Sound waves are changes in air pressure. When something vibrates, it causes pressure waves to move through the air.
- When we hear a sound it’s because pressure waves have reached our ears and are making our eardrums vibrate.
- This vibration is then converted into electrical signals, and transmitted by the nerves to our brain.
- The more waves that hit our eardrums per second, the higher the pitch, and therefore the higher the note we hear. The number of waves per second is referred to as frequency, hence the “frequency counter” at the exhibit.
- Someone who is tone-deaf cannot distinguish between different pitches of sound: although they can hear all of the sounds, each note sounds the same.

IR Camera

What to do

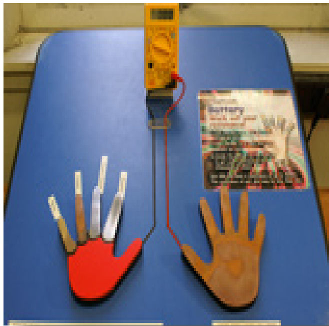
- **Hold the button on the infra-red torch and look at the two bulbs. Can you see anything?**
- **Repeat this, but now shine the torch towards the camera. You should see the bulbs working on the TV screen.**
- **Shine the torch at the camera again, and then pass the black bottle between the torch and the camera. Can you still see the infra-red?**
- **Point the TV remote at the camera and press the button. Can you explain what you see?**

How does it work?

- Our eyes can see all the colours of the rainbow, but this is only part of the *electromagnetic spectrum*.
- When our eyes detect visible light we see different waves as different colours. Shorter waves are blue and longer waves appear as red. Light with a longer wavelength than we can see is called *infra-red.*
- Infra-red radiation is invisible to us, but we experience infra-red every time we feel the heat of the sun on our skin or the heat of a fire. Gamma rays, X-rays, ultraviolet light, microwaves and radio waves are all part of the electromagnetic spectrum, but we cannot see them.

- Infra-red radiation has the same properties as visible light as it can be focused and reflected. Video cameras are sensitive to some infra-red; this is the same radiation used by remote control. Some fish, including goldfish, can see infra-red, which helps them detect things in murky waters (such as the rivers where they live naturally).

Human Battery



What to do

- **Place your right hand on the copper plate**
- **Place one finger from your left hand on any one of the metals (aluminium, copper, brass and steel).**
- **You are now part of the circuit allowing electrons – and therefore electricity – to flow.**
- **The meter measures the current and voltage: these will vary depending on the metals in the circuit.**

How does it work?

- Inside a battery an electrochemical reaction produces electrons and positively charged ions. The negatively charged electrons collect on the negative terminal and the positively charged ions collect on the positive terminal. If you connect a wire between the negative and positive terminals, electrons will flow from the negative to the positive terminals.
- Your skin and two different metals can create a battery, with a thin layer of sweat on your hands acting like a weak acid.
- In an electrical circuit, the number if electrons that are moving per second is called the current (measured in amps). The "pressure" pushing the electrons along is called the voltage (measured in volts).
- The sweatier your hands are the faster the electrons will flow, causing a higher current to be shown on the meter. This is how lie detectors work: if asked a question that we lie about, we are more likely to sweat so the current will quickly increase. (This is not very accurate, however.)

Hole in the Hand

What to do

- **Hold the plastic tube up to one eye and then hold your other hand next to the tube with your palm facing you. Keep BOTH eyes open.**
- **One eye will see the distant image at the end of the tube and the other eye will see the palm of your hand. What is happening?**
- **Look at the chessboard: which square is darker, A or B?**
- **Square A should look darker than square B. Now pick up the additional card with the two holes cut in it, and place it over the poster. Is A still darker than B?**

How does it work?

- Hole in the hand: your brain quickly tries to combine these images in a "sensible" way producing an optical illusion of a hole in your hand.
- Our eye is a complex structure that works by capturing light and transforming it into impulses that the brain can interpret as images.
- Our eyes see roughly the same image, but there is a small difference between each eye. Our primate brains have evolved to quickly combine the left and right images to construct a 3D model of the world around us.
- *Chessboard:* your visual system tries to work out the true colour of objects in the real world under different conditions of light and shade. By looking at the board you can see that B is a shadow of the green cylinder. Because your brain understands that objects in shadow are much lighter than they appear, it makes you think the square B is lighter than A when in fact they are the same shade of grey.

BMI (Body Mass Index)

A person's BMI is calculated by measuring their height and weight and performing the following calculation:

$$\textbf{BMI = Weight (Kg) / Height}^2\ \textbf{(m}^2\textbf{)}$$

To measure the person's height

- Hold the device horizontally, with the white panel on top of the person's head. Use the spirit level to ensure it is level.
- Press the red button until a beep is heard.
- Continue to hold the device steady until a double beep is heard (about 5 seconds).
- The height (in metres) can then be read from the display.

Note: make sure the device is facing the right direction; the red button should be on the underside when you press it, otherwise you will be measuring the distance between the person's head and the ceiling!

To measure the person's weight

- Tap the scales to ensure they are switched on and display reads "0".
- Get the person to stand still on the scales until the display stops flashing: the weight will be displayed in kilograms on the screen
- Use the table provided to match up the person's weight and height to determine their BMI.
- Healthy values of BMI vary with age and also depending on whether someone is male or female; healthy ranges are shown underneath the table.
- BMI does not take into account muscle mass, so people who have a large amount of muscle may have a BMI above the healthy range while still being healthy.

Periodic Table

What to do

Test your group's knowledge on the elements present in:

- **water**
- **sugar**
- **table salt**
- **elements in the human body**
- **petroleum**
- **main greenhouse gases**
- **radioactive elements**
- **most abundant element in atmosphere/earth/the universe**

Press the buttons to find out if you're right and lift the flaps to find out more information.

What is the periodic table?

- The periodic table arranges all the known elements in order of increasing atomic number from left to right and from top to bottom.
- The atomic number of an element tells us the number of protons (positively charged particles) present in each element, helps us to identify what the element is and what chemical properties it has.
- The periodic table groups similar elements together from metals (alkali metals, transitions metals) on the left-hand side to non-metals (halogens and noble gases) on the right-hand side.
- Elements are named after many different things including people, planets, minerals and sometimes their chemical properties. Some more recently discovered elements are given systematic names (e.g. elements 112-118) until such time as an official name is decided upon.
- (Recently (May 2010), element 112 has been named *Copernicium.*)

Note: *element 117 is listed as "undiscovered": no form of it has been found that is stable enough for it to be regarded as a new element.*

Conflicting Signals

What to do

- **Your task is to read the *colour* of the word, and not the word itself. For example, you should read "BLUE" as "RED", because the *colour* is red.**
- **Now turn the board around, and try the words on that side. Again, you must read the *colour* of the word rather than the word itself. Is it easier or harder to do the exercise now that each word has been mirror-reversed?**
- **Try reading the paragraph on the A4 card; how easy do you find this task?**

How does it work?

- Your brain is receiving conflicting signals regarding the colour you are seeing. Through life we have been taught that is RED, and the word "BLUE" relates to this colour:
- Therefore, when we are presented with the word "BLUE" written in red, our brain receives two signals: the word (blue) and the colour (red). Our brains are well trained to say the word, and this signal gets in the way: it makes us hesitate when we try to quickly say what colour the word is.
- Mirror-reversing the words should in theory make it easier, because this lessens the effects of the word signal to the brain, and the word makes less sense. Some people, however, find this task more difficult. One theory suggests that in seeing a reversed word we automatically try to put it back round the correct way to make sense of it. This adds an additional mental step which confuses us further.
- The paragraph on the card is quite readable despite the random alterations. Spoken and written language has lots of redundancy: you can still work out what is being said even when there are errors or whole pieces missing. Some sentences can prove more difficult if we don't randomise the letter order: ***A dootcr has aimttded the magltheuansr of a tageene ceacnr pintaet who deid aetfr a hatospil durg blendur***. In this case we see what might look like real words, which is confusing.

Animal Tracks

What to do

- **Smooth out the sand.**
- **Take one animal foot cast and print it hard on the surface.**
- **Try to work out what animal could have made the print, before lifting the flaps to find the answer.**

What does it tell us?

- Studying the tracks allows you to identify the animals that made them.
- Animals leave different impressions in the ground depending on how they walk:

  a) A Plantigrade animal walks with the entire sole of its foot on the ground. (Examples are Humans, bears and squirrels.)

  b) A Digitigrade animal walks with the whole length of its foot on the ground but not the sole, so the impression in the ground will show only the toes. (Examples are dogs, cats and foxes.)

  c) Ungiligrades animals are hoofed mammals that walk on their tip toes (horses, cows, deer).

A full cycle of motion of a mammal walking or running is called a *stride*. By studying animal tracks we can work out the speed at which the animal was moving, because the faster the animal moves, the further apart are its tracks.

Forensics

Forensic scientists use clues found at crime scenes to figure out who was responsible for the crime.

What to do

Get your group to work through each clue to determine who was responsible for the crime in this case. Each clue can help you eliminate one suspect: lift the flap at the end to see if you were correct.

• *Clue 1: Soil Samples*

Soil from different areas will have a different pH value depending on how acidic or alkaline it is.

Check the pH of soil collected from the crime scene and from the shoes of the suspects. See if each suspect can be ruled out or linked to the crime scene.

Forensics

• Clue 2: Fingerprints

Each person has a unique set of fingerprints that identify them as different from everybody else.

Match the fingerprints of each suspect with those found at the scene of the crime.

• Clue 3: DNA Fingerprinting

Our DNA is what makes us truly unique.DNA found at a crime scene can be matched up to samples taken from victims and suspects to determine who was at the scene of the crime. DNA samples from the crime scene will be likely to contain both that of the suspect and the victim, putting the card under the UV lamp shows the DNA present in the sample.

Compare the DNA found at the crime scene with that of the victim and each of the suspects to work out who could have committed the crime.

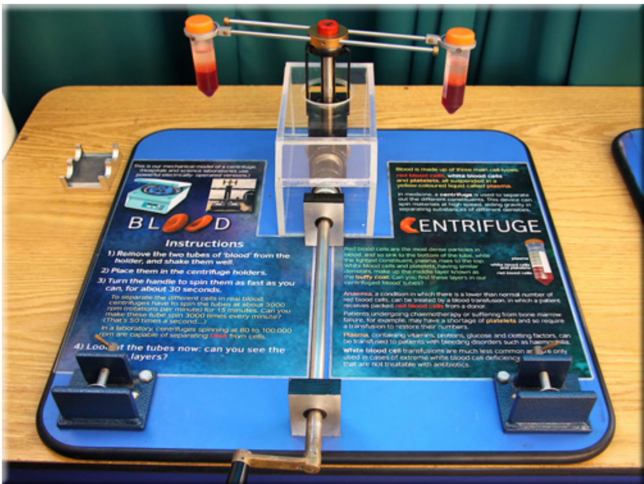
Centrifuge

How to use the centrifuge

- **Shake up the tubes to ensure that all the layers are well mixed.**
- **Place one tube in either arm of the centrifuge, behind the plastic screen.**
- **Get a member of your group to turn the handle as fast as they can for about 20 seconds.**
- **Once the centrifuge has stopped remove the tubes: three distinct layers should now be visible.**

Can you name the three layers, based on the board notes?

Safety note: Ensure all members of your group are in front of the plastic safety screen before spinning the tubes.



How does it work?

- The three main components of blood have different densities.
- The centrifuge apparatus spins them at high speed, which causes heavier cells to be forced to the bottom of the tube while lighter cells remain on the top of the sample, allowing the three different layers to form from each different type of cell found in blood.

Components of Blood

The plastic tubes contain representations of the three main components found in blood:

- Red blood cells
- White Blood cells
- Platelets

Each of these is responsible for a different function; these are explained in depth on the board.The speed at which the different components fall through the tubes depends on their size and shape.

Can your group correctly predict which cells will reach the bottom of the tubes first?

Body Imaging

Different imaging techniques can give us information on what is happening to the bones, soft tissues and organs within our bodies. The basic concepts behind how the imaging techniques work and what they are used for are outlined below; more detailed information can be found on the poster.

a) Ultrasound

- Uses high-frequency sound waves to build up a cross-sectional picture of a certain area.
- Some of the sound waves are reflected by different tissues, and the speed of sound can be used to determine how far away these tissue layers are, and to build up an overall picture of the area under study.

b) X-rays

- X-rays are very high-frequency electromagnetic waves (similar to light, but with greater energy); the amount of radiation absorbed depends on the density of the material through which the beam is passing.
- This makes them extremely useful for detecting bone abnormalities: bones are much denser than the surrounding tissues and show up very clearly on an x-ray image.

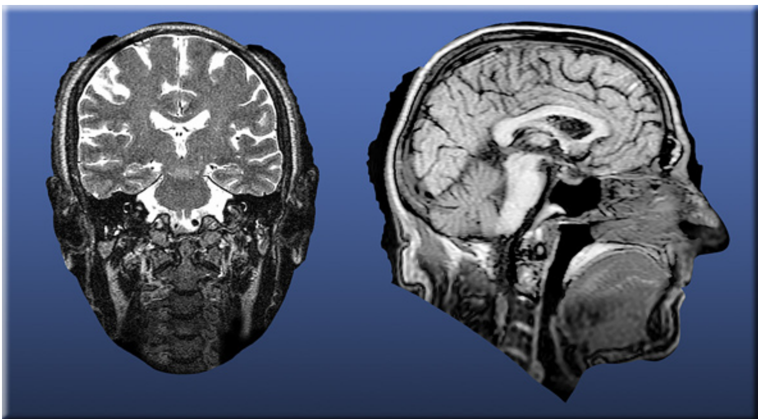
Body Imaging

c) CT scans

- These use X-rays to scan the body, but a movable source is used under control of a computer to generate many cross-sectional images of a small area, which are then combined to produce a 3D image. Such images can be rotated and inspected from many angles.

d) Magnetic Resonance Imaging (MRI)

- MRI scanners use magnetic fields and radio frequency waves to determine the distribution of hydrogen atoms in a certain area of the body.
- Since our bodies are largely water (H_2O), MRI scans are very useful for imaging soft tissues and organs.
- The difference between healthy and unhealthy tissues is very clear using this method as there is a big difference in the metabolism in such tissues, with a consequent variation in the presence of water.

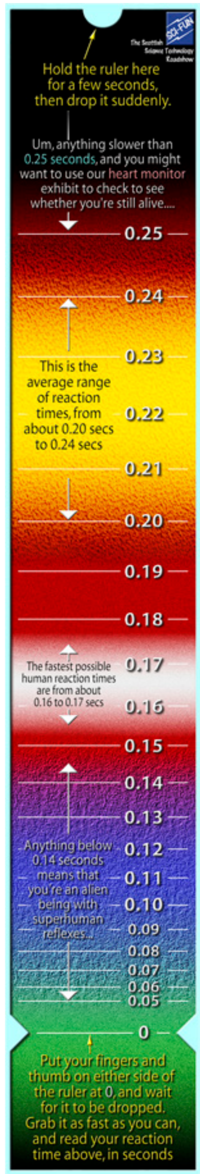


Lift up the covers on Alan's head to see the MRI scans of his brain

Reaction Timer

What to do

- In this exhibit we use specially-marked rulers to measure human reaction times: the markings are not in centimetres, but in seconds.
- One person must hold the ruler by its top, ready to drop it at some random time.
- Another person must be ready to catch it, holding their fingers on either side of the "0" mark on the ruler (but not quite touching it).
- They must catch the ruler when it is dropped, by closing their fingers. The person dropping the ruler should give no advance warning.
- When the ruler is caught, read the number nearest to the point where the fingers have gripped it: this is a direct measure of their reaction time in seconds.



Reaction Timer

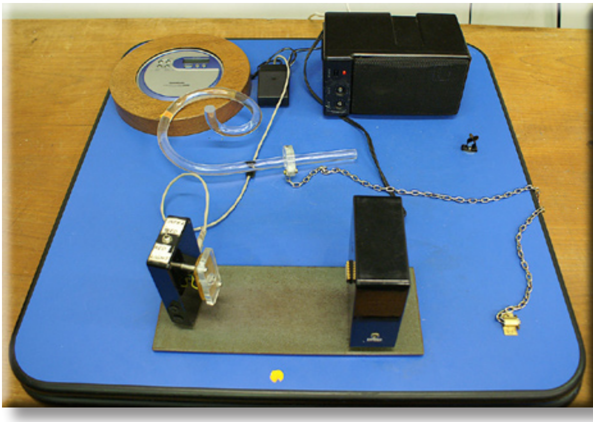
How does it work?

- The average human reaction time is between 0.2 and 0.25 seconds, with the shortest times being around 0.13 seconds. Reaction time can be affected by factors such as age, gender, tiredness and external stimuli (including distractions).
- The reaction time is the period from the moment of a change in the environment (stimulus) to the beginning of your response.
- The response is coordinated by the *nervous system* which regulates the activity of the muscles and initiates actions.
- There are two different parts of our nervous system:
  a) *Central Nervous System* (CNS): brain and spinal cord
  b) *Peripheral Nervous System* (PNS): nerves and neurons outside the CNS

The nervous system recognises a stimulus, and neurons within the CNS transfer this information to the brain and other nerves. The PNS send a message from the brain to spinal cord; this message is then delivered to your muscles telling them whether to contract or expand.

Fibre optics & Sound

What to do



- **Turn the MP3 player on.**
- **Sound from the MP3 player is converted into light.**
- **Place one end of the plastic tube on the light source and the other on the microchip in the detector... You should hear music.**

How does it work?

- A fibre optic cable is a thin transparent fibre, usually made of plastic or glass, which transmits light.
- If the light ray hits the fibre optic wall beyond a certain angle, the ray is reflected and it is then transmitted along the fibre due to the mechanism of total internal reflection (as in the diagram above).
- In this exhibit, the light is able to travel through the "fibre optic" to the microchip. The chip receives the data and sends it to the speaker where it is converted into sound.

Fibre optics have a wide range of uses: light guides in medical applications; decorative illumination using sunlight as its source; endoscopy (a medical procedure to look inside the body without having to make a large incision); and (most frequently) in telecommunications.

Lightning on a Desk

What to do

- **Move your hand to the centre of the circular plate (to touch the "cloud").**
- **Using your fingers, control the lightning strikes, and where they contact the "ground" round the edge of the plate.**
- **There should be enough energy in the cloud to create two or three strikes: not enough for four, and too much for just one. Can you prove this statement wrong?**

How does it work?

- Real lightning is the transfer of electrical energy through the air, from a highly charged cloud, often to the earth. A *step leader* feels its way down from the cloud, zig-zagging through the ionised air (the charge is so great that electrons are stripped from the atoms), looking for a path to the ground.
- From the ground, *positive streamers* are conducting paths that try to join up with the descending step leader. When one does join, the circuit is made, and the flash of lightning occurs.
- The *crackle tube* is a safe way to simulate some of these properties. The tube is filled with small beads, coated with a substance that ionises under charge (and glows).
- The central electrode is at several thousand volts (but with only a tiny current), and represents the cloud.
- Your fingers can draw off tiny amounts of current, changing the properties of the "air", and altering the path of the step leader, as it tries to make contact with the "ground".

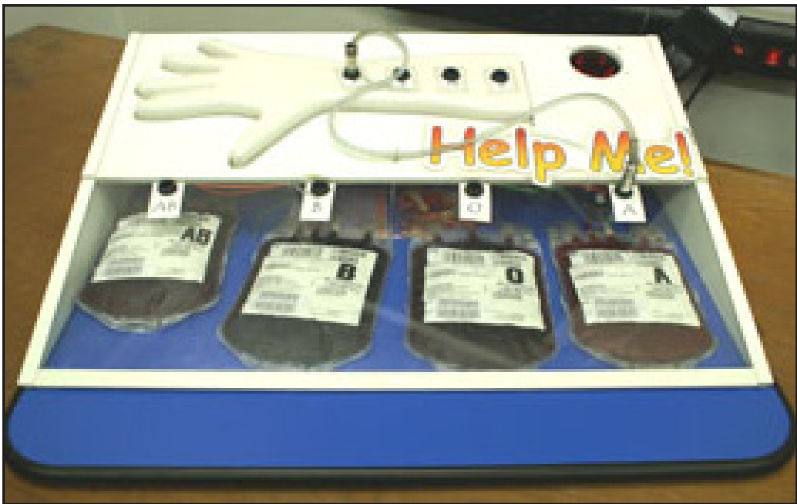
Blood Groups

What to do

- **Choose your patient's blood group by putting the plug into one of the sockets on the arm (sockets labelled A, B, O and AB).**

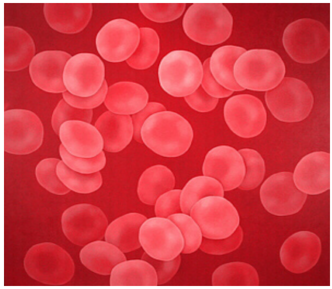
- **Your patient needs a transfusion. Choose the appropriate donor bag according to your patient's blood group.**

- **Check the round screen on the top right to find out if you made the right choice (and whether or not your patient dies...)**



Blood Groups

How does it work?



- The blood of every person belongs to one of four groups: **A**, **B**, **AB** or **O**.
- If you need a transfusion, it's your own blood type which specifies those types that your body can safely receive. If the wrong blood type is administered, the reaction can be fatal.
- On the surface of each red blood cell there are *antigens*. You can think of them as flags which are recognised by your immune system. The immune system keeps a constant check on the blood in your body via a system of *antibodies*. These antibodies will cause massive red blood cell destruction when they come across the wrong antigens.
- If you are blood group **A**, for example, your blood will carry **B** antibodies. If you were accidently given a transfusion of **B** or **AB** blood (both of which have **B** antigens) your immune system would immediately attack the donated blood cells (and potentially killing you in the process).
- Type **O** cells have no antigens on their surface, and are not recognised at all by the immune system. **O** blood can therefore be given to everyone. People with **O** blood have antibodies to **A** and **B**, however, so they can't receive blood from anyone except **O** donors.
- People with type **AB** blood have no antibodies to the other blood types; they can safely be given blood from any donor.

Blood Group	Antigens	Antibodies	Can receive
A	A	Anti-B	Group A & O
B	B	Anti-A	Group B & O
AB	AB	None	A, B, AB & O (Universal Recipient)
O	O	Anti-A; Anti-B	O only (Universal Donor)

Power Bike

What to do

- **How much power can each member of your group generate?**
- **Pedal as fast as you can and see how much power is generated.**
- **The amount of power in Watts required to power various electrical appliances is shown on the side of the scale; see which member of your group can produce the most power.**

How does this work?

- The bike is attached to a device which measures the power produced while pedalling.
- The display will light up and show you how much power is being generated.
- Power is measured in Watts and tells you how much energy you are producing every second (1W = 1 Joule of energy per second).

Safety note: Keep one foot on the back of the bike to ensure it does not slide too far forward. If the bike moves too far forward take care when returning it to its initial position that the display and power wiring does not get trapped under the wheels.

Body Clocks

What to do

- **Are you a morning person (a LARK) or an evening person (an OWL)?**
- **After reading the information on the board, work through the quiz, answering each question, then adding up the scores to find out when you (think you) are at your best: early on, or later in the day.**
- **Spin the centre dial of the disk and read the information in the windows: find out what the best time of day is for eating, exercising and lots more (including dropping dead...)**

Turn the exhibit around to find out more about body clocks and their role in your everyday life.

How does it work?

- Every cell in your body contains a rhythmic timekeeper: a *clock*. Our brain contains a "master clock" – the *Suprachiasmatic Nucleus* – that makes sure cells throughout the body are kept in synchronisation with each other.
- Body clocks help control nearly every process in our bodies, from sleeping patterns to our digestion.
- For example, body clocks help warm our muscles up and raise our blood pressure just before we wake up so that our bodies are ready to use straight away.

Energy Consumption

What to do

- **See how much energy we use every time we switch on a light or a heater.**
- **Press the middle button on the meter to change the display to show how much power is being used. Power is shown in Watts, a measure of the energy used per second.**
- **Turn the dial of the heater to change the settings: what happens to the power?**
- **Heater settings:**
  1: Only the fan is on;
  2: Both the fan and the heating element are on.

What does it show you?

- This exhibit gives you an indication of the amount of energy used by different appliances often found in our houses.
- It is important that we use energy more efficiently, to reduce the emission of greenhouse gases, which contribute to climate change.
- We can do this by ensuring that we:
  - Turn the lights off in unoccupied rooms;
  - Do not leave computers or televisions on standby;
  - Use energy-efficient appliances and energy efficient light bulbs.

Kinetic Cars

What to do

- **Get two pupils to turn the handles as fast as they can, and see which car finishes the circuit first.**

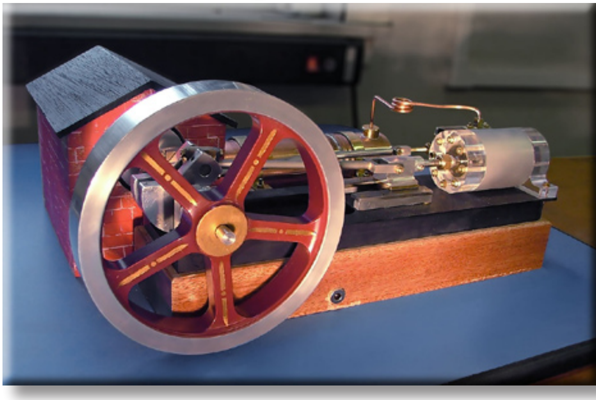
How does it work?

- Energy is required to do work (loosely, to make something *change*).
- Energy can't be created or destroyed, only changed from one type to another. You use your muscles to generate kinetic energy (energy of motion) in the handle and the dynamo. The motion causes electrical energy to be created, which then makes the cars' motors turn (kinetic energy again), which causes the axles to spin, and the cars to move. Energy is then lost as sound and heat.
- As the board shows, we can start earlier in the chain. Solar energy (light from the Sun) is converted to chemical energy in plant molecules, which animals like us convert to chemical energy in our muscles. That's where the energy came for you to turn the handles...

Steam Engine

What to do

- **Press the button and watch the engine move.**



How does it work?

- Water is heated until it boils into steam. (This is only simulated in our little model, of course.)
- Steam accumulates in a chamber where it expands.
- The steam is then passed into a cylinder at high pressure, pushing a piston outwards.
- The steam is then passed to a cool secondary cylinder, where it rapidly cools down and contracts, creating a vacuum, pulling the piston back.
- This repeated expansion and contraction of the steam in the cylinder causes the piston to move rapidly back and forth.
- The piston drives the sliding rod, making the flywheel move.

This exhibit shows you how force is transferred from expanding gas in the cylinder into the connected rod, eventually moving the flywheel.

This principle is still used today: over 90% of our electricity is generated using steam turbines.

Stem Cells

What to do

- **Do you think stem cells could be useful in treating some human conditions?**
- **Choose your answer for each human condition by pressing the *yes/no* buttons, and find out if you are right or wrong…**
- **Lift each of the flaps for a detailed explanation on each of the human conditions shown on the exhibit.**

How does it work?

- Stem cells have the ability to develop into more specialised cell types such as brain cells (neurons), liver cells, heart cells etc…
- Scientists are now able to transform stem cells into more specialised cells in the laboratory.
- Stem-cell based therapies have the potential to change the treatment of some serious human diseases.

An example: Parkinson's disease results from reduced activity in some neurons. By using stem cell therapy, new fully-functional neurons could be developed to replace those that have been damaged, reducing (and perhaps in future even reversing) the symptoms of the disease.

Dolly

What to do

- **The video shows you the process used to create Dolly – the first mammal to be cloned.**

How was Dolly cloned?

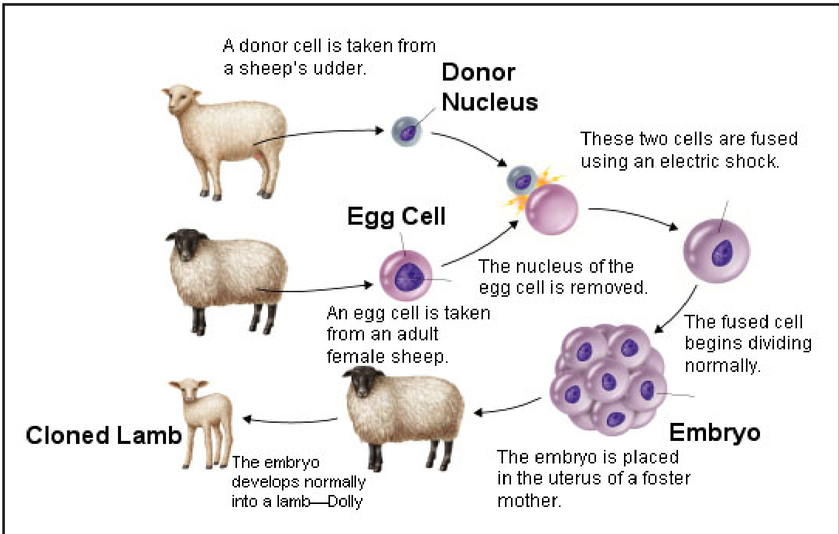
- Dolly was produced from an adult cell using the nuclear transfer technique (described in the film).
- The cell nucleus, containing the cell's genetic information, was removed from an adult cell and transferred into an unfertilised egg which had previously had its nucleus removed.
- The egg cell with its new adult nucleus was allowed to divide and grow before being implanted into the surrogate mother.

Dolly

- The birth of Dolly showed that any adult cell in our body may be able to revert back to an undifferentiated state – these are referred to as *totipotent cells.*

- These cells are then able to develop into any part of the animal, producing a normal embryo which in turn gives rise to a normal, fully developed animal.

Dolly was born in 1996 and died in 2003. She was cloned by Ian Wilmut and his team at the Roslin Institute, near Edinburgh. Unfortunately, the nuclear transfer technique is highly inefficient; it took 277 attempts to produce Dolly!



Gyrowheel

What to do

- **Stand on the turntable, holding the black handles of the wheel with both hands.**
- **Spin the wheel then try to tilt it up and down.**
- **What happens?**

How does it work?

- A gyroscope hates changing position, so it will always try and stay at the same angle when it is spinning.
- When the wheel is tilted, it applies a force to the person holding it which in turn moves the turntable the pupil is standing on.
- When you tip a spinning gyroscope, it feels a force in one direction at the top and a force in the opposite direction at the bottom and both parts will rotate in that direction instead of tipping downwards.

Gyroscopes move in strange ways that seem to defy gravity. The properties of gyroscopes make them important in many things from your bicycle to the navigational systems of aircraft and spacecraft.

Safety note: when a pupil steps on or off the base plate, put your foot on the plate to stop any unwanted rotation.

Rattleback

What to do

- **First spin the rattleback anticlockwise, and watch what happens to its motion.**
- **Then try to turn it clockwise: what happens now?**
- **Try simply rocking the rattleback, back and forwards. what happens?**

How does it work?

- The rattleback seems to spin normally in the anticlockwise direction. However, when spun in the other direction it begins to rock back and forth (or 'rattle') and eventually reverse its spin direction.
- The rattleback changes its spin direction because of its shape. Rattlebacks are not symmetrical (even though it looks as though they are) in their distribution of mass.
- Because of this off-centre shape, if you rock a rattleback, it will tend to start spinning anticlockwise: this is the direction in which it tends to move.
- When you spin it clockwise, the asymmetric shape means that instabilities in movement grow and it begins to rock back and forth.
- As we've seen, the off-centre curved shape transfers the energy from rocking to rotation in the anticlockwise direction. So the rattleback soon stops moving clockwise, rocks up and down for a short time, then ends up moving anticlockwise.

Tippy Tops

What to do

- **Place the tippy top in the tray, and spin it using the stem.**
- **Why does the tippy top suddenly flip over and start spinning on the other end?**

How does it work?

- The important thing about a tippy top is its “mushroom” shape: it must have a smooth, spherical surface with no sharp points.
- After it starts spinning the top will wander about on the table, and will also begin to tilt, or wobble, an effect known as *precession*.
- As it does this it moves, so that the point of contact with the table is not in line with the axis of rotation, and this makes it unstable.
- Friction with the table causes this point of contact to move further and further away from the vertical. The top wants to be in a more stable position and the only way for it to do this is to flip over.
- The centre of gravity of the top rises when it flips, which would *appear* to violate the conservation of energy: energy is needed to raise the top. Having flipped, however the top is then spinning much more slowly, so energy has been lost overall.
- Another interesting property of the tippy top is that it completely reverses it spin while it flips over. If you look at it from above, you see that, before and after it flips, the top spins in the same direction, relative to the table. But, since it is upside down after it flips, the top itself is actually spinning backwards!
- At some point during the flip over, the top stops spinning and reverses, which can be seen in slow motion films of a top spinning.

Reuleaux Curves

What to do

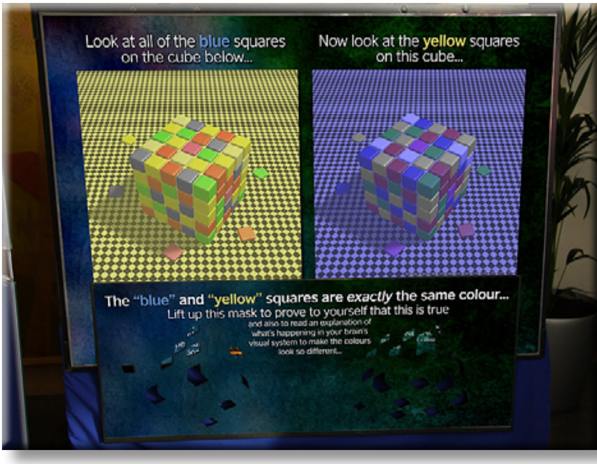
- **Roll the giant coin through the upper slot of the backboard: do you notice anything unusual?**
- **Place two of the axles under the plastic sheet (at the front of the base-board), press your hand on the sheet and move back and forward.**
- **Look at the top of the sheet: does it move as you would expect? Are the wheels and axles moving smoothly?**
- **Can you answer the question: why are loose man-hole covers circular, and not square, triangular or elliptical? What *other* shape could they be?....**

How does it work?

- We know that circles have a constant diameter: this is why they roll easily. Circles are not, however, the only shapes that can behave in this way. The giant 20 pence coin and the axles in the exhibit are also examples of shapes with a constant width, known as *Reuleaux curves*.
- The simplest version is an equilateral triangle with circular arcs along each side.
- The 50 pence coin was the first to be made as a Reuleaux curve; this means that it rolls in the same way as other circular coins (in coin slot machines, for example), while being easier to identify for people with visual impairment.The construction techniques for the 50 and 20 pence coins are shown on the poster beside the exhibit.

Cube Illusion

What to do



- **In the cube on the left (the one in yellow light), look at the blue squares.**
- **In the cube on the right (the one in blue light), look at the yellow squares.**
- **It seems as if these two sets of squares are totally different colours.**
- **Now lift up the flap, and look at the squares again through the holes. You should notice something unusual...**

How does it work?

- This illusion works because our brain compensates for the fact that the two cubes appear to be lit by entirely different coloured lights.
- The retinas of our eyes see exactly the same colour of squares in both cases (grey), but our brain changes what we see to account for the surroundings. The visual centres of the brain have evolved in a world where – in yellow light – this shade of grey *should* represent something that is blue. In blue light, however, the exact same shade of grey actually represents something that is yellow.
- When the flap is then lifted, the surroundings are covered and there is no context; we now see both squares as the colour they have been printed: grey.
- This colour processing is done entirely unconsciously. (In fact, these capabilities of our ancestors' visual systems were present long before conscious humans had evolved: they are simply a way to let an animal make sense of its changing surroundings.)

Anaglyphs

What to do

- **Look at the images through the glasses, making sure that the red lens is over your left eye and the blue/green lens is over your right.**
- **The images should now appear in 3-D.**

How does it work?

- Anaglyphs are usually made from two slightly offset images, one red and the other blue/green, superimposed on top of each other.
- When viewed through the glasses, each eye is seeing a slightly different image, due to the colour of the filter that it is looking through, as follows:

  1) The areas that appear to be black and white in the picture, when viewed without the glasses, still appear to be black and white when viewed through the filters.
  2) The eye looking through the red filter sees the red parts of the image as white, with the blue/green parts appearing black.
  3) The eye looking through the blue/green filter sees things the opposite way round: the blue/green parts look white, with the red parts now appearing black.

- There is a slightly different image from each eye (just as when you are looking around normally): this results in our brain merging these images together to give one single picture that appears to be 3D.

Ball Race

What to do

- **Before you start, decide which ball would win the race, if they are both fired with exactly the same speed. Would it be the one on the shorter straight track (Ball 1), or the one on the longer track with the dip (Ball 2)? Or would they arrive at the same time?**

- **Once you have decided, use the spring to send the two metal balls down the tracks. Which ball reaches the end first?**
- **Were you correct?**

How does it work?

- When the balls start off they are both travelling at the same speed. When ball 2 encounters the dip in the track it starts to move faster.
- In the middle part of the race, ball 2 – having reached the bottom of the track – is moving at a faster speed than ball 1, and so it begins to pull ahead in the race.
- When ball 2 travels back up the slope it slows down. Assuming that the track is fairly frictionless (which it is) ball 2 ends up at its original speed (the same speed as ball 1), but it is further ahead.
- The two balls end the race moving at the same speed, but ball 2 reaches the end first.
- So, although we may initially think that ball 1 will arrive at the end first – due to its shorter course – ball 2 does in fact win, because it was travelling at a faster speed in the middle part of the race.

Microscope

What to do

- **Place one of the slides from the collection onto the microscope stand.**
- **Select a magnification level. It's best to start at low power (×20), and then the higher powers in turn, up to ×200.**
- **Turn the focusing knob on the microscope very gently, to bring the image on the slide into sharp focus.**

How does it work?

- This is a modern version of the first type of microscope, which uses visible light to magnify small objects. A small camera has been placed at the eyepiece, and the image is viewed on the laptop screen.
- Our microscope can magnify up to around 200 times, although the subject under view must be very securely held: even the slightest shake will make the image hard to see.
- Light microscopes can magnify up to about 1500 times. A general principle of magnification is that the size of the light waves used to view the object must be smaller than the object size itself.

  The following analogy may help to explain this. If you were to use your hands to try to feel the shape of an object, and you had to wear boxing gloves, you would only be able to make out very general shapes. Wearing just a normal pair of gloves (equivalent to using much shorter wavelengths of light), you could detect much smaller variations in an object's shape.
- To see smaller objects, we use shorter light waves (such as UV), or even *electrons*: quantum physics tells us that particles such as electrons can be thought of as having very short wavelengths.

Health & Safety

Spinning Chair: Make sure you secure the seat belt before starting. Rotate the chair clockwise: rotating the chair anticlockwise may loosen the bolts at the bottom of the chair, making it unsafe. Make sure you keep a foot on a corner of the board to stop it moving. Also, keep an eye on the audience: make sure they are not too close or they could be hit.

Coanda Effect: The jet of air for this exhibit travels at approximately sixty miles per hour, so it's extremely important that the pupils do not aim it at their own or anyone else's face. If a piece of grit gets caught in the jet of air it could cause some significant eye damage (although this is very unlikely).

Gyrowheel: When a pupil steps on or off the base plate, put your foot on the plate to stop any unwanted rotation.

Centrifuge: Ensure all members of your group are in front of the plastic safety screen before spinning the tubes.

Power Bike: Keep one foot on the back of the bike to ensure it does not slide too far forward. If the bike moves too far forward take care when returning it to the initial position that the display and power wiring does not get trapped under the wheels.

That's about all. If having read this book you have any other questions, find someone in a SCI-FUN (or University of Edinburgh) T-shirt and just ask: we'll be happy to help.

Thank you