

PHYSICS

ACTIVITY

PACK

theWI
INSPIRING WOMEN

PART ONE
INTRODUCTION



INTRODUCTION

What's in this pack?

This Institute of Physics activity pack contains ideas, resources and activities for anyone wanting to put on a physics-based event. From entertaining interactive quizzes to finding the perfect speaker, you'll find all you need in here.

In this first section you will find some information about existing activities and events that you can get involved in. You might want to run a book group, find out if there is a science event happening locally, or find someone to give a talk on a topic that you are interested in.



Section 2 contains activities to put together yourself. Most of these activities take a single evening but some could take longer if you would like them to be part of a bigger event. There are activities for both indoors and outdoors. While some require a little preparation in advance, any materials that you need can be found in a supermarket.

In the final section, you will find a list of short experiments. Some of the longer activities suggest using specific short experiments as part of the activity. You'll be able to pick the experiments that you find most appealing, or use the resources below to find your own online.

The activities can be done by anyone (but young children, if involved, may need a little help with some of them). Although the materials involved are all safe and easily available you will want to keep safety in mind for each activity.

Organising one of the longer activities is easy with a little preparation. Each activity comes with specific advice on how to prepare, but here are some general hints to help everything run smoothly.

How to prepare for the activities

The first thing to do is to have a go! Most of the short experiments only take a few minutes to put together so it is a good idea to do a trial run of the experiments involved. You can then spot any pitfalls. The Physics to Go experiments have tips for success.

If the physics activity is only part of the evening or event you will need to look at how long it takes to do. You may also want to consider set up and clearing up times.

Some activities can be a little messy so you may need to think about being somewhere where there is water to help you clear up.

Many of the activities have web addresses where you can find further background information.

Don't forget that even the best rehearsed experiments can go wrong. If something doesn't work on the night, try again. If it still doesn't work remember that some of the greatest discoveries have been made when experiments haven't gone as expected!



Science festivals and events

There are many science events that take place all over the country throughout the year. Science festivals are a collection of events usually held over a few days or a week. They usually take place around the same time each year, so if you have missed this year's you can always put next year's in your diary.

Festivals have programmes filled with events exploring all areas of science and aimed at all ages so you'll definitely find something that interests you. They are great for getting everyone involved.

February

Brighton Science Festival

www.brightonscience.com

Kent Festival of Science

www.sciencefestival.org.uk/

March

Cambridge Science Festival

www.sciencefestival.cam.ac.uk

Newcastle Science Festival

www.newcastlesciencefest.com

Oxfordshire Science Festival

www.oxfordshiresciencefestival.com

York Festival of Ideas

www.yorkfestivalofideas.com

A fun day out can be had at any of the science and discovery centres around the UK and they're not just for children.

Most are open all year round. Use the interactive map on the **Association for Science and Discovery Centres'** website to find one near you.

<http://sciencecentres.org.uk/centres>

September

Aberdeen TechFest

www.techfestsetpoint.org.uk/tis

Orkney International Science Festival

www.oisf.org

October

Manchester Science Festival

www.manchestersciencefestival.com

The British Science Association organises **The British Science Festival** every year in September.

It is in a different city each year, so have a look at their website to find out if it will be near you.

www.britishsociety.org/british-science-festival

April

Edinburgh Science Festival

www.sciencefestival.co.uk

June

Bristol Festival of Nature

www.bnhc.org.uk/festival-of-nature

Cheltenham Science Festival

www.cheltenhamfestivals.com/science

July

The Royal Society Summer Science Exhibition

<https://royalsociety.org/summer-science>

British Science Week happens in March each year. Events take place all around the country. To find out how to take part, have a look at the British Science Association's website.

www.britishsociety.org/british-science-week



Find a speaker

If you are looking for someone to bring lively science debate to your evening there are a number of places you can go to find the right people and the right topic. Some people may charge to give talks.

Café Scientifique

www.cafescientifique.org

Café Scientifique is for the general public. Go along and have a cup of coffee or a glass of wine and discuss topics in science in an informal setting. A short talk by a scientist is followed by discussion and questions, and you can join in or just relax and listen.

Meet a physicist

You can also get in touch with your local Institute of Physics branch. They may be able to help you find someone locally to give a talk. Go to www.iop.org/activity/branches/index.html and contact the secretary of the branch covering your area.



Local branches also run programmes of talks which members of the public are welcome to attend. Details are available from the website above.

Find an astronomer

www.fedastro.org.uk/fas/

Many areas have a local amateur astronomy society and most of these societies will have at least one member who is interested in talking to non-astronomers. You can find your local society and contact details through the Federation of Astronomical Societies.

If the astronomer is going to give you a guided tour of the night sky, the society will be able to advise you on the best dates.

Geocaching

If you would like to make a walk a little more interesting you could have a go at geocaching.

Geocaching is rather like a high-tech treasure hunt. The 'treasure' is hidden in boxes, or caches, and the treasure hunters use GPS (Global Positioning System) units or SatNavs to find them.

The website www.geocaching.com has a list of prepared caches and you can search the site for one near you.

If you would like to make your own geocaching trail, take a look at 'Quest', put together by the Institute of Physics. 'Quest' is geocaching with a science twist. Instead of the usual trinkets as treasure, each cache contains an outdoor

physics activity. Take a look at the website for more ideas of what to add to your caches (www.physics.org/article-activity.asp?id=71).

You'll need to get permission from the landowner before you hide caches on a piece of land. Then decide how many you want and what kind of activities you want to put in each one. The treasure hunters will need the GPS co-ordinates of each one and a GPS unit. Of course you will also have to hide the caches carefully so they aren't too easy to find.

Make sure that the treasure hunters have all they need to carry out the activities – it is best to devise activities that don't use anything up, for example taking measurements or answering questions.

If your treasure hunters work in teams you could award a prize for the team who completed all of the activities correctly, or who finished the quickest.





Find out more

You can find a lot more information online. There are a number of really good, clear science websites that will give you more background information about various activities, further short experiments or news about current scientific discoveries that may interest you.

Planet Science

www.planet-science.com

This website is full of free fun science resources for young people, parents and teachers. You'll find the Little Book of Experiments, a collection of short easy experiments that anyone can do, as well quizzes and online games.

Royal Greenwich Observatory

www.nmm.ac.uk/places/royal-observatory

Here you will find more than visitor information for the Observatory. Explore online about astronomy and time, why we have British summer time, what an equinox is and even how to make your own comet.

How Stuff Works

www.howstuffworks.com

You can look up pretty much any topic here, whether that is science, technology or medicine. Browse through the topics or search for a specific question.

Exploratorium

www.exploratorium.edu

A great website for browsing around. It also contains lots of activities for all ages.

New Scientist

www.newscientist.com

Although you may need to subscribe to *New Scientist* to read all of their online articles there are still lots available to everyone. Read their "Instant expert" guides to get a great overview on a huge range of topics.

BBC – Bang Goes the Theory

www.bbc.co.uk/bang

This great website contains videos from the programme, hands-on activities, answers to questions and links to other websites.

Contact the Institute of Physics

If you would like any help, support or advice with anything that you find in this pack, please get in touch with the Outreach & Engagement Team at the Institute of Physics

Outreach & Engagement Team, Institute of Physics, 76 Portland Place,
London W1B 1NT

Tel +44 0207 470 4800, fax +44 0207 470 4861, e-mail engagement@iop.org



Don't forget health and safety!

You'll have to think about health and safety with each activity.

If you try out activities first you should be able to spot where things can go wrong and you'll find safety alerts in some of the longer activities.

You may also want to think in advance of any resultant mess and take appropriate precautions to minimise the amount of time spent cleaning up.

Spillages onto a floor can lead to slips and falls so make sure that where liquids are involved they stay on the table if possible.

If in doubt, take advice!

If you intend to run some of the activities in the wider community you may have to take some advice about health and safety issues.

Resources and websites provided by other organisations have not been safety checked by the Institute of Physics.

It is your responsibility to ensure that any activities are conducted in a safe manner.

PART TWO
ACTIVITIES



PHONY PHYSICS

ACTIVITY 01

Do you know physics from fiction? Instead of a plain old quiz night why not try some phony physics? The quizmaster demonstrates a cunning physics trick and teams are asked to pick the correct explanation – not as easy as you might think!

Choose your tricks...

Each trick will take a couple of minutes to demonstrate and then the teams will need about five minutes to try it themselves and decide on the correct explanation. Five tricks is about right for a game lasting around an hour, but you might want to have a couple in reserve in case the group gets through them quickly, or for a tie-breaker.

Once you've decided on the tricks that will be used in the game, prepare a small box of kit for each team. The box should include all the bits and bobs that the teams will need to try the tricks for themselves. Shoe boxes or large Tupperware boxes are good and reusable.

Preparing explanations

If you have access to a laptop or overhead projector, produce some slides so that all the teams are able to see the explanations (true and false) for each trick that you've demonstrated. If not, you could produce printed explanation sheets for each trick that you can hand out at the appropriate time.

Mix the explanations up so that they're not all in the order: True, False, False.

See opposite and on pp8–9 for possible explanations for some of the most popular tricks. If you choose different tricks, remember that the wrong explanations will need to sound at least plausible.

Remember to leave time for scoring and prize giving. Think about having a range of prizes, not only for the top scorers but also for the team who made the most effort, had the best team name or anything else that rewards participation.

Playing the game

If they're not already in small groups, ask people to form teams of 4–6 and come up with a team name.

Explain that the game involves the teams working out the correct explanation (out of the three given) for each of the tricks that you are going to demonstrate. To help them decide, they will be able to have a go at the experiments themselves using the kit provided.

Once all of the tricks have been done, ask the teams to swap answer sheets with a neighbouring team for the scoring.



Each team will need an answer sheet:

Team name _____	
Name of experiment	Correct explanation (a, b or c)
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Marvin and Milo #22 Impossible Straws

True... For the water to be forced into your mouth, the pressure outside your mouth (atmospheric pressure) needs to be greater than the pressure inside. This means that, no matter how much you suck, a straw won't work if air can get into your mouth.

False... By having two straws in your mouth (with at least one going into air), the brain is fooled into thinking that your mouth is a nose, with two nostrils. The brain then stops you from being able to suck enough, which prevents choking.

False... Air is lighter than the water so it is easier to suck up a straw. This means that with the two straws (one in water, one in air), the air gets sucked preferentially and you end up with a mouthful of air.

PHONY PHYSICS

ACTIVITY 01

Physics to Go #2

Waterproof hanky

True... When the cloth is loose, the water can pour through the gaps in the fabric. However, when the hanky is pulled tight, the water molecules can form a single surface or membrane across the material. At the same time there is a pressure difference between the inside and the outside of the glass. The pressure of the atmosphere surrounding the glass is greater than the pressure inside, and this helps to hold the water inside the glass.

False... As you pull the cloth tight, all the gaps in the fabric close up so not letting any water pass through. This makes the cloth waterproof and the tighter you pull the cloth, the more waterproof it becomes. This changes the cloth structurally, from being hydrophilic (water-loving) to being hydrophobic (water-hating).

False... The elastic band is not only holding the cloth in place, but it is stopping air getting into or out of the glass. As the air can't move, neither can the water.

Marvin and Milo #30 Inseparable books

True... This is all about friction. The pages of the book are slightly rough, which means that there is a small amount of friction between each of the touching pages. With just two pages you don't notice the friction much at all, but if you interweave lots of pages and then try to pull the books apart the friction increases.

False... When you squeeze the spine of the books you create a force that acts along the entire length of the book and clamps all of the pages together. This acts in much the same way as a pair of pliers would, by using levers to multiply the mechanical force at work.

False... This is to do with air pressure. The combined books have a larger volume than the books on their own and so the effects of air pressure are more easily seen. The force of the air pushing in all directions on the books means that they become stuck together.

Physics to Go #3 Straw oboes

True... The flattened triangular tip acts like the reed found in most wind instruments. Blowing on the reed causes the air inside the straw to vibrate. A standing wave pattern is created along the length of the straw, which we hear as sound. As you shorten the straw you shorten the wavelength of the standing wave pattern, and so increases the pitch of the note.

False... As you shorten the straw you instinctively blow harder down the straw, and the harder you blow through the straw the higher the pitch of the note. This is the same principle as in a woodwind orchestra: piccolo players need more puff to create a higher note than bassoon players.

False... If you can't whistle, you won't be able to get the straw oboe to make a peep. This is because all the straw is doing is acting as a sound box and amplifying your normal whistle sound.

Marvin and Milo #33 Gripping rice

True... As you push it in, the pencil forces the grains sideways, but they fall back into the gap as you try to pull it out. The rice becomes more and more tightly packed until the friction between the rice and the pencil is so great that you can lift the jar.

False... The rice is magnetically attracted to the wooden pencil and to the glass jar. With enough rubbing the magnetic field builds up until it is strong enough to lift the heavy glass jar off the table.

False... As you push the pencil in and out, the grains of rice start to heat up and gradually become softer and more sticky – as it does in the first stages of the cooking process. With enough pushing in and out, the rice becomes soft and sticky enough to stick to the pencil, and so you can lift the jar.

PHONY PHYSICS

ACTIVITY 01

Physics to Go #6

The power of words

True... Atmospheric pressure exerts a downward force on the sheet of newspaper. The area of the sheet is large, so the downward force of the atmospheric pressure exerted on the newspaper is strong enough to counter the upward force from the ruler when you hit it. The folded newspaper has a smaller surface area over which the atmospheric pressure can act, so it doesn't prevent the ruler from flipping off the table.

False... This is about the way that the newspaper is made. Newspaper is made in large sheets with the fibres of paper laid in a criss-cross fashion. This makes the sheet of newspaper very strong. As you hit the ruler it hits these long thin paper fibres within the newspaper. This spreads the force across the whole sheet of paper and the impact is dissipated. This means that no matter what you try to move the paper with when it is laid flat, it is really hard to move.

False... The greater the amount of area of the newspaper that is in contact with the table, the greater the friction between the paper and the table. When the newspaper is folded, the contact area is only small so the upward force from the ruler can overcome the friction. However, when the unfolded paper is laid out, the friction is much greater than the upward force from the ruler, and it stays put.

Marvin and Milo #42

Antigravity Maltesers

True... The glass pushes inwards on the Malteser, forcing it to move in a circle rather than a straight line. At the same time the angle of the glass means that it also pushes the Malteser upwards, supporting its weight.

False... As you hold the glass it conducts body heat away from your hands that then starts to heat up the entire glass. When the Malteser comes onto contact with this warmed up glass it starts to ever so slightly melt the chocolate and it becomes so sticky that it starts to stick to the side of the glass.

False... Maltesers are mostly air so the density of a Malteser is very close to that of air itself. Objects that are less dense than their surroundings float. By rotating the Malteser quickly, more air is forced into the sweet reducing its density and allowing it to float.

Marvin and Milo #36

On a roll

True... Rubbing a balloon moves negatively charged electrons from your hair to the surface of the balloon. When you hold the balloon close to the can, the negative charge causes the electrons in the can to move away. This leaves a positive charge on the surface of the can. The can is attracted towards the negative charge on the balloon and rolls towards it.

False... Rubber is a magnetic material. By rubbing it, you magnetise it by physically moving the atoms so that they all point in one direction. The drinks can is also magnetic and is attracted to the north pole of the magnetic balloon, just like a magnet is attracted to a metal fridge.

False... Rubbing the balloon removes any grease from its surface. Without this protection, the bare rubber surface is vulnerable to decay. Greasy substances on the can, such as fingerprints, help to replenish the protective balloon covering and are therefore attracted to the bare plastic and the can moves towards the balloon.

Physics to Go #12

Balloon kebabs

True... Most of the balloon is stretched evenly, but there are two points where it is less stretched, and where the surface tension is at its lowest: the tied section and the darker patch at the opposite end of the balloon. Most of the balloon is under high tension, so attempting to push the skewer through just makes the balloon pop. However, at the low tension sections it is possible to make a small hole without breaking the overall surface of the balloon.

False... You have to use a special type of kebab skewer to make this trick work. Because these skewers are made of bamboo, they secrete a very thin layer of oil. When this oil comes into contact with the balloon, it reinforces the surface making it stronger and enabling us to make a hole without popping it.

False... This trick only works if you do it really slowly. By pushing the skewers very slowly into the balloon, the molecules that make up the rubber of the balloon don't notice its presence. The skewer can therefore slip past the molecules, making a hole before they have a chance to react and make the balloon pop.

ROCKETS

ACTIVITY 02

Making a rocket is not rocket science! Take an empty photo film canister and some ingredients found in any kitchen, and you can make a rocket to rival NASA. Well, nearly.

Before you begin...

Have a look at **Marvin and Milo's Alka-Seltzer rocket #9** at the back of this pack, or follow the instructions below to make a sodium bicarbonate and vinegar version.

You'll need to decide which rocket you'd like to make and then assemble the equipment. You can include cardboard and sticky tape if you would like to make launch pads, and paper and pens for decoration.

Film canisters can be picked up free from many film-processing shops – they often keep them for such activities. This activity can be a little messy, so it is best to do this somewhere that you can clean easily, or outside if the weather permits.

Making a sodium bicarbonate and vinegar rocket

What you need:

- An empty film canister
- Vinegar
- Sodium bicarbonate (baking soda)
- Tissue or toilet paper
- Newspaper for the mess!

What to do:

- Half fill the film canister with vinegar.
- Put the sheet of tissue paper over the top and push it in a little with your finger so that it makes a well for the

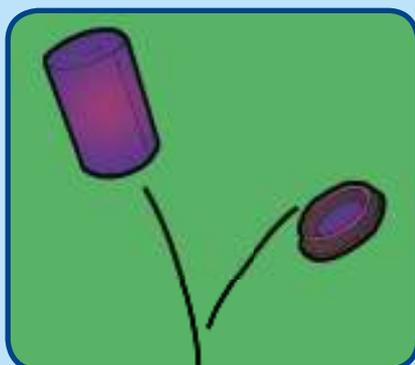
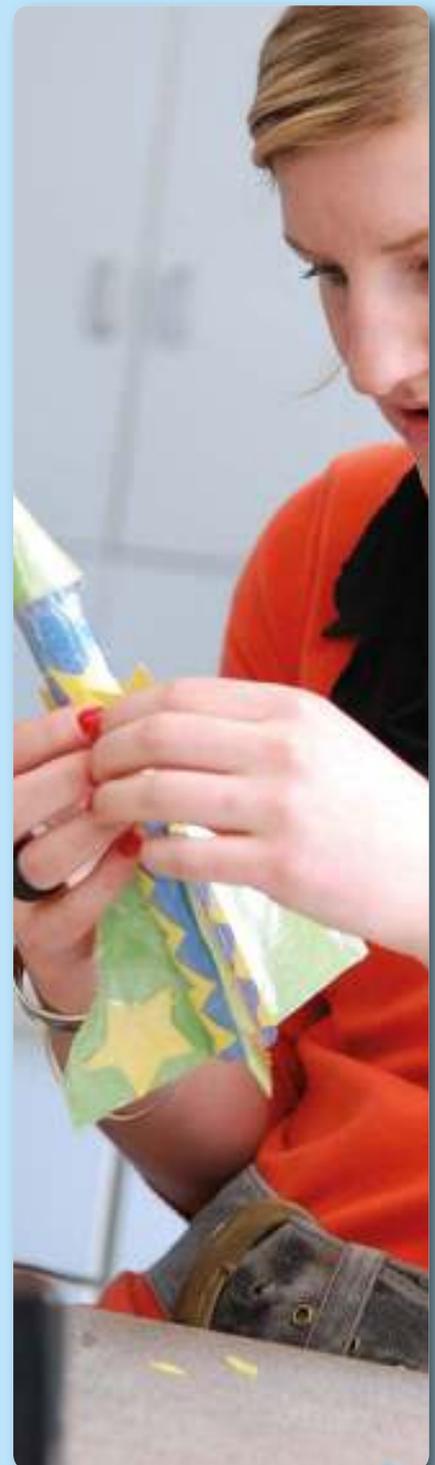
powder. Don't let it dip into the vinegar: the objective is to keep the vinegar and sodium bicarbonate apart.

- Put a teaspoon of sodium bicarbonate in the tissue paper.
- Put the lid on, trapping the tissue paper around the edge. Trim off the excess paper.
- When you are ready, turn the canister over and stand it on its lid on some newspaper.
- Move back and wait for launch – it can take up to 30 seconds.

You have now made your first sodium bicarbonate rocket...

What is happening:

The sodium bicarbonate mixes with the acidic vinegar to release carbon dioxide. The carbon dioxide builds up in the sealed film canister, increasing the pressure inside until the lid pops off. The gas and the contents all push downwards and this gives the now empty film canister an upward thrust, launching it into the air.



ROCKETS

ACTIVITY 02

Engine design

So everyone can get involved, divide into small groups. You'll be making more than one rocket, so start with just one per group and get used to building and setting them off.

Once you are happy with the basic rocket you may want to move on to the design phase. At this stage you are only looking at the rocket engine: what makes it fly.

Both the Alka-Seltzer and sodium bicarbonate rockets launch because gas is released in a chemical reaction in the film canister. There are several ways to make the reaction happen more quickly...

1. Try warming the water or vinegar before putting it in the film canister. Warming the liquids causes the molecules to collide more often, and it is these collisions that cause the reaction.
2. Break the Alka-Seltzer tablet into smaller pieces. Increasing the surface area means there are more places for the water react. Don't be tempted to make it into a powder though, or you won't get

the lid on fast enough!

Of course, making the reaction happen faster may not lead to the rocket lifting higher, you may just have to run faster to get out of the way!

Some film canister designs launch more consistently than others – if you have more than one type you can compare how they fly.

Aerodynamics

Very little is going to improve the aerodynamics of a film canister rocket, however, you can make it look like it could take a payload into orbit.

Before you make your next rocket take a clean, empty film canister. Wrap paper round the film canister and hold it in place with sticky tape. This can extend well above the top (technically the bottom) of the film canister. Make a nose cone from a circle of paper. You can also add fins, give your rocket a name and colour the paper.

Once the rocket is designed you will need to hold it while filling it as it won't sit on a table any more.

The launch pad

You can easily launch your rockets straight up if you put them on a flat surface, but you can also get them to fly distances if you create a launch pad.

Fold a piece of cardboard over and use the sticky tape to hold it in place at the angle that you want. In theory the best angle for a launch pad is 45° . Finding the right angle is a balance between wanting the rocket to stay in the air for a long time, while giving it enough speed along the ground for it to actually fly somewhere in this time.

You can now take some time to admire other groups' efforts, or better still have a quick competition to see whose rockets fly the highest or simply look the best.



and beyond...

www.npl.co.uk/waterrockets

If you enjoyed making these small rockets you could try making water rockets. You can hold your own competition, or enter the NPL Water Rocket Challenge that is usually held in June. For more information about how to make water rockets and how to enter have a look at their website.

DAYTIME ASTRONOMY

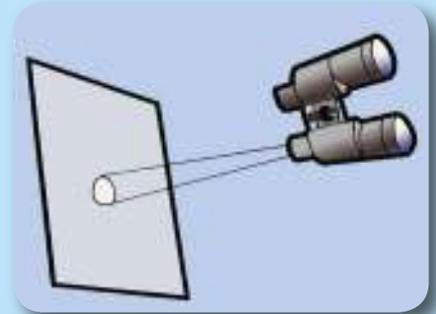
ACTIVITY 03

Who says that you need to stay up all night to do astronomy?

Before you begin...



This activity involves making observations of the Sun. Anyone can do it, but it is important that **NO-ONE should ever look directly at the Sun**, because this can cause **permanent blindness**. **DO NOT** use sunglasses, cameras, binoculars or a telescope to look directly at the Sun: it can cause permanent damage to the retina.



Observing the Sun

The Sun might just look like a bright blob in the sky, but there is a surprisingly large amount going on if we could just see it. We can never look directly at the Sun, but to see what is going on we can build certain devices that reduce the brightness and the danger to our eyesight.

The first and most commonly used device is a pinhole camera. This is very easy to make, but the image you get of the Sun is usually very small. If you would like to have a go see www.scienceprojectideas.co.uk/tracking-sunspots-across-sun.html.

Although the pinhole camera gives a nice, low-tech view of the Sun, if you use a pair of binoculars you can project a good image of the Sun onto a screen. This should be big enough and bright enough to see sunspots.

Eclipses

To find out when the next partial solar eclipse is, visit the NASA eclipse website (<http://eclipse.gsfc.nasa.gov/eclipse.html>).

Use the JavaScript solar (or lunar) eclipse predictor to work out when a partial solar or lunar eclipse will be visible from where you are. Although total solar eclipses occur every couple of years, they are rare in the UK, and you may have to wait several years even to see a partial eclipse.

To make observations of the Sun you can use binoculars to project an image of it onto a flat surface.

Whatever you do, NEVER look through binoculars at the Sun.

You will need:

- a large piece of paper
- a pencil
- binoculars, preferably with a tripod

What to do:

1. If you don't have a tripod, the best way to keep the binoculars steady is to use your shoulder. Cover one of the binoculars' lenses.
2. Hold the binoculars on your shoulder with your back to the Sun and with the wide end of the binoculars towards the Sun. The eyepiece of the binoculars should point towards a paper screen, which is taped in place on a wall, or on the floor if the Sun is high overhead.
3. Move the binoculars towards or away from the screen until you get a large image of the Sun. Then change the focus of the binoculars until the image is very sharp.
4. It is difficult to hold the binoculars steady, but do your best and get your friend to draw round the image of the Sun. Look carefully for any dark spots and mark these on the drawing – you may have found your first sunspots.

DAYTIME ASTRONOMY

ACTIVITY 03

Sunspots

If you can produce a big, bright image of the Sun using the binoculars, you may see some sunspots. You can compare what you saw with the Solar and Heliospheric Observatory images of the Sun (<http://sohowww.nascom.nasa.gov>).

Sunspots occur in the top-most layers of the Sun, where magnetic fields cause clumps of gas to be considerably cooler than the surrounding gas – and cooler means darker. The new solar cycle started in mid-2008 when the number of sunspots was at a minimum. As the cycle progresses over its usual 11 years, the Sun will become more active with more sunspots and more eruptions from the Sun's surface, throwing hot gas into space.

For more information about sunspots, have a look at the National Maritime Museum website and search for "sunspots" (www.nmm.ac.uk).

Auroras: what the Sun does at night

The Sun doesn't just emit light. Massive amounts of highly energetic charged particles are blasted off from it every second. The more sunspots that are visible, the more material that is being blasted into space. Some of these charged particles collide with the Earth and it takes around two days for them to get here. Instead of just filtering down into the Earth's atmosphere, these particles spiral around the Earth's magnetic field and give off light (accelerating charged particles emit light). The light creates beautiful patterns in the night sky, most frequently

visible over the Arctic and Antarctic, but sometimes at much lower latitudes.

For more information about auroras, see the National Maritime Museum website (www.nmm.ac.uk).

For the prediction of auroras and sunspots, visit www.spaceweather.com.

You can also find videos of the effects on video sharing sites such as YouTube (www.youtube.com).

For more projects, information and activities related to the Sun, visit the Suntrek website (www.suntrek.org).

The speed of light

Light doesn't travel instantly from place to place. It takes time, and though light may move very fast, it still takes more than 8 minutes for light to travel from the Sun to the Earth. How do you measure something that fast? Well, you can do it indirectly using the frequency and wavelength of microwaves. Microwaves are part of the same spectrum as lightwaves, so we can use them instead of using light.

What to do:

1. Take a large, flat plate and sprinkle the chocolate over it. It is best if you can cover the plate evenly and completely.
2. If your microwave has a turntable, take it out and turn it upside down so that it stops rotating. Check that your microwave will still work like this.
3. Put your plate of chocolate in the microwave and turn it on full power – it will take about 30 seconds. Keep an eye on it to make sure that the chocolate isn't overcooking, and don't let too much chocolate melt or you won't be able to measure the distance accurately.
4. Take the plate out and look at the uneven patches of melted chocolate. Some of it should still be solid while evenly spaced patches are melted.
5. Measure the distance between the melted patches of chocolate. Take care with microwave-melted chocolate because it can be extremely hot.
6. Use the formulae on the next page to work out the speed of light, then work out exactly how long it takes light to reach us from the Sun.

You will need:

- several packets of chocolate buttons, chocolate drops or Milkyway Magic Stars for a celestial feel
- a microwave oven, either without a turntable or with a turntable that can be disabled or removed
- a microwave-safe plate
- a ruler

DAYTIME ASTRONOMY

ACTIVITY 03

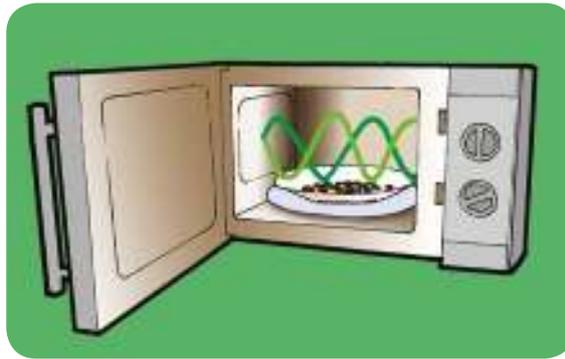
How to measure the speed of light in a microwave

A microwave oven generates microwaves (radio waves with a frequency of around 2.45 GHz), which bounce around inside the box containing the food. As the microwaves pass through the food, they are absorbed by the water, fat and sugar molecules, which become excited and jiggle about. Atomic motion is heat, and, since the microwaves can penetrate throughout the food immediately, the heating of it is quick and even.

The microwaves reflect off the inside of the oven and bounce back towards the source. At certain points the peak of one wave coming out of the generator meets the trough of a reflected wave and they cancel each other out. If your chocolate is at this point it won't melt. In other places the peak of one wave meets the peak of the reflected wave, so the chocolate at this point begins to melt. The same is true when a trough of the emitted wave meets a trough of the reflected wave.

Even though both the emitted and reflected waves are moving, the way that they reinforce and cancel each other means that they create what's called a standing wave.

The points where the chocolate melts tell us about the wavelength of the wave – this is the distance between the peaks of two waves, or the troughs of two waves. The standing wave is at a maximum at both the peak and the trough of the moving waves, so the distance between the melted chocolate patches is exactly half a wavelength.



Calculating the speed of light

The frequency of the radiation in the microwave should be labelled on the back of the microwave (usually around 2.45 GHz, or 2 450 000 000 Hz). You should find that the distance between the melted patches of chocolate is around 6 cm, giving the waves a wavelength of 12 cm (0.12 m).

For waves,

$$\text{speed} = \text{wavelength} \times \text{frequency}$$

$$\text{speed} = 0.12 \times 2\,450\,000\,000$$

Using the numbers above, we arrive at a speed of 294 000 000 metres per second, which is pretty much the speed of light.

You can go on to work out how long it would take for light to reach the Earth from the Sun, using the formula $\text{time} = \text{distance}/\text{speed}$

If everything is in metres and seconds, we have...

speed of light = 300 000 000 metres per second (or use the value you worked out from the microwave!)

distance between the Sun and the Earth is 149 000 000 000 m

giving a time of 496 s, which is 8 min 16 s.

PLAYING WITH YOUR FOOD

ACTIVITY 04

Jelly is not normally known for its structural integrity. However, in this activity you will be taking a jelly – a mixture of solid gelatine and water – and making it considerably stronger. The objective is to build the tallest jelly in the world, or at least the tallest on that day!

The idea for this activity comes from the Institute of Food Research's Tallest Jelly Competition. Visit its website for fantastic videos and photos of the most recent competition (www.ifr.ac.uk/jellyvision).

This activity is most suitable for a family afternoon, summer fete or barbeque – you'll need to prepare in advance and give out instruction sheets to everyone who intends to take part.

Before you begin...

To run this as a competition you will need to make sure you have given everyone the 'Tallest Jelly' sheet in advance (p16). You can ask people to work in teams or individually. Entrants will probably want to experiment with different designs before producing their final jelly structure on the day.

You can run the competition in several ways, and entrants will need to bring their jellies in moulds to the event and then set them up on the day.

You may ask all the entrants to set their jellies up at the same time, and then judge them on height, artistic merit, ingenuity. Or if you have a small number of entrants, they could set their jellies up after each other. This would allow you to time how long each jelly remains upright.

Each team should have its own table when setting up, as even a tiny knock could sabotage a brilliant entry!

Have a look through some experiments with food in this pack and online. You might want to try:

#8 Physics to Go: Erupting fizz, (where a gas is contained in liquid)

#10 Physics to Go: Amazing marshmallows, (where a gas is contained in a solid)

The rules

The Institute of Food Research has set out some rules, which you can use, adapt or change entirely...

1. Each team is limited to a certain number of packets of jelly, to make either a small quantity of very strong jelly or a large quantity of weaker jelly. Entrants in the Tallest Jelly Competition were limited to four packets of jelly, and each could only be made four times as strong as the packets recommended.
2. Only food can be used to strengthen the structure: no pouring concrete in with the mixture! According to the Institute of Food Research's rules, you must be prepared to eat any part of the jelly.
3. The base of the jelly can't be bigger than an A3 piece of paper.
4. The jelly has to stand up on its own: no holding it up with spaghetti scaffolding around the outside.



PLAYING WITH YOUR FOOD

ACTIVITY 04

Tallest Jelly

Food is rarely just a solid or a liquid: it's the gas in fizzy drinks that make them tingle, the air in marshmallows that make them squidgy and the water in apples that makes them juicy.

But what is it about a jelly that makes it wobble, and are you up to the challenge of taming it?

The objective is to build the tallest jelly in the world. It may sound simple but making a tall jelly is astoundingly difficult.

What makes a jelly wobble?

Despite first appearances, food is rarely made up of just one phase of matter. Most people might guess that the jelly is entirely a solid. However, the gelatine protein strands in a jelly are not very ordered, unlike the molecules in a "normal" solid, leaving gaps that are filled with water molecules. This is what makes the jelly wobbly.

The tiny pockets of liquid water in the tangled proteins make it extremely difficult to build a tall, structurally sound jelly.

There are number of things that can help you to build a strong, tall jelly. The first is to add more gelatine. If you make up jellies at strengths that are different from the manufacturer's instructions you will notice that the ones with more jelly mixture and less water in them are stronger and less wobbly. In these cases there are simply more tangled-up gelatine proteins to hold the jelly together.

Things to think about!

- Do you want to make stronger, more concentrated jellies, or weaker, less concentrated jellies? The more concentrated ones will be stronger but smaller.
- Will you be making a single jelly, from one mould, or many jellies that you will build together on the day?
- What substances will you add to your jelly to improve its structure? Some things absorb water and stop being rigid so try lots of things to find out what works and what doesn't.
- Try pushing over a plastic bottle filled with water. When a line from the centre of the bottle (its centre of gravity) to the table lies outside its base, the bottle will fall over. A larger base will mean it can tip further before falling.
- Try out a number of jelly moulds, jelly concentrations and the kinds of materials that you use to make them stronger.

BUILD YOUR OWN EGGPOD

ACTIVITY 05

Eggs are surprisingly tough, but are they tough enough to survive a fall of a couple of storeys onto concrete? We don't think so, at least, not without a little help...

Before you begin...

You will be throwing or dropping an egg in a way that is sure to make it smash into pieces if it isn't protected. The objective is to make a protective case for a raw egg so that it can survive the fall intact. The eggpod itself can be damaged, but the egg must not be cracked!

You will want to make sure that you have got together all of the equipment that you need to design your eggpods. This might mean paper, cardboard, jam jars, glue, sticky tape – whatever you think you are going to need to protect your egg.

Pick out some short experiments that explore how and where eggs are strong and where they are at their weakest. If you have time you can try a few of these out before you start making the eggpods. Take a look at the list on the right for some examples.

If you want to go a step further with the egg drop, you can film the design, construction and potential destruction of your eggpods. It would make a perfect entry for SciCast Physics (www.planet-scicast.com/scicast_physics.cfm).

In this pack you will find:

- #4 Marvin and Milo: Spinning the eggs
- #17 Physics to Go: Egg-citing physics
- #18 Physics to Go: One in the hand
- #40 Marvin and Milo: Daredevil egg

The eggpod challenge

You may decide to drop the egg or try throwing it over a certain distance. Each impact will be different and may require different designs.

There are very few rules to this, but you can always add a few to make it trickier. Try the following:

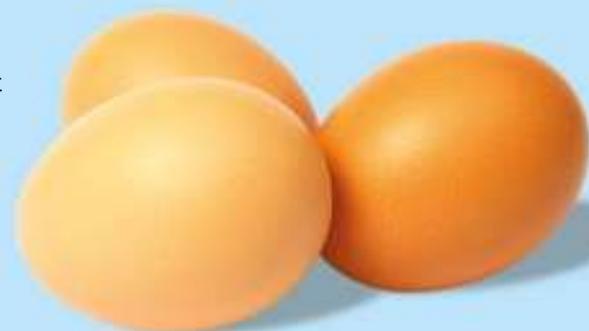
1. You can only use paper to protect the egg.
2. The egg must be visible. This is brilliant if you decorate it like an astronaut.
3. You must be able to construct the design in less than 5 min.
4. The weight limit of the eggpod (without

the egg) is 500 g.

5. You can construct a suitable base to soften the impact.
6. The eggpod must be made with more than five different types of material.

If you are planning to make this into a competition, you could also add a few judging criteria:

- The winner will be the person with the lightest eggpod.
- The eggpod must land in a designated area.
- Extra points are awarded for the most attractive eggpod.



BUILD YOUR OWN EGGPOD

ACTIVITY 05

The egg shape is an incredibly strong design. If you apply pressure over an area the force is spread out over the entire surface. If you try to squeeze it in one hand it is surprisingly hard to break. The thing to avoid is a sharp force at one point, particularly a sharp force directed inwards towards the centre of the egg.



The egg design has been copied in arched doorways, in bridges, and you will find huge, strong arches in cathedrals. All arches spread the tremendous force that they experience, creating an incredibly strong structure.

We spend a lot of time and money on protecting objects that are likely to experience some kind of impact. People in cars are held in place with seat belts and airbags so that they do not collide with the inside of the vehicle. Cars themselves have crumple zones, so the force of an impact is spread out: the exterior of the car is destroyed leaving the people inside safe.

Physicists have designed the ultimate impact protection for planetary explorer probes. These delicate pieces of equipment are protected (it is hoped!) as they fall from space to the hard, rocky, surface of the planet. Engineers have used airbags on Mars, where the lander was protected inside what looks like a large balloon. Parachutes are also used to slow the descent. Heat shields are used on planetary probes to stop the delicate equipment melting as the lander enters the planet's atmosphere.

Getting started

Divide into small teams and start thinking about how you want to protect your egg. If you are having problems coming up with your first idea, read about some other people's crackpot ideas. You can then adapt and improve on them.

Once you have an egg and an idea of how you want to protect it you can start constructing the eggpod. Try testing some of your eggpod designs at low heights first: no standing on chairs or tables.

Crackpot eggpod ideas

- Put your egg in a jar of peanut butter, make sure it has peanut butter all around it.
- Use popcorn to cushion your egg in either a bag or a box, or use polystyrene packing chips.
- Use polystyrene cups to create a crumple zone around your egg.
- Bubble wrap the egg.
- Suspend your egg within a cage – the cage should crumple leaving the egg intact.
- Surround the egg in balloons.
- Use a parachute to slow the fall and then also protect the egg below.

Take the challenge

Once you think you have the perfect design, it is time to challenge the other teams. Find somewhere high to drop the eggpods.



WARNING

Some of the designs may be heavy and they are falling from a height. Make sure that no one is in a position where they could be hit by an eggpod, and that you do not have to lean over too far.

You can set your own criteria for the winner if more than one egg survives the fall – or if none survives (e.g. ingenuity of design or best decorated egg-stronaut).

NAKED EYE ASTRONOMY

ACTIVITY 06

You don't need fancy equipment and expensive telescopes to get a good look at the night sky. In fact, naked eye observing is the best way to get an overview of the sky. You'll be surprised at how much you can see once you're away from the orange glow of street lights. Once you know what you're looking at, ordinary binoculars can give you a more detailed view of individual objects.

Before you begin...

There are different things to observe at different times of the year, so you'll want to think about what you'd like to see before deciding on a date. You'll find more information below on things to take into account when deciding when and where to go naked eye observing, but perhaps the biggest factor is whether you want to have an early night, or stay warm...

It may be slightly warmer in the summer, but you will have to wait longer for the sky to be dark enough to make some good observations. You'll need to wrap up more in the winter but you can go out earlier!

Whatever time of year you decide on it will be dark, so make sure everyone takes care. Let your eyes adjust to the dark before moving around too much.

Things to bring with you...

Although none are essential, these can all help to make the evening more enlightening and comfortable:

- Warm clothing and drinks (clear nights can be chilly even in summer)
- Torch covered with transparent red film
- Binoculars
- Compass
- A guide to the night sky (see below)

Daily changes in the night sky are due to the Earth spinning on its axis. Each night, the stars rise in the east, move across the sky and then set in the west – just like the Sun. Yearly changes are due to the Earth orbiting around the Sun.

guides to help you get started.

One of the best is Prime Sky from the Royal Observatory Greenwich (www.nmm.ac.uk/primesky/). This is updated regularly and you can print out information for the weeks ahead.

The Society for Popular Astronomy has a monthly sky guide (www.popastro.com/youngstargazers/thismonth.html) that includes printer-friendly sky charts and tips on how to find what you're looking for.

Heavens Above (www.heavens-above.com) also has sky charts as well as predictions for when satellites, including the International Space Station, are visible.

Most guides will give two pieces of information to help you find what you're looking for:

- the direction to face (north, north east, east, south east, south, south west, west, north west); and

horizon, 15°, 30°, 45°, 60°, 75°, 90° – directly overhead).

Tips to get the best possible view:

- Avoid evenings with a full Moon: the light from a full Moon will block out the light from almost all other objects in the sky.
- Find a location well away from light sources such as street lamps.
- Give your eyes at least 15 min to adjust to the dark.
- Don't switch on lights or torches. If you need to see something, use a torch covered by a transparent red film.
- Binoculars allow you to see more detail, but lean against a wall or something similar to steady your view.

- how high to look up (0° – towards the

NAKED EYE ASTRONOMY

ACTIVITY 06

Here are some ideas for what you could look for. You may need to do a little research first so that you know roughly where and when to look, but there is always something to see.

The North Star

Also called the Pole Star or Polaris, this star stays in almost the same position in the sky all the time whilst all the other stars rotate about it. This makes it ideal to navigate by as it is always due north. You can find Polaris quite easily once you've found the Plough – just follow the two stars on the right-hand side of the Plough's pan upwards. See www.popastro.com/youngstargazers/bearings.html for a diagram.

The Milky Way

The Milky Way is the white smudge across the sky that looks vaguely like a cloud. This is our galaxy and is host to up to 400 billion stars. The Milky Way is just one of billions of galaxies in the Universe. See www.space.com/milkyway/ for more information.



The Moon

The Moon is perhaps the best known object in the night sky. It is often very low in the sky during the summer months, making detailed observation trickier than normal, but you could try making observations in the winter. Try to avoid observing during the full Moon as the sky will be very bright. See www.popastro.com/moonwatch/moon_guide/observing4.php for more information.

NAKED EYE ASTRONOMY

ACTIVITY 06



Satellites

Man-made things can also be seen in the night sky. Satellites can be easily identified as they pass across the sky at a steady rate and often flash as they tumble and catch the light from the Sun. You can get predictions for when the International Space Station and other satellites are visible from www.heavens-above.com.

Planets

Mercury, Venus, Mars, Jupiter and Saturn are all visible with the naked eye, although they are only rarely all visible at the same time. Venus is the brightest object in the sky after the Sun and the Moon, and is visible during twilight hours. Jupiter is often the next brightest object in the sky. The planets can be distinguished from stars as they do not twinkle and their position relative to the stars changes from night to night. See <http://homepage.ntlworld.com/mjpowell/Astro/Naked-Eye-Planets/Naked-Eye-Planets.htm> for more information.

Constellations

In strict astronomical terms, constellations are areas of the night sky rather than groups of stars that form a pattern. However, for most people, spotting the constellations means trying to make out the signs of the zodiac such as Leo and Taurus, along with patterns such as the Plough and Orion. See <http://stardate.org/nightsky/constellations/> for more information.

Meteor showers

Meteors, or shooting stars, are pieces of debris from space burning up in our atmosphere. Meteor showers occur when a comet passes by Earth leaving a trail of ice and rock in its wake. This produces a spectacular show as it falls through the atmosphere. The Perseid meteor shower occurs each August as the Earth passes through the debris left by the comet Swift-Tuttle. See www.bbc.co.uk/science/space/solarsystem/meteors/index.shtml for more information.



SEASONAL SCIENCE

ACTIVITY 07

If you would like to fill an evening with some fantastic seasonal science, or plan to squeeze some physics into an event, you'll find all you need in this section and in the short experiments at the back of the pack.

Choosing a theme

Putting together a few physics tricks to amuse and entertain is easy once you have decided on a theme. You can do some activities that are related to the time of year or to a calendar event. If you don't have a specific event in mind, have a look at some online calendars: you will find lots of national events to inspire you.

Once you have decided on a theme you can either do them as demonstrations, or get everyone involved in carrying out the activities and figuring out how they work. You'll need to put together all the equipment first, perhaps with one activity per table. Then everyone can move from activity to activity.

For Brain Awareness Week, usually held in March, you may want to do some experiments that use even more brain power than normal.

The following Marvin and Milo experiments may look simple but the physics is complex:

- #36 On a roll
- #39 Loop the loop
- #42 Antigravity Maltasers

For Red Nose Day try some activities that are sure to make you laugh.

Why not try the following experiments:

- #8 Physics to Go: Erupting fizz
- #12 Physics to Go: Balloon kebabs
- #9 Marvin and Milo: Alka-Seltzer rocket
- #25 Marvin and Milo: Indestructible bag

If you want to stay dry, stick to these Marvin and Milo experiments:

- #12 Foil boat
- #17 Reversing glass
- #20 Melting race
- #21 Simple siphon

If you find yourself with a very wet day, why not use water as your theme.

However, if you are prepared to get out a few towels, try these Marvin and Milo experiments:

- #1 Straw water gun
- #18 Juice carton sprinkler
- #23 Stringy water
- #24 Water jets



SEASONAL SCIENCE

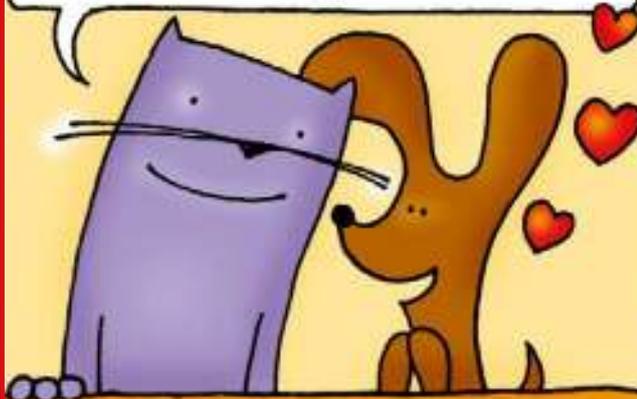
ACTIVITY 07

Left-Hander's Day is usually in August. Do you know how difficult it is being a left-handed person living in a right-handed world? How about trying some tricky (but safe) experiments using mainly your left hand if you are right-handed, or your right hand if you are left-handed, then switch and see how bizarrely asymmetrical the human body is.

You could try the following Marvin and Milo experiments:

- #37 Clumsy catching
- #39 Loop the loop
- #40 Daredevil egg

Do you want to see my homemade sunset?



On Valentine's Day why not set the right mood with some romantic activities?

#32 Marvin and Milo: Homemade sunset

Add some chocolate...

#42 Marvin and Milo: Antigravity Malters

Wine glasses...

#27 Marvin and Milo: Singing paperclip

And, of course, something fizzy...

#8 Physics to Go: Erupting fizz

Try these Marvin and Milo experiments:

- #19 Balloon rocket
- #12 Foil boat
- #44 Hover crafty
- #36 On a roll

Whether or not you can get to Royal Ascot in June you could still have a race day.



SEASONAL SCIENCE

ACTIVITY 07

A larger event

If you are interested in doing a series of physics tricks as part of an event, the short experiments included in this pack are a great place to start.

Carefully select which ones are most appropriate to your venue and audience. One possible running order for “physics busking” – attracting a crowd in a public venue using physics tricks – is given below. You can adapt this for different audiences and include any physics that you find especially interesting.

You will have to prepare for the event...

You may want to rehearse with a small friendly audience, try to find people who most closely match your target audience, for example families with people of all ages, teenagers or adults.

Try to use language suited to that audience – if you have a lot of young children you will need to make sure that the physics is as clear and simple as it can be.

Remember to enjoy yourself!

Possible running order from Physics to Go...

- #12 Balloon kebabs
- #3 Straw oboes
- #7 Potato straw
- #5 Lifting lemon
- #2 Water-Proof hanky
- #1 Alka-Seltzer rocket

Gathering an audience

Start with an attention-seeking demonstration – something visual or noisy usually works best. Targeting children first (balloons always attract children) is a very effective way of attracting an audience. The adults will drift along after the children to see what is happening.

Once you have a few people gathered, try to involve them. Invite them to try some tricks. “Straw oboes” and the “potato straw” are good for this. Again, these tricks are highly visual or noisy so more people are likely to join in.

Get the audience involved

Another thing to keep in mind is how to keep your audience gripped. A good script will do this, or a well-planned running order for the demonstrations. However, even better is getting the audience to be part of the science. If the demonstration involves someone getting messy or wet, put a stooge in the audience – as far as the audience is concerned, this could be any one of them getting soaked.

Even if you don't need someone from the audience helping with the



demonstration, ask them questions about what they expect to happen, how the demonstration worked or what other materials could be used in the demonstration. This works particularly well if you are working in small groups. The more your audience does for themselves, the more they will enjoy it.



Remember safety

Consider how safe the experiments are. Rockets and flying things are always spectacular, but they will have to come down somewhere, so keep this in mind if you are going to use them. If some of the experiments are a little too dangerous for audience members to repeat on their own, make sure that you don't give away too many instructions and let the audience know not to repeat them.

PART THREE
SHORT

EXPERIMENTS



SHORT EXPERIMENTS

The following short experiments are taken from the Institute's Physics to Go pack and Marvin and Milo cartoon series.

You can find videos demonstrating the Physics to Go experiments, and a full list of all of the Marvin and Milo's at www.physics.org. The keywords at the end of each cartoon allow you to search the database on www.physics.org for websites with more information on that topic.

The explanation of the science behind the experiment follows each set of instructions – you might want to cover these up if you're photocopying the pages for others to do them as a challenge.

Physics to Go

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Marvin and Milo

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ALKA-SELTZER ROCKET

01

Turn simple, familiar household ingredients into an awesome rocket.

What to do:

1. Break the Alka-Seltzer in half and place half in the film canister.
2. Add about 1 cm of water.
3. Fit the lid onto the canister, making sure that the seal is tight.
4. Turn the canister upside-down and place it on a flat surface.
5. Stand back.

You will need:

- an empty film canister
- an Alka-Seltzer tablet
- some water

Tips for success

Make sure that the film canister lid is tightly fitting or you will only get a disappointing “fizz”. You should also clean the canister lip and lid between launches so that no pieces of Alka-Seltzer get stuck between them, ruining the seal. You will need to stand well back when your rocket launches.

What's going on?

When water is added to the Alka-Seltzer tablet, bubbles of carbon dioxide gas are given off. When the lid is fitted tightly to the canister, this gas is contained in an enclosed space. As more gas is given off, the pressure inside the canister rises until there is enough force to overcome the seal of the lid. The built-up pressure exerts enough force to shoot the canister into the air, creating a rocket.

Did you know?

The Chinese began building chemical-powered rockets as long ago as the 1150s. One of the great pioneers of modern rocketry, N I Kibaltchich, was executed in 1881 after manufacturing the bomb that was used to assassinate Tsar Alexander II.

WATERPROOF HANKY

02

This is a great excuse to threaten to pour water over your friends, but with a surprise twist, thanks to physics.

What to do:

1. Push the centre of the handkerchief into the glass, so that the edges are hanging over the outside of the rim.
2. Pour water into it, through the loose hanky. Make sure that everyone can see the water easily passing through the hanky into the glass. Keep pouring the water until the glass is roughly half full.
3. Pull the corners of the hanky so that the material is taut over the top of the glass. Hold the glass and hanky so that the material stays tightly stretched over the opening. Secure it with an elastic band.
4. Place the plate on top of the glass and tip it all upside-down, making sure that the hanky is pulled tight.
5. Choose a likely suspect from your audience to threaten with a drenching. Hold the upside-down glass and plate above their head, making sure that the glass is vertical and the hanky is tight. Remove the plate and... nothing happens – the water stays inside the glass.

You will need:

- a large, sturdy plastic glass
- a small plastic plate
- some water
- a hanky or dish cloth

Tips for success

Don't try to substitute a paper tissue for the handkerchief because it won't work. If the glass isn't held vertically, some water may dribble out at the edges.

What's going on?

This experiment is based on surface tension. When the hanky is loose, the water can pour through the gaps in the fabric. However, when the hanky is pulled tight, the water molecules can form a single surface or membrane across the material. At the same time there is a pressure difference between the inside and the outside of the glass. The pressure of the atmosphere surrounding the glass is greater than the pressure inside, and this helps to hold the water inside the glass.

Did you know?

Galileo was among the earliest to demonstrate the existence of surface tension in water by showing that an iron needle will float lengthways on water, but not on its point.

STRAW OBOES

03

A noisy, amusing demonstration of the physics of music.

What to do:

1. Flatten one end of a straw about 2 cm from the end to the tip.
2. Make two cuts in the now flattened end of the straw to form a triangular tip.
3. Insert the triangular tip of the straw into your mouth and blow hard. You should hear a loud “buzzing” sound.
4. While blowing on the straw “oboe”, get a volunteer to cut the straw shorter – about 1 cm at a time. With each cut you will hear the pitch of the sound go up.

You will need:

- some new plastic straws (which need to be straight – cut off the bendy bits, if there are any)
- a pair of clean scissors

Tips for success

It can take some practice to get the right sound. If it doesn't work straightaway then slowly move the straw in and out of your mouth while still blowing, until you hear the sound. It may help to press down on the straw with your lips or teeth.

Remember to tidy up afterwards and put all used straws and bits you've cut off in the bin.



The tip of the straw oboe

What's going on?

The flattened triangular tip acts like the reed found in most wind instruments. Blowing on the reed causes the straw to vibrate. A standing wave pattern is created along the length of the straw, which we hear as sound. As you shorten the straw you shorten the wavelength of the standing wave pattern and increase the pitch of the note.

Did you know?

As long ago as the 5th century BC, Pythagoras and his followers were experimenting with standing waves and calculating the values of their harmonics. Another way to set up a standing wave is to blow across the top of a bottle filled with water. The note gets deeper as you empty the water out.

CLOUD IN A BOTTLE

04

Now you see it, now you don't.

What to do:

1. Place a splash (~1 teaspoon) of water into the plastic bottle.
2. Light the match and make sure that it is burning well, then drop it into the bottle.
3. Quickly screw the cap on, and squeeze the bottle with your hand five or six times (for larger bottles you may have to do this more). You should see a cloud form in the bottle, then magically disappear when you squeeze it.
4. Pass the bottle round to give everyone a chance to experience it for themselves.

You will need:

- a 2 litre flexible plastic bottle with a cap (e.g. from most fizzy drinks)
- some water
- a safety match

Tips for success

Try adding a small amount of food colouring to the water. This can help to increase the visibility of the effect.

What's going on?

Clouds are formed when water droplets in the air cool and then collect on dust particles.

In this demonstration the dust particles are provided by the smoke from the match. The amount of air is constant, but squeezing the bottle raises the temperature and changes the volume of the gas, while letting the bottle expand causes the air temperature to drop.

In this case the drop in temperature is enough to cause the water gas to form a liquid – the cloud.

Did you know?

This demonstration involves building a small cloud chamber exactly like those used to record the tracks of subatomic particles (alpha and beta radiation) by Charles Wilson in 1911. He was awarded the Nobel Prize in 1927 for this discovery.

LIFTING LEMON

05

Levitate a slice of lemon using a few simple ingredients.

What to do:

1. Pour water into the bowl until it is about 1 cm deep.
2. Push three matchsticks into the slice of lemon in the shape of a triangle, with the match heads together at the top to form a pyramid.
3. Place the lemon and matchsticks in the centre of the bowl, floating on the water.
4. Light the fourth match and use it to light the other three together.
5. Invert the glass over the lemon and matches, letting it sit inside the bowl with its rim under the water.
6. Watch as the lemon slice rises up inside the glass.

You will need:

- a slice of lemon
- four safety matches
- a large glass
- a glass bowl – one with a flat base is best
- some water

Tips for success

The lemon slice needs to be thick enough to support the matches but light enough to float on the water.

What's going on?

The simplicity of this trick belies the complexity of the physical processes that contribute to the effect.

First, there is a simple air pressure effect caused by the expansion and contraction of the gas in the glass as it heats up and cools down. The heat from the three matches causes the air inside the pint glass to get hot. When all of the oxygen is exhausted, the matches go out and the air cools down. The cooler air takes up less space, so water gets pushed up into the glass to take up the extra volume.

Second, the combustion reaction changes the types of gas present, which changes the volume of gas in the glass. When the matches burn they use up oxygen. The products from the burning matches are carbon dioxide and water. The water is a liquid, so there will be less gas in the glass, causing the water to be pushed up into the glass to fill the volume.

Did you know?

This demonstration is based on the methodology used by Joseph Priestley to demonstrate that oxygen is a component of air, and to estimate the proportion of oxygen in the air.

THE POWER OF WORDS

06

All you need is a ruler and a sheet of newspaper for this physics trick.

What to do:

1. Lay the ruler over the edge of the table so that about one-third of its length is over the edge.
2. Hit the ruler so that it flips off the table.
3. Replace the ruler. Fold up a sheet of newspaper as small as possible and place it at the back end of the ruler so that it acts as a counterweight. Hit the ruler again and it still flips off the table, this time along with the newspaper.
4. Replace the ruler. Lay a single sheet of newspaper flat on the table and on top of the ruler with the ruler roughly in the centre. When you hit the ruler it will stay on the table.

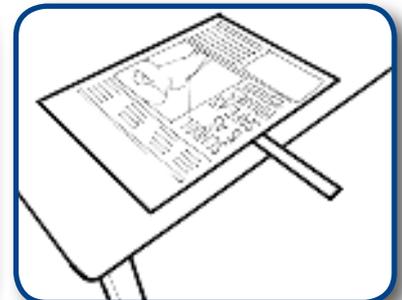
You will need:

- a table with a flat edge
- a ruler
- a newspaper

Tips for success

For optimal effect, make sure that as little air as possible is under the newspaper by smoothing it out flat prior to hitting the ruler.

Use eye protection if you are concerned about the ruler flying across the room.



What's going on?

It all comes down to air pressure. Atmospheric pressure exerts a downward force on the sheet of newspaper. The area of the sheet is large, so the downward force of the atmospheric pressure exerted on the newspaper is strong enough to counter the upward force from the ruler when you hit it. The folded-up newspaper has a smaller surface area over which the atmospheric pressure can act, so it doesn't prevent the ruler from flipping off the table.

Did you know?

During the scientific revolution it was common to think of air pressure in terms of the total weight of a column of air pressing down on a unit area. In 1643 Evangelista Torricelli, a pupil of Galileo, inverted a mercury-filled glass tube, sealed at one end, into a basin also containing mercury. He found that the weight of air over the basin was sufficient to support a column of mercury to a height of 76 cm. This invention is the basis of using "millimetres of mercury" as a unit of air pressure.

POTATO STRAW

07

Probably one of the quickest ways to make holes in a potato.

What to do:

1. Challenge your volunteers to see who can insert a straw the farthest into a potato. To increase the excitement you may want to line up a row of them, each with a straw and a potato, and run the demonstration as a race.
2. Give them a while to try the challenge – they will almost certainly twist the straws slowly into the flesh of the potato. When their straws are bent and won't go any further, show them how to do it:
 - a. Hold the potato between thumb and fingers (don't have your hand behind the potato).
 - b. Grasp the straw firmly about two-thirds of the way up so that you have plenty of straw to go into the potato.
 - c. Use a sharp, thrusting movement to force the straw through. Be confident – it really will go.

You will need:

- some plastic straws (which need to be straight – cut off the bendy bits, if there are any)
- some large baking potatoes (not for eating)
- some volunteers

Tips for success

The straws need to be straight, with no defects. Don't reuse straws. Have confidence that the straw will go through – you don't have to be particularly strong to make this trick work but you do need to be aggressive.

If you still have difficulty getting the straw very far into the potato, try changing your grip – some people find that holding the straw with their thumb over the other end works best, while others like to pinch the straw part-way down.

Remember to dispose of your potato and any little bits that have wedged in your straw properly afterwards.

What's going on?

There are two principles contributing to this trick:

1. The sharp, thrusting movement delivers a much larger instantaneous force than the slow, gradual, twisting motion, thereby making the straw go farther.
2. The end of the straw has a very small surface area, so the force that you apply is concentrated strongly. If you try the trick with a pencil roughly the same size as the straw, you will find it more difficult – you will need to displace a much greater area of potato, which will require a much greater force.

Did you know?

This effect (the concentration of force into a small area) can be seen quite frequently in everyday life (e.g. a stiletto heel sticking in a vinyl floor). The inverse effect is illustrated by extra wide tyres on tractors and wheelbarrows, which spread the force across a wider area to prevent damage to the ground.

ERUPTING FIZZ

08

An impressive demonstration using things you can find in the kitchen.

What to do:

1. Half-fill the glass with fizzy drink
2. Pour vegetable oil into the glass so that it is roughly two-thirds full.
3. Add a few drops of food colouring and stir the mixture. Wait until the two layers have clearly separated.
4. Add approximately two tablespoons of salt to the liquid in one go. A great foam eruption occurs. Observe the liquids after the eruption has settled down. You should be able to see a lava-lamp-style bubble effect.
5. Add an Alka-Seltzer tablet to the liquid. You should see some interesting bubbling effects from the gas given off by the Alka-Seltzer, and the change in the speed of those bubbles as they travel through water versus oil. You can prolong the effect by breaking the Alka-Seltzer tablet into smaller pieces.

You will need:

- a large glass
- a fizzy drink - preferably a clear one
- some vegetable oil
- some food colouring
- an Alka-Seltzer tablet
- some salt
- a stirrer

Tips for success

This trick can keep working for quite a while – just add more Alka-Seltzer. You won't see the big fizzy eruption once the drink loses its fizz, but the bubble effect is still very clear. The salt will tend to supersaturate the drink solution after a while, making it go cloudy and reducing the effect of the trick. Make sure that your fizzy drink isn't too dark to allow you to see the bubbles passing through the liquid.

What's going on?

Water and oil do not mix – they are called immiscible liquids. Water is more dense than oil, so it sinks to the bottom of the glass, leaving a layer of oil on top. Food colouring is water-based, so it will only mix with the water, leaving the oil layer its original colour.

Adding salt to a fizzy drink causes a release of large quantities of the trapped carbon dioxide, creating the highly visible eruption. Pouring the salt into the liquid in one go also causes some oil to be dragged down into the water layer. As the salt dissolves in the water, the oil is released and rises back through the water layer, creating the lava-lamp effect.

When Alka-Seltzer is placed into water it starts fizzing, giving off bubbles of carbon dioxide. The bubbles are much less dense than either the water or the oil, so they travel upwards through the liquid layers. Oil is more viscous than water, so the bubbles travel through the layers at different rates. You may also be able to see small coloured bubbles passing through the oil layer. When the coloured bubbles get to the top and are released, the coloured water sinks back down through the oil layer.

MAGICAL MATCH

09

A neat physics-related magic trick to wow your friends.

What to do:

1. Lie the empty matchbox flat on a heat-proof surface, slightly open, with the empty section facing upwards.
2. Insert two matches so that the heads point out. Close the matchbox as much as possible so that the two matches are held securely.
3. Angle the two matches so that the heads touch.
4. Rest a third match so that the head meets the other two with the tail resting on the table, pointing away from the matchbox. The three should now form a pyramid with the three heads at the top.
5. Use a fourth match to light the others from underneath.
6. Watch as the third match rises off the table.

You will need:

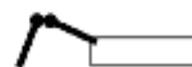
- an empty matchbox
- some safety matches
- a heat-proof surface

Tips for success

For the greatest amount of lift, make sure that the matches are placed as symmetrically and as securely as possible.



top view



side view

What's going on?

When the three match heads ignite, they fuse together. In the case of the third match, the top and bottom surfaces burn at different rates, causing a gradient in the surface temperature and tension across the match. The different tensions across the third match cause an upward force to be exerted on it. The two original matches are fixed in place, so the three heads form a pivot point, from which the third match rises.

Did you know?

The same effect can be seen in many domestic thermostats. This can be demonstrated by joining together two strips of material with different rates of expansion (e.g. a bimetallic strip). As the temperature rises, the greater expansion of one metal causes the combined strip to curve further and further. This can be incorporated into a switch that will connect and cut off a heating apparatus when a particular temperature has been reached.

AMAZING MARSHMALLOWS

10

Find out what happens to marshmallows in a vacuum with this physics demonstration.

What to do:

1. Roll the marshmallows gently between your hands until they are small enough to pass through the opening of the wine bottle. If they become sticky, roll them in cornflour so that they don't stick to the sides of the bottle.
2. Insert the vacuum stopper.
3. Pump the vacuum pump a few times. The marshmallows will begin to expand. Shake the bottle gently up and down to distribute the marshmallows throughout the bottle, then pump again. Watch as the marshmallows start to take over the bottle.
4. Let the air back into the bottle by releasing the valve on the vacuum stopper. The marshmallows will rapidly shrink back to their normal size.

You will need:

- some marshmallows (and maybe some cornflour, depending on the type of marshmallows)
- an empty glass bottle (which must be clean and dry with the label removed, and preferably made from sturdy, clear glass)
- a vacuum wine saver pump and stopper (following its instructions for use)

Tips for success

Don't try to reuse the same marshmallows too much or they'll stretch and stop working properly. Long, thin marshmallows work best because they are less sticky than the traditional sort. If you have access to a vacuum pump and a bell jar, this trick works beautifully.

You shouldn't use unusual-shaped wine bottles or those with decorative mouldings because these may implode when being evacuated. If you don't want to use a wine bottle then you can buy plastic jars that also use a hand pump to evacuate the air.

What's going on?

Marshmallows have small bubbles of air trapped inside them. These are at atmospheric pressure. When the air inside the glass container is sucked out, the volume of the container remains the same although there is much less air inside, so the pressure decreases. The air bubbles inside the marshmallows are therefore at a much higher pressure than the air surrounding the marshmallows, so the bubbles push outwards, causing the marshmallows to expand. When air is let back into the glass container, the surrounding pressure increases again and the marshmallows deflate back to their normal size.

Did you know?

Although aircraft cabins are pressurised, they are not kept at sea-level pressure. A similar effect to the marshmallow experiment can be observed by drinking half a bottle of water during a flight. When the aircraft lands you will see that the sealed plastic bottle becomes slightly crushed by the higher atmospheric pressure at about the same time as your ears pop on the approach to landing.

CARTESIAN DIVER

11

Make a diver out of a straw, pipette or ketchup sachet – anything that contains a bubble of air.

What to do:

1. Cut the straw to about 4 cm in length.
2. Use small blobs of Blu-Tack to seal each end of the straw.
3. Check that the sealed straw just floats in the glass of water. It should slowly rise to the top of the water after you drop it in. If it sinks, remove some of the Blu-Tack. If it floats too easily, add more Blu-Tack.
4. Drop the straw diver into the bottle.
5. Fill the bottle with water from the glass, if necessary, and screw the cap on the bottle.
6. Squeeze the sides of the bottle (fairly firmly). The diver will sink. Let go of the bottle and the diver will return to the top.

You will need:

- a 2 litre plastic bottle with a lid, filled with water
- a glass filled with water (for testing the “diver”)
- a straw
- some Blu-Tack
- a pair of scissors

Tips for success

Don't be scared about pushing hard on the sides of the bottle – they can take a lot of force. It may be easier to rest the bottle on a flat surface and then use both hands to push the sides. If the diver keeps floating then take it out and add more Blu-Tack, making sure to test it in the glass of water to be sure that it doesn't sink immediately – you'll find it easier to get it out of the glass than out of the bottle if it does sink.

What's going on?

The diver contains an air bubble. The combined density of the straw, air and Blu-Tack is slightly lower than that of the water, so it floats. When you squeeze the sides of the bottle you increase the pressure pushing on the air bubble, making it compress into a smaller space. This decrease in volume causes the air bubble to increase in density, so that the overall density of the diver is greater than that of the surrounding water, making it sink. Releasing the pressure (by letting go of the bottle) allows the air bubble to expand back to its normal size, allowing the straw diver to float again.

Did you know?

Sperm whales regularly dive to depths of at least 1000 m, where the water pressure is in the order of 100 atmospheres. In the process the whale's ribcage folds and collapses, and the lungs compress down to 1% of their size at the surface. The associated change in buoyancy is essential to keep the animal at such a great depth.

BALLOON KEBABS

12

A great physics trick to challenge your friends with. All it needs is a bit of nerve.

What to do:

1. Blow up the balloons (not fully) and tie them off.
2. Challenge your audience to make a “balloon kebab” – to pierce a wooden skewer all the way through the balloon without popping it. Let a few people have a try – they will invariably try to insert the skewer fairly slowly through the side and the balloon will pop.
3. Show them how physics can make the trick work:
 - a. Start by lining up the skewer point with the darker patch on the balloon, opposite the tie end. Gently push the skewer through. You may find that a twisting motion works best.
 - b. Once the skewer is through one side, push it gently through the balloon until the point of the skewer is at the opposite end – the darker area around the tie.
 - c. Insert the skewer tip gently through the soft part of the balloon where the tie is. Again, use the twisting motion if it helps.

You will need:

- some balloons
- some wooden kebab skewers
- some volunteers

Tips for success

This trick works best with round balloons (rather than long skinny ones), mainly because the skewers reach from one end to the other. Don't blow up the balloon too much or it will pop, even if you do it correctly. Make sure the skewer ends are fairly sharp – blunt skewers are more likely to pop the balloon. You may find that your balloons sometimes burst even when you follow the instructions.

What's going on?

This trick works because of surface properties. A balloon is formed by inserting air into a flexible, thin rubber sheet. Most of the balloon is stretched evenly, but there are two points where it is least stretched, and here is where the surface tension is at its lowest. These correspond to the tied section and the darker patch at the opposite end of the balloon – the darker colour indicates that the balloon is less stretched over that region. Most of the balloon is under high tension, so attempting to push the skewer through just makes the balloon pop. At the low tension sections, however, it is possible to make a small hole without breaking the overall surface of the balloon.

LAVA LAMP

13

Traditional retro lava lamps are familiar to most, but try this home made version.

What to do:

1. Three-quarters fill the glass with fizzy drink.
2. Stir it to release some of the bubbles.
3. While it is traditional to use nuts for this, you may want to use raisins or sultanas instead in case of nut allergies. Tip a few in.
4. Watch as they gradually float up to the surface of the liquid, then fall back down again, just like a lava lamp.

You will need:

- a fizzy drink - preferably a clear one
- a large glass
- a handful of nuts or raisins
- a spoon

Tips for success

This trick works best if the fizzy drink doesn't have too much gas in it. If the nuts or raisins all float on the top then there is too much gas. Conversely, if the drink is too flat then they will mostly stay on the bottom.

What's going on?

This effect relies on the gas in the fizzy drink. The nuts at the bottom of the drink have imperfect surfaces, where small pockets of air will form. The longer they stay still, the larger the bubbles of air become. Eventually they become large enough to provide enough buoyancy to counter the weight of the nuts, thereby lifting them off the bottom of the glass. When they get to the top, the bubbles burst, removing the buoyancy from the nuts and causing them to fall back down.

Did you know?

This demonstration has been in use for several centuries and was very popular at Versailles, where a single raisin would be dropped into a flute of champagne and would bob up and down all afternoon.

SHRINKING COIN

14

Most people won't believe this trick can be done – but with some 3D thinking it's easy.

What to do:

1. Lay the 1p coin in the centre of the piece of paper. Trace round it using the pencil.
2. Cut out the circle so that you are left with a piece of paper with a hole in the centre.
3. Demonstrate that the 1p coin slips easily through the hole.
4. Challenge your volunteers to get the 2p coin through the 1p-sized hole – without ripping the paper or altering it in any way.
5. Show them how it can be done:
 - a. Take the piece of paper and bend it in half. Hold the paper so that the bend is at the bottom. Drop the 2p coin between the sides of the paper into the centre of the hole.
 - b. Grasp the paper between finger and thumb near the bend, on either side of the coin. Slide your fingers upwards around the coin. Allow the paper to buckle outwards in the direction perpendicular to the coin. The coin should slip through the hole.

You will need:

- a 1p coin
- a 2p coin
- a piece of paper (approximately 10 cm x 10 cm)
- a pencil
- some scissors
- some volunteers

Tips for success

Don't use the same piece of paper too often or it will develop permanent folds in it, which can cause the coin to get stuck and help your audience to guess how the trick is done.

What's going on?

This is all to do with non-Euclidean geometry. The small 2D hole may be stretched in the third dimension to produce a slit that is large enough to allow the larger coin through.

EXTRA BOUNCE

15

Add a ball to give it extra bounce.

What to do:

1. Pick up the large ball and hold it out at shoulder height.
2. Drop the ball and see how high it bounces.
3. Pick up the small ball and repeat this, again noting how high it bounces.
4. Hold the small ball on top of the large ball at shoulder height and then drop them. The small one will shoot off much higher than the sum of the original bounces put together. Repeat and watch the larger ball. You will see that it hardly bounces at all.

You will need:

- one large ball that bounces (e.g. a football)
- one small ball that bounces (~10 cm in diameter)

Tips for success

For indoor spaces use a small ball that isn't too bouncy or it may cause some damage.

What's going on?

This experiment is all about conservation of energy and momentum. When the balls are dropped together, most of the momentum from both is transferred to the small one. Both the kinetic energy and the momentum of any moving object depend on its mass. If the smaller ball receives all of the kinetic energy and momentum from the larger one, it will bounce much higher than the original larger ball because it is so much lighter. Add to that the original energy and momentum in the smaller ball and you get a bounce that is much greater than the sum of the two original bounces. There are also complications due to the materials used to make the balls (bouncy balls go wild). This experiment can also be used as a good demonstration of chaos effects – small changes in the initial conditions (e.g. exactly how the two balls are held above each other) can cause large differences in the end result.

THE SWING THING

16

A great demonstration to investigate our perception of 3D.

What to do:

1. Use the Blu-Tack to stick together the 2p coins to make a weight. Tie the string to the weight. You now have a pendulum.
2. Ask your volunteer to watch the pendulum. Get them to stand about 2 m away from you and swing the pendulum so that it is perpendicular to the line between them and you. Ask them what direction the pendulum is swinging in.
3. Break the sunglasses in half at the nose so that the two lenses are separate. Get your volunteer to hold one lens in front of one eye, keeping both eyes open. Swing the pendulum again, exactly as before. Ask them what direction the pendulum is swinging in. They will see it going in a circle.
4. Get the volunteer to hold the lens in front of the other eye. They will see the pendulum going in a circle in the opposite direction.

You will need:

- a piece of string (~1 m long)
- two 2p coins
- some Blu-Tack
- an old pair of sunglasses
- a volunteer

Tips for success

Some people don't see the effect so quickly – they may need to move the lens back and forth in front of one eye to see the difference.

Neutral-density filters will work just as well as sunglasses.

What's going on?

Sunglasses block some of the light travelling towards them so that less light reaches your eyes when you wear them. This makes your eyes more sensitive to light. If you think about how a camera works, in darker conditions it is necessary to increase the size of the aperture and the exposure time to get a decent photo. In the same way, your eye's aperture (the pupil) automatically increases in size, and the timing of the signals being sent from the eye to the brain is delayed when you wear sunglasses.

You don't normally notice this effect because both eyes are covered up and so both signals are delayed by the sunglasses. However, in this experiment only one eye is covered, so you can distinguish the difference between the two. The eye with the lens in front of it sees the pendulum delayed with respect to the normal eye – and therefore in a different position. This has the effect of tricking your brain into thinking that the pendulum is moving in three dimensions instead of two (i.e. in a circle instead of a straight line). When you swap the lens to hold it in front of the other eye, you swap which signal is being delayed, thereby changing the apparent direction of swing.

EGG-CITING PHYSICS

17

Ever mixed up your eggs? Some simple physics will enable you to avoid that problem in future

What to do:

1. Place the eggs on a flat surface and set them both spinning.
2. Gently and briefly place your finger on the top of each egg.
3. Notice that the hard-boiled egg is much easier to spin, but it stays still when you take your finger off. In contrast, the raw egg is difficult to start spinning but will keep spinning when you take your finger off.

You will need:

- a raw egg
- a hard-boiled egg

Tips for success

Don't set your eggs spinning too fast or they may roll off the table.

What's going on?

Momentum is the key to this demonstration. A raw egg is filled with a liquid, whereas a hard-boiled egg is solid. First consider what happens when you stop the eggs. When you gently place your finger on the top, you stop the shell of both eggs from moving. The hard-boiled egg is solid, so all of it stops moving and it remains stationary when you remove your finger. However, the liquid inside the raw egg keeps spinning even when you have stopped the movement of the shell. The drag of the liquid on the shell starts the raw egg spinning again when you let go. A hard-boiled egg is easier to spin because the solid egg spins as a single entity, whereas the raw egg and its shell spin at different rates – the shell starts first and then gradually the liquid inside begins to spin as it is dragged round by the shell.

ONE IN THE HAND

18

Eggs are traditionally thought of as being very fragile, but in fact the physics behind their shape is astounding.

What to do:

Challenge your volunteers to break the egg just by squeezing it. Let them wrap the egg in a plastic bag or wear a glove, if they're worried. Believe it or not, it can't be done.

You will need:

- a raw egg
- a plastic bag or glove
- some volunteers who are scared of getting messy

Tips for success

Ask your volunteers to remove any rings, etc before trying this trick – the sharp uneven force from such metal objects can cause the egg to break. Check your eggs for hairline fractures before attempting this trick. If there is any existing damage to the egg, it won't work.

What's going on?

The shape of an egg is one of the strongest designs possible. The curved structure means that applying pressure to any particular area actually spreads the force out over the entire surface, so just squeezing it won't cause it to break. Of course, applying a very sharp force to one point will break it, which is why we usually tap an egg on the side of a bowl to break it.

Did you know?

The ornate and intricate arched doorways and ceilings in many old buildings aren't just there for their aesthetic qualities – arches are in fact one of the strongest structures. In effect, every brick or piece of masonry in the arch is falling on all of the others, distributing the weight evenly over the structure.

BERNOULLI BALLS

19

A simple hairdryer becomes a levitation device through an understanding of the principles of fluid flow.

What to do:

1. Point the hairdryer nozzle upwards and turn it on.
2. Place a ball carefully in the airstream. It will balance in the air, appearing to levitate.
3. Gently move the hairdryer from side to side. The ball will stay in the airstream (i.e. will also move back and forth). Repeat this process, moving the hairdryer up and down.
4. Carefully tilt the hairdryer. The ball will still stay in the airstream, hanging in mid-air with nothing directly underneath it.
5. See how many balls you can “hold” in one airstream.

You will need:

- a hairdryer (PAT tested if used in the classroom)
- some small light balls (e.g. polystyrene or ping-pong balls)

Tips for success

Use a hairdryer with a “cool” setting so that it doesn’t overheat. Make sure that the balls aren’t larger than the airstream or it won’t work. Tilting the hairdryer to too great an angle will cause the ball to fall out of the airstream, but you can always see how far you can move it.

Some hairdryer designs, such as those with uneven airflow, may be unsuitable.

What’s going on?

The upward pressure from the hairdryer balances the downward force of gravity, keeping the ball “levitating”. The more impressive part of this trick – being able to move the ball with the hairdryer and hold it at an angle – is based on the Bernoulli principle. This states that fast-moving fluids (including gases, such as air) are at a lower pressure than slow-moving fluids. The airstream from the hairdryer is therefore at a much lower pressure than the air outside. A ball that is smaller than the diameter of the airstream can therefore be held within it. If the ball starts “falling” out of the airstream to one side, the higher pressure of the air outside the airstream will push the ball back into the centre. This is the process that enables the ball to balance inside the airstream and move around as the hairdryer is moved around.

Did you know?

The Bernoulli effect can also be demonstrated by holding up two sheets of paper and blowing between them. Instead of moving apart, they are drawn together. If you thought anyone could have worked this out, remember that Daniel Bernoulli was awarded his master’s degree at the ripe old age of 16.

TAME TORNADO

20

This is a great demonstration of forces, and in particular vortices.

What to do:

1. Fill one of the bottles with water until it is almost full.
2. Screw the tornado adapter into the empty bottle.
3. Turn the empty bottle upside-down and screw the other side of the tornado adapter into the water-filled bottle.
4. Turn the whole thing upside-down.
5. Grasp the top and middle of the set-up and spin it in a circular motion – clockwise or anticlockwise.
6. Once a vortex forms in the upper bottle, stop spinning – you should see the vortex form throughout the liquid and continue as long as there is liquid in the upper bottle.

You will need:

- two large (~2 litre) empty fizzy drink bottles
- a tornado adapter (available online or from most science centres and museums)
- some water

Tips for success

Try adding food colouring to the water for a more colourful visual effect. Practice making the vortex until you're sure how to do it. If it doesn't work straightaway, try reducing the size and increasing the speed of the circles that you make. Make sure that the bottles are held vertically and your circles are centred. Replace the plastic bottles if they get too bent out of shape – they need to be round to make a proper vortex.

What's going on?

This demonstration produces a vortex such as those observed in cyclones, tornadoes and whirlpools. As the water spins round the bottle there is a downward pull due to the water passing through the opening into the empty bottle below. The initial small rotation caused by spinning the bottles gains speed as the water is sucked through the opening. As the rotation speeds up, the vortex forms.

Did you know?

It's commonly believed that, because of the Earth's rotation, water always goes down the plughole in a clockwise direction in the northern hemisphere and anticlockwise in the southern hemisphere. Unfortunately, this so called Coriolis force is too small to have an effect in your home, so it is the shape of the basin and the movement that you make in the water as you take the plug out that cause water to drain down the plughole in one direction or the other. However, large bodies of liquid, such as the oceans and the atmosphere, are affected by the spinning of the Earth. The whirlpool was first mechanically induced in a bathtub in 1968 by Roy Jacuzzi.

MARVIN AND MILO

01

DO NOT TRY THIS AT HOME

#1



with Marvin

What you need:

- drinking straw
- a friend
- a ruler
- scissors
- sticky tape
- saucer of water

The challenge:



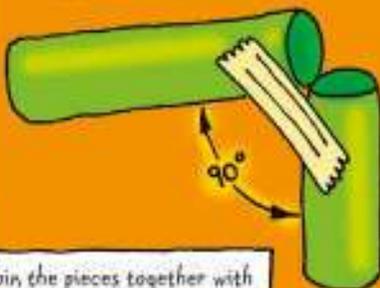
To lift the water from the saucer using a straw without sucking.

Step 1.



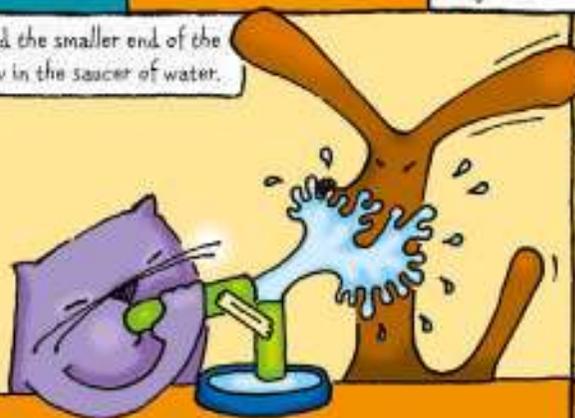
Get your ruler and cut your drinking straw into two pieces: one 3 cm long and one 5 cm long.

Step 2.



Join the pieces together with sticky tape along one side so they form a 90 degree angle, but leave both ends open.

Stand the smaller end of the straw in the saucer of water.



Now blow hard!

So what happened? Well, when air moves, its pressure falls. So when you blow, the pressure at the top of the straw drops. But the air over the saucer keeps the same pressure, so the water is pushed up the straw.

By Le Dille

The End

Visit www.physics.org keywords: air pressure, Bernoulli

DO NOT TRY THIS AT HOME #2 with Marvin

What you need:

- a nylon comb
- a water tap

Turn on the tap until you have a very thin stream of water.

Now grab your comb.

Run the comb through your hair several times.

Slowly bring the comb towards the water, 10 cm below the tap.

When the comb is about 3 cm away, the water bends towards it!

Some objects, like hair and plastic, develop an electrical charge when rubbed together. The charge in your comb attracts tiny electrical charges in the water molecules, pulling them towards it.

The End

www.physics.org keywords: electrostatics, charge

MARVIN AND MILO

DO NOT TRY THIS AT HOME #3



with Marvin

What you need:

- a microwave
- a bar of quality soap



Bonjour! Today we are going to create soap art.



Put the soap on a dish in the microwave.

Heat it on full power for about 1 min.



WARNING:

The soap may smell strongly so don't do this before heating food!

What happened?



Tiny pockets of gas in the soap get hot and expand in all directions, pushing the soap into strange and artistic shapes.

Vic Le Billan

The End

DO NOT TRY THIS AT HOME

#4

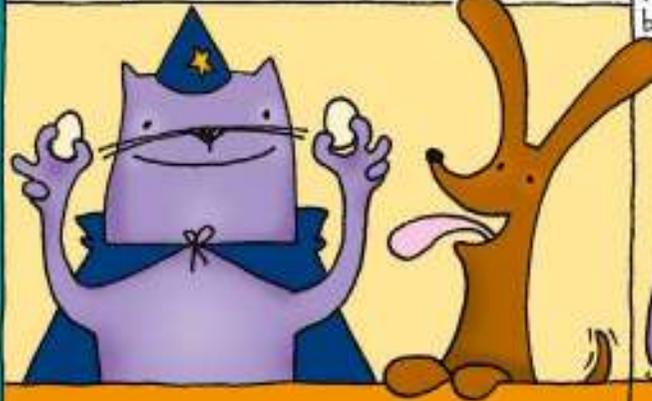


with Marvin

What you need:

- a raw egg
- a hard-boiled egg

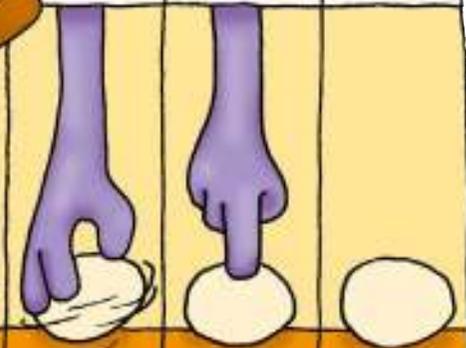
Amaze your friends with this clever trick.



First, spin the hard-boiled egg.

Stop it and let go immediately.

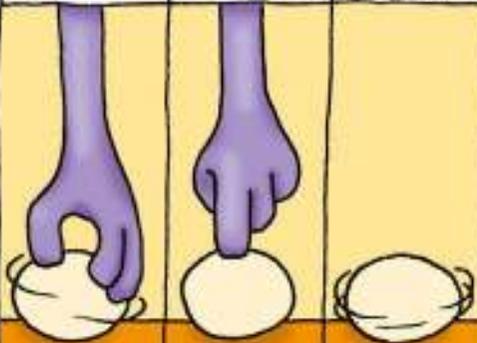
Watch what happens.



Now spin the raw egg.

Stop it and let go immediately.

The egg starts spinning!



The yolk and white aren't attached to the shell so they carry on moving when you stop the raw egg.



Get a friend to mix up the eggs and use the trick to tell them apart.

Vic Le Biller



The End

www.physics.org keywords: egg, spin

MARVIN AND MILO

DO ~~IT~~ TRY THIS AT HOME

ISSUE #5

Featuring: **Marvin and Milo**

What you need: • salt • a cup of cold water • 20cm of sewing thread • an ice cube

Float the ice cube in the cup of water.

Lay one end of the thread (or a loop) on the top of the ice cube.

Sprinkle a little salt over the top.

Wait one minute and then gently lift the thread.

Salt lowers the melting point of water, so the ice melts. But the water quickly refreezes, trapping the string in place.

DO ~~NOT~~ TRY THIS AT HOME

ISSUE #6

Featuring: **Marvin and Milo**

What you need: • a large glass • lemonade (or fizzy water) • peanuts (or raisins)

Today we are going to make a simple lava lamp.

First, fill the glass with lemonade.

Stir for 1 min or leave to go slightly flat.

Drop some peanuts into the glass.

The nuts float up to the top and fall back down again, like in a lava lamp.

Gas bubbles grow on the peanuts, making them float upwards. When they reach the top the bubbles burst and the peanuts fall back down again.

Groovy, baby.

Vic Le Billon

www.physics.org keywords: buoyancy

Issue #7

DO TRY THIS AT HOME

Featuring: **Marvin and Milo**

What you need: • a clear plastic bottle • a pen • a balloon (blow it up a few times beforehand)

Watch my amazing balloon trick!

Make a hole in the bottom of the bottle with the pen.

Push the balloon inside and stretch it over the mouth.

Blow up the balloon. Notice air is coming out of the hole.

Cover the hole with your finger and stop blowing.

Look! It stays inflated!

As the balloon expanded, it pushed air out of the bottle. That made the air pressure inside the bottle lower than that in the balloon, so it wasn't strong enough to squeeze the air out.

Vic Le Billon

www.physics.org keywords: air pressure

DO IT YOURSELF TRY THIS AT HOME

Issue #8

Featuring: **Marvin and Milo**

What you need: • a metal coat hanger
• two pieces of string • a fork

Watch me tune in to this coat hanger.

Tie a piece of string to each corner...

... and wrap the ends around your fingers.

Put your fingers in your ears and I'll tap the hanger.

Was it loud?

"dong"

It sounds louder because the vibrations travel through the metal and string more easily than through air.

www.physies.org keywords: sound travel

DO TRY THIS AT HOME

ISSUE #9

Featuring: Marvin and Milo

What you need: •an Alka-Seltzer tablet
•an empty film canister •an old newspaper •water

I can make a brilliant rocket!

Put the tablet in the film canister.

Add about 1 cm of water.

Put the lid on...

...lightly shake the canister.

Quickly place it upside down on the newspaper and stand back!

The Alka-Seltzer fizzes when in water, releasing gas.

This gas builds up in the canister until the pressure is too great, and the lid is forced off!

Vic Le Billon

www.physics.org keywords: pressure

#10 **DO ~~IT~~ TRY THIS AT HOME**

Featuring: **Marvin and Milo**

What you need: • five wooden toothpicks
• a small sponge • a plate • a little water

Carefully squeeze a drop of water into the middle.

Arrange the toothpicks on the plate like this...

Snap the toothpicks in half but don't break them fully.

Did you see them move?

Just like synchronized swimmers!

The water makes the wood expand, the broken ends press against each other and the toothpick opens out. The same thing happens to doors when it's humid—they swell up and get jammed.

Make sure it touches the end of each toothpick.

Vic Le Billon

www.physics.org

MARVIN AND MILO

011

DO TRY THIS AT HOME

#11

Featuring Marvin and Milo

What you need: • a stick (1m long) • a lump of clay

Push a lump of clay about the size of your fist on to the stick...

20cm

...20cm from the end.

With the clay-end closest to your hand, try balancing the stick.

It's much easier!

The stick rotates slower when the clay is at the top, so there's more time to adjust and keep it balanced.

The further the mass is from the centre of rotation (your hand), the slower it rotates.

Now turn the stick upside down and try balancing it again.

www.physies.org keywords: 'centre of mass'

#12 DO ~~NOT~~ TRY THIS AT HOME

Featuring: **Marvin and Milo**

What you need: • piece of foil • scissors
• washing-up liquid • sink or bath

Ahoy there me land lubbers! Today we are going to race my metal boat against Milo's ship.

To make a boat like mine, cut this shape...
... out of the foil.

Gently place your boat into a sink full of clean water.

Carefully place a drop of washing-up liquid into the boat's hole.

IT MOVES!

Water molecules are attracted to each other, creating "surface tension". The soap disrupts the surface behind the boat but the molecules in front are still pulling together, so the boat is pulled forward.

www.physics.org keywords: surface tension

MARVIN AND MILO

013

#13 **DO ~~NOT~~ TRY THIS AT HOME**

Featuring: **Marvin and Milo**

What you need:

- a television (turned on!)
- a rubber band

Watch this!

Stretch the rubber band between your thumb and first finger.

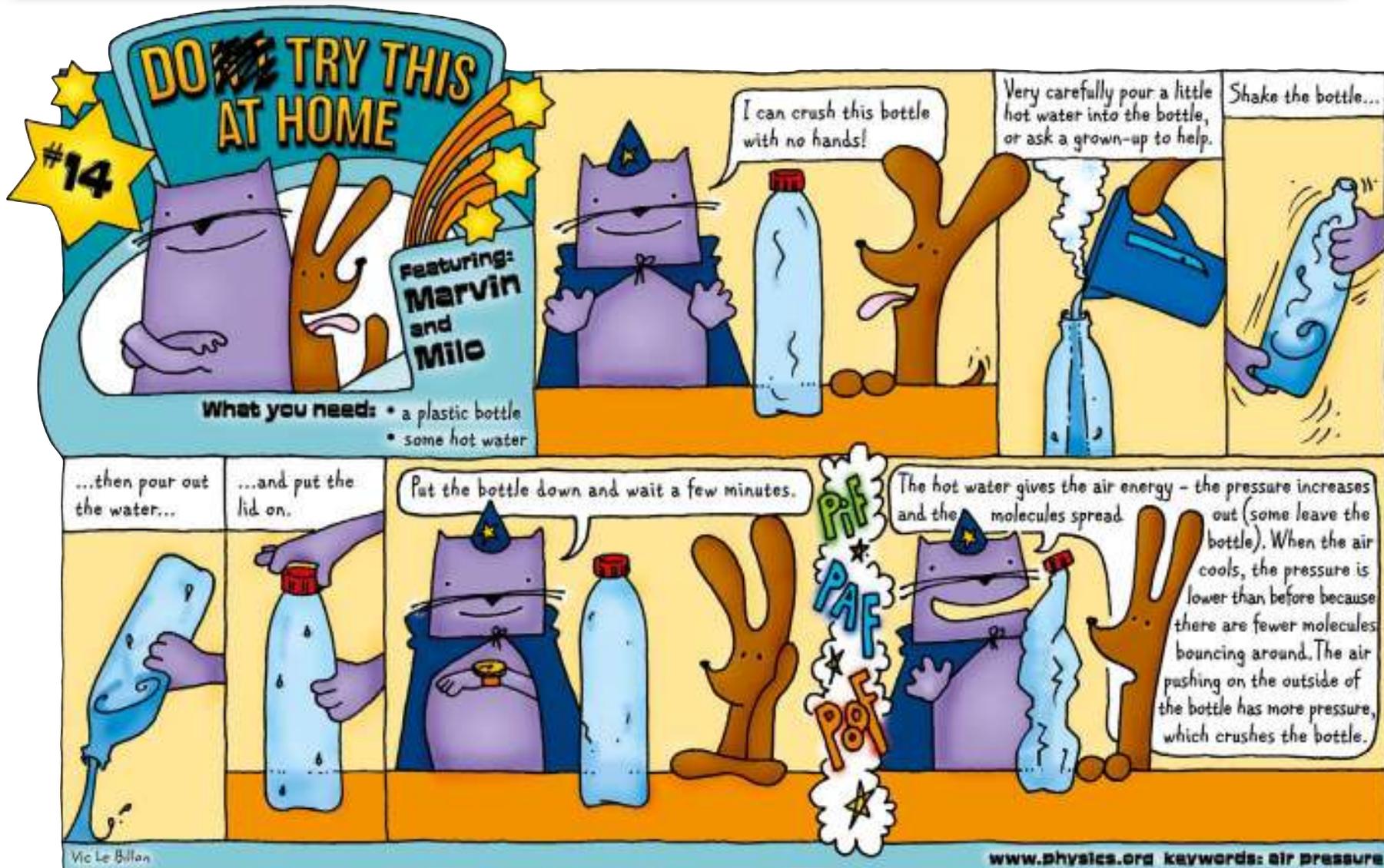
Holding the band between you and the television screen, pluck one side.

The television picture is made up of tiny dots flashing on and off. It acts like a strobe light, freezing the band's vibrations at different positions so it looks like it's moving in slow motion.

Vic Le Billon

www.physics.org keywords: television, vibration





MARVIN AND MILO

015

#15 **DO ~~NOT~~ TRY THIS AT HOME**

Featuring: **Marvin and Milo**

What you need: • a sheet of paper • cotton thread • scissors

I can make a moving snake.

Cut a spiral shape from the paper.

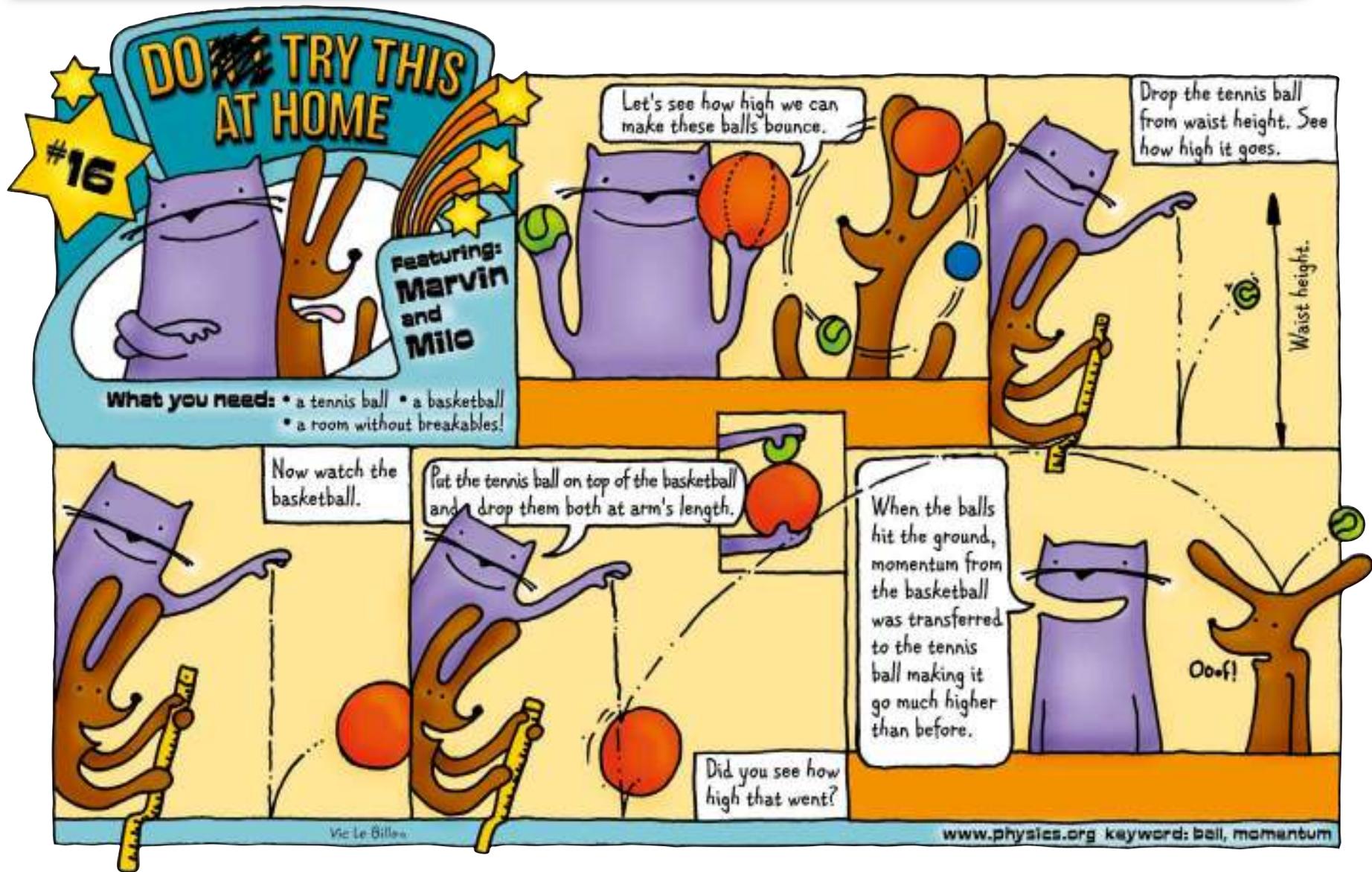
Make a hole in the centre and thread the cotton through.

Hang your spiral above the radiator.

The radiator heats the air around it so the particles have more energy to spread out. This means the air is less dense and rises upwards. The rising air pushes on the paper causing it to spin.

no snakes were harmed in the making of this cartoon

www.physics.org keyword: convection



MARVIN AND MILO

017



DO ~~NOT~~ TRY THIS AT HOME

#18

Featuring: **Marvin and Milo**

You can make your own garden sprinkler.

What you need:

- an empty juice carton
- water
- a piece of string
- a pair of scissors
- a washing-up bowl

Get an adult to poke a hole in the bottom left-hand corner of each face of the carton.

Put some water in the bowl, stand the carton in it, then fill it up to the top.

Lift the carton out by the string.

As the water shoots out it pushes back on the carton with an equal force. Because the holes are off-centre this force makes it spin around.

...and thread the string through it.

do be doo doo

Vic Le Billon

www.physics.org keywords: water, Newton

MARVIN AND MILO

019





DO ~~NOT~~ TRY THIS AT HOME

#21

Featuring: **Marvin and Milo**

What you need: • a bendy straw • water
• two small flat bowls • food colouring

This bowl can drink on its own!

Fill the first bowl with water and a little food colouring.

Half fill the second bowl.

Submerge the straw in water, making sure you get rid of any air bubbles.

Tightly pinch the ends.

Hold the straw with one end in each bowl.

Release the ends when they're under the water.

The bowl with the higher water level has more stored (potential) energy, so water moves through the straw to the lower level.

Vic Le Billon

www.physics.org keywords: siphon

DO TRY THIS AT HOME

#22

Featuring: **Marvin and Milo**

What you need: • three straws
• glass of water or juice • a drawing pin

I bet you can't drink this using my special straws.

First try using two straws. One in the glass, and one outside the glass.

Now try using this straw, which has a small hole 3cm from the top.

What Milo doesn't realise is that for the liquid to be forced up the straw, the pressure in your mouth needs to be lower than atmospheric pressure. So no matter how hard you suck, a straw won't work if air can get into your mouth.

Vic Le Billen

www.physics.org keywords: atmospheric pressure

DO TRY THIS AT HOME

#23

Featuring: **Marvin and Milo**

What you need: • a jug • water
• about 50cm of string • a basin or sink

I've invented a non-drip jug!

Tie the string around the handle of the jug of water and pull it across the top of the jug and over the lip.

Hold the string tight at an angle, below the jug, and begin to pour.

The water is attracted to the string and as the flow slows down the water clings to the string. This is the Coanda Effect.

Try creating an amazing route for the water by holding the string at different angles, even getting the water to turn corners as it goes down. But be careful, no sharp turns or the water falls off!

Vic Le Billon

www.physics.org keywords: coanda effect

DO TRY THIS AT HOME

24

Featuring: **Marvin and Milo**

What you need: • some water
• small plastic drinks bottle • a drawing pin

Today we are going to make a water jet using this bottle.

Use the drawing pin to make three small holes about 4mm apart at the bottom of the bottle and one near the neck.

4mm

Fill the bottle with water and put the top on.

Tip: Cover up the top hole to stop the water shooting out of the bottom three.

Watch me turn three jets into one!

Simply rub or 'smear' the three jets with your fingers.

Once the jets have been forced together, they stay together because of surface tension.

www.physics.org keywords: surface tension

MARVIN AND MILO

025

#25

DO TRY THIS AT HOME

Featuring: Marvin and Milo

What you need: • some water
• a clear plastic watertight bag • some pencils

Have you seen my Ingenious Indestructible Bag?

Fill the plastic bag with water.

Push a pencil through the bag.

Then another... and another.

The bag doesn't burst because the plastic stretches rather than tears as the pencils are pushed through it.

If you take a pencil out, you can plug the leak simply by putting it back through the holes ...MILO!

www.physics.org keywords: plastic

DO ~~NOT~~ TRY THIS AT HOME

#26

Featuring: **Marvin and Milo**

What you need: • 2 apples with stalks
• 2 pieces of string about 30cm long
• some sticky tape

Watch this! Tie a piece of string to the stalk of each apple.

6cm

Use the tape to hang up the two apples so that they are about 6cm apart and free to move around.

What do you think is going to happen if you blow hard between the apples?

The two apples move together!

Blowing reduces the air pressure between the apples, and the air pushing on the outer sides of them makes the apples move together, into the area of lower pressure.

Vic Le Billan

www.physics.org keywords: air pressure

DO ~~IT~~ TRY THIS AT HOME
#27
Featuring: Marvin and Milo

What you need: • a paperclip • water
• two identical wine glasses

I bet you can't make the paperclip move without touching it.

Put equal amounts of water in both glasses and stand them next to each other but not touching.

Straighten out the paperclip, bend it slightly and then balance it on the rim of one of the glasses.

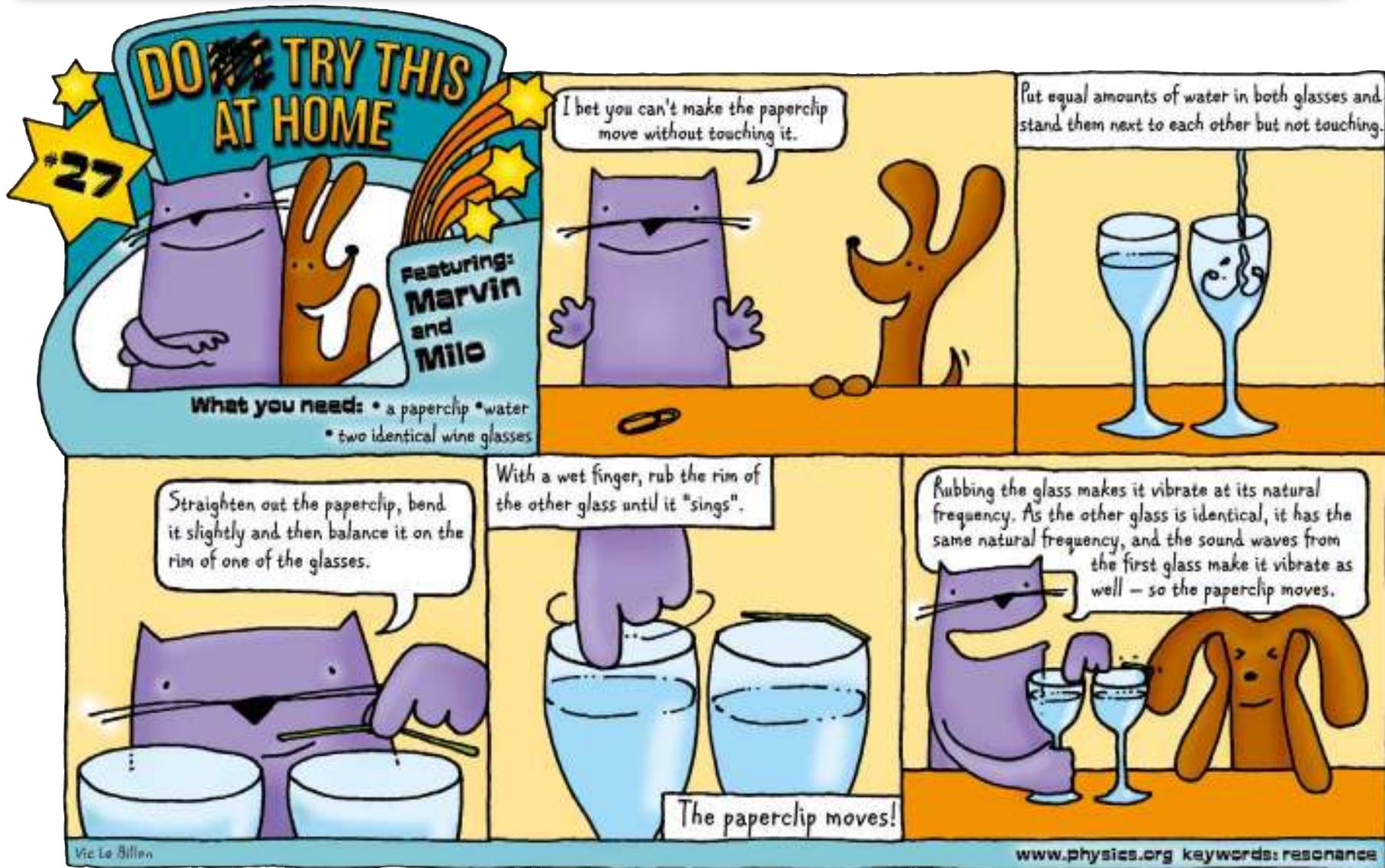
With a wet finger, rub the rim of the other glass until it "sings".

The paperclip moves!

Rubbing the glass makes it vibrate at its natural frequency. As the other glass is identical, it has the same natural frequency, and the sound waves from the first glass make it vibrate as well – so the paperclip moves.

Vic Le Billon

www.physics.org keywords: resonance



DO ~~IT~~ TRY THIS AT HOME

#28

Featuring: **Marvin and Milo**

Hey Milo, let's do chicken impressions!

To do mine, make a hole in the bottom of the plastic cup. Get an adult to help.

What you need: • a plastic cup or yoghurt pot
• a damp cloth • smooth string

Cut a length of string, thread it through the hole, and tie a knot in the end inside the cup to stop it from slipping back through the hole.

Take the damp cloth and hold it tightly around the string. Now pull the cloth firmly along the string to hear the cup cluck.

Pulling the cloth along the string makes it vibrate and produce a faint sound. But the cup and the air around it also vibrate so the sound is amplified enough for us to hear it.

www.physics.org keywords: amplification

DO TRY THIS AT HOME

#29

Featuring: **Marvin and Milo**

Today we are going deep sea diving with this ketchup sachet.

Put the ketchup sachet into a bowl of water to see if it floats upright – if not then add a little Blue Tac to its bottom.

What you need: • 2 litre plastic bottle • Blue Tac
• a bowl of water • a ketchup sachet

Put the lid on tightly, squeeze the bottle hard and watch your diver dive.

Squeezing the bottle squeezes everything inside it, including the air bubbles in the ketchup sachet. As the air molecules squash together, the sachet gets more dense than the water and it sinks. What happens when you stop squeezing?

Fill a 2 litre bottle with water right to the very top.

Push your ketchup diver through the neck.

www.physics.org keywords: density

Vic Le Billon

DO TRY THIS AT HOME

#30

Featuring: Marvin and Milo

What you need: • two very similar sized books with at least 100 pages each

I can join these two books together so well that you won't be able to pull them apart – and I won't use glue or staples or sticky tape.

My books are about the same size and have about the same number of pages.

Carefully, and evenly, interweave the pages of the books so that they overlap to about the middle of the page.

Hold the books by the spines and pull! The books don't separate, no matter how hard you pull, because of the friction between the pages.

Friction is the force that acts against the motion of two surfaces in contact. The friction between just two pages is tiny but with lots of pages in the books, the force becomes very noticeable!

interactions

Vic Le Billow

www.physics.org keywords: friction

MARVIN AND MILO

031

DO TRY THIS AT HOME

#31

Featuring: **Marvin and Milo**

What you need:

- some water
- an empty fizzy drink can

Today I'm going to show you how to make a pop can pirouette!

Pour about 100ml of water into an empty fizzy pop can.

Tip it slightly to one side and balance it so that the two parts of the bottom rim are touching the table.

Once the can is stable, give it a gentle push and it will pirouette!

For something to balance, its centre of mass has to be above its point of support. Water can flow which means that as the can pirouettes, the water moves and the centre of mass always stays above where the rim touches the table.

BURP!

Vic Le Billon

www.physigs.org keywords: centre of mass

DO ~~NOT~~ TRY THIS AT HOME

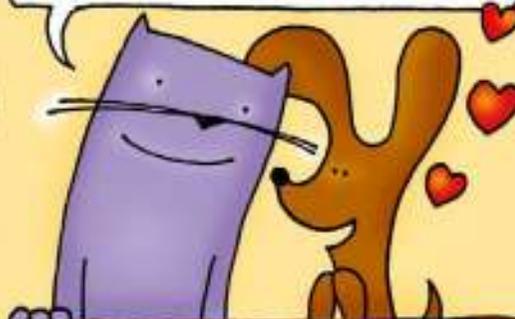
32

Featuring: **Marvin and Milo**

What you need: • a large clear, straight-sided glass
• water • milk • teaspoon • torch • darkened room



Do you want to see my homemade sunset?



Fill the glass about $\frac{2}{3}$ full of water...



... add half a teaspoon of milk...



... and stir.



In a darkened room, shine the torch down onto the top of the water whilst looking through the side of the glass. Can you see the blue colour?

Click



Then try shining the torch through the side of the glass whilst looking through the opposite side. What colours can you see now?



Finally, shine the torch up through the bottom of the glass and peer down through the water. What a lovely sunset!

The milk particles in the water scatter the light from the torch like dust and molecules in the atmosphere scatter light from the sun. The further the light has to travel through the water, the more of the blue light has been scattered, leaving only red light for you to see. Just like at sunset.



DO ~~NOT~~ TRY THIS AT HOME

#33

Featuring: **Marvin and Milo**

What you need: • uncooked rice • a pencil
• a large empty jar with a narrow neck

Today I'm going to show you how to lift this jar up using just a pencil and some rice!

Fill the jar up to the brim with uncooked rice.

(Make sure you have a jar which narrows towards the top.)

Push the pencil right into the rice.

Then, alternating between shallow and deep stabs, stab the rice repeatedly. It could take about 40 stabs, but you'll start to feel the pencil gripping the rice.

When you feel a firm grip, carefully lift up the jar by the pencil.

As you push it in, the pencil forces the grains sideways, but they fall back into the gap as you pull it out. The rice becomes more and more tightly packed until the friction between the rice and the pencil is so great you can lift the jar.

Vic Le Billow

www.physics.org keywords: friction



DO ~~IT~~ TRY THIS AT HOME

#35

Featuring: Marvin and Milo

What you need: • Kitchen towels • Water • Non permanent coloured felt tip pens

Nice outfit Milo, but don't you know that blue, purple and yellow are the new black?

Draw a dot in the centre of the kitchen towel with a felt tip pen, black works well but you could experiment with other colours.

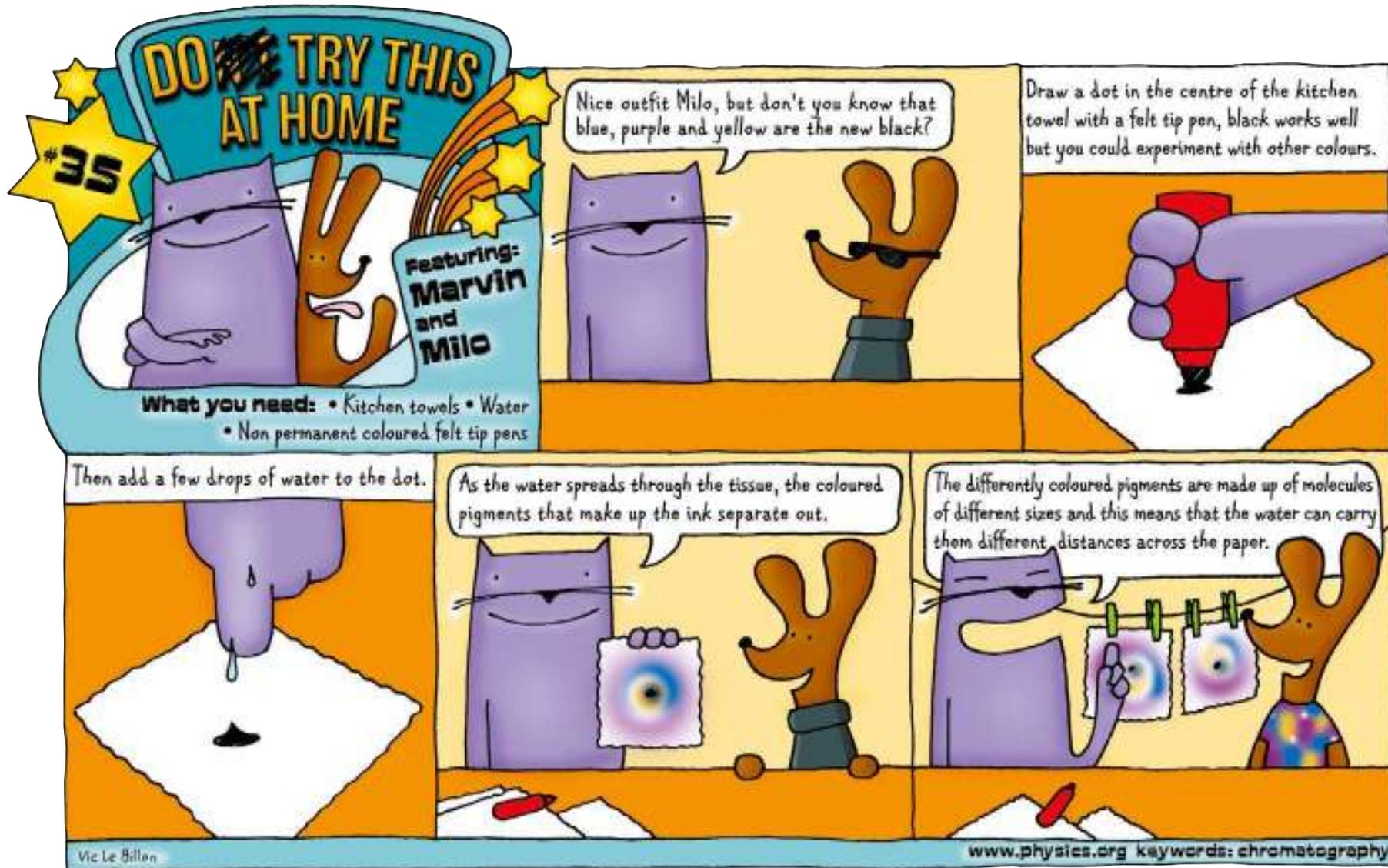
Then add a few drops of water to the dot.

As the water spreads through the tissue, the coloured pigments that make up the ink separate out.

The differently coloured pigments are made up of molecules of different sizes and this means that the water can carry them different distances across the paper.

Vic Le Billon

www.physics.org keywords: chromatography



DO TRY THIS AT HOME

#36

Featuring: **Marvin and Milo**

What you need:

- A balloon
- An empty pop can (aluminium cans are best)

Watch me make this can roll across the table, with just a balloon!

Place the empty can on its side on a flat surface.

Then rub the balloon really fast against your hair.

Hold the balloon close to the can. It will start rolling towards the balloon.

Slowly move the balloon away from the can and watch in amazement as the can follows the balloon.

When you rub the balloon against your hair, negative electrons build up on the balloon. This negative charge induces a positive charge on the can making it roll towards the balloon.

Vic Le Billion

www.physics.org keywords: static electricity

MARVIN AND MILO

037

DO ~~NOT~~ TRY THIS AT HOME

#37

Featuring: **Marvin and Milo**

What you need: • A cone shaped party hat
• Scissors • A soft ball • A friend

Tests show that wearing a party hat makes you much worse at catching a ball.

Cut the tip off the party hat to make a hole about 2cm in diameter.

Wear the hat over your face.

Try to play catch with your friend using a soft ball.

When you're wearing the hat you can only see with one eye at a time. Without your normal, two-eyed, binocular vision you can't judge distances as well and it's much harder to catch the ball.

Ooof!

www.physics.org keywords: binocular vision

DO ~~WE~~ TRY THIS AT HOME

#39

Featuring: **Marvin and Milo**

What you need:

- Two polystyrene cups
- Two large elastic bands
- Sticky tape

Chooos away Milo! It's time to make these ordinary cups loop the loop!

Tape the two polystyrene cups together at the base.

Then tie the two elastic bands together.

Hold one end of the elastic where the cups join and wind it around a few times until the other end of the elastic is at the bottom and pointing away from you.

Hold the cups in one hand and stretch the elastic with the other. Fire the cups like a catapult. With a bit of practice the cups will soon be looping in the air.

The elastic makes the cups spin backwards as well as move forward through the air. This back spin creates lift, forcing the cups upwards. But air resistance soon slows the cups down and they fall towards the ground, completing the loop.

Vic Le Billon

www.physics.org keywords: Magnus effect

MARVIN AND MILO

040

DO ~~NOT~~ TRY THIS AT HOME

40

Featuring: **Marvin and Milo**

Roll up, roll up for the amazing daredevil eggstravaganza!

What you need: • An egg • A glass of water • An empty Smarties tube • A placemat

Put the placemat on top of the glass of water, shiny side down.

Stand the Smarties tube on the placemat directly over the glass...

...and balance the small pointy end of the egg on top of the tube.

Give the side of the placemat a short, sharp, horizontal whack.

And the egg falls into the glass!

The egg doesn't go flying because the sideways force is only on the mat and the bottom of the tube, not the egg.

Vic Le Billon www.physies.org keywords: inertia

DO ~~NOT~~ TRY THIS AT HOME

#41

Featuring: **Marvin and Milo**

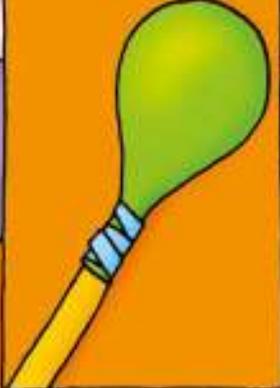
I hope you've got lots of puff Milo, you're going to demonstrate Newton's third law!

What you need: • Pencil with a rubber on the end
• Drawing pin • Drinking straw • Sticky tape

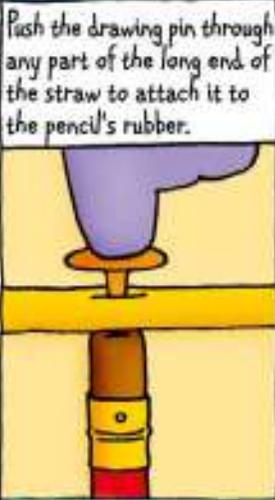
Insert the long end of the straw into the balloon...



... and tape it in place.



Push the drawing pin through any part of the long end of the straw to attach it to the pencil's rubber.



Bend the short end.

Blow up the balloon using the straw, release, and watch it spin!



Try changing the position of the drawing pin and the angle of the short end to make it spin faster. The air rushes along the straw and around the bend. As the straw pushes on the air to force it round the corner, the air pushes back on the straw - making it move.



MARVIN AND MILO

042

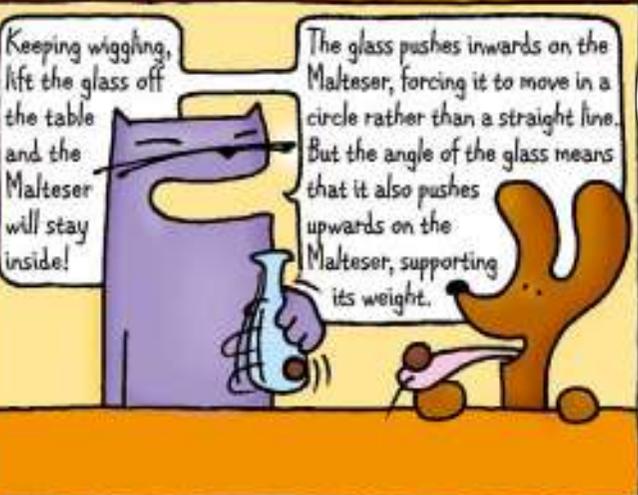
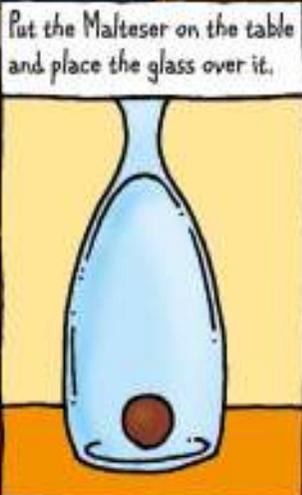
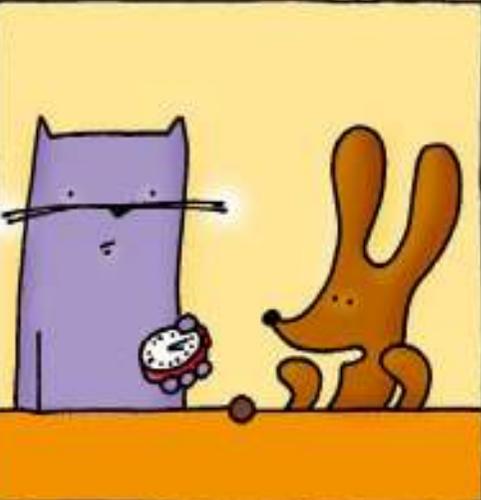
DO ~~NOT~~ TRY THIS AT HOME

#42

Featuring: **Marvin and Milo**

What you need:

- A Malteser
- A wine glass (narrower towards the top)



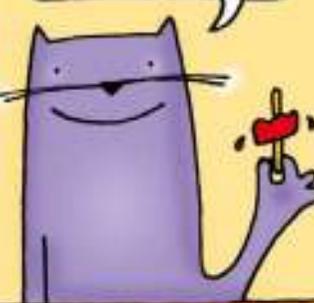
DO ~~NOT~~ TRY THIS AT HOME

#43

Featuring: **Marvin and Milo**

What you need: • 2 lolly sticks • A wide elastic band • 2 smaller, narrower elastic bands • A straw • Scissors

I know what we can do with these lolly sticks!




Wrap the wide elastic band lengthwise around one of the sticks.



Cut two short pieces of straw and place them in between the stick and elastic band.

About 3cm from each end of the stick.



Place the other stick on top of the pieces of straw.

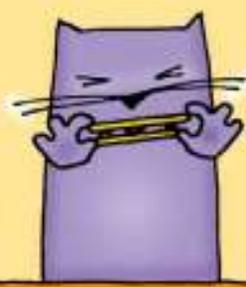


Hold the ends of both sticks together with the smaller elastic bands.

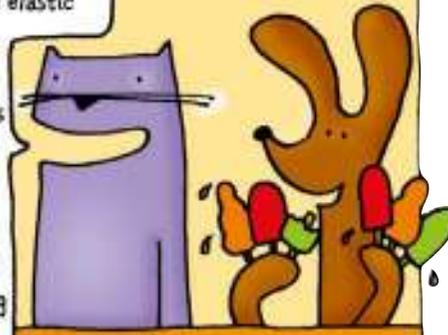


Then blow!

What happens if you move the straws closer together?




Blowing through the Loud Lollies makes the elastic band vibrate and create a sound. Moving the straws closer together shortens the section of the elastic band that can vibrate, raising the pitch of the sound produced.



#44 DO ~~NOT~~ TRY THIS AT HOME

Featuring: Marvin and Milo

What you need: • An old CD • Blu Tack
• A sports cap from a drinks bottle • A balloon

I know a much better use for that old Barry Manilow cd.

Place the sports cap over the hole in the cd...
... and fix in place with some Blu Tack.

Blow up the balloon and, making sure the sports cap is closed, pull the open end of the balloon over the cap.

Place your hovercraft on a flat surface and open the sports cap.

Give it a quick tap and watch your hovercraft go!

The air rushes out of the balloon and through the cap, lifting the cd up on a cushion of air. The air reduces the friction between the cd and surface it's on so the hovercraft can travel a surprising distance before stopping.

via Le Billou

www.physics.org search term: hovercraft

DO ~~NOT~~ TRY THIS AT HOME

#45

Featuring: **Marvin and Milo**

What you need: • A ramp or slope • A lump of plasticine • A round biscuit tin (or similar container)

... and put the lid on.

Watch me defy gravity and make this biscuit tin roll up hill.

Attach a large-fist-sized lump of plasticine to the inside of the wall of the tin at the seam...

With the seam facing upwards but towards the top of the slope, put the tin on its side at the bottom of the slope and hold it in place.

Let go and, ta da! The tin rolls up the slope.

The weight of the plasticine creates a turning force on the tin that levers it up the hill when you let go, and makes it look as though you're defying gravity.

DO ~~IT~~ TRY THIS AT HOME

46

Featuring: **Marvin and Milo**

What you need: • A bunch of about 3 keys • A pencil • A large paperclip or washer • 1 m of string

Want to see how I can catch these keys with no hands?

Tie a bunch of keys to one end of the string and the paperclip to the other.

Place the string over the pencil so that the keys hang down a couple of centimetres. Hold the paperclip horizontally out to the other side.

Let go of the paperclip.

It winds around the pencil and stops the keys hitting the floor!

The keys pull the paperclip towards the pencil, but gravity is also pulling it downwards so it moves in a circle. As the paperclip gets closer to the pencil, its angular velocity increases, and it wraps around the pencil.



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