Free!

Do Try This at Home!
Winter Activity Pack

Things to make and do
Games and challenges
Amazing physics facts

This book belongs to:

Limit Less

IOP Institute of Physics

Introduction

Information for parents and carers

We hope you and your family enjoy this new activity pack from the Institute of Physics. You'll find experiments and activities to do together and interesting articles and word puzzles to help build your child's literacy and grow their vocabulary.

This pack has been designed for children aged 8 and over – please supervise your child and help them where needed to do any activities, especially those involving scissors. These experiments have not been specifically safety tested for home use but we believe them to be safe if the instructions are followed. Adult supervision or direction is recommended as appropriate. All experiments are carried out at your own risk.

Limit Less

We hope that this activity pack will help spark conversations with your child about the world around them and stimulate their curiosity. This activity pack is part of a new campaign from the Institute of Physics – Limit Less.

Now, more than ever, we need to support our children and young people to help fulfil their potential. Studying physics opens up a huge range of opportunities for further study and careers and it's never too early to start having conversations with your child about their future.

If you'd like to learn more about the Limit Less campaign, please visit:
www.iop.org/LimitLess

Looking for more?

If you've enjoyed this activity pack and are looking for more activities to do together, please visit the IOP website: **www.iop.org/AtHome** for webpages about the physics of the world around us, experiments that you can do at home and other activity packs.

If you'd like to share a photo of your family taking part in any of the activities in this pack, we would love to see them! Please share on social media with **#IOPAtHome** and tag **@PhysicsNews**.

If you have any questions or would like to find out about the Institute of Physics, please email us at **engagement@iop.org**

Science Scavenger Hunt

Science is all around us, wherever we go. Discoveries made by scientists go on to inspire new inventions that can help make our world a better place. Some might help us understand how our bodies work and live healthier lives, and other discoveries might help us tackle climate change or reduce the amount of electricity we use. Finally there are inventions, like a mobile phone, which just can make our lives easier!

When you next go on a walk with your family, bring this page with you and see how many things you can spot! And when you get home, talk with your family about why you think these things are useful and how they might help people or be good for the environment.

What to see:	Tick	Where did you see it?	Why do you think this is useful?
A car or bus with a hybrid engine			
A building with solar panels			
A place where you can plug in an electric car			
Something that helps people that can't see to cross the road			
LED light bulbs			
Something that uses wireless technology			
Someone using a laser (hint – look for someone scanning barcodes in a shop!)			
An automatic door			
A recycling bin			
Something that is powered by the wind			
A place where you can exercise			
A hand sanitiser dispenser			

Ping Pong Pick-Up

Try this game whenever you need a "pick-me-up"! Lift your spirits at the same time as your ping pong balls as you challenge your family to... Ping Pong Pick Up!

What you'll need:

- A large, empty plastic bottle – we've used a two litre fizzy drink one
- Scissors
- Sticky tape
- A marker pen
- A bowl
- A few ping pong balls / anything small and round
- A mug (or anything circular to draw around that's wider than a ping pong ball but not as wide as the bottle)

A note for Grown-Ups:

Make sure you supervise this experiment very carefully. We're using sharp scissors as a piercing tool – combined with the risk of ping pong balls flying everywhere. You might need to do some steps either with (or for) your family depending on their ages and how sensible they are.

What to do:

Before you can start to play, you need to make your "picker-upper":

1. Turn your bottle upside down and put it in the mug. Using the mug as a template, draw a circle on your bottle in marker pen and take the bottle out again.

2. Cut along the line you've drawn. To get started you have to stab a hole in the bottle first using the pointy end of your scissors. An adult should definitely do this part.

3. We're only using the bottom of the bottle – it should look like a tall container with a small curved lip. If you've made any sharp or jagged edges with your scissors, cover them up with sticky tape so that your "picker-upper" is safe to hold and use. Now you're ready to play Ping Pong Pick Up.

Playing the game:

4. Challenge your family to pick up the ball without touching it or turning the bottle, and then drop it into the bowl. Once they've tried – show them how it's done.

5. With the ball on your table, grip the picker-upper firmly. Put it over the ball and start moving the bottle in small, fast circles.

6. Once you've got the ball spinning, lift it up (anyone else in the room should watch out for flying ping pong balls in case it goes wrong!) and drop it into the bowl.

7. And then it's a case of practice makes perfect! The challenge is to get the ball as quickly as possible from table to bowl.

What to talk about

- Does the picker-upper have to be a special shape for it to work?
- What happens if your hand gets tired and you slow down?

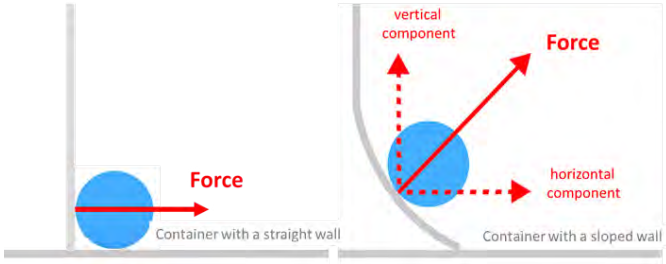
What's going on?

It's the shape of the ping-pong-picker-upper that's at the heart of this challenge. You can't just use anything!

Think about a ball moving around inside a straight-sided container like a plastic glass. As it spins, the ball wants to fly out but the glass won't let it. As it presses on the inside wall of the container, the wall pushes back and it is this force that makes the ball goes around in a circle. But a straight-sided container can't pick up the ball, it only pushes inwards. To lift the ball, we need an upward push to overcome gravity.

Our picker-upper has sloped walls and that's why it works. The push of the wall on the ball is diagonally upwards and we can think of this force as having two parts: an inwards part that makes the ball go around in a circle, and an upwards part that balances the downward pull of gravity.

The upwards and inward parts are called the vertical and horizontal **components**. If you keep the ball spinning quickly you can balance gravity using the vertical force component.



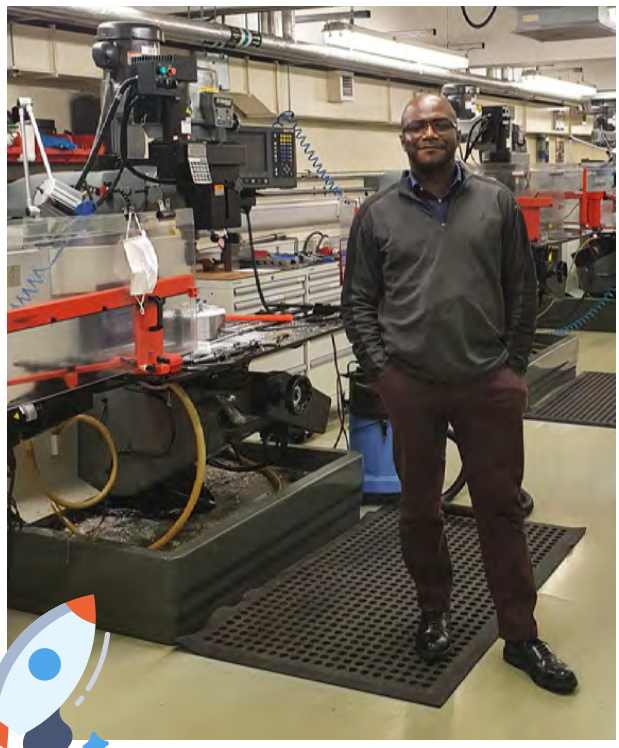
What next?

The game should work with any round object inside a container with a mouth narrower than its body. You could:

- experiment to see how high you can lift the ping pong ball
- challenge yourself by moving your bowl further away or using a smaller container for drop off
- challenge the adults in the house to a game with wine glasses and Maltesers

Did you know?

As part of their training, astronauts are spun just like a ping pong ball in a picker-upper. The sideways push of the wall recreates the large forces they experience when launching into space.



People in Physics:
Paul Brown

Name

Paul Brown

What do you do?

I am a Workshop Manager – I work with physics researchers to create new equipment that helps us find out exciting things about the universe!

Where did you grow up?

I grew up in Croydon, South London, close to where Croydon airport used to be.

How did you get where you are now?

I started as an engineering apprentice in the 1980s, at a company which made products out of aluminum. They did this by pouring hot, liquid metal into a mould, letting it set, then opening the mould to take the parts out. One of the parts we made was the end of a toaster!

I joined Imperial College Physics Department as a Junior Technician in July 1990 and became a workshop supervisor in the Optics section in 1997. I took my current role as the Mechanical Instrumentation Workshop Manager in 2005.

Why did you choose to do physics? Is there anything in particular that you wanted to find out or a challenge you wanted to solve?

I didn't do physics at university but I use my engineering and design skills to help physics researchers make discoveries. The custom-built equipment that my team makes lets researchers do amazing experiments: from trying to measure the shape of an electron, to looking for water in the atmosphere of Jupiter! We also help physics students with their projects and provide equipment that they can use in their classes.

What do you do for your job? What does a typical day look like?

As the manager of the mechanical workshop, researchers bring me designs for equipment which they need. It's my job to turn their designs into a reality! I check drawings over, order materials and tools, and give out jobs to my team. The machine shop houses lot of computer-controlled machines that we use to build new equipment. It is my responsibility to keep these vital machines up and running, so I often have to meet the engineers that repair them. The Health and Safety of my team is also important, and it is part of my job to make sure that everyone in the workshop is healthy and happy at work. Having started off as an apprentice, I am now part of the team that hires new apprentices and helps them to become technicians.

What's the best thing about your job?

The best part of my job is to help others to make new discoveries and help people to learn.
It's great when we are credited for the part we have played in successful experiments. In February 2020 the European Space Agency Solar Orbiter mission was launched to study the Sun. At Imperial we built one of the ten instruments on board the spacecraft which will measure the Sun's magnetic field. It's really cool!

Outside of your job, do you have any hobbies? Or where are you happiest?

I went skiing for the first time about four years ago which I really enjoyed, and I've been every year since! Unfortunately, you can only do that for a week each year though! I would also like to play more golf one day.

Do you have any pets?

I had a cat called Sally when I was young.

Do you like to watch or play any sports?

I follow my local football team Crystal Palace. I like to swim in the mornings before work. I have recently started e-biking to and from work. Before the country went into lockdown, I went running in the park on Saturday mornings.

Who is the most famous person that you've ever met?

I met H.R.H. the Duke of Cambridge in October 2017. I was awarded an MBE in the Queen's Birthday honors, for Services to Higher Education and on the day when I received my award, I met Prince William.

What's the best piece of advice you've ever been given?

Many times, when we judge others, we only see the destination – but don't know their journey.

Has your work changed at all since the start of this year?

It's changed quite a bit! Because of COVID-19, we had to think about how to teach students this year. In the workshop we have been making lots of things to make up "lab-in-a-box" kits. These are DIY lab kits for students who can't come to University because of the pandemic!

Amazing Physics Facts

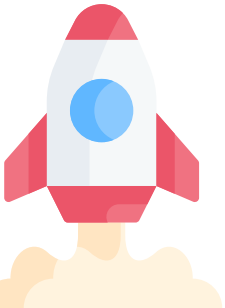
Find out about incredible discoveries, curious experiments and the fascinating people behind them!

As we know, a day lasts for **24 hours** and a year lasts for **365 days (366 in a leap year!).** But by looking at fossils from coral that lived **370 million years ago,** scientists have found that the length of a year has actually got shorter! When the corals were alive, a year lasted between **385** and **410 days** and this change might have happened due to the effects of the Moon or the motion of the tides.

There's a saying that lightning doesn't strike twice in the same place. But if you wanted to put that to the test, the best place to try would be where the Catatumbo River flows into Lake Maracaibo in Venezuela, South America. Due to the climate there, there are **10-hour** long lightning storms that happen almost **150 nights a year.** These produce over a million bolts of lightning a year!

It can be really frustrating when your mobile phone, laptop or tablet runs out of battery! But one battery at the University of Oxford, has been working for over **180 years!** The battery is connected to a bell which has been ringing ever since it was set up in **1840.**

The fastest speed that a human has ever travelled is **11km per second** (or about **24,600 miles per hour)** when the crew of the **Apollo 10** space capsule re-entered the Earth's atmosphere. This is about **100 times** faster than the top speed of a Formula One racing car!

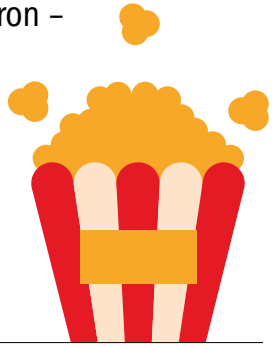


Heinrich Hertz discovered **electromagnetic waves: radio waves, microwaves, x-rays and visible light** are all types of electromagnetic waves and are used in a huge amount of electronics including televisions, radios, Wi-Fi and pretty much anything that uses wireless technology! But when a student asked Hertz about how useful his discovery would be, Hertz replied: **"It is of no use whatsoever".**

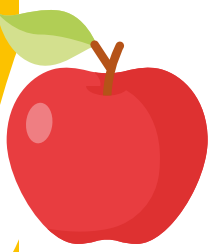
At an **observatory** in the United States in 2017, scientists noticed that some of their data looked very strange. They investigated their equipment and found that a pipeline that was **normally covered in ice** had been pecked by a **flock of ravens** and the scientists then managed to take photos of the birds enjoying a refreshing snack!

Once described as “the most beautiful woman in the world”, actress **Hedy Lamarr** worked in Hollywood in the 1930s and 1940s. Alongside a successful film career, Lamarr also developed an interest in science and technology and patented a new way of transmitting radio signals. She offered this to the U.S. Navy at the time, as a way to wirelessly control torpedoes, but the Navy didn’t take any notice. **Now, we use Hedy Lamarr’s invention as part of Bluetooth and WiFi!**

You might have a microwave in your kitchen – it quickly heats up food using **radio waves** – but the original use of microwaves was in **the invention of radar** in the Second World War. Percy Spencer was working with a piece of the radar equipment called a **magnetron** when he noticed that a candy bar in his pocket (Percy often carried one to feed squirrels!) had melted. He then tried making popcorn with his magnetron – **the first ever batch of microwave popcorn!**

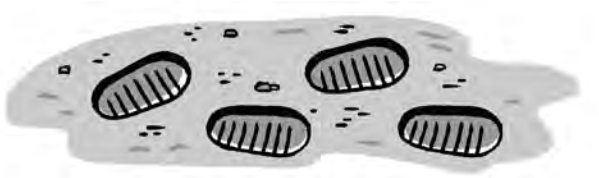


As well as being a **physicist** and **mathematician**, **Isaac Newton** was also a Member of Parliament! But his political career doesn’t seem to have been as successful as his work on gravity, light and colour as his only recorded contribution to UK politics is asking to have a window closed in the Houses of Parliament.



When you are watching television and find a TV station that just shows static or a “snowstorm”, a small part of what you are seeing is the background “heat” caused by the Big Bang – **the creation of the universe!** After the Big Bang (about 14 billion years ago), the universe **expanded** and **cooled down** and at its current temperature the universe **“glows”** very faintly. This was discovered accidentally in the 1940s (they originally thought it was caused by pigeons nesting in their telescope!) and won its discoverers the **Nobel Prize in 1978.**

Invention Challenge:
Living on the Moon



Just over 50 years ago, the first people walked on the Moon. And even though we haven't been back since 1972, NASA is planning to return by 2024, sending a man and a woman to the Moon's surface.

The Moon is very dangerous to people – in the bright sunshine, the temperatures can go up to 127°C (much hotter than a boiling kettle!) but in the dark shadows, it can go down to a freezing -173°C. There is lots of radiation from space and there is no air to breathe but you can have a lot of fun bouncing around in the low gravity, jumping 6 times higher than you can on Earth!

If it's so dangerous on the Moon, why do we want to go back there? One reason is that it would be the perfect launchpad to explore space and send people to Mars, our neighbouring planet in the Solar System. We could also set up a permanent home for people on the Moon and learn more about it than ever before.

In 2009, we found something that would make living on the Moon a lot easier – water. Not liquid water but ice hidden in the deepest shadows of some of the craters on the Moon. And then in 2020, a telescope called Sofia found even more water on the Moon, hidden in the dusty surface, giving us even more options for where to set up a Moon base. The Sofia telescope is attached to the back of a plane that flies at the edge of the Earth's atmosphere where it can get an amazingly clear picture of the Moon and the rest of the Solar System.

But why is ice so important? We can melt this ice and extract it from the Moon's surface to make drinking water or to grow plants to eat but water is also really useful for other things because of what water is made of.

Water is made up of two ingredients: Hydrogen and Oxygen. If you can split these apart (using solar powered electricity, for example – and there's lots of sunshine on the Moon!) you can create Oxygen which all living things need to breathe and Hydrogen is one of the main ingredients for making rocket fuel which we would need to travel onwards to Mars.

Your challenge – design an invention to make use of the water on the Moon. You choose – what would you use this water for? Would it be for astronauts to drink? To create oxygen to breathe? To water plants for food? Or to make rocket fuel to take your astronauts to Mars?

Draw a picture of your invention on the next page and write a short description of how it works.

If you'd like to share your invention with us, take a photo of the page and ask an adult to post it to social media – tag the Institute of Physics (@PhysicsNews) and use the hashtag **#IOPAtHome**.

We'd love to see what you can imagine!

My invention is called:

Draw your invention here:

Write about it here:

People in Physics: Kathryn Plummer

Name

Kathryn Plummer

What do you do?

I'm a Patent Attorney – I work with inventors to help them make their inventions protected by law.

Where did you grow up?

I grew up in Waltham Abbey in Essex

How did you get where you are now?

Like you, I started off by going to school. I grew up, learnt how to play the piano, did my GCSEs and A Levels, and then I went to university to do a degree in Physics at Imperial College London.

Each summer when I was studying, I spent some time getting work experience. One year I wrote computer code for an engineering company in Washington DC in the United States. Then I spent a whole year in France writing computer code to help understand the information coming from one of the European Space Agency's satellites.

I graduated in 2019 and now, here I am!

Why did you choose to do physics? Is there anything in particular that you wanted to find out or a challenge you wanted to solve?

When I was growing up, I loved to read books because I enjoyed finding out about worlds beyond my imagination. Studying physics made me feel the same!

For example, I found out that the way regular sized objects behave is totally different to the way really tiny objects like atoms behave (which is what physicists call the quantum level). This made me feel like I was discovering a new world, inside the world that we live in.

The amount that you can learn in physics is endless!

What do you do for your job? What does a typical day look like?

I am a Patent Attorney – this means I work with inventors to make sure that they legally own their inventions, and nobody else can copy them. A patent is proof that it is their invention and has to be given by somebody called a patent examiner.

A typical day in my job starts with reading about a new invention. If an examiner doesn't want to give them a patent I have to work out what to do. Sometimes I agree that something looks wrong so I'll help the inventor to describe the invention in a different way. But, if I don't agree with the examiner - which is always more fun - then I will send them lots of reasons why the inventor deserves a patent.

What's the best thing about your job?

The best thing about my job is learning about completely new inventions and new types of

technology every day. My favourite things that I've learnt about are magnetic wind turbines, and ultrasonic medical equipment.

Outside of your job, do you have any hobbies? Or where are you happiest?

I love to cook! I've spent lockdown collecting cooking equipment. I have bought a pasta machine so that I can make pasta from scratch, a mixer for kneading bread with chocolate inside, and several cookery books.

Do you have any pets?

We are on the cat adoption waiting list!

Do you like to watch or play any sports?

I enjoy bouldering, which is a type of climbing (when there's no lockdown) and cycling (when there is a lockdown). However, I only watch world cups or the Olympics, so I watch sports once every two years.

Who is the most famous person that you've ever met?

Stormzy! I went to the signing of his first album.

What's the best piece of advice you've ever been given?

If you ever find yourself feeling nervous about your ideas, you should remember that you've worked hard to get where you are, so have the confidence to act like it!

Has your work changed at all since the start of this year?

Luckily enough, I have been able to do all of my work from home. Whenever I have meetings they're over skype, so I definitely miss seeing my colleagues in person!

Let it snow, let it snow, let it snow!

When was the last time you saw snow? It snows in the UK on average 23.7 days every year, which living in London, I find difficult to imagine! Most of that snow will only fall over hills and mountains and even then, it rarely settles on the ground. But try to remember a time you saw those fluffy white flakes drifting slowly out of the sky. Did you think about what they actually are and where they come from?

You might have learned in school about states of matter: solid, liquid and gas. Solid water is called ice, gaseous water is called steam and liquid water... well that's just water. So where does snow fit in? It is more complicated, and, in my opinion more beautiful, than lumps of ice falling from the sky (those are hailstones, and they hurt!) because no two snowflakes are exactly alike.

Each snowflake will start to grow inside a very cold cloud when a tiny droplet of water vapour freezes onto a bit of pollen or a dust particle in the sky. This is the start of our snowflake and is called the primary ice crystal. As this ice crystal falls to the ground it picks up more and more water vapour on its journey to the ground, which freezes onto the primary crystal. The freezing water grows the famous six arms of our snowflake. Exactly how it grows those arms and the final shape of the snowflake depends on two things, the temperature of the air and how much water vapour there is.

The study of snowflakes has been going on for over 90 years, and physicists have discovered the shapes they grow into as snow clouds get colder and colder, but it is still a bit of a mystery why exactly they grow the way that they do. It needs to be around -2°C for snowflakes to grow, at this temperature they make flat, six sided flakes. As it gets colder their shape changes drastically. At only a little bit cooler, near -5°C, they form six sided columns and needles.

Down at a chilly -15°C we get the most complicated pointed star shapes, these are the shapes you might have in your head if someone asked you to imagine a snowflake. Finally, when temperatures fall below -30°C, they're back to columns again.

Even snowflakes that grow and fall from the same cloud won't be the same by the time that they reach the ground. Every crystal will encounter different things on its journey to all the others. It might be buffeted by the wind or fall straight down. It might fall through a colder or warmer patch of air. These differences make the ice crystals build up one way or another until each flake that reaches the Earth will be unique. Every snow crystal ends up slightly different to all the others that land and settle, or more likely in London – melt.

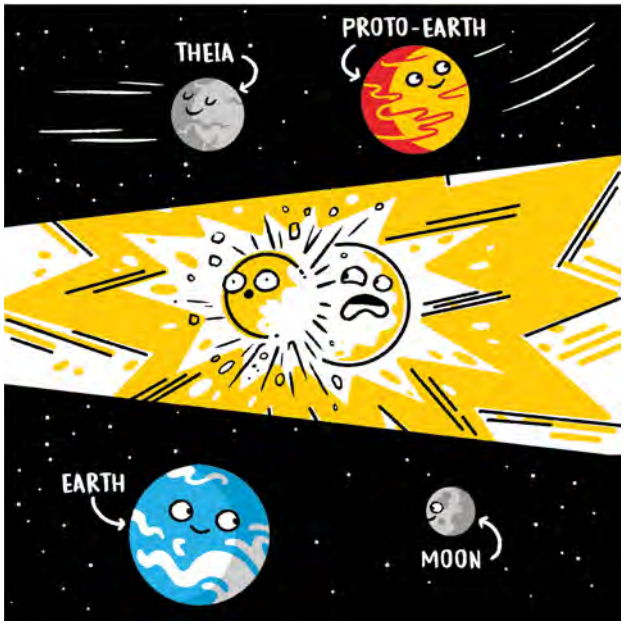
This is why I think snowflakes are so fascinating. Although they all start off in the same way, and they'll all end up with six symmetrical sides, the different shapes and sizes tell a story about what it was like in the snow cloud, how they have grown and the path they have taken from the sky to the earth. Next time it snows – use a piece of black paper or card to catch a snowflake and look really closely. Or even better, use a magnifying glass and see if you can spot the differences between them to try and work out what their story is.

Fun fact: An American woman called Frances Chickering made the first paper snowflakes! She studied the shapes of the crystals that fell on her windowsill and quickly cut them into paper. She published a book with all these paper snowflakes designs back in 1864, and people have been making them at this time of year ever since.

What is winter anyway?

The word 'winter' comes from an old German word meaning 'time of water' and with all of the rain (and sometimes snow) at this time of year it isn't hard to see why! Winter is one of the four seasons and is the coldest time of the year, with the shortest days and the longest nights. You might have noticed it can get dark before you have even finished school.

The reason we have day and night, and the seasons, is down to the way the Earth travels around the Sun. One trip all the way round the Sun takes one year and the path the Earth follows is called an orbit. The orbit of the Earth is roughly a circle, but not quite, meaning that it is closer to the Sun at some times of the year and further away at others. But this doesn't make enough difference to cause the seasons, so what does?



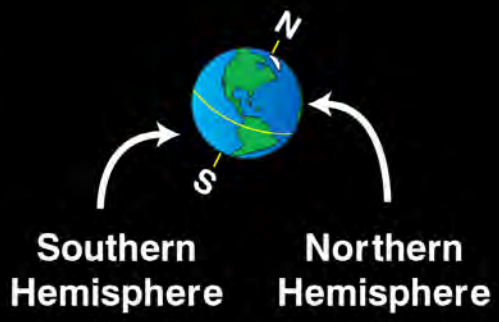
There is an imaginary line through the centre of the earth, from the North pole to the South pole, which is called the Earth's axis. Scientists think it used to point straight "up" and "down" until billions of years ago a Mars sized object called Theia smashed into the young Earth. The crash sent chunks of the Earth into space and some it stuck to what was left of Theia to form the moon as we know it today. This impact was also big enough to knock the axis of the Earth sideways a bit. So instead of rotating with the axis up and down, it now has a permanent lean of just over 20 degrees, so as the Earth travels around the Sun, half the time the "top half" (Northern hemisphere) is leaning towards the Sun and half the time it is leaning away.

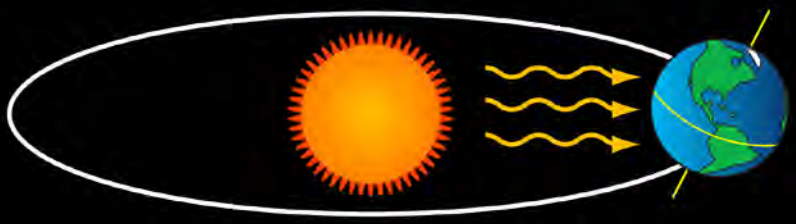
Astronomers measure the first day of winter from the time that the north pole is pointing away from the Sun. This gives us the shortest day of the year and in the northern hemisphere this happens around the 21st December. Of course, it will be the opposite in the Southern hemisphere, as they will be tilting towards the sun, so that will be their longest day and the first day of summer.

But why does a tilt towards or away from the sun matter so much? It has two effects, when it is tilted away in winter it makes the days shorter, so that the Sun has less time to warm up the ground. And secondly, when it is daytime the sun is lower in the sky, so the warming effect of it is spread over more ground. You can test this out yourself by measuring the length of your shadow at midday throughout the year. Your shadow will be longer (more spread out) in the winter, and shorter in the summer. Exactly how short the days get depends on where you live on the Earth. The tilt towards or away from the sun makes more and more difference the further you live from the equator and the closer you live to the either the north or south pole. The north pole is in darkness for 163 days each year during winter, and countries around the equator don't really have seasons at all.

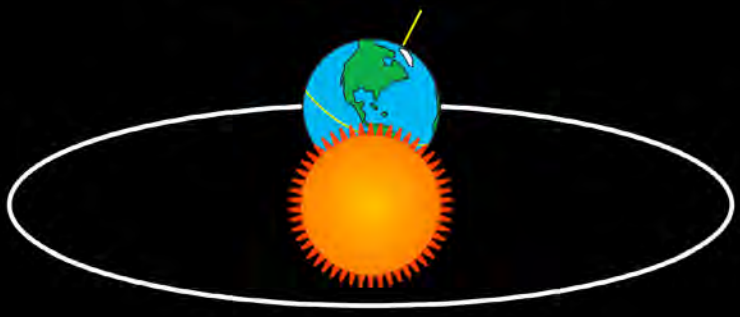
This is how astronomers describe the winter but you have probably noticed that it feels like winter long before the 21st of December! There is a second way to measure exactly what time of the year winter is and that is done by weather scientists called meteorologists. They measure the three coldest months of the year so winter starts at the beginning of December and lasts until the end of February. Having it always take place over exactly the same time, rather than where we are in our orbit around the Sun, means that meteorologists can compare the weather and temperatures between different years more easily and this helps us to understand things like Climate Change.

Earth has seasons because its axis is tilted. Earth rotates on its axis as it orbits the Sun, but the axis always points in the same direction.





December



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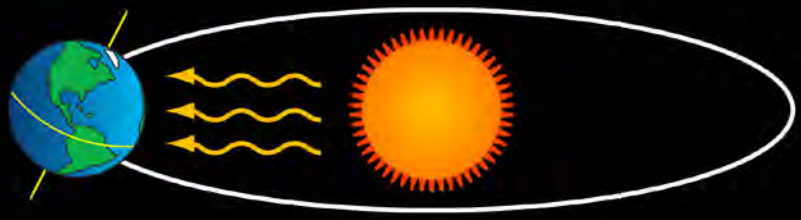

June

September

Fun fact:
The Earth is actually a bit closer to the Sun during winter in the Northern hemisphere.

Do Try This at Home

From the Institute of Physics

Snowball Slingshot

This winter one-off should be s-now trouble at all! Make your very own snowball launcher and put it to the test to uncover the science to sending snowballs soaring through the sky.

Before you start:
These experiments have not been specifically safety tested for home use but we believe them to be safe if the instructions are followed. Adult supervision or direction is recommended as appropriate. All experiments are carried out at your own risk.

What you'll need:

- Plastic bottle with tapered neck (we used a squash bottle)
- Marker pen
- Tape
- Balloon
- Scissors
- Some "snowballs" to send flying: cotton wool balls, or scrunched tin foil work perfectly

Optional

- Paper
- Colouring pencils/felt tips
- Any other decorations to make your launcher as jazzy as possible.

A note for Grown-Ups:

Before you can start to play, you are going to you need make your Snowball slingshot. Make sure you supervise this experiment very carefully. We are using sharp scissors as a stabbing tool so you will need to do some steps with (or for) your family depending on their ages and how sensible they are

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What to do:

1. Draw a circle around the neck of your bottle in marker pen

2. Cut along the line you have drawn. To get started you have to stab a hole in the bottle first using the pointy end of your scissors, an adult should definitely do this part.

3. We are only using the top of the bottle here, you can use the bottom part to play ping pong pick up! If you have made any sharp or jagged edges with your scissors, cover them up with sticky tape so that your slingshot is safe to hold and use.

4. Take off the cap and stretch the balloon over the mouth of the bottle. If your balloon bunches up when you do this, gently pull it, so that it is even all the way round.

Now is the time to test your launcher. We recommend launching rolled up bits of tin foil or cotton wool balls so your home remains unscathed. And it should go without saying - don't fire them at each other!

5. Put your snowball into the bottle, hold onto the neck with one hand and pull the balloon back with the other. Then take aim and release the balloon to shoot snow through the sky.

6. Challenge your friends and family to see who can shoot the furthest and who has got the best aim – we created targets on the floor, you can use bowls or boxes and place them wherever you like:

    a. An easy target scores 10 points
    b. Medium target, 20 points
    c. Difficult, 40 points

The competitor with the most points after 5 launches is the winner and you don't have to play nice!

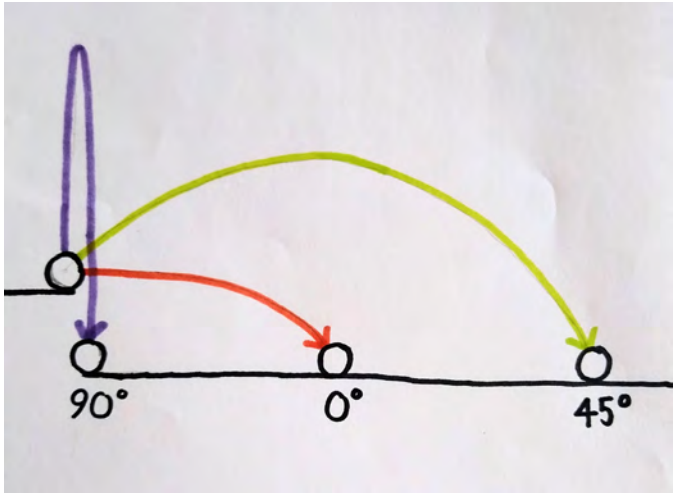
What to talk about

- What happens to the distance when we change the angle we launch the ball at?
- What do you think makes a good slingshot?

What's going on?

Pulling the balloon back stretches it out of shape. When you let go, the balloon snaps back into its original shape, flicking into the snowball. This flicking force is what launches the snowball and sends it flying.

But to win a game of snowball slingshot you need to know best way to hold the tube. The secret is the direction, or angle, that you are pointing it. This is because from the moment the snowball leaves the slingshot, the force of gravity controls the journey it takes. An object is called a projectile if, once it has been launched the only force acting on it is gravity. So why does the angle that you fire your snowball make such a difference?



If you point straight upwards and launch, the snowball starts off quickly but the downwards pull of gravity causes the ball to travel slower and slower until it stops going upwards and starts to fall. The snowball speeds up as it falls back down and lands exactly where it started. Launching straight up like this keeps the snowball in the air for the longest time possible, but it hasn't gone forwards at all, which won't get you any points.

At the other extreme; when you point straight ahead and launch, we are pointing in the right direction. But because we aren't firing upwards at all, the snowball doesn't stay in the air very long so it doesn't go very far.

When you tilt the tube diagonally upwards and then launch, it's a compromise between the two and the snowball takes a lovely curved path up and back down to the floor. To get the maximum distance and the most points you should launch diagonally upwards at 45^0. This angle is exactly between straight up and straight forwards and is the perfect balance between the two. Knowing the physics behind snowball (or any projectile) launching should give you the secret to winning a game of snowball slingshot, it is up to you whether you decide to tell your family and friends!

What next?

There are loads of interesting things still left to investigate together. Can you improve the design of the slingshot at all?

Think about:

- The shape and size of your projectile
- Can you swap the balloon for a different material to launch your projectile?
- The size, length and material of your tube

How will you know for sure that you have made the design better?

Did you know?

If you launch a projectile fast enough it will never hit the ground! It ends up constantly falling around the earth, and is called a satellite.

Word puzzle – crack the code!

Solve the clues below and put them into the correct row to crack the code and find the word that's hidden in the red box. Clue – it's something that all physicists need!

1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										

1. The season that takes its name from the Old German word for "time of water", see page 16 (6 letters)
2. The most famous person that Kathryn has ever met, see page 13 (7 letters)
3. The name of Paul's cat when he was growing up, see page 7 (5 letters)
4. The type of ball that you'll need for the experiment on page 4 (4 and 4 letters)
5. A special type of engine found in cars or buses that you might find on the scavenger hunt on page 3 (6 letters)
6. Paul's first job was as an Engineering _____ at a company that makes things out of aluminium, see page 6 (10 letters)
7. Kathryn is a _____ Attorney – this is the word for the proof that someone owns their invention and no-one else can copy it, see page 12 (6 letters)
8. This is the shape that snowflakes make when it gets down to a chilly -15°C! A pointed _____ shape, see page 14 (4 letters)
9. This is the name for the path that the Earth takes on its trip around the Sun, see page 16 (5 letters)
10. Just over 50 years ago, people walked here for the first time, see page 10 (4 letters)
11. A famous British physicist and mathematician who was also a Member of Parliament, see page 9 (6 letters)

Wordsearch

I	Q	E	G	H	V	F	H	S	J	I	Y	U	D	H	F
K	N	G	B	T	E	X	P	E	R	I	M	E	N	T	X
B	Q	V	F	B	E	B	G	M	I	U	G	C	X	Z	R
E	E	V	E	G	J	Y	V	S	W	D	M	N	D	A	W
E	N	G	I	N	E	E	R	B	V	I	D	R	E	F	I
A	I	Q	X	W	T	T	J	P	Q	S	Y	R	N	O	N
T	G	Y	Q	R	L	I	P	K	Q	C	D	F	D	R	T
X	A	K	P	L	N	X	O	H	M	O	O	N	T	C	E
O	M	T	P	W	Q	W	R	N	F	V	R	D	W	E	R
G	I	G	H	H	I	C	E	V	B	E	Y	W	R	S	B
W	Z	S	Y	F	R	N	G	W	Q	R	P	L	E	T	T
O	Q	F	S	C	I	E	N	C	E	R	N	A	K	P	M
N	V	X	I	D	D	P	R	W	X	Z	S	Y	G	D	F
S	P	A	C	E	P	H	J	M	K	O	B	D	V	C	D
R	T	W	S	G	T	E	C	H	N	O	L	O	G	Y	B
S	C	V	W	R	Y	T	R	S	B	H	W	Q	P	L	Z

Winter		Experiment		Seasons	
Physics		Space		Technology	
Invention		Forces		Imagine	
Ice		Moon		Snow	

Notes

Answers!

1					W	I	N	T	E	R
2		S	T	O	R	M	Z	Y		
3					S	A	L	L	Y	
4			P	I	N	G	P	O	N	G
5		H	Y	B	R	I	D			
6	A	P	P	R	E	N	T	I	C	E
7					P	A	T	E	N	T
8					S	T	A	R		
9			O	R	B	I	T			
10					M	O	O	N		
11	N	E	W	T	O	N				

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