



INSTITUTE OF PHYSICS

I AM A PHYSICIST CHALLENGE



I am a Physicist



Welcome to the Institute of Physics **I am a Physicist challenge!** We hope you enjoy taking part. The challenge has been created by The East Midlands branch of the Institute of Physics (IOP) and is designed to introduce girls to the fascinating world of physics in a way that is accessible, fun and educational.

The challenge is in four sections:

Section 1: Experience

Section 2: Create

Section 3: Investigate

Section 4: Meet, Visit, Community

We suggest that you do as many of the fun and short experiments from section one as you can fit into a unit meeting. To complete the badge Rainbows, need to do at least four, while Brownies, Guides and Rangers need to do at least six. All sections need to do one activity from each of the remaining sections. The activities in section one will give your girls ideas and skills for sections two and three.

This resource is a menu to pick your activities from. We have included activities for all age groups and there's loads of choices, **so don't think you have to do everything!** The recommended age groups for each activity are for **guidance**. Feel free to do whichever activities you think your girls will be comfortable with.

We recognise that while some of you will be comfortable doing experiments, others may need some support. As well as the simple step-by-step guides included in this resource, you can also:

- **Take part** in workshops at a Girlguiding Nottinghamshire training day
- **Watch** helpful videos of the Experience experiments on our YouTube playlist:
<https://www.youtube.com/playlist?list=PLBpUCXeYUyITiZhBzz4LtDbdxC0NkskOg>
- **Contact** the IOP East Midlands branch for advice about the experiments or to help you find a physicist to come along to a unit meeting. Email: iamaphysicistbadge@iop.org

Once you've finished the challenge, complete the badge order form online at <https://www.smartsurvey.co.uk/s/IOPGGBadges>. Badges are currently **free**, however in order to receive your badges you **must compete the feedback form**. We would also appreciate it if you could complete the impact questionnaire at <https://www.smartsurvey.co.uk/s/JEZ81N/>. This includes questions to ask your group which can be answered with a show of hands.

Feel free to share pictures, videos and stories on social media using **#Iamaphysicist**. This hashtag is used by women all over the world to talk about what they do in physics, so make sure you are part of the conversation!

Thank you for taking part in this exciting new challenge and inspiring girls for the future.



Challenge summary



SECTION 1 – EXPERIENCE

This is a collection of simple and fun activities that will introduce some basic ideas and get you used to doing experiments. The activities have been designed to only require things you can find in a supermarket. Each has a step-by-step guide and explanation. The activities are very simple and short, and we suggest you devote a whole meeting to doing as many of these experiments as you want, but Brownies, Guides and Rangers need to do at least six, while Rainbows need to do at least four to complete the badge. These experiments should inspire your girls, as well as giving them the confidence and ideas to tackle sections two and three.

SECTION 2 – CREATE

Now you have some ideas, it's time to put them to use. There are lava lamps and tornados for Rainbows and Brownies, and musical instruments and Egg Mars Landers for Guides and Rangers. This section includes objects or devices for your girls to build. Some activities may require a trip to a crafting shop (unless you have lots of crafting materials already). If you know which 'Create' activities your girls would like to do, you might suggest that they pick the activities in section one that will support this. This is all explained in the badge contents page. These activities will get the girls making, as well as increasing their understanding and inspiring their engineering skills.

SECTION 3 – INVESTIGATE

This is the section where the name of the badge "I am a Physicist" really comes true. These are experiments where your girls will find out *what happens if...?* Rainbows could find out what objects around them are magnetic, while Brownies could find out how much fuel to put into their fizzy rockets for the highest launch. Again, no specialist equipment is needed and there are plenty of helpful suggestions to help it run smoothly. We also would encourage Guides and Rangers to design their own experiments. It's important to remember that there is no right or wrong result. Your girls will change something and see what happens... that's what it is to be a physicist!

SECTION 4 – MEET, VISIT, COMMUNITY

We hope that as well as enjoying themselves and learning something, your girls will be inspired to want to be physicists or engineers in the future. We want this resource to help them to see that they could be having this kind of fun as a job. In this section, we'd like them to either meet a physicist or visit a museum or science centre where they can see physics in action. Included in the resource is a list of local venues, including Greens Mill in Nottingham and The National Space Centre in Leicester (both of which are great visits even if you're not doing this resource!). There's also Science in the Park, which is an event held at Wollaton Hall in Nottingham. The IOP and Girlguiding Nottinghamshire will be hosting a joint stand in 2019. It's definitely worth a visit! Alternatively, contact the IOP East Midlands branch committee at iamaphysicistbadge@iop.org, who will help you find a speaker to visit your unit. Your girls could also get out in the community, demonstrating their new skills at a local event.

TO COMPLETE THE BADGE

	Experience	Create	Investigate	Meet, Visit, Community
No. of activities	Rainbows: 4 Brownies, Guides, Rangers: 6	All sections: 1	All sections: 1	Either Meet or Visit Community is optional

These are the minimum requirements - feel free to do as many as you have time for.

There's also some fun cartoons that you might want to show your girls:

www.physics.org/marvinandmilo.asp

And you could encourage your girls and leaders to keep experimenting at home.

Below is a list of the experiments within this resource and where you can find them.

EXPERIENCE

You can choose to do **any combination** of the Experience activities and Create activities. However, some Experience activities will help prepare for Create activities. This is shown below. Experience activities are suitable for all age groups.

Experience activity	Page	Associated Create activity
Hovercrafty Make a functioning hovercraft out of a CD and a balloon.	6	Balloon Powered Cars (Available in the expansion pack) (Brownies, Guides, Rangers)
String Balloon Rockets Use a balloon as a guided rocket along a string.	7	
Eggstrordinary I Spin eggs to find out which is cooked then use salt to make them float.	8	Mars Lander (Brownies, Guides, Rangers)
Eggstrordinary II Squeeze eggs to discover their surprising strength then drop them intact.	9	
Musical Coat Hangers Turn a metal coat hanger into a gong.	10	Build an Orchestra (All sections)
Screaming Balloons Make a balloon scream by spinning different coins in it.	11	
Balloon Kebabs Push a skewer through an inflated balloon without it bursting.	12	
Flaming Balloons Apply a naked flame to a balloon... and it doesn't burst.	13	
Fizzy Rockets Use water and effervescent tablets to launch film canisters.	14	Not a Create activity but it is useful for Fizzy Rocket Investigate activity. (Brownies, Guides, Rangers)

CREATE

Below are **construction** activities, where your girls will build devices (that actually work!) to demonstrate principles.

Activity	Section	Page
Fun with Bottles Use plastic bottles to construct a lava lamp, Cartesian diver and a tornado.	Rainbows /Brownies	15
Build an Orchestra Construct strange musical instruments.	Rainbows /Brownies/ Guides, Rangers	18
Egg Mars Lander Use random materials to construct a lander that will keep an egg safe when dropped from a height.	Brownies/ Guides, Rangers	20

INVESTIGATE

Your girls should carry out an experiment to investigate something. We provide some example experiments they might like to try, along with instructions, but we encourage all sections (especially Guides and Rangers) to come up with their own experiment.	21
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MEET, VISIT, COMMUNITY

Now that your girls have found out how fun and interesting physics experiments can be, we would like them to meet a physicist or visit a museum or science centre to be inspired into thinking of this as a career option.	23
As an additional, optional, task, they might like to consider presenting the activities you've done, as part of an event in the local community.	25

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Hovercrafty

Make a functioning hovercraft out of a CD and a balloon

INSTRUCTIONS

- 1)** Place the sports cap over the hole in the middle of the CD.
- 2)** Use Blu Tac to hold it in place and form an air-tight seal round it.
- 3)** Makes sure the cap is closed and then blow up a balloon and twist the end to keep the air inside.
- 4)** Stretch the neck of the balloon over the cap. Once it is on, untwist the neck.
- 5)** Place your hovercraft on a flat surface and open the cap.
- 6)** Give it a push and watch it go!

YOU WILL NEED:

- An old CD
- Blu Tac
- Sports cap from a drinks bottle – the kind that you pull to open
- A balloon

WHAT'S HAPPENING?

Rainbows: The air rushes out of the balloon, through the cap, and spreads out under the CD. The CD then floats around on this air.

Brownies: Because the CD is sitting on this cushion of air, it is no longer touching the ground. This means that it has no friction with the ground and only a very small amount with the air it is sitting on. That is why it will go so far without slowing down.

Guides and Rangers: You probably noticed the biggest problem is the balloon dragging along the ground. Why not think about ways you could alter the CD to keep the balloon out of the way?

String Balloon Rockets

**Using a balloon as a guided rocket
along a string**

INSTRUCTIONS

- 1) Blow up the balloon and then peg the neck to keep the air in.
- 2) Cut the drinking straw in half and use a part where there is no "bendy" bit.
- 3) Take 3 to 4 metres of string and thread it through the straw.
- 4) Now tape the straw length ways on to the balloon – so that the neck with the peg on it is facing backwards along the string.
- 5) Hold one end of the string with the balloon on it right next to you – the neck end facing back towards you. Get a friend to take the other end away and make the string tight.
- 6) Release the peg and watch it go!

Experience

Suitable for all sections

YOU WILL NEED:

- Several metres of string
- A balloon – ideally the long type
 - A peg
- Sellotape and scissors
- A straw

WHAT'S HAPPENING?

Rainbows: The balloon squeezes all of the air out of the hole, pushing the balloon forwards. The string makes it go in a straight line. What would happen if you just let it go without a string?

Brownies: Blowing into the balloon stores energy in the stretched-out rubber. When the rocket "launches" that energy is released and transfers into the moving air.

Guides and Rangers: Newton's third law says that for every action, there is an equal and opposite reaction. The motion of the air going backwards out of the balloon will be equalled by the forward motion of the balloon.

Eggstrordinary

Part 1

Spin eggs to find out which is cooked then use salt to make them float.

INSTRUCTIONS

- 1) Keep track of which eggs are boiled and which are raw – maybe label them.
- 2) Spin the hardboiled egg. Then stop it with your finger on top and *immediately* let it go again. Watch what happens.
- 3) Now spin the raw egg and do the same. It should start spinning again!
- 4) Now half fill the glass with water and add 4 table spoons of salt – mix until it is all dissolved.
- 5) Put a raw egg into the glass. It should float.
- 6) Now gently pour in more fresh water. The egg should begin to sink. Add just enough so it floats in the middle. **Keep this water for Part 2!**

Experience

Suitable for all sections

YOU WILL NEED:

- Raw eggs
- Hard boiled eggs that have cooled
- A pint-sized glass (large enough to fit an egg)
- Salt
- Fresh water

WHAT'S HAPPENING?

Rainbows: When spinning the eggs, in the hardboiled egg it all spins together. But in the raw egg the stuff inside is loose and liquid. When you stop the egg, the insides keep moving.

Brownies: The weight of the egg is heavier compared to pure water than it is to salt water. When you add the pure, it **dilutes** the salt water.

Guides and Rangers: The liquid insides of the egg keep their **momentum** and transfer it back to the shell. In the floating experiment. The salt in the floating experiment increases the **density** of the water and increases the **buoyancy** of the egg.

Eggstrordinary Part 2

Squeeze eggs to discover their surprising strength then drop them

INSTRUCTIONS

- 1) Check an egg for cracks and remove any rings from your fingers
- 2) Put the egg in the palm of your hand and hold it inside the bucket. Squeeze evenly as hard as you can – the bucket catches any mess from the occasional one that breaks!
- 4) Cut the top off the bottle and put the egg inside.
- 5) Fill with enough of the salt water from part 1 to cover the egg so it floats. If you don't have enough, use tap water and add salt until the egg floats. The egg must float!
- 6) Tape the top of the bottle back on and drop from waist height to the floor. The egg should survive.

Experience

Suitable for all sections

YOU WILL NEED:

- Raw eggs
- A bucket (or wrap the egg in a plastic bag)
- Wipes/washing facilities for breakages
- Large plastic bottle
- The salt water you made in Eggs Part 1
- Scissors and sticky tape

WHAT'S HAPPENING?

Rainbows: The shape of the egg makes it very strong and the squeeze of your hand is spread round the whole egg.

Brownies: The curved shape of the egg means that the **force** applied by your hand is distributed across the whole shell evenly. The salt water in the drop experiment does the same with the force of the **impact**.

Guides and Rangers: The amount of **pressure** over **surface area** plays a part here and this is why you have to remove rings. That would create a point where more pressure is on a single point.

Musical Coat Hangers

Turn a metal coat hanger into a gong

INSTRUCTIONS

- 1) Tie a piece of string to the two corners of the coat hanger. Put a small loop in the end of each string.
- 2) Put an index finger through each loop and hold it up so it dangles.
- 3) Have a friend hit the hanger with the fork/spoon. You can see and feel it vibrating. Can you hear it?
- 4) Now stick your fingers in your ears and bend over so the hanger hangs freely. Have it hit again. What can you hear this time?
- 5) Swap with your friend.

Experience

Suitable for all sections

YOU WILL NEED:

- A metal coat hanger
- 2 pieces of string
- A fork or spoon

WHAT'S HAPPENING?

Rainbows: Noises are made by things wobbling or **vibrating**. That vibrating goes up the string, through your fingers and into your ears.

Brownies: In step 3, the **vibrating** coat hanger makes the air around it vibrates but air, being a **gas**, is very bad at passing on these vibrations. **Solids** are much better and the string and your finger are a solid all the way to your ear.

Guides and Rangers: The **molecules** in the air are too spread out to easily pass on the vibrating **sound waves**. The molecules in solids are close together and the sound waves pass from one to the next more easily.

Screaming balloons

Make a balloon scream by spinning different coins in it

INSTRUCTIONS

- 1) Squeeze the coin through the mouth of the balloon – make sure it goes all the way in.
- 2) Blow up the balloon but do not be tempted to over-inflate it. Tie it off.
- 3) Grip the balloon at the stem end, like you're holding a bowling ball, and palm down swirl it in a circular motion
- 4) The coin may bounce around at first but will then roll, making a noise.
- 5) Vary the speed and change coins – listen to the sounds made.

Experience

Suitable for all sections

YOU WILL NEED:

- Balloons (of the round variety)
- Bevelled edge coins – 20p, 50p or £1
- A good pair of lungs (or balloon inflator)

WHAT'S HAPPENING?

Rainbows: The coin is running round the outside of the balloon and the edges are “tapping” the rubber. The faster it goes, the faster the taps and the higher it sounds.

Brownies: Sound is a vibration. The shape of the coin means that it is vibrating inside and those vibrations then make the air around vibrate so you can hear it.

Guides and Rangers: The coin is moving around the balloon thanks to **centripetal force** – the inward pointing force that makes objects move in a circular path. The screaming sound is made when the side of the coin vibrate so as to make a **standing wave**.

Balloon Kebabs

Push a skewer through an inflated balloon without it bursting

INSTRUCTIONS

- 1) Inflate the balloon to a reasonable size but do not go too far. There should still be a darker area of rubber at the end.
- 2) Tie a knot so the balloon stays inflated.
- 3) Find the darker patch of rubber at the end opposite the knot. Firmly press the pointed end of the skewer into this patch.
- 4) If it bursts, try again.
- 5) Hopefully it hasn't burst. Now push the skewer all the way through, taking care to come out of the thick bit round the knot. Remember: balloons can be burst from the inside as well as the outside!

Experience

Suitable for all sections

YOU WILL NEED:

- A bamboo or wooden skewer
- Balloons (round and of reasonable quality)
- The ability to blow it up

WHAT'S HAPPENING?

Rainbows: When you blow up a balloon, the rubber gets all stretched. The dark patch on the end and around the knot are least stretched and won't break when you skewer it.

Brownies: The **energy** you are using to blow up the balloon is being stored in the stretched rubber – just like an elastic band. When you burst a balloon that energy is all released.

Guides and Rangers: The stretched rubber is under high **surface tension**. The points where we push in the skewer have low surface tension and thus won't break. A lot of the stored energy is released as sound – that's why there's a BANG.

Flaming Balloons

Apply a naked flame to a balloon
and it doesn't burst

INSTRUCTIONS

Close adult supervision is definitely required.

- 1) Blow up one of the balloons and tie a knot in it.
- 2) Hold a flame from the lighter or match against it and watch it go bang.
- 3) Put some water into the second balloon – easiest to do this from a tap.
- 4) Inflate the rest of the balloon with air and tie a knot.
- 5) Hold it up and let the water settle.
- 6) Apply the flame right under the water. It should not pop. You'll still see soot on the balloon though!

Experience

Suitable for all sections

YOU WILL NEED:

- 2 Balloons
- Water – ideally a tap
- Cooker/cigarette lighter, candle or matches.

WHAT'S HAPPENING?

Rainbows: When you burn the balloon by itself it melts through the rubber straight away. When there is water the heat of the flame goes into the water instead.

Brownies: The heat energy from the water passes straight through the rubber into the water. The water takes a lot longer to heat up than rubber. So, it stays relatively cool and stops the rubber right next to it heating up as well.

Guides and Rangers: The amount of energy needed to increase 1kg of a substance by 1 degree Celsius (or Kelvin) is known as the **Specific Heat Capacity** of that substance. For water it is 4186 joules per kg.



WE DISCOVER, WE GROW

Girlguiding

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Launching Fizzy Rockets

Use water and effervescent tablets
you can launch film canisters

INSTRUCTIONS

- 1) Go outside to somewhere it doesn't matter if the floor gets wet and a few metres away from buildings and cars.
- 2) Break up half a tablet into smaller pieces and drop them in the canister.
- 3) Put about 1-2cm of water into the canister with the tablet.
- 4) Put the lid on tightly and give it a quick shake.
- 5) Turn it over and place it lid-down on the floor. Step away and make sure everyone stays away from it.
- 6) See if you can guess when it will launch and how high it will go!

Experience

Suitable for all sections

YOU WILL NEED:

- Effervescent tablet – one that fizzes in water. Vitamin C for example.
- An old film canister. Can be got from a photography shop or contact the IOP. Some drinking yoghurts have plastic clip lids.
- A jug of water

WHAT'S HAPPENING?

Rainbows: The fizzing tablet gives off a gas that is trapped inside the canister. When there is too much gas it forces the lid off and the canister explodes away.

Brownies: The trapped gas has nowhere to go and so the **pressure** increases. Once the pressure is strong enough to overcome the **friction** of the lid, it pushes down.

Guides and Rangers: **Newton's laws** say that for the rocket to move up, it must throw something away downwards – that is the lid.

Fun with Bottles

Explore the idea of density and create a spectacular vortex! Use plastic bottles to construct a lava lamp, Cartesian diver and a tornado

Create

Suitable for Rainbows and Brownies

We'd suggest each girl makes a lava lamp to take home. The diver and tornado are more suited to small groups.

Ensure you dispose of any plastic you're using in an environmentally friendly way.

YOU WILL NEED:

Lava lamp	Cartesian diver	Tornado
<ul style="list-style-type: none"> Buckets Food colouring Vegetable oil Sequins (optional) 	<ul style="list-style-type: none"> Effervescent (fizzy) vitamin C tablets (like Alka-Seltzer) Funnels Small, clear water bottles 	<ul style="list-style-type: none"> Plastic bottle of any size Water and a jug Straw Blu-Tac

LAVA LAMP

- Pour out about $\frac{1}{4}$ of the water from the bottle
- To the remaining quarter add a few drops of food colouring
- Split the girls into pairs and give each pair a funnel
- Get one of them to hold the bottle while the other pours in cooking oil until it is $\frac{1}{4}$ full. Make sure a quarter of the bottle is just air at the top
- Wait for the liquids to fully separate – oil floats on water
- Add a small hand full of sequins now (if using)
- Break up one of the effervescent tablets and drop it into the bottle. Watch what happens

Top tip:

Don't put the lid on during the fizzy bit. If the girls are taking the lava lamp home you'll need the lids for then.

WHAT'S HAPPENING?

The oil separates out and floats on top of the water as it is lighter – **less dense**. This is because the particles in the oil are less tightly packed together. The fizzing of the tablet releases small bubbles of carbon dioxide gas that rise to the top of the liquid and carry some of the water with it. The gas escapes when it reaches the top and the coloured water sinks back below the oil.





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CARTESIAN DIVER

- 1) Cut a length of straw about 5cm long.
- 2) Seal up each end with a bit of Blu-Tac
- 3) Use the jug of water to see if it floats. Keep changing the amount of Blu-tac until it *only just* floats
- 4) Now put it into the bottle full of water

Now, when you squeeze the bottle the diver sinks and when you let go it floats back to the top.



WHAT'S HAPPENING?

The water does not compress much when you squeeze it so the air inside the diver gets squashed. The overall mass does not change but the volume gets smaller. We talked about **density** in the last activity – here it increases and it sinks.

It's also possible to do this experiment using sauce sachets and Blu-Tac:

TRY THIS AT HOME

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Featuring: Marvin and Milo

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

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.

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

Push your ketchup diver through the neck.

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?

www.physics.org keywords: density

Vic le Ballon



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TORNADO!

- 1) Fill one of the 2-litre bottles until it is almost full
- 2) Create a "worm" of Blu-Tac long enough and thick enough so that you can put it round the rim of the bottle. It needs to be thick enough so that it will form a seal when you...
- 3) Turn the second (empty) bottle upside down and push the rim into the Blu-Tac seal
- 4) Use gaffer tape around the join to make sure that the bottles will stay together
- 5) Turn it all over so that the water is now at the top
- 6) Hold the top bottle and the join and spin it in a circular motion
- 7) Once a **vortex** (whirlpool) 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.

Top tip:

- You could add food colouring to the water.
- Try to use room-temperature water – if you use cold it makes the air inside the bottle cold. Because cold things get smaller, the bottles will crumple up!
- Bottle tornado adapters can be bought online.



WHAT'S HAPPENING?

This is the same kind of **vortex** that you see in cyclones, tornadoes and whirlpools.

A less dense material (in this case the air) is rising, being sucked up by the dropping **pressure** in the top bottle as the water falls to the bottom. The small rotation you give it is increased in speed as the water drops through the opening.

In the case of a real tornado it is less dense hot air rising up the middle as denser, cold air spirals down the outside.



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Build an Orchestra

This is a construction activity to create strange musical instruments

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Create

Suitable for all sections

Ensure you dispose of any plastic you're using in an environmentally friendly way.

YOU WILL NEED:

Chicken Sounds

- Plastic cup or yoghurt pot
- String
- Damp cloth

Growler

- Cardboard box
- Pencil
- String
- Wet cloth

Straw Oboe

- A straw
- Scissors

Gloaphone

- Thin latex glove
- A straw
- Tape
- Cardboard tube with open ends

PURPOSE OF THE ACTIVITY

The sound of musical instruments is always created by making things vibrate. In woodwind it is the reed, in string instruments the strings, in brass the player's lips and in percussion it is by hitting things. The sound is often amplified by creating chambers for the sound waves and the pitch of the note is often related to the size of the instrument or chamber. Here we will show you how to make four "instruments" that explore these ideas. Then you could get older girls to try creating their own.

STRING VIBRATIONS: THE CHICKEN AND THE GROWLER

In these first two, the string is made to vibrate by holding a damp cloth tightly round it and pulling it along the string. Try doing it to some string by itself. You can feel the vibrations and hear a quiet sound.

Now:

Chicken Sounds

- 1) Make a hole in the bottom of the cup
- 2) Cut a length of string
- 3) Thread it through the hole and tie a knot to stop it slipping out
- 4) Now take the cloth and pull it along the string again

Growler

- 1) Make a small hole in the cardboard box
- 2) Tie some string round a pencil
- 3) Feed the string through the hole so that the pencil is inside
- 4) Pull the wet cloth along the string again

In each case, the box and the cup has **amplified** the sounds of the string. The size and shape has affected the pitch. The tightness of the cloth and speed of movement are also factors. Try changing them – see what happens.

STRAW OBOE

- 1) Cut away the bendy part of the straw
- 2) Flatten one end about 2cm from the tip
- 3) Make two cuts along the folds to make a triangular tip
- 4) Insert the tip into your mouth so that that triangles do not touch anything. Blow hard!

The triangles vibrate in the air. What happens if you shorten the straw?



GLOVAPHONE

- 1) Cut a small hole in one of the fingers of the glove
- 2) Feed the straw a small way in and seal with tape
- 3) Put the end of the glove over the cardboard tube and tape down to the tube – make sure there are no holes
- 4) Insert the tip into your mouth so that that triangles do not touch anything. Blow hard!
- 5) Pull the rest of the fingers down against the side of the tube and blow until the top of the glove vibrates.



TIME TO GET CREATIVE!

You've now seen some of the ways to make sound vibrations – and we haven't even plucked a string or hit anything yet! You have seen how we can use boxes or "horn-shaped" cups to **amplify** the sounds (make them louder). The size of the instrument will change the note, as will how hard you blow things or rub things.

Instruments rely on what we call a **standing wave** – a vibration that keeps repeating on the same frequency. When you change the length of the straw oboe, the shorter ones have a smaller wavelength and so the note rises. On a flute or recorder you change the "length" by covering holes. On a string instrument, you change the length of the string by putting your fingers on it. In percussion instruments, smaller things generally give higher notes – think of the blocks on a xylophone. Or maybe fill glasses with different amounts of water.

So, now you should encourage your girls to invent their own instruments. **Build yourselves an orchestra!**

Egg Mars Lander

Use random materials to construct a lander that will keep an egg safe when dropped from a height

PURPOSE OF THE ACTIVITY

Just like in the last *Balloon Powered Cars* activity, this is another opportunity to flex your creative muscles. If you did both the Eggstrordinary activities in Experience, then you have already started exploring the strength of eggs and how to protect them. In this activity, you're going to throw them off the roof (or top of a ladder or any other high place). Using lots of random junk and crafting materials, try to keep it in one piece.



Eggstra challenges

Succeeding isn't actually too tricky so you could choose some extra elements to the challenge:

- You must be able to get the egg out after the drop in less than 10 seconds. An eggsit hatch?
- Increase the number of eggs – half a dozen?
- Impose a maximum weight limit.

Create

Suitable for Brownies, Guides and Rangers

YOU WILL NEED:

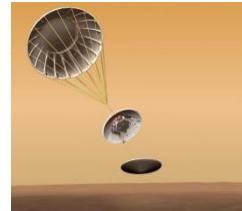
- Eggs
- Lots of random materials – craft stocks, junk, recycling. People could bring in rubbish from home
- Suggested (and not limited to): tape, scissors, glue, cardboard, rubber bands, pencils, paper, tissue paper, cotton wool, cartons, boxes, plastic bags, scrap polystyrene, string

Stuck for ideas?

If your budding engineers are struggling, here are some of the methods real planetary landers use and other things they could consider.

- Parachutes
- Propellants
- Airbags
- Crumple zones
- Padding
- Suspension

Also consider things like the water drop activity in Eggstrordinary 2 or encasing it in sponge.



CHALLENGE YOUR RANGERS!

Have a go at building a lander that you put on top of a rocket! Here is an example of one you could build:

www.wikihow.com/Make-a-Powerful-Air-Pressure-Rocket



WE DISCOVER, WE GROW

Girlguiding

Nottinghamshire County

Investigate

It is time to do actual experiments to investigate physics phenomena

Suitable for all sections

IOP
Institute of Physics

PURPOSE OF THE ACTIVITY

This is where **I am a Physicist** really comes true. The girls should carry out an experiment to **investigate** something. We've provided some example experiments they might like to try and how to do them, but it would be great if, especially the older girls, came up with their own experiment. To help them along the way we will mention some basic principles of designing an experiment.

HOW TO USE THIS SECTION

You will find several suggested experiments here, along with the age group we think might be appropriate. You can read through them and find one you want to do or create your own. We suggest:

- **Rainbows** to carry out a small investigation and produce a simple table of results
- **Brownies** to do an experiment, probably one suggested here, with a single variable.
- **Guides** to carry out an experiment where they identify the variables.
- **Rangers** to address a question, designing the experiment themselves.

In each case the girls can then choose to either talk about their results or create a poster.

THE EXPERIMENTAL METHOD

All sections should all follow the same simple steps:

1. The question	E.g. is it magnetic? How do bubbles form differently in different types of milk?
2. The guess	What do you think will happen? Why? (It doesn't matter if you don't get it right).
3. Fair investigation	E.g. same magnet/ same amount of milk/size of glass.
4. Compare the results to the guess	Did it do what you expected? If not why not?
5. Present	Tell someone else about what you did and found out. You might need to draw a picture or a chart. Or show them.

CHOOSE AN INVESTIGATION

Rainbows, Brownies and Guides should choose an experiment from the next page or find another in a book or online.

Rangers should pick a question from the suggestions or choose one of their own.

Here's a quick one to get you started...

Hungry? Which biscuits dunk best?

Get different varieties of biscuit and ask which will dunk best? Why? Make it a fair test – same amount of time in tea/hot choc. Same temperature. Time how long it takes before the bottom falls off!



Rainbows / younger Brownies

MAGNETS

INSTRUCTIONS

- 1) Write a list of stuff around you.
- 2) Guess if it'll stick to a magnet or not – write down your guess next to each.
- 3) Try it. Were you right? Don't worry if you weren't. Not all metals are magnetic.

Top tip: to help get a good range of materials, including some sticky and some non-sticky metals.

EXTENSION

- 4) Does the magnet work through paper? material? card?
- 5) How many layers of card do you think? Try it – are you right?
- 6) Make a maze – magnet one side of the card, paper clip the other, can you lead your paper clip through the maze you drew?

Brownies

MILK BUBBLES

You will need: Full fat milk, semi-skimmed milk, skimmed milk, three identical glasses/beakers, 3 straws, stopwatch.

INSTRUCTIONS

- 1) Pour 5cm of each milk into a glass – remember which is which.
- 2) On the word "go" have three of you blow through straws. Bubbles should build up.
- 3) Use the stopwatch to time how long it takes for the first bubbles to reach the top in one glass and shout stop.
- 4) Now time how long it takes for the bubbles to disappear.

SOME QUESTIONS FOR RANGERS

We suggest that Rangers come up with their own investigations, and design and investigation accordingly. However, if they are stuck for ideas, here are some suggestions:

- What makes pendulums swing at different speeds?
- How do you build the perfect paper plane?
- How could you measure the rotation of the Earth with a weight and a piece of string?
- If ice is the solid form of water, why does it float in your glass on a hot day? What makes water and ice so special?

Rainbows / younger Brownies

SINK OR FLOAT

INSTRUCTIONS

- 1) Write a list of things you're going to test to see if they float or sink in water.
- 2) Think back to other floating experiments you have done for this badge and guess if they will – write down your guess next to each.
- 3) Try it by putting each into a bucket of water. Were you right? Don't worry if you weren't. Not all materials will float.
- 4) Get a piece of modelling clay or playdough if you haven't already. Drop it in as a ball. Does it float?
- 5) Is there a different shape you could mould it into to make it float?

Older Brownies / Guides and Rangers

ROCKET FUEL

This is an extension to the activity Launching Fizzy Rockets on page 14, so read this through first.

You will also need: a device for measuring small quantities of water (Calpol syringe?) and a stopwatch.

INSTRUCTIONS

- 1) Pour 10ml of water into the canister and add a tablet. Put on the lid, turn upside down and place on the floor.
- 2) When the rocket launches, start the stop watch and stop when it lands. This is the same as measuring how high the rocket goes.
- 3) Keep changing the amount of water you put in. Note down the time and amount of water each time.
- 4) Guides/rangers could now plot a graph with water amount at the bottom and time up the side.

Meet or Visit

This is an activity or visit to show how physics is relevant to the real world and is a career they should consider. You can of course do both if you wish!

Meet

Suitable for all sections

PURPOSE OF THE ACTIVITY

Physicists do a wide range of jobs, from medical to astronomy, research to manufacturing and even forensics. It may well be that one of your leaders, helpers or one of your girls' parents is a physicist. Most are happy to talk about their work. The East Midlands Branch of the IOP will be very happy to help you find a speaker

TOP TIP

Why not invite the physicist along on a night when you are doing one of the other activities? Then they could help out and answer the really tricky questions!

You can contact the IOP East Midlands branch at iamaphysicistbadge@iop.org for help finding a speaker.

This could be a member of the branch themselves, a local physicist, an IOP member or a student.

SOME PHYSICISTS IN THE EAST MIDLANDS

Deborah Phelps

Deborah studied physics and maths, and has worked in industry since graduating. She works at Rolls Royce, Civil Aerospace and is Brown Owl at 14th West Bridgford Brownies.



Kelly Morrison

Kelly uses magnets for everything from harvesting waste heat, to building new types of refrigerators – magnetic fields up to 100,000 stronger than the Earth's & temperatures as low as -271°C.



Rebecca Dewey

Becky did a PhD looking at the brain using magnetic resonance imaging. MRI helps answer all sorts of questions about how the brain works, how it goes wrong, and how we can fix it.



Susie Cumberland

Susie is a Senior Research Analyst in an Energy Technology company, as well as owning a science/space themed craft business.



David Wilkinson

David studied medical physics at university before specialising in forensics – weapons and drugs detection. He now works for the IOP and is a science fiction author.



Edward Breeds

Ed is a lecturer of physics at Nottingham Trent University. He thinks seeing what is going on underneath the surface of our everyday experiences makes the world even more beautiful.





WE DISCOVER, WE GROW
Girlguiding

Nottinghamshire County

PURPOSE OF THE ACTIVITY

We all love a trip out and the world of science, engineering and physics can be a fascinating place. Many will have discounts for groups and often will lay on something a little extra. Alternatively, have you ever wanted to visit a real physics laboratory at a university or factory?

TOP TIP

The IOP East Midlands branch organise outreach events, activities and evening lectures throughout the year. Events can be found online at www.events.iop.org/org for details you can also contact iamaphysicistbadge@iop.org

INDUSTRY AND FACILITIES

Some industrial facilities will happily arrange tours. We will be trying to get some contacts for you to use but there is nothing to stop you contacting organisations yourself. Examples in the East Midlands include:

- Rolls Royce
- Staythorpe Power Station, Newark
- Wymeswold solar farm
- Big Hospitals have **medical physics**

LOCAL SCIENCE EVENTS

Here are some you could search for online

- Science in the Park (Wollaton, usually around March)
- Light Night (Nottingham centre, around February)
- Nottingham Pint of Science in May
- Blue Dot Festival (Jodrell Bank in July)

Visit

Suitable for all sections

VISITOR ATTRACTIONS IN THE MIDLANDS

Nottingham

Greens Mill and Science Centre

www.greensmill.org.uk

Nottingham Industrial Museum

www.nottinghamindustrialmuseum.org.uk



Leicester

National Space Centre

<https://spacecentre.co.uk/>

Abbey Pumping Station

<http://www.abbeypumpingstation.org/>



Birmingham

Think Tank

<http://www.birminghammuseums.org.uk/thinktank>

PLACES FURTHER AFIELD

Cheshire

Jodrell Bank Discovery Centre

<http://www.jodrellbank.net/>



Manchester

Museum of Science and Industry

<https://www.msimanchester.org.uk/>



London

National Science Museum

<https://www.sciencemuseum.org.uk/>



PHYSICS DEPARTMENTS

Some universities might be able to have you visit. Physics departments in the East Midlands are:

Nottingham

Leicester

Nottingham Trent

Lincoln

Loughborough

Some have observatories!



Nottinghamshire County

Community
Now that you have become experts in fun physics experiments, share it with other people

Suitable for all sections

IOP
Institute of Physics

PURPOSE OF THE ACTIVITY

The IOP created this challenge to show girls and young women in Girlguiding that physics is interesting, fun and worth considering as a career.

Now you can help us spread that message by using the activities in this badge to take part in outreach in your local community. Perhaps have a stand at a local fair, science festival, guide camp or even take it to a local, younger unit (like another Rainbow or Brownie unit).

LET'S CELEBRATE!

You could choose to celebrate completing your badge by having a party where everyone comes dressed as their favourite physicist. For inspiration, check out this Einstein's Birthday Party pack:

www.physics.org/UploadDocs/Feature/documents/EinstiensBirthdayPartyPack.pdf

You could invite family and friends and show them your favourite physics tricks, present your experiments and display posters.



SCIENCE IN THE PARK

In March 2018, the Institute of Physics teamed up with Girlguiding Nottinghamshire to deliver a physics outreach stand at the Wollaton Hall Science in the Park event. Several hundred people enjoyed being shown activities you have covered in this badge by Brownies, Guides and Girlguiding Volunteers. We plan to do the same at the next event in March 2019!



HOST AN EVENT!

If you're confident in finding a venue and putting on an event, then there's nothing stopping you. Make sure you do a Risk Assessment and observe Girlguiding guidance and policies. If you'd like some guidance, help or support, contact the IOP East Midlands branch committee at iamaphysicistbadge@iop.org



Record Card

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Girl's name	Experience	Create	Exp	M / V / C
		Balloon Kebabs	Eggstrordinary I	Eggstrordinary II
	Fizzy Rockets	Flaming Balloons	Hovercrafty	Musical Coat Hangers
		Screaming Balloons	String Balloon Rocket	String Balloon Rocket
		Mars Lander	Fun with bottles	Fun with bottles
			Build an Orchestra	Build an Orchestra
			Experiment	Experiment
			Meet	Meet
			Visit	Visit
			Community	Community

Badge order form and feedback



Badges are currently free. You can obtain your free badges by filling in an online form:

<https://www.smartsurvey.co.uk/s/IOPGGBadges>

Of course, we are happy to hear any feedback you may wish to give and hope that you will help us by completing the impact questionnaire at <https://www.smartsurvey.co.uk/s/JEZ81N/>. This includes questions to ask your group which can be answered with a show of hands.

Although this badge was created in partnership with GirlGuiding Nottinghamshire, it is now available to groups across the country.



About The Institute of Physics



About The Institute of Physics (IOP)

The Institute of Physics is the professional and learned society for physics in the UK and Ireland, inspiring people to develop their knowledge, understanding and enjoyment of physics.

We work with a range of partners to support and develop the teaching of physics in schools; we encourage innovation, growth and productivity in business, including addressing significant skills shortages; and we provide evidence-based advice and support to governments in the UK and Ireland.

Our members come from across the physics community, whether in industry, academia, the classroom, technician roles or in training programmes as an apprentice or a student.

Our reach goes well beyond our membership to all who have an interest in physics and the contribution it makes to our culture, our society and the economy. We are a world-leading science publisher and we are proud to be a trusted and valued voice for the physics community.

To find out more visit: www.iop.org