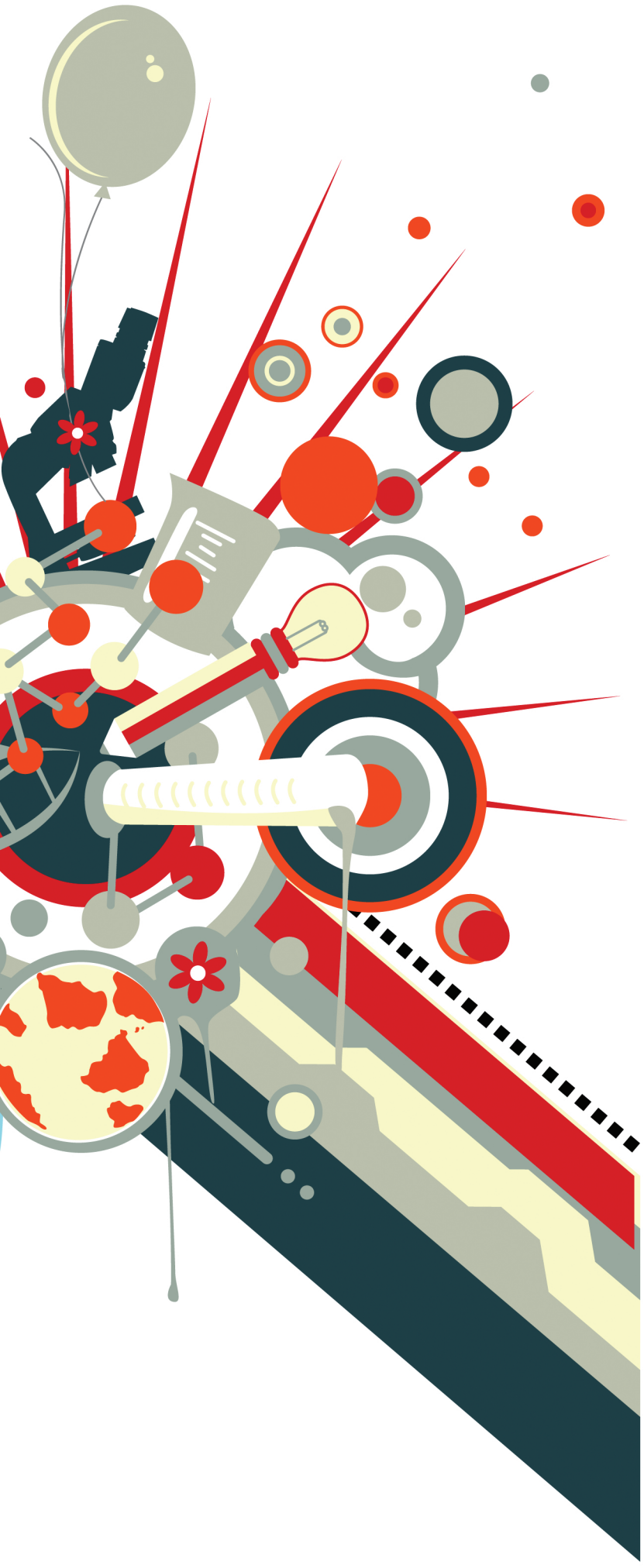


NATIONAL SCIENCE & ENGINEERING WEEK

nsew.org.uk

Einsteins' birthday party

Part of the British Science Association's National Science & Engineering Week activity pack series. **www.nsew.org.uk**

BIS | Department for Business Innovation & Skills

BRITISH SCIENCE ASSOCIATION

About this pack

Background

Albert Einstein's birthday was on March 14th. His work changed the way we view the world for ever. Below you'll find a selection of physics experiments that could be performed at a birthday party for Albert Einstein.

Audience

The ideas in this activity pack have been designed to be flexible and adaptable to the needs of a range of audiences. You may wish to pilot test these activities on a sample audience prior to holding your National Science & Engineering Week event.

Activities

Activity 1:
Wobbly Water

You will need: A balloon (sausage shaped balloons work best)/plastic ruler, a tap or hosepipe, paper and marker.

Adjust the tap or hosepipe until you get a thin stream of running water. Rub the balloon on your hair, or a woolly jumper. Bring the balloon close to, but not touching, the stream of water. What happens to the stream of water? Can you explain this? Mark how far the water has moved on a piece of paper attached to the wall behind the tap and find whose balloon is the most charged and can move the stream of water the furthest. You could try using a plastic ruler instead of the balloon and see if this works better or worse.

Activity 2
It's Slime Time!

You will need: Cornflour, water, food colouring (optional).

Liquid or solid? This is one confused mixture! Put two cups of cornflour in a bowl, add two teaspoons of food colouring (this is optional) and 1 cup of water. Mix it all up with your hands until all the powder is wet and then continue adding a few drops of water at a time, until you have a thick, smooth mixture. Now play with it, hit it, squeeze it, push it slowly and smack it hard! Do you notice anything strange about this material?

Activity 3:
A Fizzics Experiment

You will need: A balloon, some fizzy drink

A self-inflating balloon? Well, almost! Take a balloon and blow it up before letting all the air out (this is just to stretch it so that it is easier to inflate from now on). Now put some fizzy drink in the balloon, tie the end, and shake the balloon. The balloon should start to inflate. What's happening? Who can get a balloon to inflate the most?

Activity 4:
Bubbletastic

You will need: A large bowl, 2 cups of warm water, 1/2 cup of washing-up liquid, 5 tsp glycerin (if available), coat hangers.

Fill the bowl (the bowl must be large enough for a coat hanger to fit inside) with the warm water. Now add the detergent and glycerin. If you need more mixture, continue adding the ingredients in the same proportions.

Take a coat hanger and stretch it so that it makes a circular shape (~12cm diameter works well). This is your bubble wand. Dip it in the bubble mixture and pull it out slowly so that a film of mixture fills the circle. Now drag the wand through the air to form a bubble. Who

can make the biggest bubbles?

What is it about soapy water that allows it to form bubbles? What do you think the glycerin is for? Why are bubbles rainbow coloured? Why do they eventually pop?

Activity 5:
Bubble Tennis

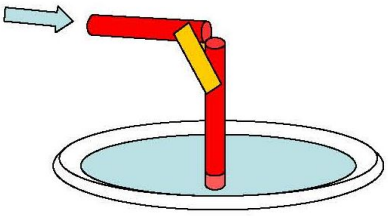
You will need: Bubble mixture and large bowl as above, 2 coat hangers, tube from a ballpoint pen (without the ink cartridge).

Shape the coat hangers until they are in the shape of a circle (~12cm diameter) with a handle. Dip each hanger in the soap solution and pull them out so that a film of soap fills up the whole circle. These are your bubble racquets. Hold the pen tube by one end and dip the other into the solution for a few seconds. Pull the tube out and blow into the other end, forming a soap bubble. This is your tennis ball. Now you can practice your serve. This may take a little practice and works better if you are able to add glycerine to the bubble mixture. Make sure your actions are gentle or the bubble and racquet will burst!

Activity 6:
Test your sucking power

You will need: Lots of drinking straws (approximately 50), sticky tape, some water

How many straws can you stick together before you stop being able to suck up any water? Start with one straw and increase the number to find the biggest sucker – the person who can still get the drink with the most number of straws stuck together into one long super-straw. Why does it get harder to suck the water with more straws? Can you explain what's going on?



Activity 6:
The Magic Straw

You will need: 2 drinking straws, a pair of scissors, sticky tape, 2 saucers full of water, 2 paper targets

Cut the drinking straw into two pieces, one longer than the other. Using sticky tape, join them back together, end to end, at an angle of 90 degrees. There will be an opening where the two straws form the right angle (so all four ends are open). Stand the smaller piece of straw in the saucer, blow through the longer piece aiming at a target a set distance away. The team to knock over their target first wins.

Activity 8:
Blowing hot and cold

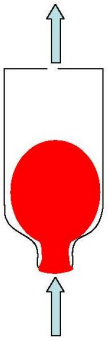
You will need: A balloon (pre-blown is best), a plastic bottle, a large glass beaker or any other large container, hot water from the tap (don't use boiling water), ice in cold water from the tap.

Stretch the neck of the balloon over the mouth of the bottle before placing the bottle into a glass beaker of hot water. Wait for a while. What do you observe?

Now place the bottle in a beaker of ice and water. What happens now?
Can you explain what's going on?

Activity 9:
The Magic Balloon

You will need: A balloon (pre-blown is best), plastic transparent bottle.



With a pen or pencil, make a small hole (about 2mm diameter) in the bottom of the bottle. Push the balloon inside the bottle and stretch the end of the balloon over the mouth. Now blow into the bottle to inflate the balloon. While you are blowing, air will come out of the hole you made in the bottle (put your finger there to check). Just before you finish blowing, cover the little hole with your finger. What happens to the balloon with the open end when you stop blowing? Uncover the hole and see what happens now!

Do the trick again. With the balloon filled, place your palm over the bottle's mouth and uncover the little hole. What happens to the balloon?

Activity 10:
The Unbreakable Balloon

You will need: A balloon, a pin, sticky tape.

The idea is to blow up a balloon and pierce it with the pin without making it go "pop"! Teams can try different ways of piercing the balloon; the successful team is the one with a balloon with a hole that is still inflated. Can you pierce the balloon without using the sticky tape and still avoid bursting it? Why does a burst balloon look like it has been shredded? Why does a burst balloon go "bang"?

Background Notes

Activity 1: Wobbly Water

Rubbing the balloon on your hair or woolly jumper causes movement of charged particles from one surface to the other and you end up with a negatively charged balloon. Water molecules are polar, which means they are positive at one end, and negative at the other. When you bring the charged balloon close to the stream of water, the positively charged hydrogen end of the water molecules are attracted to the balloon, and bend towards it as a result.

Activity 2: Slime Time

You'll notice when you start mixing the water with the corn flour that the powder immediately turns to a thick, almost solid, paste. As you add more water and stir, it will clump together like a solid. But when you leave it alone it will look runny and you'll be able to pour it like very thick paint.

When you slowly push your finger into the mixture it should resemble a thick paint. When you try to pick up a piece of the material you find it's one big solid lump. When you push your finger onto the surface of the 'liquid' quickly, and with a lot of force it appears solid. The harder you hit; the more solid it appears.

The mixture is an example of a *dilatant colloid suspension*. These substances get more viscous (even solid) when you hit them hard. When a small sideways force is applied, by shaking the bowl, or pushing into it slowly with a finger, the weak bonds between the particles break, and the substance flows just like a liquid.

Activity 3: A Fizzics Experiment

Fizzy drink has carbon dioxide dissolved in it. This is what gives it its bubbles. Gases take up a larger volume than liquids, therefore, when you shake the drink, causing large amounts of carbon dioxide to be released, the volume of the balloon increases. Can you explain why it's a bad idea to shake a bottle of fizzy drink and then open it?

Activity 4: Bubbletastic

A bubble is formed because of a fine balance between the surface tension of the water and the pressure of the air inside the bubble. Normally the surface tension, caused by forces between water molecules, is too high, so the bubbles skin contracts and breaks. When detergent is added to water, it reduces the forces between water molecules, so there is less surface tension and you are able to make bubbles.

Light waves, like water waves, can interfere with each other. A bubble film is a sort of sandwich: a layer of soap molecules, a filling of water molecules, and then another layer of soap molecules. When light waves reflecting from one layer of soap molecules meet up with light waves reflecting from the second layer of soap molecules, the two sets of waves interfere. Some waves add together, making certain frequencies or colours of light brighter. Other waves cancel each other, removing a frequency or colour from the mixture. The colours that you see are what are left after the light waves interfere. They're called interference colours.

If you look at the bottom of a bubble you should see water dripping out of the bottom.

The layer of water will eventually get too thin to support the air inside, and the bubble pops.

The addition of glycerin makes the bubbles last longer as it slows down the rate of evaporation and dripping of the water.

Activity 5: Bubble Tennis

Detergent contains molecules called hydrocarbons. Each molecule has a 'head' and a 'tail'. If the head of the molecule loves water, the tail hates it. This means that all the tails arrange themselves so they are on the outside of the film, as far away from the water as possible. When two soap films come into contact they repel each other because the tails on the surface of one want to avoid the water in the other film. This is why the soap ball and racquet don't stick to each other.

Activity 6: Test your sucking power

When you suck through a normal length straw, you're creating a vacuum at the top of the straw with your lungs. The pressure of the air (the weight of the atmosphere) around the drink in the glass then causes the drink to be pushed up through the straw. There is a limit on the height, and weight, of liquid that atmospheric pressure can support. This means that, even if you created a perfect vacuum with your lungs, you couldn't get the drink to rise above a certain height in the straw. Can you work out what the maximum height is? – How would you do this?

Activity 7: The Magic Straw

When air moves, its pressure falls. So when you blow through the horizontal straw, the pressure at the top of the vertical straw drops. Because the air pressure over the saucer remains the same, the water is pushed up the straw from the normal pressure to the low pressure and squirts your target!

Activity 8: Blowing Hot and Cold

The hot water heats up the air inside the bottle. This causes the volume of the gas to increase and the balloon to expand. The opposite happens when the bottle is placed in the cold water; the gas reduces in volume and the balloon deflates.

Activity 9: The Magic Balloon

As the balloon is blown up, it pushes air out of the hole you've made. The pressure inside the balloon is much higher than the pressure on the outside. If you didn't cover the hole with your finger after you've finished blowing, air would rush back into the bottle to equalise the pressure, pushing the air out of the open end of the balloon. When your finger is over the hole, it stops this from happening so the balloon stays in place.

In the second part of the experiment, you kept your hand over the mouth of the bottle, and let go of the hole. Now air is allowed back into the bottle, so it flows into the bottle, raising the pressure on the outside of the balloon. The balloon shrinks until the pressure inside the balloon is equal to the pressure on the outside.

The Unbreakable Balloon

When a balloon is blown up, the rubber stretches and becomes thinner. When the thin rubber is pierced it tears and cracks spread out easily across the stretched layer - the result is that the balloon bursts. The balloon is full of air at high pressure. With the balloon gone,

the high-pressure air is released as a wave. Sound is a wave of highpressure air. When this air hits your ears it makes a bang!

The spread of the cracks makes it appear like the balloon has been shredded. However, if the rubber is reinforced with, say, a piece of sticky tape, then the rubber is not only thicker but the tears and cracks are held together so they are not able to spread across the surface of the balloon. To pierce the balloon without the use of sticky tape, it is easiest to insert the pin through the thickest bits of rubber at the base of the balloon, where the rubber hasn't been stretched by inflation. The thick, slack rubber area is only broken very close to the point of the pin and the cracks do not spread so the rest of the balloon is left undamaged.

Problem-solving Activities

Activity 10:
Rocket science

You will need: A balloon, the inside of a toilet roll, a length of string, sticky tape, two walls, decorations e.g. pens, glitter, coloured paper etc.

You're each going to build a rocket and race them to see who can get theirs to go the fastest.

The propulsion system is a balloon, so begin by taping one side of the balloon to the toilet roll, either tape loosely over the balloon neck (so you can still blow the balloon up) or use double sided tape to attach the balloon to the toilet roll. Make sure that you have enough balloon neck over the end of the toilet roll to blow the balloon up. Then decorate your balloon using felt pens, glitter, card, and anything else that comes to hand. This is your rocket! Now use the sticky tape to fasten two lengths of string to the walls so that they run parallel to each other, in a straight line from one wall to another. Before you attach the strings, thread a rocket onto each string. Each team will have to blow their balloon up, and let them go at the same time. Five seconds to blow the balloons up and then release them should be enough time to start with. Who wins the race? How can you get your rocket to go faster? What makes the rocket move in the first place?

Activity 11:
Balloon Bursting Machine

You will need a selection of any of the following materials:
Balloons
Assorted pins
Elastic bands
Glue stick
Cotton/string
Syringes
Dominoes
Plasticine
Scissors
Paper/card
Plastic tubing
Assorted plastic bottles
Marbles
Sticky tape/masking tape
Pencil
Plus…assortment of items of the judge's choosing.

Your objective is to construct a 'Balloon Bursting Machine' with as many moving parts as possible.

Rules: 1/ Items other than those supplied may be used only if prior permission is obtained from the judge.
2/ The machine may be manually started after which it should run by itself.
3/ The judge's decision in all matters is final!

Judging: If the machine works the team is awarded 50 points.
Each team receives a bonus of 10 points for each moving part (a set of dominoes counts as one moving part)

Activity 12:
Party Time

You will need: 1 sheet of A4 paper (for the final cup), a few sheets of A4 paper to practice with, party pop of your choice!

Your objective is to make yourself a party cup from a sheet of A4 paper (to drink your party 'pop' in!).

Or, if you want to make this competitive...

You will need for a team of three people: 5 sheets of A4 paper per team, a bucket of water, an empty bucket to transfer water into.

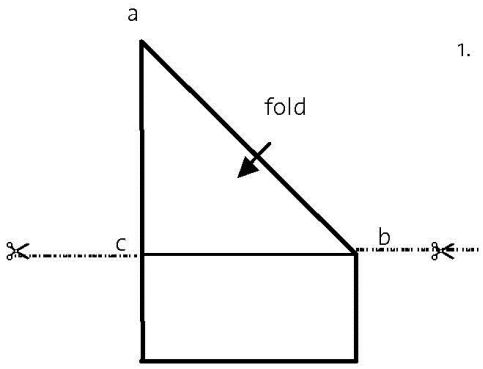
Your objective is to transport as much water as possible across a room using only a container (or containers) constructed from the paper supplied.

Time allowed: 15 minutes

Rules: 1/ Only one cup of water at a time can be transferred.
2/ A second water run can only be commenced when the first team member returns to the water bucket.
3/ Only the materials supplied may be used.
4/ The judge's decision in all matters is final!

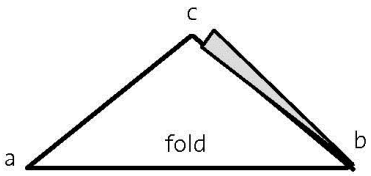
Judging: The winning team will be the one that transfers the greatest volume of water across the room in the time available.

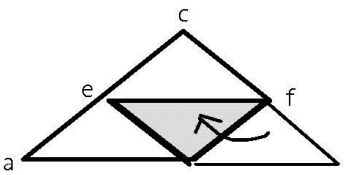
Instructions on how to make a paper cup



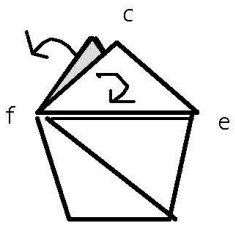
1. Fold a piece of A4 paper and cut to make it square

2. Fold corner **b** to point **e** on **ac** (so that **ce** equals **cf**)





3. Turn paper over and fold corner **a** to point **f**



4. Open out - fold back pointed corners(**c**)and tuck in

Background Notes

Activity 10: Rocket Science

Your rocket is a demonstration of Newton's third law: every force has an equal and opposite force. As the air is being forced out of the balloon by the air pressure inside, it exerts an equal and opposite force on the balloon, which is what makes your rocket move.

The rockets also demonstrate the principle of conservation of momentum. Momentum is the velocity of an object multiplied by its mass. In this case, the momentum of the rocket is zero before it is released, and remains zero once it has stopped moving. The momentum of the balloon is equal and opposite to that of the air coming out, so they cancel each other out.

Activity 11: Balloon Bursting Machine

Bursting the balloon in this activity isn't quite as easy as it sounds. The balloon needs to be held firmly in place so that the pin can pierce it.

Ideas for moving parts might include the following

- Clothes peg releases a string weighted with Plasticine that swings and hits...
- Elastic band stretched taught is released and...
- Two syringes joined together with a piece of tubing, start the machine by pushing in the plunger of one syringe and the plunger on the other moves out and causes...
- A row of dominoes, knock one and they knock each other in sequence, then finish by knocking...
- A marble runs down a ramp and knocks...
- A plastic bottle filled with water, rolls down a ramp and causes...
- A simple seesaw, weight lands on one side, causes the seesaw to tip and...

A junk box can be used at your discretion. It contains extra things that the teams can use. There could even be a bonus score for including one particular nominated item in the machine.

Activity 12: Party Time

This activity is effectively a relay race with water – but the water carrying devices have to be designed and made out of paper. You can either use the diagram below to make a cup or you can use your imagination and invent one of your own. Do you want to make 5 cups from your paper or do you want to make fewer, stronger cups? It is generally best to set up your course outside with a full bucket of water at one end and an empty bucket at the other. Be careful not to slip over on any of the spilt water!

Thank you for using Einstein's Birthday Pack!

We hope you enjoyed the activities within this pack. To help us to continue to provide new activity packs, we'd like to ask you to tell us a little about what you did for National Science & Engineering Week.

Please take a few minutes to fill in this form. If you used this activity pack for NSEW, send in this completed form and we will send you a National Science & Engineering Week Certificate.

Organisation: _____

Address: _____

_____

Postcode: _____

Tel: _____

Fax: _____

Email: _____

Which dates did you do National Science & Engineering Week activities on? _____
What did you do?

Please make any comments about this activity pack, National Science & Engineering Week and/or other possible topics for future packs (feel free to continue on a separate sheet of paper).

☐ Tick this box to be added to our mailing list. This will keep you up to date with NSEW, including grants, resources and activities. Your contact details will not be passed onto third parties.

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CREST ★ Investigators is a UK-wide award scheme that enables students to solve scientific problems through practical investigation. The activities focus on thinking about, talking about, and doing science. The activities develop students's scientific enquiry skills in an enjoyable context with links to the National Curriculum where appropriate.

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