The Magical World
Of
Crazy Science
and
Wild Weather
Shows

Teacher Resource Kit

Welcome to the Teacher Resource Kit for
The Magical World of Crazy Science and
Wild Weather.

We hope that you find this kit useful in engaging your students with Science curriculum activities.

Contents

INTERNET USE IN THE CLASSROOM

Teachers are advised to preview any sites used and provide a list of URL's that is tailored to the individual school curriculum.

The Magical World of Crazy Science

Take a beaker full of crazy science, add a test tube of comedy, then a pipette full of magic, and you'll have *The Magical World of Crazy Science!* In a multi-coloured spectacle of giant smoke rings, glowing test tubes, mountains of slime and enormous bubbles, this production offers a fascinating and vibrant peek inside the crazy scientist's lab.

Performer Richard Scholes has an equally impressive cocktail of experience as an artist and scientist, allowing him to produce this unique fusion of theatre, chemistry and physics. No other artist with national awards, including Australian Stage Magician of the Year and twice winner of an Australian 'MO' Award for best variety artist in Australia, can also boast 10 years experience as a scientist at the University of Queensland.

Richard teaches students about chemical reactions, catalysts, water, Bernoulli, bubbles and science safety.

Produced by Richard Scholes

Links

Science, Technology, Drama

Content Covered

- Chemical Reactions
- Polymers
- Bernoulli
- Air Pressure
- Vortexes
- Water
- Weather
- Bubbles
- Optical Illusions

Performance Structure

- Scientific experiments
- Magic
- Comedy
- Mime
- Puppetry

About the Crazy Science Show

Art Form	Creative Demonstration
Role of Performer	Presenter/Scientist
Audience Participation	Volunteers
Target Year Levels	P - 9
Script based around…	Science experiments/key concepts
Script Structure	Linked Scenes
Cast/crew	1 Presenter and 1 Assistant
Sound	Music and Sound Effects

Australian Curriculum Connections – Crazy Science

Foundation to Year 2

Module:	**Science and Understanding**	**Science as a Human Endeavor**	**Science Inquiry Skills**
Introduction		People use science in their daily lives (ACSHE022)	
Weather/Water	Living things live in different places where their needs are met (ACSSU211) Observable changes occur in the sky and landscape (ACSSU019) Earth's resources, including water, are used in a variety of ways (ACSSU032)	Science involves asking questions about, and describing changes in, objects and events (ACSHE021)	Questioning and predicting Processing information Communicating
Chemistry: Including chemical reactions, polymers, bubbles	Everyday materials can be physically changed in a variety of ways (ACSSU018) Different materials can be combined, including mixing, for a particular purpose (ACSSU031)	Science involves asking questions about, and describing changes in, objects and events (ACSHE021)	Questioning and predicting Processing information Communicating
Physics: Including sound, light, Bernoulli, air pressure, vortex and optical illusions	Light and sound are produced by a range of sources and can be sensed (ACSSU020) A push or a pull affects how an object moves or changes shape (ACSSU033)	Science involves asking questions about, and describing changes in, objects and events (ACSHE021)	Questioning and predicting Processing information Communicating

Years 3 to 6

Module	Science and Understanding	Science as a Human Endeavor	Science Inquiry Skills
Intro/Conclusion		Science involves making predictions and describing patterns and relationships (ACSHE050) Science knowledge helps people to understand the effect of their actions (ACSHE051)	Questioning and predicting Processing information Communicating
Weather/Water	Earth's rotation on its axis causes regular changes, including night and day A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046) Living things, including plants and animals, depend on each other and the environment to survive (ACSSU073) Earths surface changes over time as a result of natural processes and human activity (ACSSU075) Living things have structural features and adaptations that help them to survive in their environment (ACSSU043) The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094) Energy from a variety of sources can be used to generate electricity (ACSSU219)	Science knowledge helps people to understand the effect of their actions (ACSHE051) Science involves testing predictions (ACSHE098)	Questioning and predicting Processing information Communicating

Chemistry: Including chemical reactions, polymers, bubbles	Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077) Changes to materials can be reversible, such as melting, freezing, evaporating: or irreversible such as burning and rusting (ACSSU095) A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046)	Science involves testing predictions (ACSHE098) Important contributions to the advancement of science have been made by people from a range of cultures (ACSHE098)	Questioning and predicting Processing information Communicating
Physics: Including sound, light, Bernoulli, air pressure, vortex, electricity and optical illusions	Energy from a variety of sources can be used to generate electricity (ACSSU219) Changes to materials can be reversible, such as melting, freezing, evaporating: or irreversible such as burning and rusting (ACSSU095)	Science involves testing predictions (ACSHE098) Important contributions to the advancement of science have been made by people from a range of cultures (ACSHE098)	Questioning and predicting Processing information Communicating

Years 7 – 9

Module	**Science and Understanding**	**Science as a Human Endeavor**	**Science Inquiry Skills**
Intro/ Conclusion		Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world (ACSHE119) People use understanding from across the disciplines of science in their occupations (ACSHE224) Science knowledge can develop through collaboration and connecting ideas across the disciplines of science (ACSHE223)	
Weather/Water	Water is an important resource that cycles through the environment (ACSSU222) Some of Earths resources are renewable, but others are non-renewable (ACSSU116) Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and moon (ACSSU115)	Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120)	Questioning/predicting Processing information Communicating
Chemistry	Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113)	Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world (ACSHE119)	Questioning/predicting Processing information Communicating
Physics: Including sound, light, Bernoulli, air pressure, vortex, electricity and optical illusion	Change to an object's motion is caused by unbalanced forces acting on the object (ACSSU11)	Scientific knowledge changes as new evidence becomes available (ACSHE119)	

Pre-Performance Lesson/s

Aim To introduce key scientific concepts that will be explored in the presentation of *The Magical World of Crazy Science.*

Early Years

Activity	Procedure
Warm Up	**Crazy Scientist's Invisible Box** Students sit in a circle Teacher pretends to pull out of an invisible box an invention/machine and mime its use. Students try to guess what it is. Teacher tells about the science/history of the machine. E.g. Teacher mimes a phone. • Invented by Alexander Bell and Thomas Watson • Bell's patent for the phone was on Jan 30th 1877 Dr. Martin Cooper, who worked for Motorola, in 1973, demonstrated the first mobile phone. The handset weighed 1kg. Teacher then asks students what did people do when telephones didn't exist e.g. letters, telegrams, carrier pigeons etc. The invisible box is then passed on to students who mime a machine/invention. Homework: Whatever invention students pull out, they have to research who invented it, when and what people did when these inventions didn't exist.

	What is a Scientist?
	Students think of a definition.
Think/Pair/Share	Students work with a partner.
	Partners share responses with the class.
	Teacher's response: A person who is studying or has expert knowledge of one or more of the natural or physical sciences.
	The word 'science' comes from the Latin "scientia" meaning knowledge.

Science is Everywhere	**Students brainstorm** something that they have used today that is in existence as a result of science

Exploring a Science Concept	Teacher to choose one of the concepts from the following pages, discuss and then do one of the corresponding…
Experiment	…experiments from the topics that will be covered in the presentation.

Summary	**Recap** basic principles of the concept explored. Remind students about good audience etiquette for the presentation

Post-Performance Lesson

Aim For students to think about the scientific concepts explored in the presentation of ***The Magical World of Crazy Science.***

I Liked… I Learnt…	General discussion about the performance. Students share their ideas about what they enjoyed about the performance, what part interested them most and what they learnt. Teacher can write down responses for later reference.
Experiment	Teacher to discuss what areas of science would the students be most interested in performing experiments. Teacher can organize the students to perform group experiments from the following pages or the teacher can perform the experiment in front of the class as a demonstration. Students are to right up the experiment in a proper scientific manner

How to write up a Science Experiment

A science experiment is written up using the following words:

Aim, Equipment, Procedure, Safety/Risks, Results, Discussion, Conclusion

Depending on what type of experiment you performed, tables, diagrams and graphs can be drawn up, photos can be included etc.

What do all those words all mean?

Aim: What did the experiment want to test or prove?
OR
What do you want to learn or discover?

Equipment: List the equipment you need to conduct the experiment. Draw a labeled diagram clearly showing what the equipment is and how it is used.

Procedure: List the steps needed to conduct the experiment.

Safety/Risks: What danger could there be in doing this experiment? Consider electric shock, burns, and dangerous chemicals etc.

Results: Write up results or draw up a TABLE to record results, if numerical data is obtained. Results may include written observations in a list or table, sketches, diagrams, photos, etc.

Discussion: How did they/you ensure that the measuring was accurate? What mistakes were made? How could this improve? What did you observe? Is the result what you expected? Compare to published information. Were there any hazards (dangerous things/situations)?

Conclusion: Did the experiment prove what you had as your aim? Say that you have done so in a clear, logical statement. Make an assessment of your experiment

Students Create Their Own Crazy Science Presentation

Method 1	Students are given time to research a simple and safe science experiment from the library/internet etc. They have to gather all equipment necessary and test out their experiment before showing it to the class. Teacher can decide if students work alone, pairs, groups etc. The Crazy Scientists will say what their experiment is about and the class has say what they think will happen. Class to discuss what happened and why.

Method 2

Students are to create a performance style Crazy Science presentation.

Teacher to distribute **Task Sheet** to students.

Read and discuss

Students make a list of the props and costumes they will need for their presentations.

Teacher to help groups with presentations, experiments, etc.

Students can take their experiments from the ones in this resource kit or from the library/internet etc.

Crazy Science Presentation Task Sheet

Now that you have seen *The Magical World of Crazy Science* you can create your own presentation for your classmates.

Your teacher may guide you through steps 1 to 4 by making selections for you.

Performance length 3 – 5 minutes per group.

Steps to Follow

1. Form performance **groups** of 3-4 presenters
2. Select a science **topic** for your presentation
3. Decide on the **experiment** that you will perform
4. **Divide** up the experiment assigning steps amongst the presenters
5. Devise an exciting **introduction**
6. Write a **definition** of the scientific concept that you will be presenting
7. Decide on a **name** for your presentation
8. Write a **script** for your group's presentation.
9. **HINT**: Sometimes it is easier to have one person demonstrating the experiment and one explaining, another in charge of materials etc.
10. **Rehearse** your scene without using the 'props'.
11. Do a dress rehearsal with your **props. Be careful about making a mess!**
12. **Present** your performance piece to your class, a younger grade or your parents.

Performance Suggestions

Crazy Science uses a variety of ways to engage and hold the audiences interest.

- Magic
- Mime
- Comedy
- Vocal expression
- Bright costumes and props
- Audience participation
- Puppetry

Also consider the performance skills of the people in your group.

Can they…

- Sing?
- Dance?
- Tell jokes?
- Do gymnastics?
- Play an instrument?

Can you dress up as a crazy scientist?

- Crazy glasses?
- Crazy hair?
- Crazy lab coat?

Learn a Science Magic Trick!

Aim Students are to learn a simple science magic trick and perform it for the class

Science magic tricks look like "magic," an effect with a secret. But with science magic tricks, the secret is a scientific principle or concept - from either chemistry or physics - that looks like a "magic" trick. You can perform science magic tricks as straight-out tricks or use them as opportunities to demonstrate or teach a scientific concept of physics or chemistry. Here are a couple of examples of science magic tricks that your students can learn and perform. In this collection of tricks, magic is science and science is magic!

- Mobius strips:
  Make loops out of newspaper strips and cut them down the center - effectively splitting them - with varying results: 1) two separate rings, 2) one long ring and 3) two interlinked rings. This science magic trick is based on a field known as "topology" and employs a well-known concept called the "Mobius strip."

- Floating Paper Clip:
  The secret involves the water's surface tension, the tendency for water molecules on the surface to be attracted to each other. This is the reason why when a glass of water is filled to the brim and small objects are added, you can see the water bowing up over the glass. And it's also the reason why small insects and such can rest on the surface of still water.
  The trick involves not breaking the water's surface tension when resting an object, in this case, a metal paper clip, on the water's surface. If you have trouble try using a fork instead of your fingers.

- Card Magic:
  Lots of card tricks use mathematics to work and a lot of card magic tricks are self-working!

There are thousands of tricks to check out in books and online and in your libraries.

There is a lot of science behind every magic trick whether its chemistry, physics, mathematics or psychology.

Learning a magic trick helps with coordination, acting and learning new skills.

Magic is a hobby that can last a lifetime or even a career in show business!

Chemical Reactions

What is a chemical reaction?

When substances are combined and something new is formed.

When substances are combined and changed into one or more new substances.

Many chemical reactions cannot be undone or reversed e.g. you cannot unmake a cake, or turn toast back into bread. Decomposing and burning are non-reversible.

In every chemical reaction there are participants known as reactants, which, by chemically reacting with one another, result in the creation of a product or products.

More difficult…

In a chemical reaction, the molecules of one substance break apart and join together with those of another substance to create a different compound (combination of molecules).

When the iron and magnesium in a firework burn, they react with oxygen and produce ash and smoke. They also release spectacular heat, light, and noise. Chemical changes produce new materials. They also usually give out or take in energy such as heat or light because chemical bonds have been broken and made.

When iron rusts, it reacts with oxygen in water or in air to create a new compound called iron oxide (rust). As in every chemical reaction, no mass is lost or gained. The same atoms from the original material are in the new materials, but in different places. If you weighed the iron oxide in this rusting ship, it would weigh the same as the original iron and oxygen.

PHYSICAL CHANGE

A melting ice is an example of a physical change, not a chemical change. The liquid ice is not a new material, just a different form of the old one. Physical changes do not create new substances and no chemical bonds are broken or made. Melting, freezing, tearing, bending, and crushing are all physical changes that alter a substance's appearance but not its chemical properties.

Chemical Reaction Experiments

Self-inflating Balloons and Popping Bags

Materials

- Small bottle
- Vinegar
- Bicarbonate of Soda (baking soda)
- Balloons
- Zip lock bags

Procedure 1

1. Pour some vinegar (20mls) into a small bottle.
2. Pour some baking soda into a balloon (2 teaspoons).
3. Stretch the mouth of the balloon over the mouth of the bottle.
4. Lift up the balloon and empty the contents into the small bottle and watch.

Procedure 2

Same experiment but using a zip-lock plastic bag instead of a balloon.

Use at least 2 students per bag

Careful, it can get messy!

1. Add 1 cup of vinegar to the bag.
2. Put a large scoop of baking soda onto a sheet of toilet paper and wrap it up.
3. Drop it into the vinegar and zip lock the bag.
4. Shake. 5. Observe.

Extensions:

6. Experiment with different quantities of vinegar and baking soda
7. Measure the different diameters or circumferences of the inflated balloons
8. Time the inflations as compared to quantity of ingredients used.

What's the Science?

This is the classic reaction between vinegar and baking soda that produces the gas carbon dioxide (those are the bubbles) and water.

Vinegar is acetic acid: CH_3COOH, Baking soda is sodium bicarbonate: $NaHCO_3$

Mixing the two is simply an acid + base reaction.

$CH_3COOH + NaHCO_3$---> $CH_3COONa + H_2O + CO_2$

The CO_2 is what you see foaming and bubbling in this reaction.

Harder…

There are actually 2 reactions, which occur giving the same result:

$CH_3COOH + NaHCO_3$ ---> $CH_3COONa + H_2CO_3$

That last product is carbonic acid, which quickly decomposes into carbon dioxide and water:

H_2CO_3 ---> $H_2O + CO_2$

Magic Lemon Suds

Materials

- Baking Soda (sodium bicarbonate)
- Lemon cut into quarters
- Plastic see-through cup
- Straw
- Liquid detergent
- Teaspoon

Pre-show

- Measure 1 teaspoon of baking soda into an empty see –through plastic cup
- Add around a teaspoon of liquid detergent to the cup and stir

Demonstration Time

1. Hold the ‘empty’ plastic cup in your left hand being careful not to show the liquid in the bottom of the cup.
2. Announce you are going to show the class some magic lemon suds.
3. Squeeze the lemon into the cup and stir with a straw.
4. Ta-da…lemon soapsuds.
5. Ask how do they think it works, then show how.

How it Works

Once again this is a chemical reaction between baking soda and an acid, in this case lemon juice (citric acid).

The suds are caused by the gas carbon dioxide being formed by the chemical reaction.

Carbon dioxide gas mixes with the detergent to make the suds (foam).

Making a Volcano – Yet Another Acid/Base Reaction

Materials

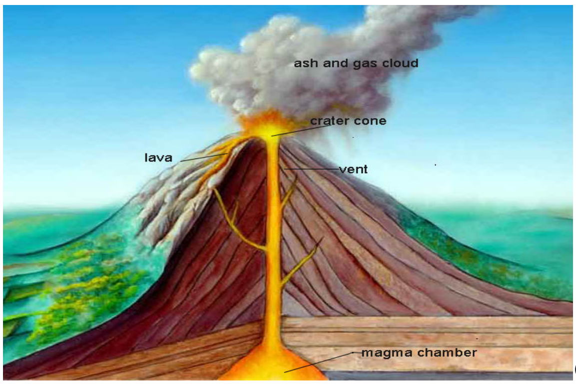
- 6 cups of flour
- 2 cups of salt
- 4 tablespoons of cooking oil
- 2 tablespoons of baking soda
- Warm water
- Plastic bottle (sports drinks have large openings)
- Dishwashing liquid
- Food colouring (red for lava)
- Vinegar
- Tray, baking dish or a pan

What are we doing?

The plastic bottle is the core of the volcano.

The reaction will take place inside the bottle.

The dough will be used to make the outside of the volcano



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Procedure

Things could get messy!

First you build the volcano, then add the ingredients together and observe our volcano spewing re lava down the sides.

1. Make the dough.
2. Mix 6 cups of flour, 2 cups of salt, 4 tablespoons of oil and 2 cups of warm water in a bowl. Work the ingredients with your hands until smooth and firm. You may have to add more water.
3. Stand the soda bottle in the pan. Mould the dough around the bottle making sure you don't cover the opening of the bottle.
4. Fill the bottle ¾ with warm water mixed with a little food colouring.
5. Add a squirt of detergent into the bottle.
6. Add 2 tablespoons of baking soda to the bottle
7. Finally pour vinegar into the bottle and jump back quick!

Harder…

This experiment was another example of a reaction between and acid (vinegar) and a base (baking soda). Such reactions typically form a "salt" and water. In this experiment, because the acid component was acetic acid (vinegar), it allowed production of one of the products ==> sodium acetate. That is the stuff referred to as the "salt."

In the general case of simple acid-base reactions, the term, "salt" refers to the non-water, ionic product.

An acid plus a base gives you salt plus water.

e.g. If hydrochloric acid and sodium hydroxide were the reactants, then NaCl (common salt) would be the non-water product of the reaction

$HCL + NaOH \implies NaCl + H_2O$

The vinegar reaction looks like this:

$C_2H_4O_2 + NaHCO_3 \implies NaC_2H_3O_2 + H_2CO_3$

Acetic acid plus sodium bicarbonate makes sodium acetate plus carbonic acid

The $NaC_2H_3O_2$ is the salt called sodium acetate.

The H_2CO_3 (carbonic acid) then quickly breaks down into water and carbon dioxide:

$H_2CO_3 \implies H_2O + CO_2$

What's the difference between acetic acid and citric acid?

Both of them are acids but they are different like HCl (hydrochloric acid) and H_2SO_4 (sulphuric acid)
Citric acid is present in lemon juice while acetic acid is used to make vinegar or vinegar is diluted acetic acid
Acetic acid, CH_3COOH, also known as ethanoic acid, is an organic acid,

which gives vinegar its sour taste and pungent smell. Pure, water-free acetic acid (glacial acetic acid) is a colourless liquid that absorbs water from the environment (hygroscopy), and freezes at 16.7 °C (62 °F) to a colourless crystalline solid. It is a weak acid, in that it is only partially dissociated acid in aqueous solution.

Acetic acid is one of the simplest carboxylic acids. It is an important chemical reagent and industrial chemical, used in the production of polyethylene terephthalate mainly used in soft drink bottles; cellulose acetate, mainly for photographic film; and polyvinyl acetate for wood glue, as well as synthetic fibres and fabrics. In households, diluted acetic acid is often used in descaling agents. In the food industry acetic acid is used under the food additive code E260 as an acidity regulator.

Citric acid is a weak organic acid, and it is a natural preservative and is also used to add an acidic, or sour, taste to foods and soft drinks
The IUPAC name is 2-hydroxypropane-1,2,3-tricarboxylic acid

Make a cool Lava Lamp

Materials

- Empty large plastic bottle
- Vegetable oil
- Alka Seltzer Tablets
- Water
- Food colouring
- Large torch

Procedure

1. **Add oil, water, and food coloring to the bottle**. Fill the bottle 3/4 of the way full with vegetable oil, then top it off with water and about 10 drops of food coloring (or enough to make the solution appear fairly dark).
2. **Cut an Alka-Seltzer tablet into pieces**. You can either ration the pieces to make your lava lamp last longer or add more than one piece at a time for more interesting effects.

3. **Add pieces of the tablet to the bottle**. This will cause the mixture to bubble. (Repeat every time the bubbling stops.)
4. **Put the cap on and tip the bottle back and forth**. This will cause the tiny droplets of colored water moving around inside the oil to join together, make bigger lava-squirt blobs.
5. **Place a strong flashlight or searchlight under the bottle**. This will illuminate the bubbles for maximum effect.

What's the Science?

This experiment demonstrates some science you already know: that oil and water do not mix. Even if you try to really shake-up the bottle, the oil breaks up into small drops but will not mix with the water *or* the (water-based) food coloring. This will keep the oil distinct from the colored water, giving the lamp a nice effect.

In addition, the Alka-Seltzer tablet reacts with the water to make tiny bubbles of carbon dioxide gas. These bubbles attach themselves to the blobs of colored water and cause them to float to the surface. When the bubbles pop, the color blobs sink back to the bottom of the bottle.

When you pour the water into the bottle with the oil, the water sinks to the bottom and the oil floats to the top. This is the same as when oil from a ship spills in the ocean. The oil floats on top of the water. Oil floats on the surface because water is heavier than oil. Scientists say that the water is denser than the oil.

You can also add decorations like glitter, sequins, or tiny beads!

Lava lamps such as these are a great way to reuse empty plastic bottles and jars . They're also great for science projects.

If you don't have Alka-Seltzer tablets, try denture tablets or Berocca tablets.

Groovy baby!

Polymers

Poly = many

Mer = unit

Introduction:

What is a polymer?

A polymer is a chemical compound formed from long chains of the same molecule group. These chains repeat over and over.

Discuss the definition of polymers with the students:

Plastics are polymers, what kind of examples of them can you think of in everyday life?
What are some of the characteristics of polymers?
What are some examples of things that are not polymers? (brick, glass, metals etc).

Polymer Characteristics:

· Polymers can be flexible, pliable and stretchy.

· When cross-links are formed in a polymer, its chains of molecules are connected in several places, producing a stronger and more elastic polymer.

· The plasticity of some polymers (thermoplastic) is affected by temperature.

· Some polymers occur naturally, as in the juice of rubber or aloe plants, and some are manmade.

· Polymers tend to be dense, strong, and flexible. Some examples are plastic bottles, Styrofoam's, latex paints and chewing gum.

Naturally Occurring Polymers

Polymers in Plants

Plants are made of a polymer called cellulose. This is the tough stuff that wood and stems are made from. Cellulose is also what makes fibers like cotton and hemp that we can twist into threads and weave into clothing. And many plants also make starch. Potatoes, corn, rice, and grains all have a lot of starch. Starch is also a polymer.

Even though starch and cellulose are both made from the same sugar (glucose) they act very differently (because the glucose molecules are joined together differently). Starch will dissolve in water, but cellulose won't. So we make food from starches and we build things and make clothing out of cellulose.

Starch is all twisted up in a tight blob, with lots of branches and ends sticking out all over. Starch is really just a compact way to store a lot of glucose in a small space. Our bodies break the starch down into glucose, which can be used for energy so you can run and jump and play and think.

Plants use cellulose for strength. The cellulose chains are all stretched out, and like to stay tight right next to each other, like raw spaghetti that's all stuck together. That's why cellulose can hold up the tallest trees! And wooden houses too! Cotton is mostly cellulose - those stretched-out chains make great fibres.

The cellulose in vegetables and grains is the fiber in our foods. We can't digest it, but it's good for us because it helps keep our insides clean.

Cellulose and starches are both made from sugars - so they're called polysaccharides (meaning "many sugars").

Polymers are in People too!

Protein is a natural polymer formed from molecules called amino acids.

Another famous polymer is **DNA** - the long molecule in the nuclei of your cells that carries all the genetic information about you.

Hair and fingernails (fur and hooves in animals) are all made from the protein **keratin.**

A special group of proteins that work inside the body are **enzymes**. Each enzyme is a specific little glob of a protein that does a specific job in the body, and does it really fast. Without enzymes, these jobs either just wouldn't happen, or would go way too slowly to make life possible! Some enzymes even make other enzymes. The enzymes all work together to keep everything in your body going, like processing your food into energy.

Synthetic Polymers

Synthetic polymers are everywhere. All types of plastic are polymers, but polymers don’t have to be plastics.

Polymers are used in cars, computers, planes, houses, eyeglasses, paints, bags, boats, kitchen appliances, televisions, carpets, tools, clothing, batteries, hospitals etc.. Millions of kilograms of polymers are produced by countries each year. The elements used to produce these polymers are virtually all made from petroleum, a non-renewable resource.

Crazy Putty Experiment

Materials

- PVA glue
- Borax solution (1 Tablespoon borax to 1 cup water)
- Water
- Food colouring
- 2 containers, one smaller than the other e.g. film canister

Procedure

1. Fill the bottom of the larger container with PVA glue.
2. Add a few squirts of water and stir.
3. Add 2 or 3 drops of food colouring and stir.
4. Add a squirt of borax (possibly a bit more depending on how much PVA glue
5. Stir the mixture up and put it into the smaller container.

By now the mixture should be joining together, acting like putty, Crazy Putty that is!

What's happening?

The PVA glue you use is a type of polymer called polyvinyl acetate (PVA for short), while the borax a chemical called sodium borate. When you combine the two in a water solution, the borax reacts with the glue molecules, joining them together into one giant molecule. This new compound is able to absorb large amounts of water, producing a putty-like substance that you can squish in your hands or even bounce.

Slime is a Polymer!

Materials

To make one golf ball size batch of slime you will need:

- White craft glue, white woodworking glue, Elmer's glue
- 2 disposable cups
- Food colouring – what colour do you want your slime to be?
- Water
- Borax (supermarkets - laundry)
- Plate, dish
- Plastic spoon
- Tablespoon

Procedure

Beforehand mix about a teaspoon of the Borax into a cup of water and stir (it usually doesn't fully dissolve)

Slime Time!

1. Fill the cup with around 10cm of glue
2. Add 20ml of water to the glue and stir
3. Add a few drops of food colouring and stir again
4. Add 2 tablespoons of the Borax solution and stir well
5. Lift out the slime with your spoon and place on a dish
6. Let it sit on the dish for around 30 seconds and then pull it off the spoon and play

How it Works

Sir Isaac Newton wouldn't believe this stuff! According to Newton solids break and liquids flow. Slime can do both!

This **polymer** is unique because it has qualities of both a solid *and* a liquid. It can take the shape of its containers like a liquid does, yet you can pick it up and hold it in your hand like a solid.

Polymer molecules **chain** themselves together (they can stretch and bend like chains) and that makes them special e.g. rubber bands, balloons, chewing gum, sneaker shoes and all types of plastic are polymers.

Amazing Facts About Water

1. The chemical symbol for water is H20

2. Each molecule of water is made from two atoms of hydrogen combined with one atom of oxygen.

3. Your brain is made up of approximately 70% water and your bones are around 1/3 water

4. The water you drink has been circling around in the water cycle for millions of years – that means the same water exists now as when dinosaurs were on Earth! In fact some of the molecules of water that you drink could have been dinosaur wee!

5. Clouds are made from millions of tiny droplets of water, each droplet being so small and light that it can float in the air, being lifted by warm air currents rising from the ground.

6. The oceans hold 97% of the world's water while 2% of it is frozen in the polar ice caps. This leaves only 1% of the world's drinking water available in all the streams, rivers, reservoirs, lakes, aquifers, and our atmosphere.

7. When water warms up it turns into a gas called water vapour.

8. Water is one of the only substances that actually get bigger as it gets colder. As water freezes and turns into ice it increases in volume. This is why frozen water in the pipe work in your home can burst your pipes

9. It is essential that you drink enough water during each day as it has many important jobs to do.

Some examples include:

a) It helps to regulate body temperature
b) It helps the body to ensure that food's carried to the organs where it's needed.
c) It helps the body to get rid of excess salt so it doesn't build up in the body and cause health problems
d) It helps the body to transport waste and also to get rid of waste from the body
e) It is the main constitute of blood and so helps the body to transport oxygen from the lungs to the organs
f) It helps the body to remove carbon dioxide by transporting it from the organs back to the lungs so it can be breathed out
g) It helps the body to digest food

10. Around 70% of your body is water!
11. Plants use water in photosynthesis 12. Water is the only naturally occurring substance on Earth to exist in 3 states of matter i.e. solid, liquid and gas.

The Magic of Salt and Water

Ever wondered why people pour salt on icy footpaths and roads to make the snow melt? Why do lakes and streams freeze over solid while the ocean remains flowing? Is there something magical about salt? Are there other uses for salt other than flavouring our food and raising our blood pressure?

Experiment 1

Materials

- 2 cups
- Water
- Tablespoon
- Salt
- Freezer

Procedure

1. Take 2 cups and fill with water
2. Place about a tablespoon of salt in one of the cups and label it
3. Place both cups into the freezer
4. Check on each cup every 10 – 15 minutes
5. Can you guess which one will freeze first

Experiment 2

Materials

- Ice cubes
- Plates
- Salt

Procedure

1. Take some ice cubes out of the freezer
2. Place ice cubes on 2 different plates
3. Sprinkle salt on ice cubes on one of the plates
4. Observe what happens
5. Can you understand why people put salt on their icy driveways?

The reason that the application of salt causes ice to melt is that a solution of water and dissolved salt has a lower freezing point than pure water. When added to ice, salt first dissolves in the film of liquid water that is always present on the surface, thereby lowering its freezing point below the ice's temperature. Ice in contact with salty water therefore melts, creating more liquid water, which dissolves more salt, thereby causing more ice to melt, and so on. The higher the concentration of dissolved salt, the lower its overall freezing point.

What's a Vortex?

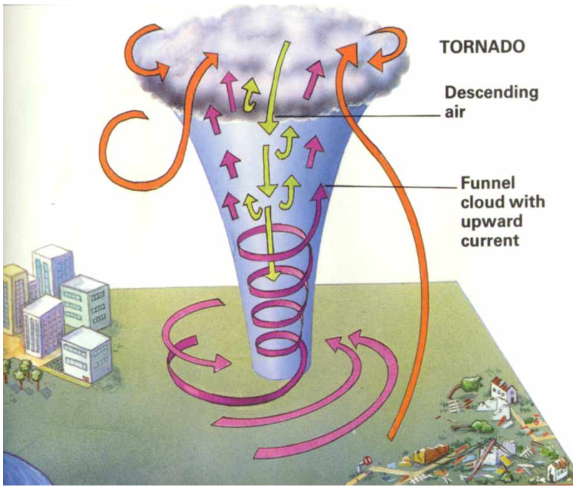
A vortex is the name given to matter that is whirling around a specific center. In nature, a vortex is a type of phenomenon such a tornado, cyclone or whirlpool.

A vortex in physics is an occurrence where matter whirls in a spiral pattern. The matter in a vortex usually has to have a specific level of cohesion and flexibility for this to occur, such as that associated with liquids and gases.

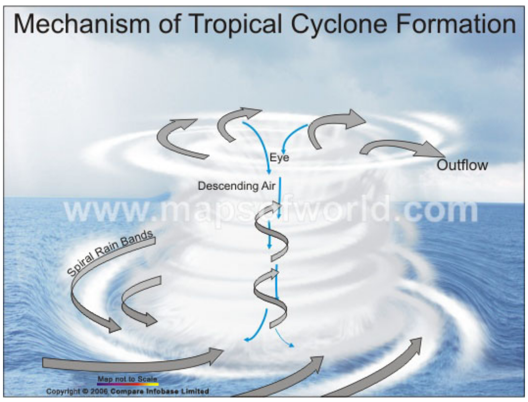
The pressure at the core of the vortex is the least, the outer edges the most (Bernoulli's Principle). A line called the vortex line can be drawn down the center of this area.

Vortices, often occur in nature. Dust devils, water spouts, tornadoes, hurricanes or cyclones are all examples of vortices. They are caused by air or water flow, and are visible due to either the water vapor or solid matter that is sucked into them. Vortices that occur in water are called whirlpools. Whirlpools are rare in nature, but usually occur due to either rough water or the creation of lower pressure areas in the water.

Tornado:



Cyclone:



Vortex Experiment

If you have seen *The Magical World of Crazy Science* then you know how much fun a vortex can be.

Let's try and make one and see…

Materials

- Clean 250 ml yoghurt container (larger containers to make a bigger vortex)
- Scissors
- Adult supervision!
- 30 cm Balloon
- Rubber band
- Candle
- Lighter (caution)

Procedure

1. Cut a small hole in the bottom of the yogurt container. The hole should be approximately 1cm in diameter.
2. Cut the mouth off the balloon and stretch it across the top opening of the yogurt container. Secure the balloon to the mouth of the container with the rubber band.
3. Practice shooting air from the container by tapping on the balloon, or pulling back on the rubber balloon and letting go.
4. Light the candle.
5. Start close, aim your 'canon' and see if you can extinguish the candle.
6. How far back can you go?

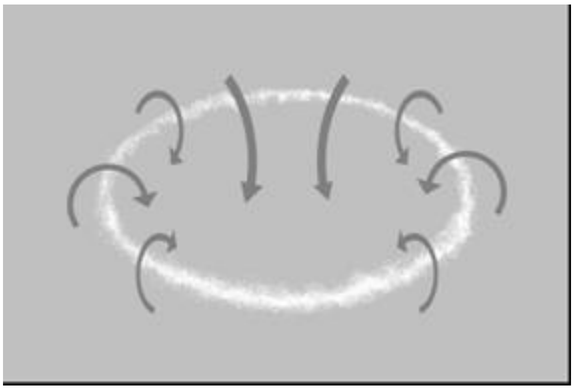
What's the Science?

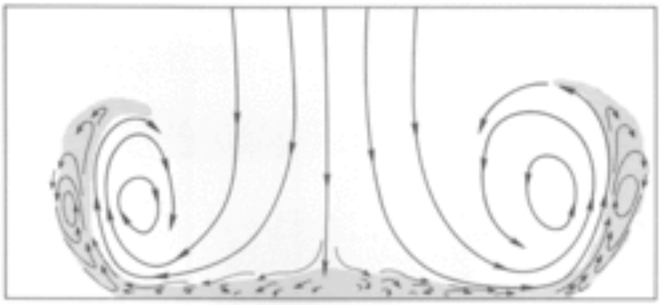
You have made what's called a toroidal vortex. When the membrane thrusts a burst of air out of the hole, it displaces the surrounding air out side. The surrounding air swirls around in the shape of a twisting doughnut.

The physics of moving air is called fluid dynamics. It may seem strange to call air a fluid but motion of gases and liquids are very similar. When a fluid twists or swirls, we call vortex. Again, note the advantage of using the fancy word vortex over the word swirl. Swirl is used when talking about the physics of ice cream.

Can you think of where you might observe a vortex at home? Look in the Bathtub, sink or toilet.

Now, our cannon generates very special vortices that differ from those found in the bathroom. They twist in the shape of a doughnut and the mathematical name for this is called a toroid. Hence our cannon generates toroidal vortices. Vortices are amazing phenomena because the motion of the air is stable and doesn't require any outside intervention to keep it going. For instance, try blowing a burst of air with your mouth. This is an unstable burst of air that disperses by the time it reaches an arms length. A toroidal vortex on the other hand, will travel all the way across the room.





Cooly Bernoulli

Daniel Bernoulli (1700 – July 27, 1782) was a Swiss mathematician who spent much of his life in Basel, Switzerland where he died. A member of a talented family of mathematicians, physicists and philosophers, he is particularly remembered for his applications of mathematics to mechanics, especially fluid mechanics and for his pioneering work in probability and statistics,

Bernoulli's Theorem, also known as Bernoulli's Principle, states that an increase in the speed of moving air is accompanied by a decrease in the air's pressure.

There are lots of cool experiments to show off Bernoulli's Principle.

Ping-pong and a Funnel

Aim

To try and blow a ping-pong ball out of a funnel

Materials

- Plastic water or soda bottle
- Ping pong ball
- scissors

Procedure

Step 1

Make a funnel – Prepare the plastic soda or water bottle for the experiment. Use your scissors to cut off the top portion of the plastic bottle. You will want to use the spout or mouthpiece of the bottle plus about two inches of the bottle. Discard the bottom portion of the bottle.

Step 2

Place the ping-pong ball in the plastic bottle and blow upward through the bottle's mouthpiece. You will note that you cannot blow the ball out of the plastic bottle due to Bernoulli's Theorem. In fact, you will note that the harder you blow on the plastic ball, the tighter the ball stays in the plastic bottle!

Step 3

Talk to the audience about airflow around a curved surface such as a ping-pong ball. When a ball or other curved object is placed in an air stream (such as in Step 2), the air will increase its speed as it moves around the outside of the ball. This happens because the air has to travel a further distance to get around the ball and meet back up on the other side of the ball.

Step 4

Mention the connection between air speed and air pressure that is at the centre of Bernoulli's Theorem. When the air increases its speed as it moves around the ball, the air pressure around the ball also drops. In the places where the air moves the fastest, the air pressure is also the lowest.

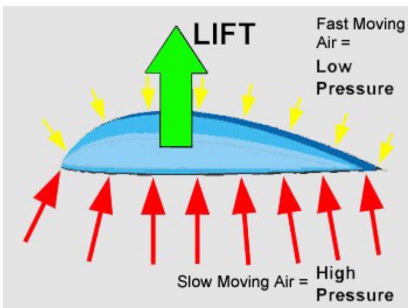
Step 5

Explain that the low air pressure around the ball causes the higher pressure in the atmosphere to push the ball into the plastic bottle. When you or a student blows hard on the ball, you increase the speed of air around the ball. This also causes the air pressure to decrease, which causes the higher pressure in the atmosphere to push the ball even further down into the plastic bottle.

Explain that this is why aeroplane wings are curved at the top so that air travels faster across the top of the wing than underneath the wing thus lowering the air pressure on top and causing greater air pressure underneath the wing to push upwards on the wing thus lifting up the aeroplane.

Please note that this is **only one** of the reasons planes can fly!

Can you blow hard enough so when you invert the funnel, the ball stays inside?



Air Pressure

What is Air Pressure?

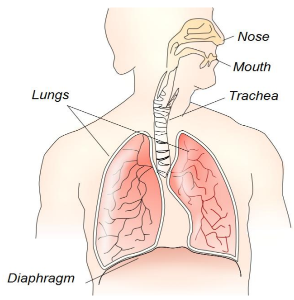
There's air surrounding us everywhere, all at the same pressure of 100,00 Newton's per square meter or 14.7 psi (pounds per square inch). It's the same force whether you're on the ceiling or on the floor, under the bed or in the shower.

Did you know that air is pushing against you all the time? You cannot feel air pushing in on you because your body pushes outwards with the same force as the air (lucky for us otherwise we would be crushed to death by air pressure!)

In outer space there is no air, so astronauts have to wear special pressurized space suits that push against their bodies with the same force as the air here on Earth.

Air pressure is created by the weight of the earth's atmosphere. Although we can't see air, air has weight. The gas molecules making up the air have mass, and gravity acts upon them. Air pressure changes due to the heating and cooling of the Earth's surface. When air gets warm, it expands, becoming less dense, and therefore pushes with less pressure. We can measure changes in atmospheric pressure with a machine called a barometer.

We use air pressure all the time when we breathe. When our diaphragm moves down, air is pushed into our lungs from the outside, expanding the volume of the chest cavity. The diaphragm doesn't "pull" air in; it expands the volume of our lungs, and the air pressure fills the volume.



When you change a pocket of air pressure – things start to move. The difference in pressure causes movement is what creates winds, tornadoes and aeroplanes to fly!

Air Pressure Science Tricks

The Moving Cans Trick

Aim

Two empty soft drink cans are placed upright, separated by a short space, onto a bed of drinking straws placed side by side on a flat surface.

If air is blown between the two cans, what will happen to the cans?

Materials

- 10 – 15 plastic drinking straws
- 2 empty aluminium drink cans

Procedure

1. Lay about 10 – 15 straws about 1 – 2 cm apart on a smooth tabletop.
2. Place two empty cans upright on the bed of straws separated by a couple of centimeters.
3. Strongly blow air between the two cans.
4. Observe what happens.

What's the Science?

This activity demonstrates one aspect of Bernoulli's Principle.

The cans should move together. Moving air has a lower pressure than stationary air. The low pressure causes an imbalance of pressure on the cans: the pressure on the outside of the cans is higher than in between the cans where you are blowing. This causes the higher pressure on the outside of the cans to push toward the area of low pressure, therefore causing the cans to move together.

More Air Pressure Science Tricks

The Newspaper Trick

Aim

Demonstration of how air pushes on things

Materials

- Wooden Ruler
- Large sheet of newspaper

Procedure

1. Place a thin wooden ruler on a flat table with around half of it hanging off the edge.
2. Place a sheet of newspaper over the ruler flat against the table. Note: Have as little air as possible under the paper.
3. Ask your students what will happen if you hit the ruler with a lot of force and why etc.
4. Quickly strike the end of the ruler hanging over the edge
5. The ruler should break near the table edge.

What's the Science?

Air is pushing on everything from all angles with tremendous force. When you lay the newspaper onto the table, air is pushing down on the large surface of the paper with a lot more force than the ruler pushing upwards when you hit it.

Water Glass Magic Trick

Aim

To demonstrate how air pushes on things

Materials

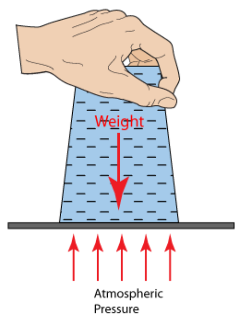
- Glass of water
- Playing card

Procedure

1. Fill a glass three-quarters with water.
2. Cover the mouth of the glass with a playing card making sure that it covers the entire mouth.
3. Place your hand on top of the card, hold and invert the glass.
4. Ask students what they think will happen if you take your hand away.
5. Remove your hand from the glass.
6. Voila! The water does not fall out and the card stays in place.

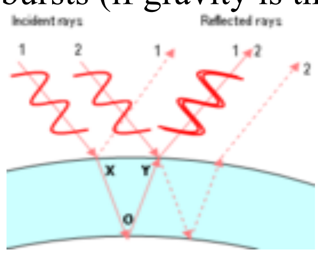
What's the Science?

The card stays in place because air is pushing upwards on the card with greater force than gravity pulling down the water.



Unbubble-lievable!

1. Soap bubbles are hollow balls of soapy water filled with air. A thin wall of soap pulls in as the air inside pushes out.
2. **More difficult…**A soap bubble is a spherical layer of soap film encapsulating air or gas. The film consists of a thin sheet of water sandwiched between two layers of soap molecules. One end of each soap molecule is attracted to water while the other end repels water. The ends of the soap molecules crowd to the surface, trying to avoid the water and they stick out away from the water molecules. As a result, water molecules separate from each other, the increased distance between water molecules causes a decrease in surface tension and bubbles are formed.
3. Similar to the way we perceive the colours in a rainbow or an oil slick, we see the colours in a bubble through the reflection and the refraction of light waves off the inner and outer surfaces of the bubble wall.
4. **More difficult…**When a light wave hits the surface of a bubble, part of the light is reflected back to a viewer's eye from the outer surface and part of the light is reflected from the inner surface that is a few millionths of a centimeter further. As the two waves of light travel back, they interfere with one another causing what we know as colour. When the waves reinforce each other, the colour is more intense. When the wave gets close to cancelling each other out, there is almost no colour. All bubbles are round, regardless of the shape of the bubble maker. They try to pull themselves into the shape which is a sphere.
5. The bubble wall becomes thinner before it pops. Less light is being reflected, so a black band forms on top of the bubble just before it pops. There are many reasons why a bubble pops. Gravity, evaporation of its water content, air turbulence, and, most commonly, dryness-contact with a surface or dry air. When you make bubbles in the sun, they evaporate quickly. When there is a strong wind, or even a gentle breeze, bubbles are much more difficult to create and are popped by the wind's force. If the air is very dry, as it is in the desert, or if a bubble touches a dry finger or a piece of clothing or the ground, it pops instantly.
6. **More difficult…**As a bubble wall gets thinner, either from a weak solution or because gravity has pulled the outside of the bubble downwards (soap and water), the distance between the inner and outer surface of the bubble becomes less and less until the two reflected waves of light start to cancel each other out. The result is a black spot forms on top of the bubble just before it bursts (if gravity is the reason)



7. Bubbles and balloons have a lot in common! Scientists refer to them as 'minimal surface structures'. This means that they always hold the gas inside of them with the least possible geometric surface area i.e. a sphere, not a cube, pyramid shape etc.

Activities with Bubbles

Lung Capacity

To measure your student's lung capacity, have each student take a deep breath and slowly blow threw a straw dipped in bubble solution onto the surface a pan covered in bubble solution. Students should pull the straw up as they blow. The larger the bubble, the stronger their lungs.

The 'Unburstable' Bubble

1. Place some bubble solution into a saucer. Have a bowl of water nearby.
2. Place the end of a drinking straw into the bubble solution and blow a large bubble.
3. Now tell your students you can stick your straw into the bubble without popping it!

Science Secret! While you are talking, dip your straw into the water, without letting your students see.

4. Carefully poke your wet straw into the centre of the bubble. It won't pop!
5. Now ask a volunteer to try the magic. Blow another big bubble, but give your volunteer a dry straw. The bubble will break immediately.

What's the Science?

Bubbles pop particularly easily when they are touched by something dry, because the dry object can take away some of the bubble's surface water! A bubble is less likely to pop if it's touched by something wet than by something dry.

Understanding Surface Tension

Knowing about surface tension is essential to understanding how bubbles work.

Surface Tension Experiment 1

1. Fill a glass almost full of water.
2. Pour water from a second glass into the first until it's filled to the brim.
3. Now carefully add more water until it begins to overflow.
4. Bend down and observe the surface of the water bulge over the rim of the glass. Why?

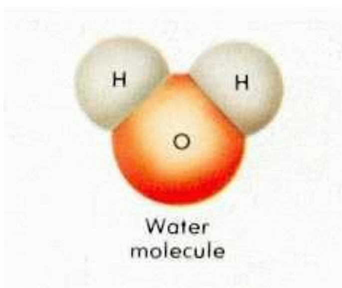
What's the Science?

Water loves itself! Its basic building blocks (H_2O – called molecules) are all attracted to each other. They hold together like a clump of little round magnets.

Beneath the surface, water molecules are completely surrounded by other water molecules. They are pulled in all directions at the same time.

Because the molecules on the surface are attracted only from below, they are pulled down into the glass and prevented from overflowing.

The force at the surface is called '**surface tension'.** Surface tension makes the water seem to have a rubbery skin.



Bubble Activities Continued…

Surface Tension Experiment 2

Materials

- Bubble solution (detergent and water)
- Bulging glass of water from Exp. 1

Procedure

1. Dip your finger into the bubble solution.
2. Lightly touch your finger to the surface of the bulging glass of water.
3. Observe what happens.

Surface Tension Experiment 3

Materials

- Bowl
- Pepper

Procedure

1. Pour some water into a bowl.
2. Sprinkle lots of pepper onto the surface of the water.
3. Dip your finger into the bubble solution.
4. Lightly touch your finger to the middle of the water.
5. Observe what happens.

Surface Tension Experiment 4

Remember the science magic trick described on page .
Do that experiment again but this time, when the paperclip is floating, dip a soapy finger onto the surface of the water.
Observe what happens.

What's the Science?

Why did the cup overflow, the pepper run away and the paperclip sink when you dipped a soapy finger onto the surface of the water?

Soap molecules are surfacants.
A surfacants is a substance that likes to be at the surface of water.

Soap molecules are curious things.
One end of the soap molecule loves water.
The other end hates water and loves dirt and grease!

When you put soap in water the soap molecules arrange themselves so the water- loving ends touch the water and the water-hating ends stick out into the air.
When you touched the surface with your soapy finger the soap spread out over the surface of the water.

With the surface covered, the water molecules were no longer at the surface and the surface tension was reduced.

The surface tension could no longer hold the water above the rim of the glass, or hold up the paper clip.

When you touched your finger to the middle of the bowl with the floating pepper, the surface tension was reduced in the middle but still remained strong on the sides. The water pulled the pepper to the sides before the soap could get there.

The next time you wash your hands, think about how the dirt-loving side of the soap attaches to the dirt on your hands, and lifts it up as water rushes underneath…clean hands!

Surface Tension Experiment 5

Materials

- Wax paper
- Spoon
- Water

Procedure

1. Take a spoonful of water and splash it down onto a piece of waxed paper.
2. Observe that the smaller drops are rounder than the big drops.

What's the Science?

Gravity (the force that keeps you from floating off the Earths surface and pulls you down when you jump up) wants to flatten the larger drops, while surface tension wants to ball the smaller ones up.

The smaller drops are lighter so the surface tension wins. The bigger drops are heavier so gravity wins. A very large drop the size of a lake would be very flat!

Surface Tension Experiment 6

How many drops can you place on a 20¢ coin?

Materials

- 20c piece
- Eyedropper
- Water
- Detergent
- Plate

Procedure

1. Ask the class how many drops do the think will fit onto a 20c piece.
2. Practice with a dropper so that you can easily drop 1 drop at a time.
3. Hold the dropper above the coin (approximately 1cm) and drip 1 drop at a time onto the coin, counting as you go.
4. Note the number of drops just before the water spills over the edge.
5. Dry the coin and repeat the experiment 2 more times.
6. Compare your results and to the results of others in the class.
7. Try the same experiment with soapy water.
8. Try the same experiment with a 10c piece. Is the result exactly half the number of drops compared to a 20c piece. Is it what you expected?
9. Try the same experiment wit a 5c piece. Is it what you expected?

Crazy Science Bubble Making Hints

- Crazy Science tends to use non-scented *Morning Fresh* if *Dawn* or *Joy* is not available
- Bubbles are best on humid days
- Bubbles are best when the wind is gentle
- Bubbles are best in shady areas out of the sun
- Scoop of any froth from your solution before you use it
- Try using corn syrup/Karo syrup as an alternative to glycerin (i.e. cheaper)
- Water quality varies e.g. hard water, soft water etc. Try using distilled water from your supermarket.
- Make sure anything that touches your bubble is wet e.g. bubble maker, straw etc.
- Mix up your recipes a few days before use for best results.
- Stir gently and try not to create suds and foam.

Bubble Solutions

Crazy Science has been experimenting for years with different homemade bubble solutions.

Good store bought bubble solutions can be very expensive, especially if you have a lot of students, so if you can make one up…great!

Crazy Science has noticed that the same solutions sometimes behave differently at different schools even though the conditions **appear** to be exactly the same.

Sometimes Crazy Science adds cheap store bought solutions into our homemade solutions to tweak them up.

Remember, every speck of dust can be a bubble killer i.e. keep everything clean!

Windy days = more dust in the air and can also destroy the surface tension of the bubble.

Sunny days are bad. Why? The sun causes evaporation, which can destroy your bubble.

Basic Bubble Solution

30 mls detergent

500 mls water

15 mls glycerin

Mix ingredients together and age for at least 24 hrs.

Longer Life Bubbles

30 mls detergent

60 mls glycerin

250 mls water

Mix ingredients, age, and store in a container with a tight lid.

Check the web for hundred's of different homemade solutions!

Optical Illusions

What are optical illusions?

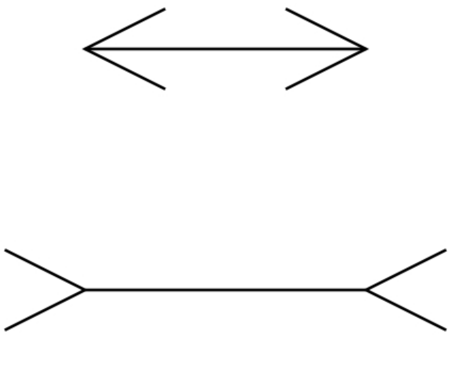
Optical illusions trick us into perceiving something than what actually exists, so what we see does not correspond to physical reality.

There are so many cool optical illusions available in books and on the web. Have fun checking them out!

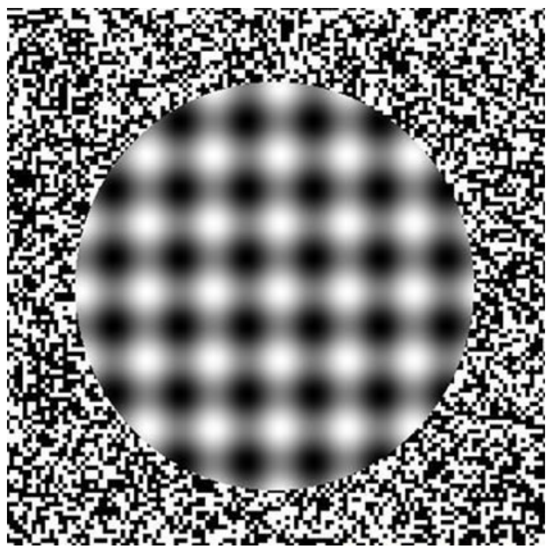
Here are a few to get you started.

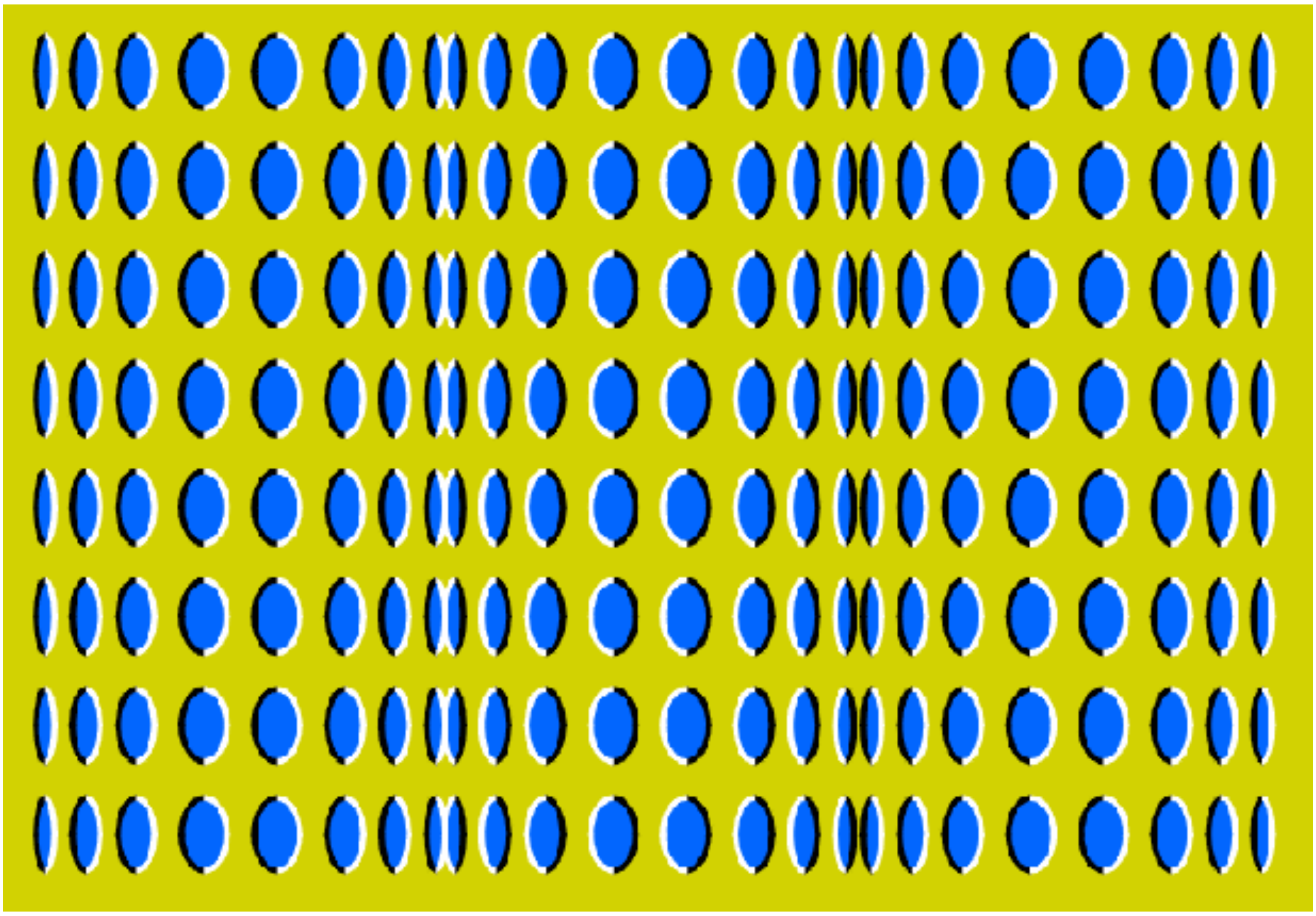
What animals have escaped?

Can you see the old lady? Can you see the young lady?

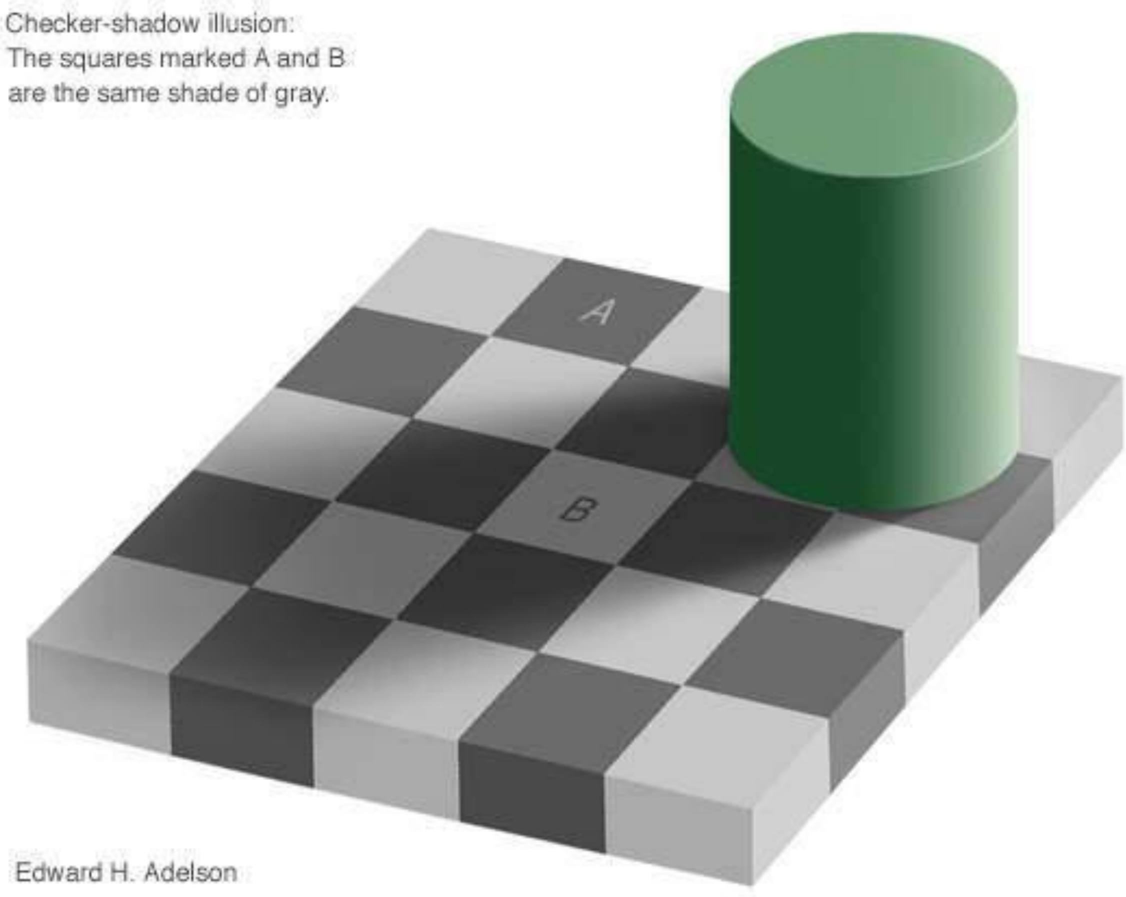


Which line is bigger?





Is there anything moving in this still picture?



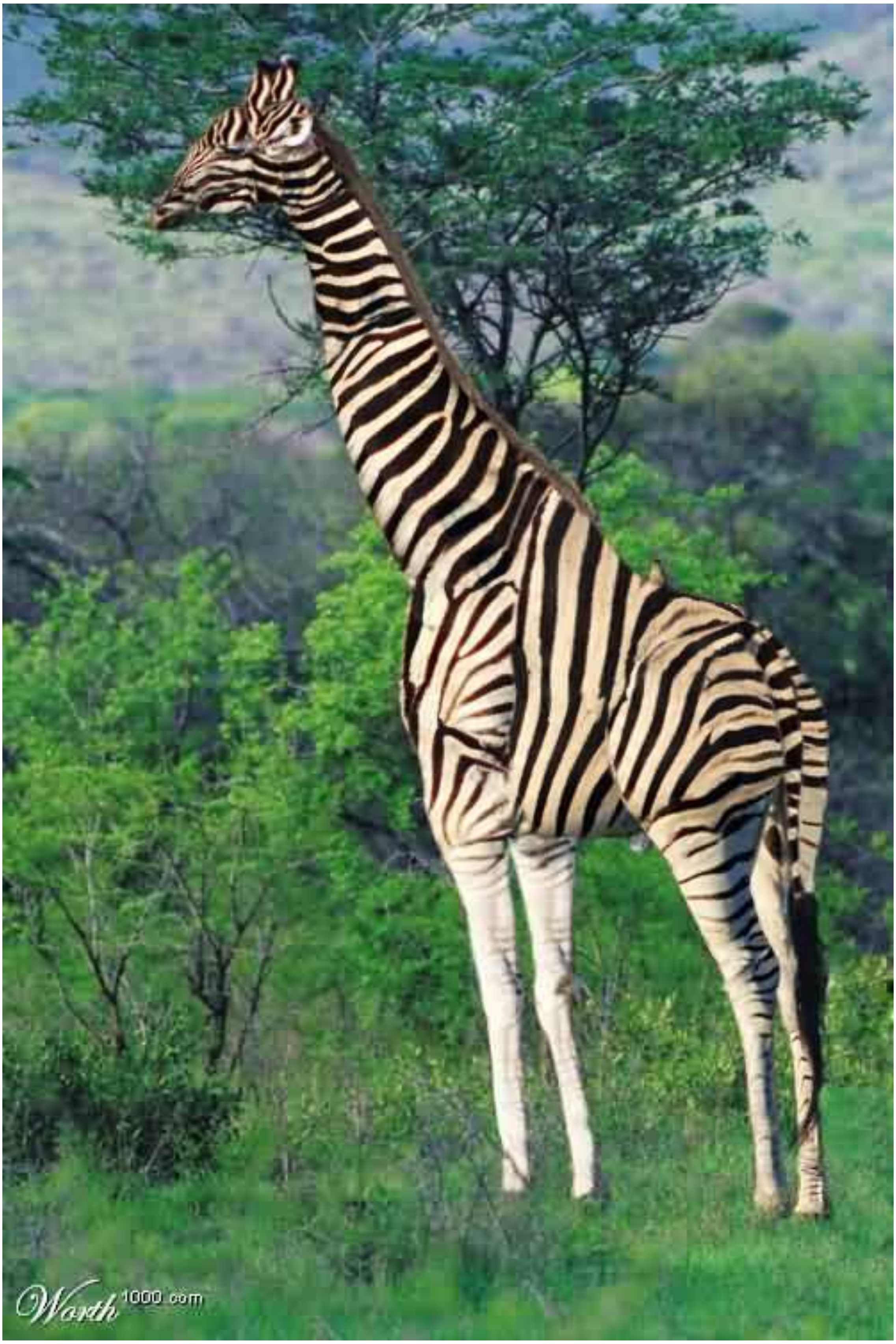
CONCENTRATE ON THE FOUR DOTS IN THE MIDDLE
OF THE PICTURE FOR ABOUT 30 SECONDS.

THEN CLOSE YOUR EYES AND TILT YOUR HEAD BACK.

KEEP THEM CLOSED. . YOU WILL SEE A CIRCLE OF LIGHT,
CONTINUE LOOKING AT THE CIRCLE...

WHAT DO YOU SEE?

Which way is the driver going?



What’s wrong with this picture?