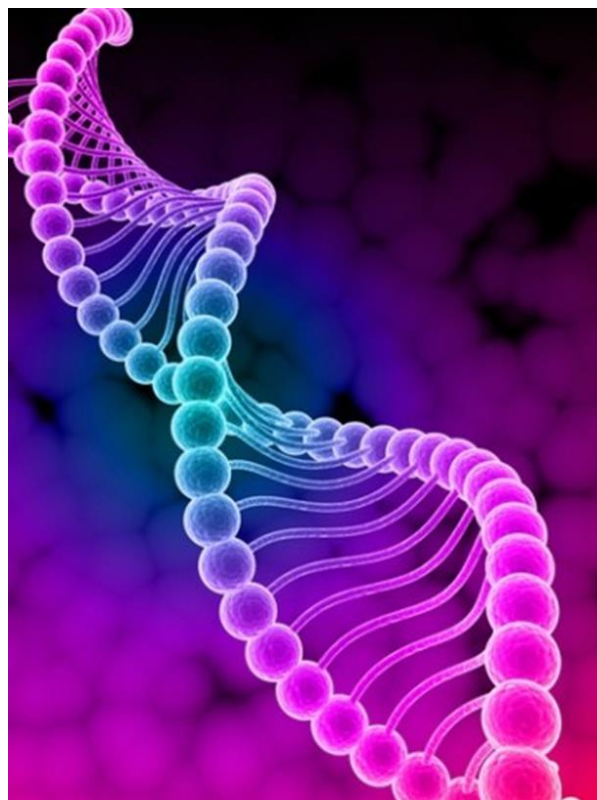


TEACHER'S HANDBOOK

Homemade Heroes



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Supervisor: Dr. Peter E. Childs

This is a teacher's guide to an 8 week transition year project developed under the Teaching Enquiry with Mysteries Incorporated (TEMI) project.

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GENERAL LAB RULES:

- Nobody has permission to enter the lab without supervision of an appropriate teacher.
- No eating/drinking in the lab.
- Bags etc. must be kept tidy under desks at all times.
- PPE (goggles, lab coats, gloves etc.) must be used when carrying out experiments or observing demonstrations.
- Equipment must be cleaned and returned to appropriate storage place after use.
- Carefully follow directions, both written and oral. Do only the steps described in the procedure of the experiment or that are described and/or approved by the teacher. If you are in doubt about any procedure, ask your teacher for help.
- Proceed with caution when in the lab. Do not carry materials around the classroom if at all possible.
- Misbehaviour in the lab will not be tolerated.
- If an accident occurs e.g. glassware is broken, chemical spill etc., notify the teacher immediately
- All students must familiarise themselves with the location of fire exits and eye wash facilities in case of emergency.
- Do not taste, touch, or smell any reagents unless directed to do so by your teacher. When smelling chemicals or gases, use a wafting motion to direct the odour toward your nose.
- Extreme caution should be used when using a Bunsen burner. Keep your head and clothing away from the flame and turn off the burner when it is not in use. Long hair should be tied back to avoid it catching fire. Before leaving the lab, check to see that all gas valves and hot plates are turned off.
- Keep insoluble waste material out of the sink. Dispose of waste material as instructed by your teacher.
- Wash hands thoroughly with soap and water before leaving the lab.

Science Safety Contract

This Transition year course offers a variety of laboratory exercises on current concepts in biology, chemistry and physics often using various methods and equipment involving various safety hazards. Various teaching techniques and materials will be employed to motivate students and enhance their understanding. Numerous laboratory methods will be utilized in demonstrations and student experiments. Safety instruction will be given and safe practices will be stressed in all laboratory work.

STUDENT SAFETY CONTRACT

I, _____, have thoroughly read the Laboratory Safety Rules and agree to follow all safety rules and procedures. I will conduct myself in a safe and cautious manner in the laboratory. I will not perform any unauthorized lab procedure. I understand that misbehaviour in the lab or failure to follow safe lab procedures could cause a serious accident. I further understand that a violation of these rules could result in my not being allowed to participate in future lab exercises.

Student Signature _____ Date: _____

EMERGENCY CONTACT NUMBERS:

Emergency services.....999/112

Doctor..... _____

Hospital..... _____

National Poisons Information Centre Dublin.....01-8092566

Introduction:

“Transition year is an opportunity for students to become familiar with a broad range of science activities. Students should be encouraged to study areas of science not typically encountered.” (Department of Education 1993c, p.27)

This module is based on the Teaching Enquiry with Mysteries incorporated ‘TEMI’ project. ‘TEMI’ is a science education project aimed at post-primary school teachers, funded by the European Commission under the Seventh Framework Programme for Research and Technological Development ‘FP7’ (TEMI 2012). The aim of the TEMI project is to transform science and mathematics teaching by offering support to teachers to introduce enquiry based teaching in to a classroom.

The lessons in this project were developed based on the 5 E’s model of Enquiry: Engage, Explore, Explain, Extend and Evaluate. The opening to each module begins with a discrepant event in that area which will engage the students. Discrepant events are incidents which disobey our understanding of the world by presenting surprising results. These occurrences can be used in science demonstrations to seize the attention of students. When carried out effectively it will encourage students to discuss what will happen before the experiment takes place; allow them to convince themselves they know what will happen before surprising them with a discrepant event. As stated in the Biological Science Curriculum Study report to get a student engaged in a new concept a teacher can use short activities that promote curiosity and elicit prior knowledge.

Department of Education (1993). *Transition Year programmes guidelines 1994 - '95*, Dublin: Department of Education.

Teaching Enquiry with Mystery Incorporated (2012). ‘Background Information’, available: <http://teachingmysteries.eu/about/> [accessed 12 June 2014]

Outline of how the module is ran:

UNITS

Single Class:

Use of Discrepant event to engage the student. Get the students thinking and asking questions.

Double Class:

Build on the event from the previous class. Use of experiment and various hands on techniques.

Optional Single Class:

Expand students' knowledge further with the aim of linking to everyday live.

Tips for Teachers:

- It is important that the teacher carries out the demonstration without giving any background on the topic.
- Make the class interactive by getting the students involved at every opportunity.
- Ask questions throughout the class and get the students make observations as the demonstration is taken place.
- Allow/encourage discussion on the topics this will get students thinking about the topic.
- Support students to attempt an answer.
- Read both students and teacher handbooks to ensure you are prepared for an answer.

Aims of the module:

1. To develop students communication skills.
2. To develop students understanding of the various topics covered.
3. To progress student's skills of investigation, speculation and interpretation of results.
4. To develop students' knowledge from junior certificate science.

Disclaimer:

The authors take no responsibility for accidents or injuries that may occur during activities listed in this module. It is the teacher's responsibility to ensure the safety of the pupils.

The teacher should carry out the experiments, investigations and activities prior to the class, in order to ensure they understand what is happening and they are prepared for whatever eventualities that may occur.

Pupils must be provided with personal protection equipment for all investigations and the safety notes must be read out and enforced.

UNIT 1:



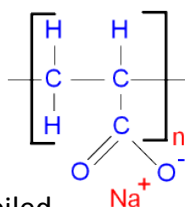
The Disappearing Act

Introduction: The aim of this units is to introduce the students to hydrogels.

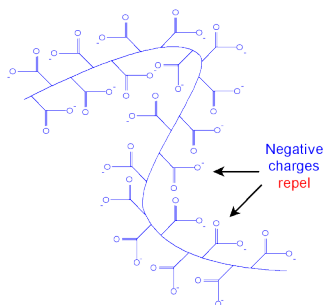
Objectives: Students will be able to explain how hydrogels work and their function.

Students will become competent in experimental procedures ensuring a fair and accurate test.

Teachers Background: In this unit we will look at the varying level of absorbance in nappies and discuss similar materials that are used. Students will all be familiar with nappies and their function but not the material present in them. **Hydrogels** are polymers that can absorb water but also contain hydrophilic groups. Polymers are known as a large molecule made up of chains or rings of linked monomer units. Hydrogel is often polymers containing carboxylic acid groups with the most common being poly sodium propenoate which is shown below.



The polymer chains are normally coiled up. If you take away all the Na particles, the chains uncoil. This is due to the negative charges on the oxide ions along the polymer chain all repelling each other as shown in the picture below. Water molecules are then attracted to the uncoiled chains, and the hydrogel absorbs up to 500 times its own weight of water. One of the main uses of this polymer is in nappies.



Water molecules are attracted to the negative charges by hydrogen bonding. When salt is added to the hydrogel, the chains start to change their shape and water is lost from the gel. Urine does contain salt, and these salts impede the performance of the sodium polyacrylate. Scientists have modified the polymer to counteract the effects of the salts in urine. Hydrogen bonds are what hold the water molecules to the polymer.

Hydrogels are used to make:

- Soft contact lenses
- Nappies
- Wound dressings
- Drug delivery systems

Single Lesson: Hide and Seek

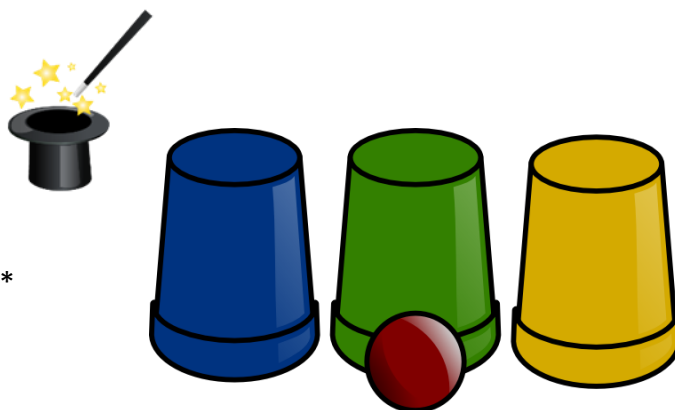
Aim: To introduce the topic of polymers- hydrogels to the students.

Discrepant event:

Engagement:

Materials:

- 3 clear plastic cups
- 3 white polystyrene cups
- Hydrogel from a nappy approx. 1Tbsp*
- Water 100 mL
- Plastic zip lock bag



***To remove the hydrogel:**

- Place a new nappy on the piece of newspaper. Carefully cut through the inside lining and remove all the cotton-like material. Put all the stuffing material and plastic lining into a clean, zipper-lock bag.
- Scoop up any of the powdery material that may have spilled onto the paper and pour it into the bag with the stuffing. Blow a little air into the bag to make it puff up like a pillow and then seal the bag.
- Shake the bag for a few minutes to remove the powdery hydrogel polymer from the stuffing. Notice how much powder falls to the bottom of the bag.
- Carefully remove the stuffing and the plastic lining from the bag and check out the powdery polymer left in the bag. Repeat steps 1-4 with another diaper, if needed, to get 15 mL of the hydrogel powder.
- Now it's time to mix the powder with water to see what happens. Pour 15 mL (1 Tbsp.) of hydrogel powder into a 266 mL plastic cup. Measure 100 mL of water and pour it into the cup along with the powder.
- This should be tested before trialling with students as tap water will also affect the absorbance level due to ions present.

Method:

1 cup contains hydrogel and 2 contain nothing.

1. Use the white cup first so students can't see what is happening.
2. Place 15mL approx. of hydrogel in a cup.
3. This is the cup that the water will be added to. 100mL will be added by the teacher.

4. Teacher will then switch the places of the cup with the other two that will be present (that contain no water and no hydrogel.) numerous times so the students will have to follow the cup.
5. Teacher will then ask students to pick the cup containing water.
6. When the teacher pours over all 3 cups no water comes out.

Exploration:

Get the students to come up with the idea of where the liquid is gone, listen to the ideas put forward.

Repeat the same procedure with the clear plastic cups.

Have a class discussion on the material used:

- Get the students talking about what the material might be?
- What could it contain? Where might something like it be used?
- Show the students a picture of a baby and ask them what the connection is if they have not already guessed. This should make it very clear that nappies are associated to the trick.
- Ask students what other materials do similar things. Example may be cat litter.



Ask them why there is a difference in the two products. ---Cat box fillers made from absorbent clay account for approximately 95% of all cat litter. Clay, a naturally-occurring, non-metallic substance, is composed of a combination of aluminium silicates and minerals. Light-coloured clays are more popular than the darker clays because the latter tends to become muddy when wet and cannot absorb additional moisture. Although most commercial cat box fillers use an absorbent clay as their base, any-thing that can absorb moisture theoretically can be used as cat litter.

Development:

- Ask students to think of a way that this could be measured and write it down in their student handbook.
- Key questions for the teacher are:
 - ✓ What will be kept constant?
 - ✓ How will it be kept fair? E.g. ensure the same amount of each nappy is used, the same amount of water. (Only 1 variable can be used for it to be a fair test)

- What different brands will be used?
*Teacher needs to facilitate students as they come up with a fair test rather than telling them how to carry out.

Explanation:

The material used is that used in nappies. This material is known as a hydrogel polymer. Polymers are long chained monomers (Showing the students an example of this will be more effective than just stating it. Use the analogy of people e.g. 1 person = monomer 5= polymer). The hydrogel attracts water as it holds a slightly negative charge and a hydrogen bond then holds the water to the hydrogel.

A video to show this: <https://www.youtube.com/watch?v=IZTQ97JndIo>

Additional Links:

How Nappies work: <http://imaginationstationtoledo.org/content/2011/03/how-do-diapers-work/>

Video of experiment being carried out: <https://www.youtube.com/watch?v=sqgg7dleVsE>

<https://www.youtube.com/watch?v=dYjNHtF8A1M>



Double Lesson: Test for the best

Expansion:

Aim: To find out how much water various nappies can absorb.

Introduction:

- Follow up on the previous lesson discussing the action of hydrogels, and their uses in everyday life. Ask students if they thought of any more similar materials.
- Students also decided on a method to test nappies of different age groups against each other.
 - ✓ This looks at whether the nappy has more hydrogel present or is it just bigger for example a new-born versus a 3 year olds.
 - ✓ Testing two different brands for absorbency.
 - ✓
- Allow students to develop their ideas in this class. Note that they may also need guidance.

Materials Needed:

- Nappies – 2 brands e.g. pampers and Tesco + 2 different age groups e.g. new born and 3+
- Timer
- Graduated cylinder 100mL
- large beakers
- Ruler
- Scissors
- Pad of sticky notes
- Pen or pencil
- Distilled water 6L



Methods: Guidelines

Testing absorbency of two different brands:

1. Take the first nappy, and measure the central part with a ruler drawing a square 7cm by 7cm, with the pen.
2. Cut it out so that you end up with a 7cm square of that nappy.

3. Take out one of the beakers, and label it with a sticky label that has the name of the nappy that will be used in that beaker
4. Measure 500 ml of water in a graduated cylinder. Pour the 500 ml. of water into the beaker.
5. Place the nappy square in the appropriate beaker.
6. Repeat steps 1-6 for the other nappy.
7. Wait 2 minutes for water to absorb into the nappy.
8. Remove nappy from water but allow it to drip back into the beaker for 15 seconds. Place the nappy piece to the side.
9. Pour the water in the first beaker into the graduated cylinder.
10. Measure the amount of water in the cylinder.
11. Subtract the amount of water that was in the graduated cylinder after the nappy was thrown away (step11) from 500 (The original amount.)
12. Record the amount of water that was absorbed in the nappy.

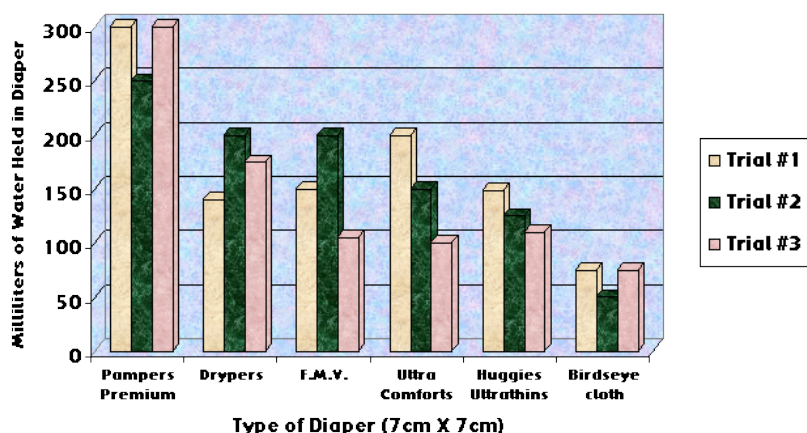
When testing the different age groups:

1. Measure the length and width of both nappies being tested.
2. Weigh both nappies being tested.
3. Once this is completed both nappies will be tested on absorbance levels.
4. Keep adding water to the point of saturation using a graduated cylinder. When the water can drop out of the nappy.
5. Note how much water has been added.

Development:

Students should complete a graph of their choice which will show the results as to how much water each nappy they trialled was able to absorb.

Absorbency of Diapers during Three Trials



This should be completed for homework if not finished within the class.

Development:

- The class should then discuss if the price has anything to with the performance of the nappy.
- The teacher will give the students the various prices paid for the nappies and ask them in their groups to discuss if price has had an impact on the results.
- In the long run which will be more cost effective?
- Is the nappy less effective due to less polymer present?

Follow up ideas:

- If time permits students can also test if the material is reusable by drying the hydrogel out and adding water again. The students can dry their material using an oven and test does it absorb the same amount as it did the first time around.
- Is this effective and could it be something used in the future?
- If this effective how would it effect waste disposal? Nappies are said to make up $\frac{1}{4}$ of the yearly waste is there any more effective way this can prevented?
- Cloth washable nappies why not use them?

Additional Links:

Explanations on nappies:

<http://www.coolscience.org/CoolScience/KidScientists/babydiaper.htm>

Experiment involving nappies and hair gel: <http://www.nuffieldfoundation.org/practical-chemistry/experiments-hydrogels-hair-gel-and-disposable-nappies>

<http://www.chemistryexplained.com/Di-Fa/Disposable-Diapers.html>

<http://chemistry.about.com/od/howthingsworkfaqs/f/diapers.htm>

Optional Single Lesson: how it works.

Introduction:

Teacher can then expand on this by asking students what the link between a nappy and garden centre is.



Answer: the polymers used in nappies are also used in soils to keep them moist Rather than having to water them.

Have a class discussion on whether it is effective.

Development:

The students could do a project exercise on different materials that have the same properties as nappies/ function in the same way.

List of topics that could be given to ensure the same area isn't used more than once.

- Hydrogels used in soil
 - ✓ What is the main hydrogel used?
 - ✓ The importance of them/benefits
 - ✓ Are there drawbacks
 - ✓ How do they work?
 - ✓ Is there a way they can be improved?

- Hair gel
 - ✓ How does it work?
 - ✓ What is the main hydrogel used?
 - ✓ How could you show it consist of a hydrogel? Experiment (add salt)
 - ✓ Uses today and other uses that it may have?
 - ✓ How could you test its effectiveness?
 - ✓ Are all brands the same?

- Contact lenses
 - ✓ Main hydrogel used?

- ✓ What is the importance of these in everyday life?
 - ✓ Survey how many people use them in the class? Year? School? At home?
 - ✓ How do they work?
 - ✓ What could affect the way they work?
-
- Hydrogel importance in medicine
 - ✓ Main uses in medicine
 - ✓ Main hydrogel used in medicine
 - ✓ Other uses that you found
 - ✓ Any uses that shocked you
 - ✓ How does this hydrogel work?
 - ✓ Are there any uses that you can think of that could be looked in to in the future?
 - ✓

This pdf. Is very useful for this area:

http://www.campoly.com/files/6113/7304/9645/GB_Hydrogels_polymers_and_plastics_in_medical_devices_2013.pdf

Conclusion:

- The project can be presented in either a PowerPoint or a poster format. The students should be given the weekend to research and complete the project and should divide the work evenly.
- The students can begin discussing how they will approach the project and divide the work in this class.
- The teacher should ask the students to give them there outline before leaving this class so they have an idea of how it will be undergone.
 - ✓ Ideas they have
 - ✓ How will they divide the work
 - ✓ Will it be in PowerPoint or poster
 - ✓ Do they have any questions regarding the topic they were given

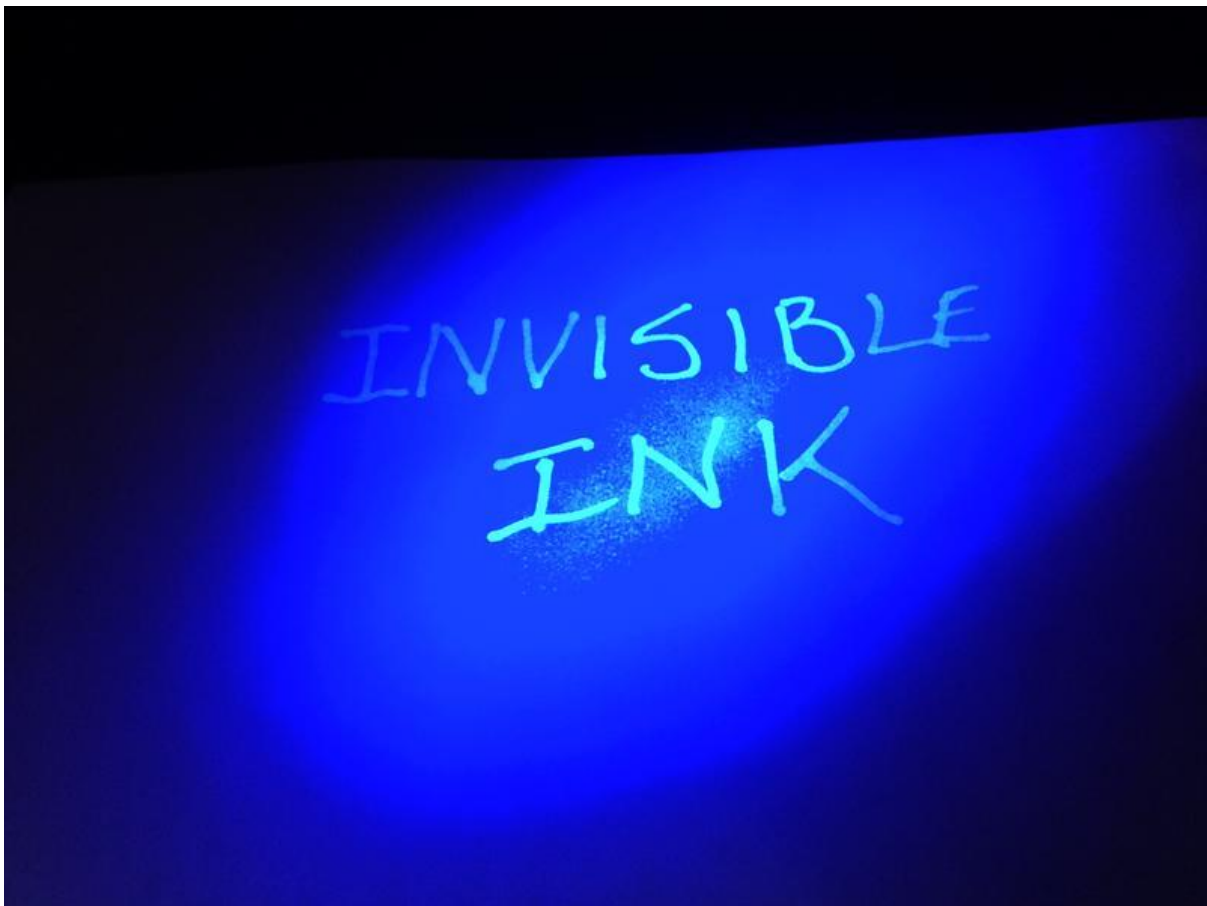
Additional Links:

Polymers in soil:

<http://www.soilmoist.com/products/soil-moist.php>

<http://davesgarden.com/guides/articles/view/1092/#b>

UNIT 2



Now you see it! Now you don't!

Introduction:

This unit focuses on students being able to identify indicators and varying acid/base pHs.

Objectives: Students will be able to

1. Identify and explain how invisible ink works and there uses.
2. Understand and illustrate different invisible inks.
3. Relate invisible inks and there uses to everyday life.



Teacher Background:

The students will have covered acids and bases in junior certificate so they will have a basic background on how indicators work. They also used indicators in other experiments such as the food tests. An indicator is a substance that undergoes a distinct observable change when conditions in its solution change. A variety of indicators change colour at different pH levels. A carefully chosen acid-base indicator can be used to visually "indicate" the approximate pH of a sample. An indicator is usually some weak organic acid or base dye that changes colours at definite pH values.

In this module we will look at hidden messages and the difference of how indicators work with things such as heating, addition of chemicals and other methods. Some invisible inks—like milk, vinegar, or lemon juice, darken when they're heated. You can read messages written with them because they burn faster than the paper they're written on. Other secret inks are solutions of chemicals that are colourless when dry but become visible when treated with another chemical, called a reagent.

You use the ink by writing your message with it using a cotton swab, dampened finger, fountain pen, or toothpick. Let the message dry. If you write a cover message, use a ballpoint pen, pencil, or crayon, since fountain pen ink could run into your invisible ink. Avoid using lined paper to write your invisible message, for the same reason.

How you reveal the message depends on the ink you used. Most invisible inks are made visible by heating the paper. Ironing the paper or holding it over a 100-watt bulb are easy ways to reveal these types of messages. Some messages are developed by spraying or wiping the paper with a second chemical. Other messages are revealed by shining an ultraviolet light on the paper.

Single Lesson 1: Hidden Message

Introduction: Introduce the topic of acid- base and indicators while building on information covered in the junior certificate regarding this area.

Discrepant event:

Engagement:



Materials:

- 0.1M NaOH or dilute ammonia solution
- Phenolphthalein
- Lab coat and goggles/paper
- Acid solution (HCl)

Method:

1. Get a student wearing their PPE up to the front of the class and then on a white lab coat squirt a clear liquid (indicator) phenolphthalein all over the back of it or an alternative would be to write a message.
2. Follow this up by spraying the coat with a colourless base solution (0.1M NaOH or dilute ammonia solution). A pink colour becomes visible where sprayed.
3. When left for a while the message will disappear.
4. Or spray with an acid to do it faster.

Exploration:

- Get the students asking questions on what has happened?
- Once they figure out what caused the hidden message get them questioning why it disappeared after a while. This can be speed up by spraying with an acid.
- Allow students the opportunity to try this activity on a piece of paper with indicator and a base.
- Will this work for any solution?
- Will all indicators respond the same?
- What happens if u spray acid over the solution?
- What are hidden messages

Development:

Students can carry out the reaction in a test tube.

Once they experience the colour change they can blow in with a straw. The carbon dioxide should change the colour back colourless due to being slightly acidic.

Explanation:

- The message was wrote in phenolphthalein solution. When the NaOH or dilute ammonia is sprayed on the coat the indicator changed from colourless to pink. Air contains a small amount of CO₂ which slowly reacts with the alkali to neutralise the solutions which thus removes the pink colour. (This is a slow process.). To clear the solution quicker spray acid on the solution.

Additional Links:

Experiment:

http://www.nce-mstl.ie/_fileupload/Science%20resources/Chemistry%20resources/Class%20Activity-%20Secret%20Writing.pdf

Double lesson: Homemade Hero's

Expansion:

In the previous class we looked at the effectiveness of the indicators in hidden messages. Today we will further the knowledge on hidden messages in the class and test many different sources that can be found in the house and discover how to uncover them. Students will be given different materials that can be used for invisible ink and they will be given time to test these. It is up to the student to decide and discover methods that they think will be suitable.

Uses of hidden messages:

- In the wars
- In letter Writing
- In top secret missions
- CIA
- Love Letters

Ask the students to think of any reasons/ideas of when invisible ink and hidden messages can be used.

Materials:

- Heat source – lamp
- Lemons
- Corn starch – mix it with water
- Iodine – mixed with water
- Vinegar
- Baking Soda
- Cola
- Milk
- Sugar- mix with water
- Red cabbage water
- Copper sulphate
- Numerous sheets of paper – cutting them in half or thirds will reduce waste paper
- Cotton buds/ toothpick/ paint brushes
- Weigh boats to put the materials in



Method:

1. Students should all decide on the first 3 recipes they are going to try out.
2. The students will be in their groups test the first method.
3. Following on with the next two ideas.
4. Students will take note in their work sheet if these recipes work or not.
5. They will then alter and trial 3 new recipes.
6. Students will write down all the methods that got trialed and whether they worked or not.

Sample Results Table:

Recipe	Pass	Fail
Lemon juice, with heating		

Discuss the results the groups in a class discussion.

- Discuss what worked and what didn't.
- Was it fun testing without knowing the results.

Development:

Get students to come up with other things that may be used to write invisible messages:

This can be given as homework- ask them to go home and see can they find anything.

- White crayon and colour over it with a marker
- Banana and a toothpick

Egg, alum and vinegar message:

This requires a teacher to have boiled eggs in the class room with them. The students will then write a message on the egg and test the next day to see if it works or not.

Teacher boils the egg before the class:

Materials:

- 1 hard-cooked egg (see instructions for hard-cooking an egg below)
- Alum (1 tbsp. or 15 mL) (Alum is commonly found at most grocery stores where spices are found.)
- White vinegar (2 cups or 500 mL)
- Fine-tipped paintbrush, toothpick or cotton bud

Method:

1. Dissolve alum 2 tsp in 500 ml vinegar by stirring it with a spoon
2. Dip a fine-tipped brush, toothpick or cotton bud into the solution and write your secret message on the shell of the boiled egg
3. Place your trick egg under high intensity light (200 watts) for 10 mins. This method make the reaction of alum darker on the egg or else leave it under a lamp overnight.

How it works:

The vinegar dissolves the calcium carbonate in the eggshell, allowing the alum to go through (or permeate) the shell and discolour the egg white. The egg white is where the colour change will be seen when the shell is removed.

**** Tell students to bring a felt tip pen to the next class. ****

Additional Links:

Egg Tricks: <http://bizarrelabs.com/egg.htm>

Making Invisible Ink for the teacher:

Heat-Activated Invisible Inks:

Iron the paper, set it on a radiator, place it in an oven (set lower than 450° F), or hold it up to a hot light bulb.

- any acidic fruit juice (e.g., lemon, apple, or orange juice)
- onion juice
- baking soda (sodium bicarbonate)
- vinegar
- dilute cola
- diluted honey
- milk
- soapy water
- sucrose (table sugar) solution
- urine

Inks Developed by Chemical Reactions:

These inks are sneakier, because you have to know how to reveal them. Most of them work using pH indicators, so when in doubt, paint or spray a suspected message with a base (like sodium carbonate solution) or an acid (like lemon juice). Some of these inks will reveal their message when heated (e.g., vinegar).

- phenolphthalein (pH indicator), developed by ammonia fumes or sodium carbonate (or another base)
- vinegar or dilute acetic acid, developed by [red cabbage water](#)
- sodium bicarbonate (baking soda), developed by grape juice
- copper sulphate, developed by sodium iodide, sodium carbonate
- iron sulphate, developed by sodium carbonate, sodium sulphide,
- starch (e.g., corn starch or potato starch), developed by iodine solution
- lemon juice, developed by iodine solution

Inks Developed by Ultraviolet Light (Black Light):

Most of the inks that become visible when you shine a black light on them also would become visible if you heated the paper. Glow-in-the-dark stuff is still cool. Here are some chemicals to try:

- dilute laundry detergent (the bluing agent glows)
- body fluids
- tonic water (quinine glows)
- vitamin B-12 dissolved in vinegar

Single Lesson Optional: Pentastic

Students get their eggs back if time permitted them to carry out activity in the class.

- Each student will pick up an egg and take the shell off.
- They will have 2 minutes to find the owner of the egg.

Development:

Ask students to take out their felt tip pens-

- Discuss the use of invisible pens how do they work?
- Have you owned one when you were younger?
- What did you use it for?

Materials:

- Felt-tipped pen
- Knife
- Scissors
- Marker
- Paper
- Starch
- Water
- Sponge – ½ large sponges
- Light source
- Grape juice



Method:

1. Open up a felt-tipped pen or marker and remove the ink capsule from inside. If your felt tipped pen doesn't open easily, you can use a knife to pry it apart.
2. Soak the pen in water to remove any ink left-over from the tip and the body. Do this several times until the water is clear.
3. Cut a piece of sponge the size of your pen capsule. It doesn't have to be exact, but it should be able to fit inside.
4. Make a mixture of half baking soda and half water and dip the sponge in it. This will be your invisible ink.



5. Put the sponge inside the pen and close the pen up. Write your invisible message on a piece of paper.
 6. Hold the message near a light bulb or other heat source to decode it. It will become yellow or brownish.
- Discuss all information covered in the past week.
 - Allow students ask any questions that they might have.

Additional Links:

Other ideas for a pen: <http://www.instructables.com/id/25-Cent-Invisible-InkPen-UV-light-visible/>

Unit 3



Ice, Ice Baby

Introduction: The aim of this unit is for students to understand cooling mixtures and how this is carried out.

Objectives: students will

- Be able to explain how cooling mixtures occurs.
- Understand salts effect on the freezing point of water.
- Explain the uses of salt in relation to its effect on ice.

Teacher background:

Ice forms when the- temperature of water reaches 0°C. When you add salt, the temperature drops: A 10-percent salt solution freezes at -6°C, and a 20-percent solution freezes at 2 -16°C. If you ever watch salt melting ice, you can see the dissolving process happen -- the ice immediately around the grain of salt melts, and the melting spreads out from that point. When you add salt to water, you introduce dissolved foreign particles into the water. The freezing point of water becomes lower as more particles are added until the point where the salt stops dissolving. For a solution of table salt (sodium chloride, NaCl) in water, this temperature is -21°C under controlled lab conditions. In the real world, on a real sidewalk, sodium chloride can melt ice only down to about -9°C.

You could use other types of salt instead of sodium chloride, but you couldn't substitute sugar for the salt because

- Sugar doesn't dissolve well in cold water and
- Sugar doesn't dissolve into multiple particles, like an ionic material such as salt.

Compounds that break into two pieces upon dissolving, like NaCl breaks into Na⁺ and Cl⁻, are better at lowering the freezing point than substances that don't separate into particles because the added particles disrupt the ability of the water to form crystalline ice. The more particles there are, the greater the disruption and the greater the impact on particle-dependent properties like freezing point depression, boiling point elevation, and osmotic pressure. The salt causes the ice to absorb more energy from the environment (becoming colder), so although it lowers the point at which water will re-freeze into ice, you can't add salt to very cold ice and expect it to freeze your ice cream or de-ice a snowy sidewalk (water has to be present!). This is why NaCl isn't used to de-ice sidewalks in areas that are very cold.

This is known as an endothermic process: this is when the reaction absorbs energy in the form of heat (endergonic processes or reactions absorb energy, not necessarily as heat). Examples of endothermic processes include the melting of ice and the depressurization of a pressurized can. In both processes, heat is absorbed from the environment. You could record the temperature change using a thermometer or by feeling the reaction with your hand. The reaction between citric acid and baking soda is a highly safe example of an endothermic reaction, commonly used as a chemistry demonstration.

Single Lesson: Ice cold class

Engagement:

Discrepant event:

Material:

- Ice
- Salt
- Thermometer
- Beaker



Method:

Just Before the class starts:

1. Place the ice in the beaker 1/3 filled.
2. Pour 3 to 4 tablespoons of salt on top of the ice.
3. Fill the beaker with another 1/3 of ice.

Now ask the students what temperatures will the ice start melting at.

4. Place thermometer in the beaker but don't let it touch the bottom.

The temperature should be lower than 0°C.

Exploration:

Questions to ask the students:

- What is going on?
- What is the thermometer reading?
- At what temperature does ice usually melt?
- Do all liquids have the same freezing/melting point?

Tell students that you have added something to the ice let them think of possible solutions



Show students this photo and ask them what the connection is.

Link to photo:

<http://www.bing.com/images/search?q=salt+on+ice+roads&FORM=HDRSC2#view=detail&id=180D9EA2E6FA01ED50330F69EA29E5381D6EFD2C&selectedIndex=16>

- After seeing this photo ask the students how salt works to stop ice.
- Is a reaction taking place if the temperature is going down?
- How is that possible? What might be happening?

Development:

- Let students work in pairs to come up with different uses and benefits of this.
 - ✓ Coolers
 - ✓ Roads
 - ✓ Keeping food cold
- Does it only work for salt will sugar have the same effect on the ice? How can we test this?

Explanation:

The freezing/melting point of water is lower than just water on its own. The addition of the salt to the ice at 0°C causes it to melt, because salt water cannot freeze at 0°C in the same way pure water can't freeze at 10°C. The melting process decreases the temperature because melting needs heat and as the heat was not supplied to the system of melting ice, it withdraws heat from its own environment.

An endothermic process or reaction absorbs energy in the form of heat. With the melting of ice and the heat is absorbed from the environment. You could record the temperature change using a thermometer or by feeling the reaction with your hand. Another reaction that could be used to show endothermic reactions is the reaction between citric acid and baking soda, it is a highly safe example, commonly used.

Additional Links:

Links to how salt works on roads: <http://sciencewithme.com/why-i-love-salt/>

<http://science.howstuffworks.com/nature/climate-weather/atmospheric/road-salt.htm>

<http://chemistry.about.com/cs/howthingswork/a/aa120703a.htm>

Double Lesson: Melting Time

Expansion:

In this lesson we will test if the concentration of salt effects the melting time and also if the temperature is lowered with a higher concentration.

Teacher should first ask students to write down their **hypothesis** on what they think will happen when the experiment is carried out. Students should do this individually. Get them discuss their hypothesis before the experiment.

Materials:

- Beaker
- spoon
- 1 scale (1g accuracy)
- Graduated cylinder
- Funnel/sieve
- Thermometer
- Weighing cups

Per Group:

- 1L tap water
- 500g ice
- 105g salt or sugar



Method:

1. Measure 200ml of tap water in a beaker.
2. Add 100g of ice to the beaker and stir vigorously.
3. Measure the temperature, but wait until it is steady (~10 sec) before you record the lowest stable temperature on the results chart.
4. Wait 3 minutes before noting the temperature at the end. While waiting, the ice will partially melt and cool the water until the solution reaches a low enough temperature where the ice cannot melt further.
5. Pour the solution through the sieve/funnel with filter paper into the graduated cylinder. Toss the ice. Record the new water volume on the results chart in the column for “final volume of water”. This step is necessary because some of the ice will have melted and this will tell if the different salt/sugar concentration affected the amount of ice melted.
6. Next dissolve 15g of salt/sugar into 200 ml of tap water in a beaker.

7. Repeat steps 2/4 and record your measurements on the results chart.
8. Repeat for 20g, 30g, 40g and 50g of salt/sugar.
9. Using your measurements for the “final volume of water”, draw a graph of final water volume versus the salt concentration.
10. You now have all the data you need to plot your own phase diagram with temperature and salt concentration on the axes.

Follow up:

- Students will then discuss as a class the hypothesis and if it has changed or stay the same and explain the results that they got.
- Students should be able to explain how and why the temperature is lowered.

Development:

*If time permits

Students can look at making an ice- pack and in there groups they should try come up with a recipe to make the ice- pack. Have an ice pack in the class so that the student can look at the different ingredients how do they work?

- What happens in the one use ice packs?
- You have to crack inside the bag what does this do?
- Name the reaction type: endothermic
- Did they find out anything interesting?
- Different chemicals that can be used.
- What is the difference between single use and reusable?

****If not student should research/ finish this at home as homework****

Additional Links:

How ice packs work and there uses: http://www.ehow.com/how-does_4925771_instant-ice-packs-work.html

Recipe for ice pack: <http://sustainableutopia.wordpress.com/2012/03/07/diy-unfreezing-ice-packs/>

TED-Ed interesting talk: <http://ed.ted.com/lessons/how-do-cold-packs-get-cold-so-fast-john-pollard#review>

Single Lesson Optional: I scream for.....

Discuss the ice packs and ask students to share the information that they gathered.

Did they answer the questions put to them?

Did they find out any interesting facts that haven't been covered in the class?



Making ice-cream

Materials:

- 1/2 cup milk
- 1/2 cup whipping cream (heavy cream)
- 1/4 cup sugar
- 1/4 teaspoon vanilla or vanilla flavouring (vanillin)
- 1/2 to 3/4 cup sodium chloride (NaCl) as table salt or rock salt
- 2 cups ice
- 1-quart Ziploc bag
- 1-gallon Ziploc bag
- Thermometer
- Cups and spoons for eating your treat!

Method:

1. Add 1/4 cup sugar, 1/2 cup milk, 1/2 cup whipping cream, and 1/4 teaspoon vanilla to the quart Ziploc bag. Seal the bag securely.
2. Put 2 cups of ice into the gallon Ziploc bag.
3. Use a thermometer to measure and record the temperature of the ice in the gallon bag.
4. Add 1/2 to 3/4 cup salt (sodium chloride) to the bag of ice.
5. Place the sealed quart bag inside the gallon bag of ice and salt. Seal the gallon bag securely.
6. Gently rock the gallon bag from side to side. It's best to hold it by the top seal or to have gloves or a cloth between the bag and your hands because the bag will be cold enough to damage your skin.
7. Continue to rock the bag for 10-15 minutes or until the contents of the quart bag have solidified into ice cream.

8. Open the gallon bag and use the thermometer to measure and record the temperature of the ice/salt mixture.
9. Remove the quart bag, open it, serve the contents into cups with spoons and ENJOY!

Explanation:

Ice has to absorb energy in order to melt, changing the phase of water from a solid to a liquid. When you use ice to cool the ingredients for ice cream, the energy is absorbed from the ingredients and from the outside environment (like your hands, if you are holding the bag of ice!). When you add salt to the ice, it lowers the freezing point of the ice, so even more energy has to be absorbed from the environment in order for the ice to melt. This makes the ice colder than it was before, which is how your ice cream freezes. Ideally, you would make your ice cream using 'ice cream salt', which is just salt sold as large crystals instead of the small crystals you see in table salt. The larger crystals take more time to dissolve in the water around the ice, which allows for even cooling of the ice cream.

Additional Links:

Steve Spangler making ice-cream:

<http://www.stevespanglerscience.com/lab/experiments/homemade-ice-cream-sick-science>

Explanation for salt in ice-cream: <http://curiosity.discovery.com/question/why-there-salt-ice-cream>

Endothermic reaction example: <http://www.sciencecompany.com/fast-freeze-experiment-an-endothermic-reaction-W149.aspx>

Unit 4:



What floats your boat?

Introduction: The aim of this unit is to build on student's previous knowledge of density and floatation and introduce the students to a hydrometer.

Objectives: the students will be able to –

- Understand how a hydrometer works and calibrate it effectively.
- Test the density of various solutions both known and unknowns
- Explain how density works

Teacher Background: Density is defined as mass divided by volume.

- Mass = how many atoms are in an object. Volume = how much space an object takes up.

For a pure substance the density has the same numerical value as its mass concentration. Different materials usually have different densities, and density may be relevant to buoyancy, purity and packaging

Sugar solutions: As you add sugar to the water, more and more sugar molecules will take over the space, making the water denser. The cup containing the 8 tablespoons of sugar will be the densest, the cup with 2 tablespoons will be least dense.

Supersaturated Solution: If you attempt to dissolve sugar in water, you reach a point where you cannot dissolve any more sugar. This is called a saturated solution. However, if you heat this solution, more sugar will dissolve. When the solution is cooled, the sugar will remain in solution. This is called a supersaturated solution, which is very unstable and will crystallize easily.

A hydrometer is a type of instrument that measures the density of liquids. Making a simple hydrometer to measure the density of several types of liquids is a good science project for students. Once you have your hydrometer, you can use it over and over again for various projects. It will be easy for anyone to use, because if you know how to read a thermometer, you can read a hydrometer. A hydrometer is a tool scientists use to measure the specific gravity of liquids. Specific gravity is the ratio of the mass of a liquid to the mass of an equal volume of pure water. Because the density of a liquid changes with temperature, hydrometers are calibrated for different reference and sample temperatures.

Hydrometers may be calibrated for different uses, such as

- lactometer for measuring the density (creaminess) of milk, a
- Saccharometer for measuring the density of sugar in a liquid
- Alcoholmeter for measuring higher levels of alcohol in spirits.

Hot and Cold water: Cold water is denser than room-temperature water. Hot water is less dense than room-temperature water. **Cold Water:** The molecules of cold water move slower and are a little closer together than the hot or room-temperature water. Also point out that when the water is cooled, the water level falls slightly in the graduated cylinder. **Hot water:**

The molecules in the hot water are moving faster and are a little farther apart than the molecules in room-temperature water. Make sure students notice that when the water is heated, the water level rises slightly in the graduated cylinder.

Single class: What Floats?

Discrepant Event:



Engagement:

Materials:

- 2 beakers 500mL
- Water 2 beakers full
- Salt
- Tray of eggs



Method:

1. Have two beakers filled with water
2. In one of these beakers there should be dissolved salt. (The amount required varies depending on the water used)
3. When the teacher places the egg in the plain water it will sink
4. When placed in the salt water it will float.

Exploration:

The off colour solution is a hint for the students.

Teacher plays 20 Questions with the students - Where the students have to find out what has happened they can continue to question why it happened.

Rules:

1. Each student can ask one question
2. Teacher can only answer Yes/No
3. When a student thinks they have the answer they raise their hand.

Aim is to find out salt is in the second solution and then continue to find out is due to density of the solution.

Teacher can tell the students that something is added to the water if students don't figure it out-

- What does this mean?
- What could it be?

Development:

If the teacher adds water to the beaker containing salt what will happen? Will the egg stay in the same position or move?

Students can trial this experiment to get the egg floating in the middle of the glass.

- They can add spatulas full of salt until the egg will float in the middle of the glass as in the 3rd cup above.
- They will have to note how much salt they use to get this to happen.
- Requires some accuracy as not enough they won't float and too much it will float too high.

Development: Introduce students to a hydrometer and explain what its use is. Only touch on the topic as more detail will be provided in the next class.

Development: ask the students the equation for density from junior certificate

Give them 3 example to carry out:

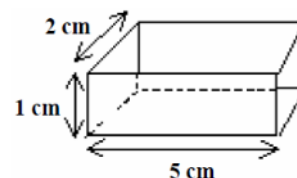
$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$
--

1. If the mass of a stone is 20 g and the volume of the stone is 10 cm³, find the density of the stone.

Answer: Density of the stone = 20/10 = 2 g/cm³

2. A block of metal has the measurements shown on the right. The mass of the metal block is 21 g.

- i) Calculate the volume of the block.
- ii) Calculate the density of the block.



- Answer: (i) Volume = 5×1×2 = 10 cm³
(ii) Density = 21/10 = 2.1 g/cm³

Explanation:

Since density is defined as how much matter takes up a certain amount of volume, we can take ordinary water, add salt to it, and make it denser. Yes, the volume increases a little bit when we add the salt but the mass increases by a much bigger factor. This is because rather than just floating around and taking up space, the salt dissolves into ions which are attracted to the water molecules and bind very tightly to them, packing more matter into the space.. The salt water has the additional mass of the sodium and chlorine atoms that dissolve into the water. In other words, the salt water that we create has more stuff in it and is much denser than ordinary water.



Additional Links:

Video of the experiment being carried out:

<https://www.youtube.com/watch?v=zszw6uCiQpc>

Double Lesson: Let's get accurate

This question will build on what the pupils learned in yesterday's class.

Question: Is there a difference between swimming in an ocean and a pool?

This same principle applies to people swimming in oceans or salt water lakes. The average person will sink in ordinary water but can float like a boat in saltwater. The Dead Sea is 33% salt by mass. People find it very odd how "floaty" they are when they swim in the Dead Sea

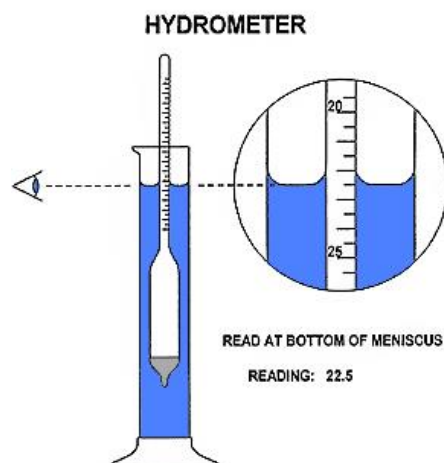
You might not know this but muscular people are denser than people with less muscle and fatter. Some championship swimmers for instance, will sink in salt water while heavier people will still float.

Expansion:

In this lesson we will make a hydrometer and then continue on to use it to test different solutions densities. The homemade hydrometer is just a simple straw and clay together and will have to be calibrated to work to find the density of solution.

Students need to be introduced to a hydrometer:

Previous class we looked at density in liquids. To measure these liquids a hydrometer is used. A hydrometer a very simple piece of equipment to use and is an instrument used to measure the specific gravity of a liquid solution and, therefore, its strength. A simple (and common) hydrometer consists of a weighted glass bulb with a graduated stem, looking similar to a large glass thermometer. It is placed in the solution, spun (to remove air bubbles that might cause it to float higher), then the column is read at the waterline to give a number that can be compared to a chart of known values for the particular solution being measured. The device is dropped into a liquid, usually water in this case, and the device will partially float, with the weighted end under water, and the rest of the device above the water line. At the point of the water line, one can see the strip of paper, and read from the paper, the metric. The metric will usually provide the specific gravity of the water, meaning, it will describe the weight of dissolved materials in the water. The hydrometer is used in beer and wine making to determine when the solution has reached the desired concentration of alcohol



Hydrometer Construction and Calibration Lab:

*** have half the class trialling salt and the other class trialling sugar***

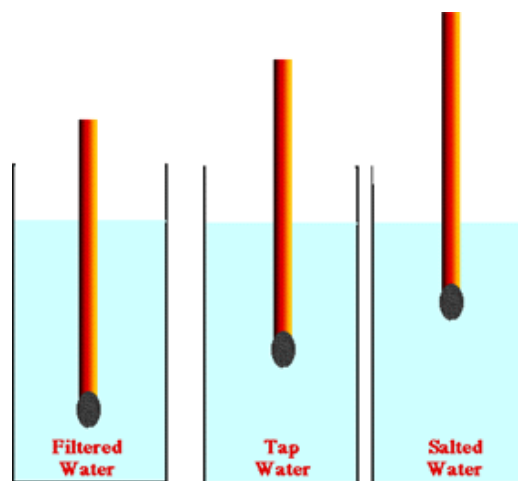
Materials:

- Straws,
- Plasticine (mala)
- permanent markers of different colours
- Graduated cylinders/ beakers
- Water
- Sugar
- Salt
- Electric balance
- Ruler
- Scissors
- An unknown solution for the students to test
- Ethanol
- Olive oil

(Alternate materials: pipette instead of straw and modelling clay, small weights (copper or lead shot, small nails or straightened paper clips) to insert into pipette bulb so that it is bottom of hydrometer)

Method:

1. Take your straw and cut it to a length of 15 cm. Take a small amount of plasticine and seal the bottom of the straw. Keep the mala symmetric about the straw.
2. Place the straw with the clay at the bottom into the beaker/graduated cylinder of distilled water. The straw should float level in the water it may take numerous goes to get it to float. If it sinks, remove some excess clay. If it is not level, even out the clay.



Once you have it floating levelly, measure the distance from the top of the straw to the water level by using your thumb and index finger just on the water level when taking the straw out and then marking it with a permanent marker.

3. Your hydrometer will show if the liquid it is placed into is more dense, less dense or the same density as pure water.

4. There are five different solutions going to be mixed. Using warm water in the beaker add the sugar and mix until completely dissolved. The solutions are 20 g/L, 40 g/L, 60 g/L, 80 g/L, 100 g/L give students enough time to decide how much they will need for 100mL.
5. Place the hydrometer in the solution. Record the measurement from the top of the straw in the appropriate row and column on the table.
6. Remove the hydrometer, replace the solution with a different one, and repeat step 6 for all five sugar solutions water solutions.

Take your hydrometer up to the front and place it in the “Unknown Solution.” Record your hydrometer reading: _____

Development:

Using the various sugar solutions add a drop of **food colouring** to each one.

- Start with the cup with the most sugar. Using a pipette, dropper or back of a spoon, begin adding the first layer of sugar water.
- After the first layer, things get challenging. Carefully drip the next dense layer onto the surface of the first. The best technique is to place the pipette right above the surface of the first layer and against the glass. Slowly drip the next colour onto the first. This will take a lot of patience. Go slow.
- The colours will begin to mix at first and then your original colour will start to show.
- Repeat with the next dense colour and the least dense colour until you have stacked all of the colours.

Additional Links:

Sugar Tower: <http://www.stevespanglerscience.com/lab/experiments/colorful-sugar-density-tower#sthash.yNI3Gogc.dpuf>

List of Specific gravities: <http://www.fao.org/docrep/017/ap815e/ap815e.pdf>

Single Lesson Optional: Difference Matters

Students have now looked at the density of liquids and are aware of how not all liquids have the same density. They have carried out the calibration and testing of a hydrometer and used it to test various sugar solutions.

- In this lesson students will build on the knowledge they have acquired on density of liquids and move on to how temperature effects it.

Key points for teacher:

- Heating a substance causes molecules to speed up and spread slightly further apart, occupying a larger volume that results in a decrease in density.
- Cooling a substance causes molecules to slow down and get slightly closer together, occupying a smaller volume that results in an increase in density.
- Hot water is less dense and will float on room-temperature water.
- Cold water is denser and will sink in room-temperature water.

A good way to show this is the demonstration of hot and cold water:

<https://www.youtube.com/watch?v=AasKk3HRyOI>



Ask students to make a prediction:

- Do you think the hot and cold water will mix or stay separate?

Materials

- Hot water (about 50 °C, coloured yellow)
- Cold water (about 5 °C, coloured blue)
- 2 identical clear baby food jars/ bottles / wide top jar
- Water-resistant card (from a deck of cards or laminated index card)
- Paper towels

Method:

Hot water on top

1. Completely fill a baby food jar with hot tap water and add 2 drops of yellow food colouring.

2. Completely fill another baby food jar with very cold water and add 2 drops of blue food colouring. Stir the water in both jars so that the colouring is well-mixed in both. Place the cold water jar on a paper towel.
3. Hold a water-resistant card over the top of the hot water jar.
4. While holding the card against the jar opening, carefully turn the jar upside down.
5. With the card still in place, position the jar of hot water directly over the jar of cold water so that the tops line up exactly.
6. Slowly and carefully remove the card so that the hot water jar sits directly on top of the cold water jar.

Although removing the card may result in a little mixing or spilling, the hot yellow water will remain in the top jar and the cold blue water will remain in the bottom jar.



Ask students:

- Why do you think the hot water stayed on top of the cold water?
- Ask students to make a prediction: What might happen if you placed the cold blue water on top of the hot yellow water and then removed the card?

Cold water on top

- Use the same procedure as above, but place the jar of cold water, upside down over the jar of hot water.

The cold blue water will immediately fall into the hot yellow water causing mixing. The water will quickly become green throughout.

Development:

Have you ever been in a very warm room on a very cold winter day and opened a door or window leading to the outside for a short period of time?

- What did you experience as you stood in the opened doorway or near the opened window?
- Did you experience a rush of cold air past you as you stood there?
- What do you think might explain this rush of air into the room?
- What if you were outside in a similar situation and opened a door in to a warm room what would have happened?

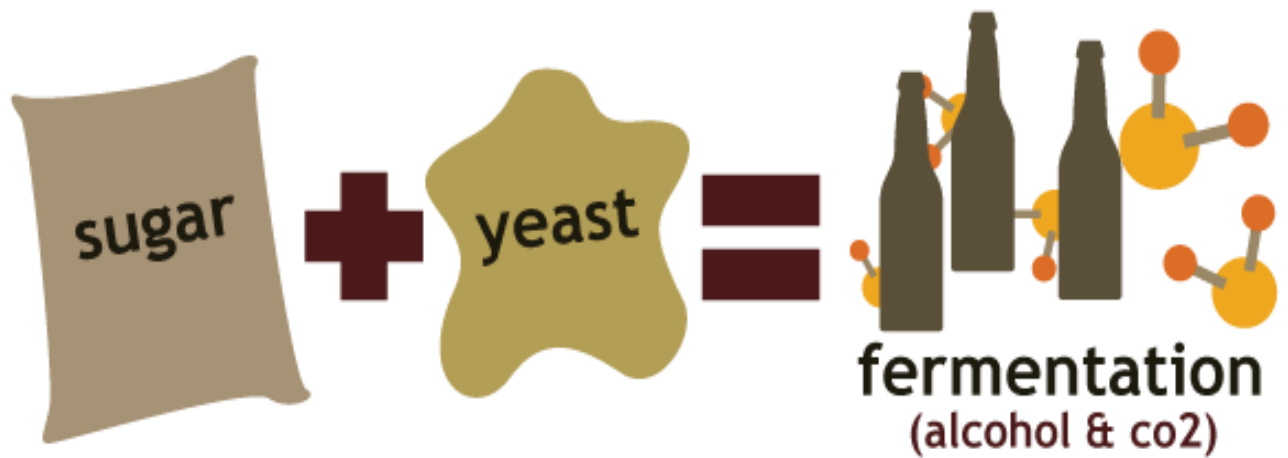
Discuss all that has been covered in this unit and address any questions that the students may have on the topic.

Additional Links:

A website with picture representations of how to carry out the experiment:

<http://sciencewithkids.com/Experiments/Matter-experiments/Hot-and-cold-water-density.html>

UNIT 5



What's going on? :

Introduction: The aim of this unit is to introduce students to the topic of fermentation. Students may not be aware of what fermentation is or how it occurs but they should be familiar with different foods and drinks that are created through the process of fermentation such as wine and cheese. Students will have previous knowledge of what glucose is from junior certificate so it is essential to build on this.

Objectives: Students will be able to identify what is required for alcohol fermentation.

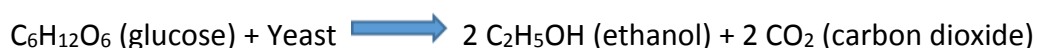
Students will understand the concept of fermentation.

Teacher Background:

Fermentation is a metabolic process and natural process in which an organism converts a carbohydrate, such as starch or a sugar, into an alcohol, gas or an acid. It occurs in yeast and bacteria, but also in oxygen-starved muscle cells for example, yeast perform fermentation to obtain energy by converting sugar into alcohol. Bacteria perform fermentation, converting carbohydrates into lactic acid. Fermentation is used to make products such as wine, cheese and beer e.g. converting juice into wine, grains into beer, carbohydrates into carbon dioxide to leaven bread, and sugars in vegetables

This unit is based on ethanol fermentation (yeast). Fermentation must be carried out in the absence of air to make alcohol. If air is present, ethanoic acid is made instead of alcohol. Yeast and certain bacteria perform ethanol fermentation where pyruvate (from glucose metabolism) is broken into ethanol and carbon dioxide.

The chemical equation for ethanol fermentation:



The word equation for ethanol fermentation is:



Carbon dioxide gas bubbles out of the solution into the air leaving a mixture of ethanol and water. Ethanol can be separated from the mixture by fractional distillation.

Yeasts ferment simple sugars (monosaccharides) into carbon dioxide and ethanol under anaerobic conditions. Yeasts are single-celled fungi. The genus *Saccharomyces* is the one most commonly used due to its efficient alcohol production and tolerance of high alcohol levels. Some yeasts can live until the alcohol concentration reaches 18%.

Single lesson: What's going on?

Discrepant event:

Engagement:



Teacher introduces the students to a case study where a man is suffering from high blood alcohol levels even though he claims that he has not drunk. Is this possible and how?

Hint: Students may not be aware as how alcohol is made so say that yogurts/ wine / cheese undergo a similar process to be made. **Fermentation**

Case Study:

A 61-year-old man — with a history of home-brewing — stumbled into a Texas emergency room complaining of dizziness. Nurses ran a Breathalyzer test. And sure enough, the man's blood alcohol concentration was a whopping 0.37 percent, or almost five times the legal limit for driving in Texas.

There was just one hitch: **The man said that he hadn't touched a drop of alcohol that day.**

"He would get drunk out of the blue — on a Sunday morning after being at church, or really, just anytime,"

Medical professionals chalked up the man's problem to "closet drinking".

So the team searched the man's belongings for liquor and then isolated him in a hospital room for 24 hours. Throughout the day, he ate carbohydrate-rich foods, and the doctors periodically checked his blood for alcohol. At one point, it rose 0.12 percent.

When he ate or drank a bunch of starch — a bagel, pasta or even a soda. The levels spiked.

Follow UP:

Other cases similar to the one in Texas: Some reports in Japan date back to the 1970s. In most instances, the infections occurred after a person took antibiotics

Students should take notes on this case study.

Link to story:

<http://www.npr.org/blogs/thesalt/2013/09/17/223345977/auto-brewery-syndrome-apparently-you-can-make-beer-in-your-gut?ft=1&f=1001>

Exploration:

Students will work in groups to figure out the secret behind the mystery. Students may ask questions regarding certain areas but give them helpful hints rather than telling them the answer.

These are some question the teacher might ask:

- He has his own brewery
 - ✓ What is a home brewery?
 - ✓ How do they work?
 - ✓ Will this matter?
- How is alcohol made? Guide them along this some students may already have an idea. (Made through a process called **fermentation** = yeast breaking sugar down into ethanol and carbon dioxide. This process is without any air present and once complete, the carbon dioxide gas bubbles out into the air, leaving ethanol and water behind.)
- He notices it happens more after eating high **glucose** foods. What could this mean?
 - ✓ What is glucose?
 - ✓ Is it found in all foods?
 - ✓ Which foods will contain high amounts of glucose?
 - ✓ In junior certificate you used glucose what were you testing for?
 - ✓ How was this carried out?

Get students to work in pairs after all this information has been covered and come up with the solution to the mysteries.

Teacher should then ask students to explain the reason behind their answer.

Explanation:

- The man from the case study, who was a devoted home brewer, had a large quantity of brewer's yeast in his stomach.
- This made his intestines act as their own small brewery.
- Thus explaining the peak in blood alcohol level.
- Brewer's yeast is in a whole host of foods, including breads, wine and, of course, beer (hence, the name). The critters usually don't do any harm. They just flow right through us. Some people even take *Saccharomyces* as a probiotic supplement.
- But it turns out that in rare cases, the yeast can indeed take up long-term residency in the gut and possibly cause problems,

Follow on:

- Introduce Alcohol to the students e.g. Bulmer's and ask them how cidona and Bulmer's differ? How is this possible?
 - ✓ Cidona sparkling apple juice is an Irish classic and a delicious alternative to cider.
 - ✓ The fermented juice comes from a cider extract from which the alcohol has been virtually eliminated giving it a real cider taste without the concerns over alcohol.
 - ✓ Look at how alcohol could be made.

Additional Links:

- How it's made: <http://www.alcoholandyou.org.uk/facts/howisitmade.html>
- Information on alcohol:
<http://www.chemguide.co.uk/organicprops/alcohols/manufacture.html>
- Fermentation information: <http://chemistry.about.com/od/lecturenoteslab1/f/What-Is-Fermentation.htm>

Double Lesson: Try it yourself

Expansion:

Aim: To test different conditions required to make alcohol:

In this double lesson the students will follow on from the previous class in relation to the case study and make their own alcohol.

Students should be aware that to make alcohol the following conditions are required:



- Students will test various properties to decide on a suitable and most effective way to make alcohol.
- Each group will be given the optimum conditions and then asked to make changes to test if other conditions will work.
 - ✓ Change the temperature instead of 30°C
 - ◆ Room Temperature
 - ◆ 35°C
 - ✓ Change glucose to sucrose/fructose
 - ✓ Add 10g of yeast instead of 5g

Materials:

- Yeast
- Glucose
- Sucrose
- Distilled water
- Labels
- 2 Rubber bungs
- 2 Conical flasks (250 cm³)
- 2 Fermentation locks
- Graduated cylinder (250 cm³)
- Weigh boats
- Weigh scales
- 2 Beakers (250 cm³)
- incubator (25 C – 35C)
- Funnel

Method:

To produce alcohol using yeast ideal situation:

Each group will adjust this as necessary to what they are testing:

1. Prepare 400 ml of a 10% w/v glucose solution.
2. Into each of the two conical flasks, add 200 ml of the glucose solution.
3. To one of the conical flasks, add 5g of yeast and swirl. Label this 'yeast + glucose'.
4. The second flask acts as a control – it has no yeast. Label this 'control'.
5. Half fill two fermentation locks with water. Attach one fermentation lock to each flask.
6. Place both flasks in an incubator at 30OC overnight.

*Tip: Boil water: removes all the dissolved oxygen.

Place a thin layer of oil on the top of the water in each. (The oil keeps the water out of contact with the air and prevents re-oxygenation)

The fermentation lock allows waste carbon dioxide to escape without the entry of air.

- **The Test for the alcohol will have to be completed in the following class.**

Development

Now that students are aware as to how alcohol is made and what is required a fun idea to keep students interested is to compile a business plan on how they will produce a new alcohol business.

Students should be split in two teams and within those teams they should divide the jobs to make a business plan.

What is a business plan?

A business plan is a written document that describes an idea for a product or service and how it will make money. It includes your marketing plan as well as estimates for revenue, expenses, and how to make a profit.

Questions to ask students:

- What is your big idea?
- What makes your idea unique?
- What do existing products/services not offer that yours will?
- Why will people buy it?

Marketing

- Who will be your customers?
- Are they adults? Men? Women? Where do they live?
- What do they like and dislike?
- Describe your target customer with as much detail as you know.

Idea:

- Where will you sell your product or service?
- Are you setting up a lemonade stand in your driveway? Selling apps online?
- How will you get the word out about your business?
- Will you email your friends? Put up signs? Put ads in the newspaper?
- What is the name of your business?
- What does this name say about your business?
- Is it unique? Memorable? Easy to pronounce?
- Design a logo.

Each group will be given this class to decide on all the details and they will present their idea to the class in the next lesson after they test for alcohol or the teacher will collect it and correct it. The task should be completed for homework.

Single Lesson Optional: how will I know?

Students could not complete the test for an alcohol on the same day as they had to wait for the process to happen.

Testing for the results:

The students have created a homemade hydrometer in the previous unit on density. They are also aware of the requirements on how it is calibrated. The students can use this technique to see if they have created alcohol.

Method same as that in the previous unit:

1. Students will use the same hydrometer that they made in the previous unit.
2. They will have the mark for water and olive oil ethanol and various sugar solutions.
3. Students will be able to tell if the solution is alcohol from the reading of the alcohol on the hydrometer.
4. The control should have a similar reading to the 2nd sugar solution in the previous unit.
5. One group should have the ideal situation so all other groups should compare their results to this.

Students should describe their results and be able to explain where it went wrong.

- What did they change
- Did it affect your overall production of alcohol?
- Was there a big/small difference in your results and the ideal trial?

Development:

If time permits students can present their business plan to the class or teacher will collect it and correct it.

If the students are presenting to the class it is a good opportunity to peer assess so aloud the students to mark each other.

Mark on a scale of 1 – 10.

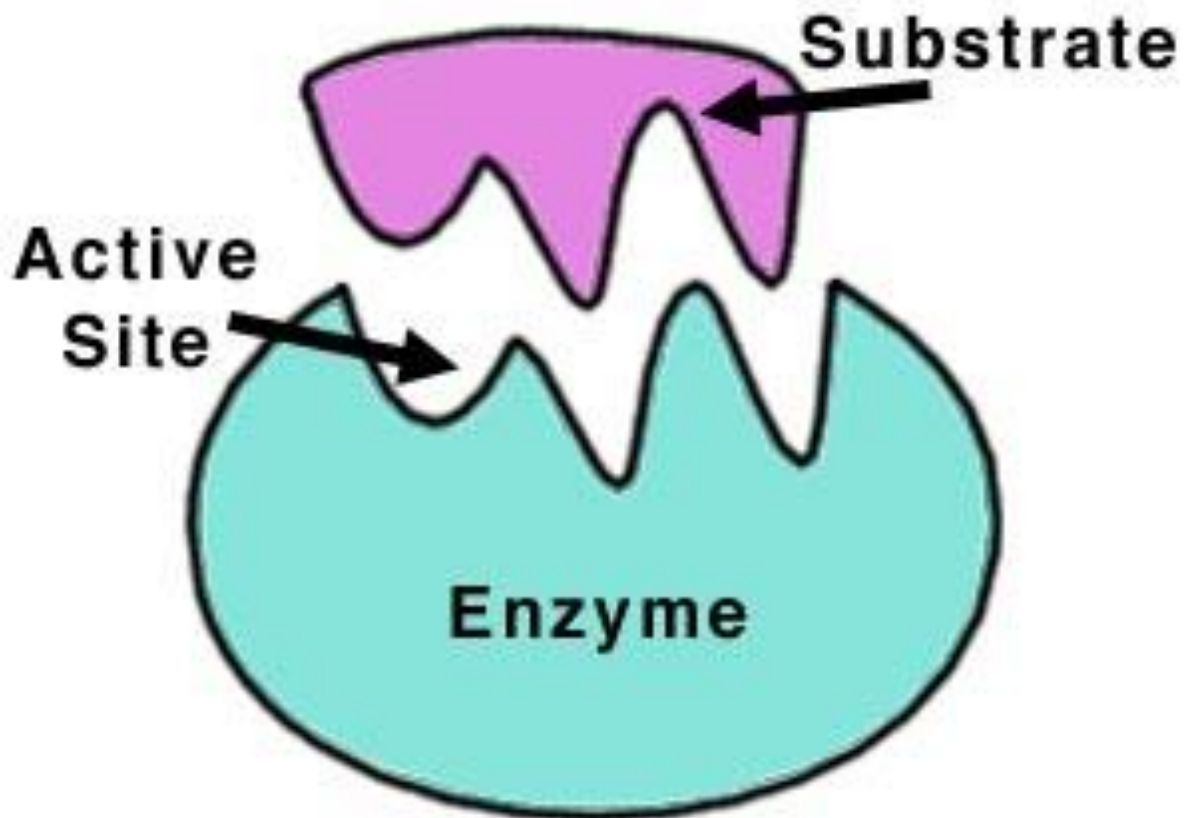
Peer Assessment Table:

GROUP	IDEA	MARKETING	LOGO	ORIGINALITY	WOULD YOU LIKE IT?	TOTAL /50
1						
2						
3						
4						
5						

Additional Links:

Bulmer's marketing: <http://bulmers.ie/marketing.html>

Unit 6:



Food for thought:

Introduction: To introduce students to the topic of enzymes and the effect temperature has on the source.

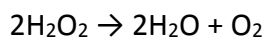
Objectives: students

- Explain in their own words the effect of heating an enzyme
- Develop their skills in the lab and ability to explain the results

Teacher Background:

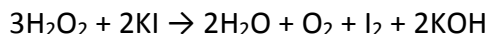
Chances are your students have heard of enzymes previously, but they probably have no idea what they actually are. Many cleaning products found in the marketplace use enzymatic action, and this is what students might be familiar with. But this is not the true function of enzymes. In our bodies, enzymes are essential. Without enzymes, most cellular reactions would take too long for us to survive. Enzymes are folded in ways that allow them to function correctly. Temperature effects enzymes in various ways. Each enzymes have a different range at which they work best and when this is exceeded the enzymes become less effective and often denatured.

Reaction: Hydrogen peroxide (H₂O₂) is commonly used as a hair bleach. It also has an interesting property in that it decomposes over time producing oxygen and water.



The oxygen can be seen here as it is a gas which blows bubbles in the soapy water. This decomposition is very slow and to watch it would be very boring so we add catalysts to speed up the reaction. Vegetables contain biological catalysts called enzymes. In particular, celery and potato contain catalase which speeds up the decomposition of hydrogen peroxide. Enzymes such as these are often used in washing powders to break up some of the grime on dirty clothes (hence “Biological” washing powder).

Enzymes are often added to washing powder a far better way to speed up the decomposition of hydrogen peroxide is to react it with potassium iodide.



Denaturation: is the unfolding of the protein in a way that affects its ability to function. When you cook food, you can watch proteins denature. Crack an egg into a hot frying pan or grill a steak. The visual changes that occur due to the heat of the pan or the grill are occurring because proteins in the food are denaturing.

Single lesson 1: Elephant Toothpaste

Discrepant Event:

Engagement:



Enzymes react differently depending on temperature and the iodine snake experiment is a good way to introduce the topic to the students.

Materials:

- 2 - 250 cm³ measuring cylinders
- A large tray to catch any foam that spills over the top of the cylinders.
- The quantities given are for one demonstration.
- 75 cm³ of 100 volume hydrogen peroxide solution.
- A small piece (2 pieces about 1 cm³) of liver.

Add 75 cm³ of water to the 75 cm³ of 100 volume hydrogen peroxide solution to make 150 cm³ of 50 volume solution.



Method:

To get cooked Liver:

- 1) Stand the cylinder and boiling tube in the water bath until the desired temperature is reached. (This should be carried out just before students enter the class)

For Demonstration:

Using an uncooked 0°C and cooked Liver piece 37°C

- 1) Place about 1 cm³ of washing up liquid into each of the measuring cylinders.
- 2) To each one add the amount of catalyst specified above.
- 3) Then add 25 cm³ of 50 volume hydrogen peroxide solution to each cylinder.
- 4) The addition of the catalyst to each cylinder should be done as nearly simultaneously as possible.

Development:

Place a glowing splint in the foam; it will re-light confirming that the gas produced is oxygen.

Students should be aware of what gas is being produced from junior certificate.

This will help them to create an equation of what is happening.

Exploration:

Give students 2 minutes to write down as many ideas they can think of what might be happening.

Questions:

- What could be the difference between the two test tubes?
- What was the liver there for? – enzyme source

Once they have carried this out allow them in pairs to discuss their idea and try work out what is happening.

- Teacher will then go through what has happened.
- Knowing the chemicals used and gas produced students will make an equation on what happened.

Teacher will then ask the students what will happen if the enzyme source had been heated above 40. This is where the word **denaturation** is introduced.

Development:

- When we are sick our temperature rises what happens our cells?
- Is this why we feel sick? (Shape changes a bit) (denaturation)

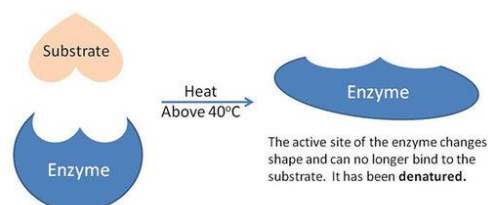
Explanation:

A different volume of foam is produced at different temperature. 0°C enzyme action is low because the movement of molecules is low. The collision frequency between enzyme and substrate is therefore low. Increasing the temperature speeds up the movement of molecules the collision frequency therefore increases. Enzyme action increases at 40°C - maximum collision frequency between native enzymes and substrates.

Enzyme action begins to decrease above 40°C because the enzymes are denaturing when all the enzymes are denatured enzyme action stops.

Tips for the teacher:

- Enzyme extracts lose activity very quickly and so must always be prepared immediately before use.



Double lesson: It's foaming up!

Expansion:

In the previous class the teacher looked at the effect of temperature on enzymes.

In this class the students will test catalase found in different sources to see which is most effective. Catalase is found in potatoes, celery and liver.

Give each group of students 2 different sources of catalase and get them to test the difference.

Students will use the previous class in order to set a hypothesis:

- What do you expect to happen?

Questions:

- What do you expect will be the best source?
- What will be the optimum temperature?
- What are the variables?
- What will be the least effective temperature?
- When the enzyme is denatured what has happened? Can it be reversed?
- Is denaturation both rising and lowering of temperature?

Materials:

- Enzyme source: catalase
- Hydrogen peroxide (20% or less)
- Buffer solution – ensure pH isn't a variable
- Washing up liquid – trap oxygen and makes foam
- Boiling tubes
- Graduated cylinders (100cm³)
- Water baths (0-70°C)
- Thermometer
- Knife
- Chopping board
- Dropper
- Gloves
- Ice



Method:

1. Add 20cm³ pH 7 buffer to a graduated cylinder
2. Using a dropper add 2 drops of washing up liquid
3. Add 5g of finely chopped liver/celery/potatoes
4. Add 2 cm³ hydrogen peroxide to the boiling tube
5. Stand both cylinder and boiling tube in water bath of desired choice. (0°C - 60°C)
6. Remove from water bath and add hydrogen peroxide to cylinder
7. Note the volume in the cylinder immediately and record
8. Read the volume again after 2 minutes and note final volume.
9. Repeat this with 3 more temperatures.

Students should graph the results that they got from carrying out the experiment.

Students should then discuss the results and compare them to other in the class room.

Questions:

- What temperature does the enzyme stop working?
- What is the optimum temperature?
- Which source of catalase is more effective?
- What is the least effective temperature?
- When the enzyme is denatured what has happened? Can it be reversed?
- Is denaturation both rising and lowering of temperature?

Tip for teacher:

There will be almost no catalytic effect above 40°C, confirming that the catalyst in these cases is an enzyme that is denatured by heat. The optimum temperature is 37°C and this is when the most amount of foam will be produced.

- Potato will be much slower than celery and liver pieces.

Additional Links:

Similar experiment with instructions and information: <http://www.nce-mstl.ie/fileupload/Science%20resources/Biology%20resources/Class%20Activity-%20Enzymes%20in%20Action!.pdf>

Single Lesson: Optional: What works best?

Students should have a debate with enzymes being the focal point:

Cooked V uncooked food what works best?



(Students may not know the answer to this question but having some knowledge on enzymes they can come up with an argument teacher can give each group a point that may be used in the class)

Raw:

- Enzymes - Digestibility and assimilation

Cooking:

- "denatures" protein molecules, so that their amino-acid chains unfold and digestive enzymes can attack them more easily

Other factors that can be considered:

- Pathogens
- Beneficial bacteria
- Nutrients
- Denaturing of proteins

Set-up:

The class should be divide in half and then split in to smaller groups.

Smaller groups:

- Appoint a captain.
- Given 5 minutes to discuss their ideas and come up with at least 10 good points of information.

Each half of the class:

- Team captains will come discuss the points that small groups decided on with the rest of the group and get some feedback.
- Each group should also think about what he other groups might say.

All people in the group can be nominated to respond to the argument posed by the other team.

Questions:

- Will the enzyme harm us if we eat it raw?
- What will the benefits of eating enzymes be?
- Teacher should allow all students to give an opinion.

- They should try relate it to enzymes and whether they think enzymes effect the human body.

Teacher can give helpful hints if required.

**** As homework the students will have to research information to back up the argument that they had. ****

Additional Links:

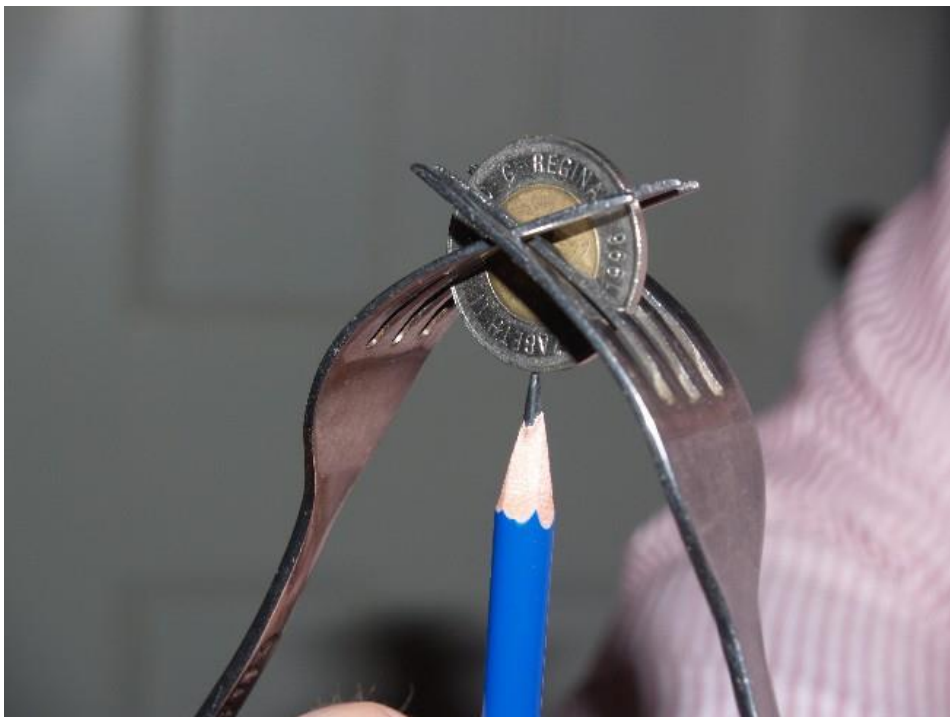
Health Benefits of catalase: <http://www.globalhealingcenter.com/natural-health/catalase/>

Points of information on raw food:

http://www.healthy.net/Health/Article/Enzymes_The_Difference_Between_Raw_and_Cooked_Foods/848

Raw V cooked food: <http://jonbarron.org/article/food-raw-versus-cooked#.VA92uvldXRc>

Unit 7



Move that Body!

Introduction: This unit is based on the centre of gravity in our body and how it changes and reacts differently in a diverse situation.

Objectives: Students will

- discover through experimentation what "centre of gravity" means
- appreciate how science can explain events we encounter in our daily lives
- develop a basic understanding of how the body reacts to changes in balance

Teacher Background:

Students will have some knowledge on this topic as it would be covered in the junior certificate.

Centre of gravity: Is the point at which all of the weight of an object appears to be concentrated the centre of gravity (centre of mass) is the point on an object that when supported on that spot, the object will balance. If an object rotates when thrown, the centre of gravity is also the centre of rotation. When an object is suspended so that it can move freely, its centre of gravity is always directly below the point of suspension. An object can be balanced on a sharp point placed directly beneath its centre of gravity.

Throw a ball in the air and gravity pulls it straight back down. Not everything moves like this when gravity acts on it. Most objects are not nice, neat shapes like balls. That means gravity acts on them in more complex ways. Even so, all objects behave as though their mass is concentrated at a point called their centre of gravity. A simple object like a ball has its centre of gravity in a very obvious place: right at its centre. But in a more complex object, like your body, the centre of gravity is slightly higher than your waist because there's more weight in the top half of your body than in the bottom half.

In the case of a single rigid body, the centre of gravity is fixed in relation to the body, and if the body has uniform density, it will be located at the centroid. The centre of gravity may be located outside the physical body, as is sometimes the case for hollow or open-shaped objects, such as a horseshoe. In the case of a distribution of separate bodies, such as the planets of the Solar System, the centre of gravity may not correspond to the position of any individual member of the system.

Single Lesson: Man versus woman

Discrepant events:

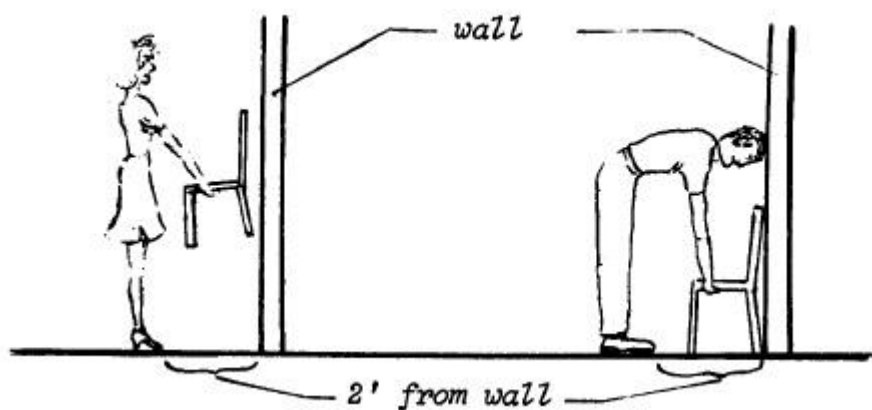
Engagement:

Males have a higher centre of gravity than females. This can be demonstrated in several ways. Students will be involved in carrying out demonstrations in this class.

Materials:

- Straight back chair
- Boys and girls
- Clear wall area

Method:



1. Place a chair against a wall with the back of the chair perpendicular to the wall.
2. Have a student stand in by the chair opposite the wall and bend over so that the top of his head is against the wall over the chair.
3. The student's body should form a right angle at the hips.
4. Have the student grab the chair with one hand on each side and lift the chair off the ground
5. Instruct the students to stand up while holding the chair off the ground.

Typically, males will simply not be able to stand up while holding the chair, but females will have no problem standing up. The higher centre of gravity on a male combined with the weight of the chair makes it next to impossible for the male to stand up.

Exploration:

- Why can girls or women straighten up and boys or men, not?
- Is the weaker sex really stronger? Explain.
- What is the difference between how men are built and how women are built?
- Where is the centre of gravity located in the above pictures?
- How do you think shoe size might affect this experiment? (men vs. women's average shoe size)

Development:

Stand with your heels against a wall and your feet together. Place a €5 bill on the floor about a foot in front of your feet. Now ... try to pick up the dollar without moving your feet or bending your knees.

- All students will think they can do this as it sounds so easy.

Explanation:

The result of this event has nothing to do with strength. It lies in the difference of the location of the centre of gravity of male and female bodies. Also important is the difference in foot size. The centre of gravity of the female body is located much lower, in the hips, while the male body is located up much higher, in the shoulders. The male foot size is also generally much bigger than females, and so he will be forced to actually stand farther away from the wall than the female. When he bends over, his centre of gravity gets shifted beyond his toes, but the female's centre of gravity stays over her feet, and straightening up is much easier for her.

€5 Note: Is as safe as if it were in the bank. You can't pick it up. Here's why. When you stand straight against the wall, your centre of gravity is over your feet (base) as it should be. When you bend forward, you move your centre of gravity forward.

In order to keep your balance, you must move your feet forward too. This maintains the base under the centre of gravity needed for stability. Since the rules of this trick don't allow you to move your feet, you're money-less. And if you persist in trying to pick it up, you'll fall flat on your face! While you are standing there with your back to the wall, here are some more wasted efforts.

Additional Links:

Link to experiment: http://www.csun.edu/~slb68113/comps/discrepant_event/index.htm

Man V woman different guidelines: <https://www.youtube.com/watch?v=WO8DtsZO1nA>

Double Lesson: It's a circus

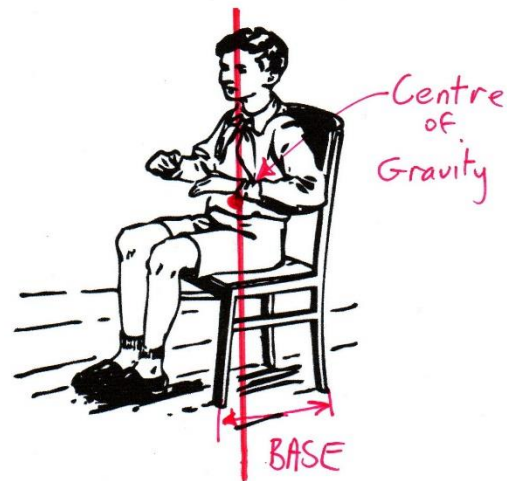
Expansion:

So how does someone learn to understand how balance effects their performance? The key to balance is the centre of gravity. This is what determines how you balance. By shifting your body weight, or your mass, around, you are also shifting the centre of that mass, and your body has to compensate quickly.

This lesson is a couple of demonstrations to emphasize the relationship between the centre of gravity and balance. Then the students will work in pairs to attempt to define for themselves what "centre of gravity" means and how to locate it.

Materials:

- Chair
- Door
- Handkerchief



Method 1: Pick it up

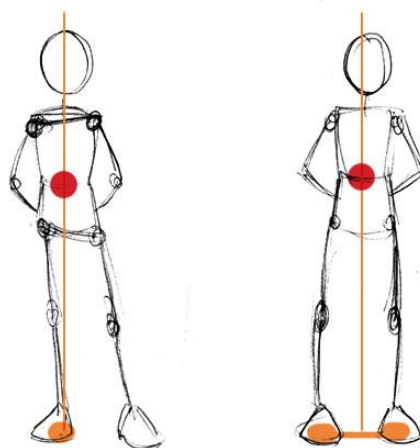
1. Squat down.
2. Place a broomstick under your bent knees and crook your elbows around it.
3. Now put a handkerchief on the ground in front of you.
4. Lean forward, using your hands for balance, and try to pick up the handkerchief with your teeth.
5. Try without the brush is it easier?

As you rotate forward toward the handkerchief, the centre of gravity is shifting away from the stable position directly above your feet. Once it goes too far, you become unstable and you will fall on your nose.

Method 2: The Foot Lift

1. Stand sideways along a wall with your foot, hip, shoulder, and arm all touching the wall.
2. Keeping all these parts on the wall, try to pick up your outside foot.
 - Can you do it? Why or why not?
 - Do you know any other ways to test the importance of the centre of gravity?
 - Where do you think your centre of gravity is?
 - Is this different when you are standing? When you are sitting?

Both of these stunts require you to shift your centre of gravity away from the support base. The first can't be done without falling over, and the second can't be done without moving the wall. The body maintains balance with little adjustments so automatic that we never think about them.



Method 3: On your Toes

1. Stand facing the edge of an open door. Your nose and stomach should just touch it.
2. Place your feet on either side of the floor slightly forward of the edge. Now try to rise onto your tiptoes.
3. It just won't happen unless you want to face plant the door.

You'll be caught flat-footed on this one. The reason you can't do this trick is because it moves your base of support out from under your centre of gravity. In order to stand on your toes, you must transfer the centre of gravity forward. To transfer the centre forward, you must lean over. The door prevents you from doing this.

Method 4: Sit down, Stand up

1. All you have to do to win is get up from a chair, Sit in a straight-backed armless chair. Keep your back against the back of the chair and put your feet flat on the floor.
2. Fold your arms across your chest.
3. Now, keeping your feet flat and your back straight, try to stand up.
4. Try to stand up again, bending a little forward at the waist, and keeping your back straight. Keep leaning forward until you are able to stand up.
 - How far forward did you have to bend in order to stand up?
 - What does this have to do with the centre of gravity?
 - What did you find helped you to stand up without bending as much?

In the sitting position the centre of gravity is at the base of your spine. By trying to stand up with your back straight, you prevent the centre of gravity from moving to a position above the feet, which are your support base. Human thigh muscles simply aren't strong enough to compensate for the balance problem during the getting-up period. So you remain pitied to your chair.

Method 5: Leap Ahead

1. Hold your toes with your hands.
2. Keep your knees slightly bent.
3. Try to jump forward in this position.

You can jump right around the block backward but you'll not get one single bound forward. A backward jump is possible because the support base moves first and the centre of gravity maintains a balanced state. To jump forward, your centre of gravity must move ahead of your base. Holding on to your toes prevents you from making the balance shift. Without shifting your centre of gravity, your leg muscles would have to be strong enough not only to lift your body off the ground but also to support the unbalanced position you would be in while jumping.

Development question:

How would your centre of gravity shift during pregnancy or with old age?

- Your centre of gravity shifts upward during pregnancy, increasing your risk of tripping or miss-stepping. The centre of gravity for adults is the hips. However, as the person grows older, a stooped posture is common because of the changes from osteoporosis and normal bone degeneration, and the knees, hips, and elbows flex. This stooped posture results in the upper torso being the centre of gravity for the elderly person.



When else does your centre of gravity change?

Introduce sport and centre of gravity to the students:

Then show the class a video on the high jump technique and how it is related to the centre of Gravity:

<https://www.youtube.com/watch?v=RaGUW1d0w8g>

Additional Links:

Numerous experiments: <http://www.ellenjmchenry.com/homeschool-freedownloads/energymachines-games/documents/CenterOfMassPhysicsLab.pdf>

Single Lesson optional: Sports galore

Engaging Question:

An interesting application of the centre of Gravity concept can be found in the sport of athletics. Ask the students if they have ever watched how a runner begins a sprinting event such as the 100 meter dash.

Perhaps the students will realize that the smart runners crouch down on their hands and feet and lean forward so that their centre of gravity is well beyond their feet. This extreme position makes the runners feel as if they will fall. However, they practice their start enough times to be able to time it perfectly so that just when they think they cannot balance any longer, the gun goes off, and the runner quickly brings their feet forward. (Remember, the only way you can balance is if your centre of gravity is above your base. In the activity above, the centre of Gravity was the pencil or your index finger.) In this case, the support base is the runner's feet. The fact that the runners have to bring the feet forward quickly to keep from falling enables them to push off with greater force and therefore gather speed more quickly in the race.



Video of Usain Bolt:

Have a class discussion on the topic:

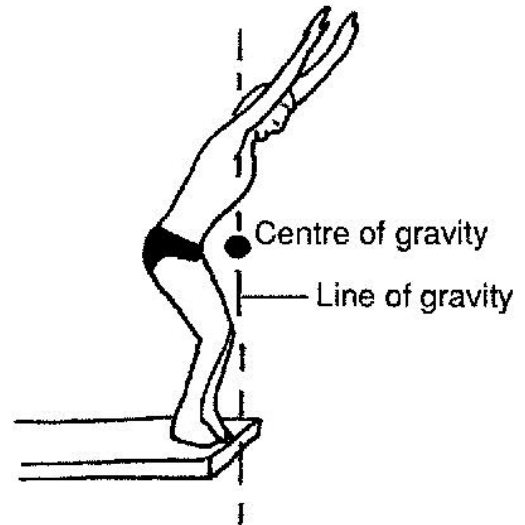
- Have any of you ever tried this technique?
- Will it not take longer to get up?
- Set yourself up in a running position: how many of ye are leaning forward?

Then divide the class in to groups and give them a sport to discuss:

- Gymnastics
- Swimming
- Surfing
- Football

Get them to draw a diagram of the person and where they think the centre of Gravity is located. This may involve two to three diagrams.

The students can then discuss what would happen if you changed the technique.



As homework students should research there technique and check to see how close it is to the technique used.

Additional Links:

Project idea: http://www.sciencebuddies.org/science-fair-projects/project_ideas/Sports_p017.shtml#background

The physics of sports: <http://www.topendsports.com/biomechanics/center-of-gravity.htm>

UNIT 8



Bubble Trouble

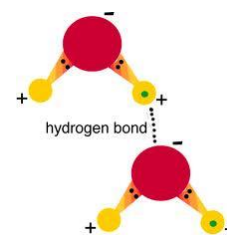
Introduction: In this unit students will be introduced to the concept of surface tension and how bubbles are formed.

Objectives: students will be able to:

1. Identify and explain the term surface tension.
2. Understand and illustrate the bonds between water molecules.
3. Describe what soap does to water.
4. Demonstrate the properties of bubble making.

Background information:

Students have covered the topic of water in junior certificate chemistry, surface tension is often associated with cohesion and adhesion which is a topic covered in leaving certificate biology. Water is a polar molecule and when the two positively charged hydrogen atoms attach to the negatively charged oxygen atom, a stable water molecule is created. Students will be aware that atoms attach in a “bent” shape. This does not allow for an equal “pulling” or sharing of the electrons between the three atoms, allowing the hydrogen atoms to develop a slight positive charge and the oxygen atom to develop a slight negative charge. The difference in charge across the molecule is called a “dipole”.



The slightly positive hydrogen side of one water molecule attracts the slightly negative oxygen side of another water molecule, creating a natural “attraction” between the molecules. Water molecules on the surface of a bowl of water are attracted to each other as well as to the water below them, which creates a strong and flexible film on the water’s surface. This is the surface tension that allows paperclips to float and a card to balance on the edge.

Thus, when you add soap to water the surface tension breaks. Soap molecules consist of nonpolar, dipole-free bodies and a polar head like the phospholipid bilayer in the cell membrane. When soap mixes with water, the polar heads attach to the surface of the water and the nonpolar bodies tend to point upwards, away from the water, reducing the water’s surface tension. Thus, the paper clips sink and it becomes difficult to float new clips and the pepper moves to the edge.

Bubbles are made from a thin layer of water is sandwiched between two layers of soap molecules. Each soap molecule is oriented so that its polar (hydrophilic) head faces the water, while its hydrophobic hydrocarbon tail extends away from the water layer. No matter what shape a bubble has initially, it will try to become a sphere. The sphere is the shape that minimizes the surface area of the structure, which makes it the shape that requires the least energy to achieve.

When two bubbles meet, they will merge walls to minimize their surface area. If bubbles that are the same size meet, then the wall that separates them will be flat. Bubbles meet to form walls at an angle of 120°. If enough bubbles meet, the cells will form hexagons.

Single class: jumping pepper

Discrepant Event:

Engagement:



Materials:

- Bowls/beaker (works better in a bowl)
- Water 100mL/200mL
- Pepper flakes
- Washing up liquid (enough to cover the top of your finger)
- Paper optional

Method:

1. Place water in the bowl and sprinkle pepper flakes on top.
2. Put your finger in the bowl and note what happens.
3. Place some washing up liquid on your finger and place in the bowl again.



Notice the pepper moves to the edge of the plate once the washing up liquid is introduced.

Exploration:

Do you think soap is the only substance that can break down water's surface tension? Try conducting the same experiment but with olive oil or hair spray. Do you think the pepper flakes will react in the same way?

Allow students to carry this out themselves and see what happens.



The teacher can then follow this up with an add on activity:

A glass of water and a glass of water with soap + 2 paper balls.

1. Fill two glasses equally full with water.
2. In one of the cups, add about 30 mL of dish soap and gently stir the solution.
3. Create two identical balls of paper that can fit into your glasses of water.
4. Gently drop one paper ball into the plain water and drop the other paper ball into the glass with the soapy water solution.
5. You will quickly observe that the paper balls react differently to the two fluids. In fact, one paper ball begins to sink while the other sits atop the water!

Explanation:

You are observing is a difference in the surface tension of the water. Soap is a surfactant, or a compound that lowers the surface tension of a liquid. Soap, in particular, decreases the surface tension of water by weakening the hydrogen bonds that make water such a special substance. Water normally bulges up a bit, like what you see when you look at a water drop. When the surface tension is lowered, the water wants to spread out. As the water flattens on the dish, the pepper that is floating on top of the water is carried to the outer edge of the plate as if by magic.

The first question to ask is why the pepper flakes float. Why don't they sink or dissolve in the water? Well, pepper is **hydrophobic**, (students may not have met this word before so it is important to be introduced to it before moving on to bubbles) meaning that water is not attracted to it. Because of that, the pepper can't dissolve in the water. But why do the flakes float on top of the water? Water molecules like to stick together. They line up in a certain way that gives the top of the water surface tension. Because pepper flakes are so light, and hydrophobic, the surface tension keeps them floating on top.

The next question to think about is why the pepper shoots to the sides when soap touches the water. Soap is able to break down the surface tension of water—that's part of what makes soap a good cleaner. As the soap moves into the water, and the surface tension changes, the pepper no longer floats on top. But the water molecules still want to keep the surface tension going, so they pull back away from the soap, and carry the pepper along with them.

Paper ball development explained:

This lower surface tension has two direct effects when it comes to the paper ball. First, the lower surface tension means that the paper can't sit atop the water's surface, allowing more of the water to come in contact with more of the paper. Second, the weakened hydrogen bonds mean that the water is more likely to soak into the porous paper, making the paper much denser and causing it to sink.

Development:

- Introduce a picture of a bubble to the class and ask them how this is possible if the detergent breaks the bonds?



Additional Links:

Pepper: <http://www.abc.net.au/science/surfingscientist/pepperscatter.htm>

Surface tension: <http://www.stevespanglerscience.com/lab/experiments/sink-or-swim-surface-tension#sthash.AEYbaz8R.dpuf>

Double Class: Burst your bubble

Expansion:

Who can make the strongest bubbles?

As stated above bubble are formed with 3 layers students should be aware of this before moving on to the activity outlined.

Many students will have blown a bubble before this class but the majority of these will have been small bubble that pop. Addition and use of different materials will allow for stronger and bigger bubbles. Most people use water and washing up soap but this may not be the best method as the ions in the tap water may affect the way the bubble turns out.



Materials:

For each group:

- Water from the tap
- Deionised water 200mL/300mL
- Dishwashing liquid 30mL
- Sugar 30g
- Laundry detergent 30g
- Glycerine 30
- Corn syrup 30mL
- Straws optional to make a wand (2)
- Bubble wands
- Ruler
- Beaker for mixing
- Paper (coloured)
- Stopwatch

Method:

- Students will be given the opportunity to trial six different recipes to make an effective bubble.
- Give each group a small amount of each ingredient and let them decide amongst themselves what ingredients they would like to use. They can then alter the recipes as they see fit.
- Students will have to note that not all recipes will work and that they will have to be careful of the ratio they use in when making the bubbles. For example you don't place 2/3 washing up liquid 1/3 water when making them at home.

Measuring the bubble:

1. Place a piece of paper on the wall. Get a student blow the bubble at the piece of paper. The diameter of the bubble can then be taken using a ruler. (coloured paper might work better)
 2. Blow a bubble and time how long it lasts. If it comes in to contact with something does it burst.
 3. Finally try join two bubbles together and note what happens.
- When all tests have been completed the students will clear up and wash all materials that have been used before moving on to a class discussion.

Development:

Class Discussion:

- Teacher will ask each group to give the best recipe they had according to the results they gathered.
- Was it hard to judge how much of each ingredient to put in?
- Did any material shock your group with the way it worked?

*If bubble wands are not available a homemade wand can be made by making a figure 8 with two straws.



Additional Links:

Giant bubble: <http://www.stevespanglerscience.com/lab/experiments/giant-bubble-experiment>

Recipes and different information about bubbles: <http://www.exploratorium.edu/ronh/bubbles/>

<http://chemistry.about.com/od/bubbles/a/bubblescience.htm>

<http://www.hometrainingtools.com/a/learn-about-bubbles>

<http://science.howstuffworks.com/dictionary/chemistry-terms/soap-bubbles-info.htm>

<http://hyperphysics.phy-astr.gsu.edu/hbase/surten2.html>

<http://www.stevespanglerscience.com/blog/experiment-of-the-week/secret-recipe-for-making-the-biggest-best-bubble/>

Single Lesson optional: World Record

In the previous lesson students made bubbles using recipes that they came up with themselves. In this lesson the teacher will show students various uses of bubbles and interesting ideas that have ended up as world records.

Development:

Teacher can then show the students a video of the World record for people in a bubble:

https://www.youtube.com/watch?v=ZLXZ08_XHO8

- Teacher can discuss what would be needed for this to happen.
- Is it possible to carry out at a low cost?
- How could you place $\frac{3}{4}$ people in a bubble? (hula hoop and kids pool)
- The following link shows how to do this and other materials that can be used to make bubbles. <http://www.monkeysee.com/play/10550-how-to-make-giant-bubbles-for-kids>

Development:

Get the Students in their groups to come up with an idea involving bubbles for a world record:

When doing this they will have to-

- Decide on a title for the world record e.g. largest amount of bubbles in a bath at one time
- Decide a place where this can be carried out
- Think of the equipment that they will need for this to work
- How will it be advertised – posters, Facebook page, slogans, etc. (draw the slogan in the worksheet)
- Is it something you can carry out at home?
- Research
 - ✓ Has it been done before?
 - ✓ If so was it successful
 - ✓ Do you think you can do better with the right equipment?

Teacher will observe the groups as they discuss their ideas for 15 minutes.

Teacher will then allow each group 3 minutes to present their ideas to the class.

Conclusion



Teacher will ask students to in their own words write 5 things that they have learned in this unit on a blank piece of paper and place it up the front of the class as they leave.

Additional Links:

A new Guinness world record:

<http://www.guinnessworldrecords.com/news/2013/3/challengers-the-fun-and-fast-way-to-attempt-a-world-record-today!-47701/>

List of World Records involving bubbles:

1. The most soap bubble domes created inside one another is 15 and was achieved by Chung-Tai Su (Taiwan) at Hold Enterprise Co. Ltd, Taipei, Taiwan, on 26 April 2012.
2. The most bounces of a soap bubble is 195, and was achieved by Kuo-Sheng Lin (Taiwan), at Hold Enterprise Co. Ltd. in Taipei, Taiwan, on 17 April 2012.
3. The most soap bubbles successfully blown inside a larger soap bubble is 152, and was achieved by Kuo- Sheng Lin (Taiwan) at the World Trade Centre, Taipei City, Taiwan, on 23 December 2011.
4. The largest free floating soap bubble has a volume of 20.65 m³ (729.25 ft³) and was made using a wand. It was produced by Megan Colby Parker (USA) at Forges Field Recreational Park, Plymouth, Massachusetts, United States, on 27 April 2013.
5. The most people inside a soap bubble is 214 and was achieved by Milka Bubbly and Matěj Kodeš (both Czech Republic) at Trade Fair Palace, Prague, Czech Republic, on 1 March 2014.
6. The longest soap bubble wall measured 50.90 m (166 ft 11 in) long and was created by Fan Yang (Canada) on the set of Zheng Da Zong Yi - Guinness World Records Special in Beijing, China on 17 November 2009
7. The largest soap sculpture measures 2.19 x 2.07 x 2.68 m (7.19 x 6.79 x 8.80 ft) and was created by Protex Soap (South Africa) in Johannesburg, South Africa, on 5 October 2010.
8. Sam Heath AKA Samsam Bubbleman (UK) created a frozen soap bubble with a volume of 4315.7 cubic cm at the Absolut Vodka Bar, London, UK, on 28 June 2010.
9. The largest exploding soap bubble was 25 cm (250mm) in diameter and was achieved by Gennadij Kil (AKA 'Blub'- Germany) at the Centro de Crecion y Formacion Joven of Guia de Isora, Tenerife, Spain on 13 January 2011.



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CERTIFICATE

This certifies that

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