Chemistry in the kitchen

Teacher's guidelines

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Unit 1. Can we do chemistry in the kitchen?

1.1. Strawberry smoothie.

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1.3. Safety in lab and in the kitchen.

1.4. Cutting onions or a scientific investigation.

1.1. Strawberry smoothie

Aim: To encourage the students to learn the content of this subject in English.

Teaching objectives:

Content

- Processes in the kitchen.
- Equipment in the kitchen.

Communication

- Explaining the equipment you need for a special process.
- Completing a recipe.
- Making questions.

Cognition

- Relation between the quantities and the ingredients of the recipe..
- Relation between the equipment and their function.
- Using the correct action to describe a step of the recipe.

Outcomes:

At the end of the lesson, students will be able to:

- Think that the English is not going to be a problem in this subject.

Development of the activities

A1. The teacher will show a PowerPoint with the Strawberry Smoothie recipe and will explain it. She will ask the pupils to take notes. When finished, she will make oral questions in Catalan to the whole group in order to check if they have understood.

a) Quins són els ingredients?
b) Quin equipament de cuina necessitem per preparar aquesta recepta?
c) Cóm es prepara?

A2. Here the students have to match the quantities for each ingredient. They have to recognise the type of substance and how we can measure it.

To prepare a Strawberry Smoothie, we need 6 large strawberries, 300 ml milk and 1 small pot of fruit yoghurt.

Then, there is a revision activity of the fruits vocabulary. In the box, there are names of different fruits in English with scrambled letters, they have to reorganise them and match with the picture. The fruits are: banana, pineapple, grapes, pear, apple, peach, grapes and kiwi.

A3. Students have to name the equipment they need to prepare the smoothie. Each small group of three will have a set of flash cards with the kitchen equipment.

A4. Now, the pupils have to write down the recipe. They have to write down the name of the recipe, the ingredients and equipment. They have worked with this vocabulary before and they shouldn't have any problem. For the procedure, they just have to complete the sentences with the verbs they learnt in **A1.** In case they need a little more help, the words could be written on the board.

Slice *Pour* *Blend* *Serve*
Place *Remove* *Pour* *Add*

A5. This is an oral activity. The students will stand up and will look for 5 different students to interview. They have 5 different questions to ask them and they should make up one more question.

Timing

This is the introduction of all the sessions; it shouldn't take more than one session.

- Session 1: (A1-A5). This is an introductory session.

Resources

- PowerPoint on how to prepare the Strawberry Smoothie.
- Flash cards with kitchen equipment:
  -http://www.foodafactoflife.org.uk/attachments/19c1c976-b26e-492bf5625706.pdf

Assessment

- This introductory session is meant as an initial assessment and also a motivating activity so that the students don't feel that English is going to be so difficult. The teacher should pay attention to:
  - The confidence of the students with the foreign language.
  - Their ability to understand it and use it.
  - The way all the activities are answered and completed.

Bibliography and other resources

- Pictures come from the next web sites:
  - http://www.menudospeques.net/recursos_infantiles/laminas_colorear/dia_alimentacion/colorear_dia_de_la_alimentacion.php
  - www.johnsesl.com/printables/pineapple.gif
- The recipe and some more pictures have been taken from:
  - http://www.nutrition.org.uk/home.asp?siteId=43&sectionId=529&subSubSectionId=442&subSectionId=312&parentSection=300&which=2
- Cooking survey from:
  - http://www.britishcouncil.org/languageassistant-cooking.htm

1.2. Laboratory versus kitchen

Aim: To know the relation between the kitchen and the laboratory.

Teaching objectives

Content

- Chemicals.
- Lab equipment and kitchen equipment.

Communication

- Explaining the use of the equipment.
- Specific vocabulary of the laboratory.
- Specific vocabulary of the kitchen.

Cognition

- Understanding that matter is made up of chemicals.
- Making the relation between the kitchen and the laboratory.
- Looking for lab and kitchen equipment you can need for a certain use.

Outcomes:

At the end of the lesson, students will be able:

- To understand that the kitchen and the chemistry lab are really similar.
- To understand that matter is made up of chemicals.
- To identify specific equipment for a certain use.

Developing of the activities

A6. In this activity, the students have to choose which of the substances mentioned are chemicals. A common misconception is that chemicals are only artificial substances like additives, while all the matter is made up of chemicals. To check their answers, they will see the video Chemicals in food. As a final conclusion, the students will have to order to sentences.

Every ingredient in your cooking is made up of chemicals.

All the matter is made up of chemicals.

A7. The teacher will give out to the groups the kitchen equipment cards or the lab equipment cards. Each small group will look for the equipment used for the differents actions, ones will look for the lab equipment and the others for the kitchen equipment. To complete their table, they will work now in pairs, one that should have worked the lab equipment and the other that should have worked the kitchen equipment. They will ask their partner which the equipment is needed for each use.

- Which is the *kitchen or lab* equipment used for *heating*?
- For *heating* in the *kitchen*, we use the *cooker* or *kitchen stoves.*
- For *heating* in the *lab*, we use the *hot plate* or *Bunsen burner.*

Instead of using the flash cards, the computer room can also be used so that the pupils look for the information to complete the chart in the next websites:

- http://www.tuhsd.k12.az.us/Desert_Vista_HS/academics/Science/Biology/standard/labeq.htm
- http://www.fordhamprep.org/gcurran/sho/sho/lessons/lesson162.htm
- http://www.cartage.org.lb/en/themes/Sciences/Chemistry/Analyticalchemistry/LabEquipment/LabEquipment.htm
- http://www.nutrition.org.uk/home.asp?siteId=43&sectionId=444&subSectionId=312&parentSection=300&which=2

Pupils that finish early can be encouraged to do the lab equipment quiz.

Timing

Only one session will be needed to complete these activities.

- Session 2: (A6-A7)

Resources

- Video: V16 Chemicals in food:
  - http://www.chemsoc.org/networks/learnnet/kitchenchemistry/00_video.htm
- Flash cards with kitchen equipment:
  - http://www.foodafactoflife.org.uk/attachments/19c1c976-b26e-492bf5625706.pdf
- Flash cards with lab equipment.
- Suggested PowerPoint for the lesson: Lab vs. Kitchen

Assessment

- In this part of the unit, the assessment will include:
  - Oral questions during A6 and during the video.
  - Observation in class of the way they complete A7 and the speaking activity.
  - The way all the activities are answered and completed on the jotter.

Bibliography and other resources

- Flash cards with lab equipment pictures have been taken from:
  - http://www.sciencegeek.net/Chemistry/Powerpoint/Equipment/Equipment_files/frame.htm
  - http://www.geocities.com/~chemfun/unit1/labequipment/equipment.html
  - http://www.fordhamprep.org/gcurran/sho/sho/lessons/lesson162.htm
  - http://www.tuhsd.k12.az.us/Desert_Vista_HS/academics/Science/Biology/standard/labeq.htm
- Lab equipment quiz: (may be for more advance level) http://www.quia.com/quiz/397345.html?AP_rand=1559704471

1.3. Safety in the lab and in the kitchen.

Aim: To establish the rules to work in the laboratory.

Teaching objectives

Content

- Dangers in the kitchen and in the laboratory.
- Rules to work in the laboratory.
- Hazard symbols.

Communication

- Oral question using why and because particles.
- Description of character and his/her position.

Cognition

- Acknowledgement of the dangers in the kitchen and the ones in the laboratory.
- Acknowledgements of the safety rules at the lab.
- Recognising the hazard symbols.
- Knowing how to use safely domestic and lab substances according to their hazard symbols.

Outcomes:

At the end of the lesson, students will be able to:

- Understand that both the laboratory and the kitchen are dangerous places and one should follow some rules.
- Recognise the most common hazard symbols.
- Analyse the hazard of chemical substances in their houses and in the lab and use this information to work safely with these substances.

Development of the activities

A8. The students have to look at the picture. The teacher will ask them where the next things are:

Fridge, dirty cookery, knife, tray, edge of the table, pet,
raw chicken, carpet, rubbish, cookery, teapot, spillage

Once they know the vocabulary, they have to circle the hazards they can see in the picture. Then a set of cards of the unsafe things will be given out. Pupils will have to match the unsafe things with the hazards they have circled before and then with the different things that can happen.

The set of cards of the consequences will be given out later. Then they will have to match them with the unsafe things. To check the answers, the teacher will ask the students why different actions are unsafe.

- *Why is it unsafe when the fridge door is not closed?*
- *Because food can go off.*

A9. This is an activity to work with the safety rules at lab, students should read the statements and decide if they are true or false. If they are false they should correct them.

A10. In this activity students should have to look for the broken safety rules in the picture. First, they should recognise them in the picture, circle and number them. Then they should describe the character who is breaking the rule and locate it. And finally, they should write down the broken safety rule. If the language level of the students is not high enough to write down the rules, they can be given out the cards with the lab safety rules.

A11. Here, the hazard symbols will be introduced. The teacher will ask the students what they know about these hazards.

A12. Then, they will be asked to read the different explanation for the symbols and to match the names of the hazards, with their symbols and the corresponding explanations.

A13. In this activity they will have to look for the symbol of different common substances. At the end, teacher will ask them to identify the hazard for each substance.

Timing

Only one session is necessary for these activities.

- Session 3: (A8-A10)
- Session 4: (A11-A13)

Resources

- Set of cards for **A8** and **A10**.
- Different common substances usually found in the house for **A13** (if it's done in the classroom and not as homework).

Assessment

- In this part of the unit, the assessment will include:
  - Oral questions
  - Observation in class of the way they recognise the hazards and how they work with the group to match the unsafe things sentences and the consequences.
  - The way all the activities are answered and completed on the jotter.
  - If they have written down the safety rules, this will be checked also.

Bibliography and other resources

Suggested PowerPoint for the lesson with some different activities:

- Safety in lab and kitchen

Extra resources for identifying the domestic hazards:

- ICT activity Calamity kitchen: http://www.foodlink.org.uk/calamity_kitchen.htm
- Another ICT activity of hazards in the kitchen: http://www.csef.net/uploads/tests/kitchen.htm
- ICT activity Electrical Safety: http://www.miamisci.org/af/sln/frankenstein/safety.html

Safety rules resources:

- Foods lab safety rules
- Looking for broken safety rules in a text activity
- http://www.sciencenewsforkids.org/pages/safetyzone.asp
- http://science.nsta.org/enewsletter/2003-07/labrules.htm
- http://www.stantonbury.org.uk/Students/Science/Year%207/Laboratory%20Safety%20Rules.doc (good document to be handed out)
- http://www.sciencemadesimple.com/lab_safety.html
- http://www.frontiernet.net/~jlkeefer/safety.html
- http://www.carnegieinstitution.org/first_light_case/horn/labsafety.html
- http://nobel.scas.bcit.ca/debeck_pt/science/safety.htm
- http://education.qld.gov.au/strategic/eppr/health/hlspr012/homeeckitchens.html (Article Hazards in the kitchen)
- Powerpoint Laboratory Safety http://online.sfsu.edu/~dewgrp/safety/sld001.htm
- video: http://www.youtube.com/watch?v=JAzsKc0zlLc
- video: http://www.youtube.com/watch?v=CdPgyQKS548&feature=related

Hazard symbol resources:

- http://tre.ngfl.gov.uk/uploads/materials/9783/Hazard%20Signs%20and%20their%20meanings.ppt#2
- Domino game with hazard symbols www.sycd.co.uk/can_we_should_we/pdf/explore/fun_size/fun10_12.pdf
- PowerPoint http://www.namedorganicreactions.co.uk/safety.pdf
- http://www.rospa.com/safetyeducation/info/dangerous_substances.pdf leaflet with hazard symbol activity.
- http://www.chemit.co.uk/ResourceDetails.aspx?ResourceID=19 PowerPoint

Set of cards for A8

The fridge door is not closed	Food can go off.
There's a spillage on the floor	Someone can slip and fall.
There's a knife on the edge of the table	Someone can cut himself.
There's a pet in the food preparation area	It can carry germs.
There's a raw chicken outside of the fridge	Raw food can be contaminated with microbes.
There's a toy on the floor	There is danger of tripping.
The carpet is folded	There is danger of tripping.
The rubbish is opened and completely full	Rotting food can contain bacteria that could produce food poisoning.
There's a big mountain of dirty cookery and utensils	This could be an place of contamination and food poisoning.
There's a tray with cups and a teapot in the edge of the table	They can fall.
There's a plate on the edge of the table	It can fall.
The power cord of toaster is passing above the kettle	There's a danger of electrocution because the electrical appliance is near the steam or water.
There is an ashtray and a cigarette on the edge of the table above the rubbish	They can fall down into the rubbish where there is paper and a fire can be started.
Someone has left the pot with milk on the stove	It can overflow.

Set of cards for A10: SAFETY RULES

DON'T EAT, DRINK OR CHEM GUM IN THE LAB
KEEP FLAME AND FLAMABLE SOLUTIONS FAR APART
BE CAREFULL AT THE TIME OF USING ELECTRICAL EQUIPMENT
CLEAN SPILLS AS SOON AS THEY ARE PRODUCED
POUR LIQUIDS CAREFULLY
DON'T SMELL CHEMICALS
NEVER POINT THE OPEN END OF A TEST TUBE TOWARD ANYONE
TIE BACK LONG HAIR AND DON'T WEAR BAGGY CLOTHES
DON'T LEAVE PERSONAL BELONGINGS ON THE PASSING PLACES
DON'T PLAY, RUN OR PUSH OTHER STUDENTS IN LAB
DON'T PUT YOUR PERSONAL OBJECTS ON THE LABORATORY TABLE
KEEP CLEAN AND TIDY THE WORKING AREAS
WASH YOUR HANDS CAREFULLY AFTER A LAB ACTIVITY
USE KNIVES AND SHARP INSTRUMENTS WITH EXTREME CARE

1.4. Cutting onions

Aim: to describe and use the scientific method to solve problems

Teaching objectives

Content

- Scientific methodology.

Communication

- Use of 'perhaps' to make a hypothesis.
- Use of conditional to design the investigation.
- Use of past to describe the results.
- Use of present to state the conclusion.

Cognition

- Making hypothesis.
- Designing and conducting experiments to check the hypothesis.
- Solving technological problems during the conduction of the experiment.
- Observing and data collection.
- Stating a conclusion.

Outcomes:

At the end of the lesson, students will be able to:

- Make a hypothesis.
- Design an experiment.
- Describe the results.
- State a conclusion.

Developing of the activity:

- Begin this experiment with a discussion of onions. Teacher will ask the students: *"who likes onions?", "Do you prefer them cooked or raw?", "Who can tell me the different colours of onions?", "Can anyone name different types of onions?" or "What are onions used for?"* After the students have had the opportunity to discuss what they know about onions, pose the following question, "What happens to people's eyes when they cut onions"? Hopefully, students will answer that people cry when they cut onions.
- Explain to the students that now they will use the scientific method to examine why people "cry" while cutting onions and ask if there is a way to cut onions without "crying".
- State what the problem is ("why do onions make us "cry"?, is there a way to cut onions so that we don't "cry" ?, etc.). Have the students (with teacher guidance) come up with a hypothesis (an onion can or cannot be cut without

"crying"). At this point emphasize that a hypothesis is not a guess, but rather a testable solution to a problem based on knowledge and information gathered.
- Next, design an experiment (introduce the concept of a control and an experimental group). Discuss different ways and conditions that onions can be cut (the regular way, holding your nose, under running water, etc.) guide the students to try two ways to cut the onion (regular and under running water).
- Do the experiment, and have the students record their observations. Record, organize and analyze the data (from your observations).
- With the students' assistance, come up with a conclusion, (when onions are cut under running water, you don't "cry").
- If the students have studied the cell structure of an onion before, explain that when you cut an onion, you tear its cell wall and then that releases a gas (propanethial-sulphur oxide); that gas turns into sulphuric acid when it hits the air. Sulphuric acid stings if it gets into your eyes (and makes you "cry"). When you cut an onion under running water, you dilute the gas before it can get into the air (and into your eyes).

Timing

Only one session is necessary for this activity.

- Session 5 (A14): This is a lab session. This activity should be guided by the teacher as it's the first time they work with the scientific methodology. At the end of the session they should write down a report of the investigation. The group should work all together to write the report, and maybe it will be necessary that the teacher writes down their ideas on the board.

Resources

- For the experiments we will need onions, knives and sinks.

Assessment

- In this part of the unit, the assessment will include:
  - Participation of the students in the planning of the investigation.
  - Observation of the way they solve the problem.
  - The written report.

Bibliography and other resources

- http://www.chatham.edu/pti/Kitchen_Chem/Hirsch_01.htm

Other activities about scientific methodology:

- http://www.rsc.org/education/teachers/learnnet/kitchenchemistry/docs/SS01c.pdf
- http://www.rsc.org/education/teachers/learnnet/kitchenchemistry/docs/SS02c.pdf
- http://www.rsc.org/education/teachers/learnnet/kitchenchemistry/docs/SS03c.pdf

Unit 2. How do we measure in the kitchen?

2.1. How do we measure the quantity of each ingredient in our cooking?

2.2. An Old Scottish Recipe or how to convert units.

2.3. Does one kilo of sugar weight the same as one of rice? or an introduction to the density.

2.4. Fresh or old eggs or the relation between density and floatability.

2.1. How we measure the quantity of each ingredient in our cooking?

Aim: To introduce the measurements of mass and volume.

Teaching objectives

Content

- Measurements of mass and volume.
- Units and subunits of mass in the SI
- Units and subunits of volume in the SI
- Equipment to measure mass and volumes.

Communication

- Using superlatives and comparatives.
- Understanding a text and introducing the words missing.

Cognition

- Recognising an accurate measuring.
- Using the correct subunit for a certain measures.
- Determination of mass with an electronic balance.
- Determination of volume of a regular object
- Determination of volume of an irregular object.
- Representation of a graph.

Outcomes:

At the end of the lesson, students will be able to:

- Measure accurately the mass and volume of different objects.
- Use the correct units and subunits when a value of mass or volume is given.
- Use properly an electronic balance and a measuring cylinder.

Procedure:

A1. The first activity is to encourage the students to think how measures in the kitchen are done. At the end of the activity, they should realise that some kind of measurements are not accurate and suggest that a unit should be used. Whether they do it or not, the teacher will explain that an international unit have to be used.

A2. Next activity is for students to know if they are used to this units or not. In the activity there are some foods we can find in common recipients. Students should match the recipient of a food and the amount of it that contains. Two different ways to represent the quantity are in the activity, this is to introduce the subunits.

A3. Here are two questions to introduce the measurement of mass. They will remember the international unit of mass and the instrument that is used for measuring the mass.

A4. Before this activity, teacher should teach the instructions and the safety rules to use an electronic balance. For example, it could be use the Appendix 1 of the *C.V. Clever consumers investigate detergents*. In this activity the students will practice how to use the electronic balance with different objects. They are asked also to measure the mass of water in a glass, they should realise they have to take the mass of the glass.

A5. This activity is to introduce the subunits. Students are supposed to know them from mathematics; if not the teacher will have to introduce them. In this activity, they just have to know which are the big and the small units.

A6. Here, the students should remember how to change the subunits. Then, when they see the different values for each subunit, they will understand why a subunit it's more appropriate in each scenario.

A7. This is a revision activity of what students should know. If not, teacher will have to explain the different subunits.

Milligram	1000	mg
Centigram	100	cg
Decigram	10	dg
Gram	1	g
Dekagram	0,1	Dag
Hectogram	0,01	Hg
Kilogram	0,001	Kg

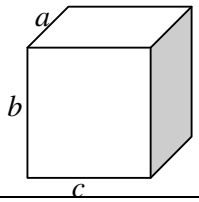
A8. This is an application activity to check if the students have understood the different subunits of mass. At the end, they have to complete four sentences with comparative and superlative structures.

3 cg < 60 mg < 2 dg < 2 Dag < 50 g < 3 Kg < 23 Hg

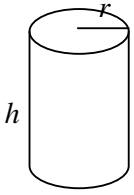
A9. These are some question to introduce the measurement of volume. We ask which substances are measured with the measuring cylinders, just to introduce the different units used for the volume. Teacher should explain that litres and subunits are used for measuring the capacity, and then they are common units to measure the volume of gases or liquids; however, m^3 and subunits are used for the volume of solids. These units, m^3 and subunits, can be used with all substances.

A10. Before this activity, teacher should teach the instructions and the safety rules to use a measuring cylinder. For example, it could be use the Appendix 1 of the *C.V. Clever consumers investigate detergents*. In this activity the students will practice how to use the measuring cylinder to measure the volume of water in different recipients.

A11. The students have seen how to measure a liquid. Now, they are going to study how to measure the volume of a solid. First, the regular objects, the easy ones. They can measure the volume doing some measures and then some calculations.



$V = a \cdot b \cdot c$



$V = \pi \cdot r^2 \cdot h$

Then the teacher will give them two regular objects to measure their volume, for example for the cube, a small box or a square chalk and for the cylinder, a can or a cylinder chalk.

A12. This activity is to relate the different units for volume that have been introduced, litres and m^3. Students will measure first the volume in dm^3 of a tetrabrick of 1 litre. Then they will calculate litres in a cube of 1 m^3.

A13. This is another revision like A7 activity of what students should know. If not, teacher will have to explain the different subunits.

Millilitre	1000	mL
Centilitre	100	cL
Decilitre	10	dL
Litre	1	L
Dekalitre	0,1	daL
Hectolitre	0,01	hL
Kilolitre	0,001	kL

A14. Here the students will study the relation between subunits of litre and subunits of m^3. In the first equality, if students don't remember, the teacher will send them to the A12.

A15. This activity is equivalent to A8 but with volume units. At the end, students will have to construct four sentences using the comparative and superlative structures.

$$1\ cm^3 < 2\ cL < 23\ mL < 0{,}5\ L < 2\ dm^3 < 1\ m^3 < 3\ kL$$

A16. This is a practical activity to make measures of the volume of irregular objects. The method to do this measure has some gaps. The students will have to read it and fill the gaps with the words in the box above. After reading and completing, they will measure the volume of an object that the teacher will propose.

A17. This is a revision activity but also an introductory activity. Students will revise what they know to measure the mass of a given volume of water or the volume of a given mass of water. Once they have complete the table, they will represent a graph mass vs. volume. This is to introduce the concept of density, students will realise that there is a relation between mass and volume, and also that they can extrapolate and know which is the mass of any volume of water or the volume of any mass of water. The teacher should explain to the students that this relation is just for water. Further, in the following sessions the concept of density will be introduced properly.

A18. This is an optional activity. In this case, the students are ask to measure the volume of a drop of water. This is an interesting activity. In the lab, there's no instrument accurate enough to measure the volume of a drop and they have to solve this problem. The solution is to measure the volume of certain number of drops or to measure the number of drops for a certain volume. After this investigation, students have to write the report, of course.

Timing

At least three sessions will be needed to complete the activities up to A17. If students are not used to the metric system, then more sessions will be necessary to introduce it.

- Session 6: up to A8. This session has to be held in the lab because in A4 and A6 students will need the electronic balance. In case there is not enough time A7 and A8 can be set as homework.
- Session 7: from A9 up to A15. This session also needs to be held in the lab although is not exactly a lab session. If there's not enough time to finish last two activities can be set as homework.
- Session 8: This is a lab session. Both activities A16 and A17 are practical. Students that finish early can be encouraged doing the investigation suggested in A18.

Resources

- Electronic balance.
- Measuring cylinders.
- Rulers.
- Substances to measure the mass (A4 and A6).
- Recipients to measure the capacity (A10).
- Regular objects to calculate the volume, cubes, cylinders, tetrabricks, cans,...
- Irregular objects to measure their volume indirectly.
- Droppers for A18.

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities and speaking activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

- Joellen Quincannon, Teresa Socias i Mª Teresa Navés. *C.V. Clever consumers investigate detergents.* 1999 Generalitat de Catalunya.

More activities to revise the metric system:

- Lots of metric lessons: http://sciencespot.net/Pages/classmetric.html
  - Worksheet metric conversions
  - Work sheet Activity to measure Gummy Bears
  - Work sheet metric mania
  - Work sheet length lab
  - Mass Presentation and mass worksheet
- http://www.middleschoolscience.com/smile.htm measuring smile lengths.
- http://teachers.net/lessons/posts/1275.html metric estimation game (like the TV Game show "The Price Is Right")

Other activities:

A1. Choose items from the container on your table that will be closest to the targeted mass. You may use a single item or mix and match items to reach the targeted mass. Say to your teacher to check your estimates before you find the actual mass with the electronic balance.

Targeted mass	Item(s)	Actual mass
1 *g*		
5 *g*		
10 *g*		
20 *g*		
50 *g*		
100 *g*		
200 *g*		
500 *g*		

2.2. An old Scottish receipt.

Aim: To introduce unit conversions.

Teaching objectives

Content

- Equivalent measures
- Factors of conversion
- SI units for mass and volume

Communication

- Using the imperative for giving instructions.
- Using *how much* and *how many* to ask for a quantity.

Cognition

- Changing units with factors of conversion.

Outcomes:

At the end of the lesson, students will be able to:

- To use the factors of conversion for changing units.
- To use *how much* and *how many* to ask for a quantity.

Procedure:

A19. In the first activity of this part of the unit, a recipe of the shortbread is presented. The teacher will introduce the verbs in the action-box giving the translation if necessary. He or she will explain the recipe for making these typical biscuits in Scotland. After this introduction, students have to complete the recipe with the appropriate verbs and the appropriate tense.

Procedure:

1. **Preheat** the oven to 180ºC or gas mark 4.
2. **Cream** the butter and sugar together in a bowl.
3. Gradually **add** the flour and continue **beating** for a further 2-3 min.
4. **Roll** into thick rounds.
5. **Place** on a baking sheet.
6. **Bake** in the preheated oven for 6-8 minutes, until bottoms are lightly browned.
7. **Remove** from the oven and **transfer** to a wire rack to cool.

Students will be asked about ounces. The teacher will introduce this new unit just as a unit for mass and just same easy equivalences to tablespoons. It's interesting that the teacher also makes the students think about the accuracy of these equivalences, if not now, at least at the next activity before introducing the equivalence with grams.

Students found always the use of factors of conversion to change the units. Here, they are going to be introduced progressively. First, the proportions between the units should be introduced by the teacher and then students should complete the proportions between ounces and tablespoons. What happens when we don't now the new proportion? Students will be asked to complete the new proportion by intuition, and then the teacher will explain how to calculate it. This is just a justification of the conversation factors, students won't be asked again to do this, just to use the factors of conversion. Then, teacher will introduce the use of the factors of conversion to the first conversion, ounces of butter to tablespoons. Students will have to use this to make the conversion of units for icing sugar and flour.

The last question is to enforce the use of the factors of conversion. What happens when we want to do the opposite conversion? The proportion is inversed, so the units are in the correct position to be taken away.

A20. This activity is supposed to be done by students more independently than the previous one. So, students will check if they have understood how to change units using factors of conversion. They have to change the units of the quantity of each ingredient in the recipe. First, the change is to another easy unit, the teaspoons. And finally, the change to the unit in the metric system, grams.

To check the final table, a oral activity can be done:

How much butter do we need to make the shortbread?

We need ..... ounces of butter.

How many grams of butter are?

They are ..... grams of butter.

Timing

One session will be needed to complete the activities up to A20.

- Session 9 (from A19 up to A20): This session doesn't need to be held in the lab. This is just an introductory lesson to the factors of conversion. More

sessions will be needed so that students can assume this tool for changing units.

Resources

- Recipe of shortbread.
- Card with the equivalent measures.

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities and speaking activities.
  - The way all the activities are developed and completed.

Bibliography and other resources

- Scottish Recipes.
- Vicki Cobb, Science Experiments you can eat, Penguin Education 1974

2.3. Does one kilo of sugar weight the same as one of rice?

Aim: To introduce the concept of denstity.

Teaching objectives

Content

- Density as a measure of heaviness.
- Density as a relation between mass and volume.
- Floatability.

Communication

- Introduction to structures type "*the more ...., the more ....*"
- Listening and taking notes.

Cognition

- Ordering substances according to its heaviness when the mass or the volume of the substances is kept constant.
- Noticing that the relation mass vs. volume for the same substance is constant and characteristic of this substance.
- Calculating density from the measures of volume and mass.
- Relating density and floatability of objects.

Outcomes:

At the end of the lesson, students will be able to:

- Recognise the density as a measure of heaviness.
- Know that the relation mass vs. volume of a substance is characteristic of this substance that it's called density.
- Calculate the density of a substance knowing the mass and the volume.

Procedure:

A21. First three activities have the same aim, ordering some substances according to the sensation of heaviness. These three activities are to introduce the concept of density without any mathematic formula, once they have the intuitive concept we will introduce the formula as a mathematic instrument to express this idea. It's interesting to work with the substances and recipients, so they can manipulate them and have a manipulative idea of sensation of heaviness to which they are used yet.
In the first activity, A21, the volume is kept constant. Students will conclude without any problem that the more mass, the more the sensation of heaviness. In this activity, small slides recipients can be used filled of each substance.

The bigger the mass, the higher the sensation of heaviness.

The sensation of heaviness is proportional to the mass.

A22. In this activity, the mass of the substances is the same, but each substance has a different volume and they can easily see it in the measuring cylinder. Students cannot have the same criteria to order the substances in order of heaviness, they have to change the criteria and analyse other variables, the volume. In this case, the more volume means less heaviness.

The smaller the volume, the higher the sensation of heaviness.

The sensation of heaviness is inversely proportional to the volume.

A23. In this activity, students have the same four substances, but the question is more difficult. What happens if any variable, mass or volume, is kept constant? Which is now the heavier and the lighter substance? How can it be measured? Probably by now students will have a better idea of sensation of heaviness and they will be able to order them in order of sensation of heaviness intuitively. Then, the teacher will introduce the need of a mathematic instrument that can express this idea. The teacher will explain that in a proportion the denominator (the upper part) refers to the proportional magnitudes and the numerator (the lower part) refers to the inversely proportional magnitudes.

	Sugar	Flour	Pasta	Lentils
Mass	..... g	..... g	..... g	..... g
Volume	..... cm^3	..... cm^3	..... cm^3	..... cm^3
$\frac{Mass}{Volume}$	..... g/cm^3	..... g/cm^3	..... g/cm^3	..... g/cm^3

Students will calculate the new relation and they will use this new magnitude to check they intuitive order of sensation of heaviness.

A24. This activity is to look a mathematical expression to the opposite idea of sensation of heaviness, the sensation of lightness. Students will be able to apply what they learn before about the relation of magnitudes. The order of sensation of lightness obviously is opposite to the sensation of heaviness as both concepts are opposite. So, the mathematical expression will be also inversed. They will answer some questions (complete the answers) to drive them to the mathematical expression. Teacher will need to lead this discussion; first students will work in small groups for a while, then it will be a group discussion so that they can express their ideas and it's in this moment when the teacher will lead them according to the ideas of the students.

If volume is kept constant, the smaller the mass, the higher the sensation of lightness.

The sensation of lightness is inversely proportional to the mass.

If mass is kept constant, the bigger the volume, the higher the sensation of lightness.

The sensation of lightness is proportional to the volume.

The relation volume vs. mass helps to compare the lightness.

	Sugar	Flour	Pasta	Lentils
Mass	..... g	..... g	..... g	..... g
Volume	..... cm^3	..... cm^3	..... cm^3	..... cm^3
$\frac{volume}{mass}$	..... cm^3/g	..... cm^3/g	..... cm^3/g	..... cm^3/g

A25. Students will be asked about these new relations. Is it going to be characteristic of substances? In order to answer this question, they will be asked to calculate the relation mass vs. volume for the same substances with the dates of activities A21 and A22. With the results, it will be a group discussion about the question. Can we say that this new magnitude is characteristic of substances? Students will complete their conclusions:

The relation between mass and volume of a certain substance is always the same. This relation is characteristic of each substance. This relation is also call density.

A26. In A17 students look for masses and volumes of different amounts of water. Using this dates, here they will have to calculate the density of water. Possibly here and in the previous activity, the density for the same substance will vary a little bit. Teacher will introduce the experimental error; even if we work very accurately, the error of the instrument cannot be avoided. Teacher can also that the density depends on the temperature.

A27. This is a revision activity where students are asked to think about the end some sentences. Then the teacher will read them and students will have to take notes and complete the sentences.

*The name of the new magnitude is **density**.*

*Density is a measure of **sensation of heaviness**.*

$$density = \frac{mass}{volume}$$

*If mass is measured in grams (g) and volume in cubic centimetres (cm^3), the unit of density will be **g/cm^3**.*

*Unit of density depend on **the units of mass and volume**.*

Timing

At least two sessions will be needed to complete the activities up to 27.

- Session 10 (from A21 up to A23): It will be interesting to work in the lab or at least having the recipients with the different substances.
- Session 11 (from A24 up to A27): Again it's interesting to continuing working in the lab or at least having the recipients with the different substances.

Resources

- Small recipients full with sugar, flour, pasta and lentils.
- Measuring cylinder, with the same mass of the different substances.

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities and speaking activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

More activities to revise the concept of density:

- Activities of matter properties.
  - http://www.fordhamprep.org/gcurran/sho/sho/worksheets/worksht15a.htm
  - http://www.sciencespot.net/Media/bnppropmtt.pdf
- Density lesson plans
  - http://www.iit.edu/~smile/ch9203.html
  - http://www.iit.edu/~smile/ch9315.html
  - http://www.iit.edu/~smile/ch9411.html
  - http://www.iit.edu/~smile/ch8801.html

2.4. Fresh old eggs.

Aim: To introduce the concept of floatability.

Teaching objectives

Content

- Relation between density and floatability.

Communication

- Using comparative particles: *less* and *more*.
- Understanding a text and filling the gaps.

Cognition

- Understand the relation between density and floatability.
- Design an experiment to determinate the density.
- Make hypothesis about how to make the fresh egg float.
- Draw conclusion.

Outcomes:

At the end of the lesson, students will be able to:

- Explain the floatability according to the density of the liquid and the object.
- Measure the density of an irregular object.

Procedure:

A28. It's a reading comprehension activity where two new verbs are introduced to sink and to float.

A29. In this activity the investigation about the density of eggs is introduced. Students will look for some information in a text (reading comprehension activity) and also to complete their hypothesis.

A30. Here, the students carry out the investigation and write their conclusions.

A31. New investigation is proposed, how affects the density of the liquid in the floatability? Conclusion is a text about the relation between the floatability and the density of the object and the liquid.

Timing

At least two sessions will be needed to complete the activities up to A31.

- Session 12 (from A28 up to A30). It's a lab session.
- Session 13: (A31) It is a lab session.

Resources

- A fresh egg and an old one.
- Lab equipments and substances for **A30** and **A31.**

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

- Eulàlia Albadalejo. *La química de la cuina.* Edicions de la Magrana. Barcelona, 1993.

Text and pictures are adapted from:

- Eggsperiments. Science on the Shelves Project. The University of York. http://www.york.ac.uk/res/sots/activities/eggs.htm

More ideas to work the density and floatability:

- Raymond Zanetti. *Using Kitchen Chemicals to Identify Key Concepts in Chemistry*. http://www.chatham.edu/pti/Kitchen_Chem/Zanetti_01.htm

  (Activities like fresh and old eggs, but also Coke vs. Light Coke)

- Susan J. Pater. *Introducing Chemical Concepts with Food.* http://www.chatham.edu/pti/Kitchen_Chem/Pater_01.htm

  (Activities that work with the different density of potatoes that depends of the content of starch. Also other activity to work with the concept of density with a Twinkie)

- Liz LaRosa. *Coke vs. Light Coke*. http://www.middleschoolscience.com/dietcoke.htm

  (Here is proposed an activity to compare the floatability of a can of coke and light coke and to relate it with their density. It also relate this to the content of sugar and sweetener in order to make sweet the beverage)

- Alice Rysdon. *Easy to Prepare, Easy to Do, Easy to Clean Up, Not Much Chance to Make Mistakes. Kitchen Chemistry.* http://www.chatham.edu/pti/Kitchen_Chem/Rysdon_01.htm

  (Here the author propose to make a household density column to illustrate the different density of liquids and the floatability of some quotidian objects)

- Krystal Wadsworth. *Water sandwich.*http://teachers.net/lessons/posts/188.html

  (Demonstration similar to the one above)

- http://www.hazelwood.k12.mo.us/~grichert/explore/dswmedia/density.htm

  (Very interesting interactive activity about density and floatability, very recommendable there is also a worksheet)

Unit 3. Let's go to investigate about solids, liquids and gases.

3.1. Cheese is a solid, milk a liquid an steam a gas or states of matter in the kitchen.

3.2. Why gases have this behaviour? Or introduction to the particle theory.

3.3. Boiling water for the tea or state changes in the kitchen.

3.4. How does the pressure cooker and the coffeemaker work? Or explaining the state changes with the particle theory.

3.5. Making ice-cream or how can we change the melting point.

3.1. Cheese is a solid, milk a liquid and steam a gas.

Aim: To know the states of matter and their properties.

Teaching objectives

Content

- Gases take up space and have a mass.
- States of matter: solid, liquid and gases.
- Properties of the three states.

Communication

- Ordering words in a sentence.
- Predicting using the future.
- Describing using the present.
- Explaining and giving reasons.
- Using affirmative and negative structures (are/aren't, can/cannot)
- Making oral questions.
- Giving oral answers.

Cognition

- Recognising gases as matter.
- Identifying the three main states of matter and their properties.

Outcomes:

At the end of the lesson, students will be able to:

- Understand that gases are matter.
- Give examples of the three states of matter.
- Match the main states of matter with their properties.

Procedure:

A1. This is an introductory activity for the states of matter. Here, students will show their previous ideas about this classification of matter. Probably, they don't have problems to identify different substances for each state of matter. Teacher will let them to give the examples in their own language if they don't now in English. At the end, the teacher will translate the examples.

A2. First of all, students have to order a sentence about matter:

Matter is anything that has mass and takes up space.

Then, once they have ordered and understood the statement. The students have to decide if the different states of matter are consequent with this statement. Probably, they will have problems with gases because gases seem not to have mass and not to

take up space. We won't correct them in this moment, we will wait so they can experiment it first.

A3. This is the classical experiment to check if gases have mass. First, the new vocabulary: equipment for the experiment and verbs in the procedure can be introduced. Then students have to label the diagram with the name of the equipment and read the procedure.

Once they have understood what they are going to do, they have to make their predictions. Students are allowed to make a draw of their prediction and next they have to try to write their prediction using the suggested expressions with the future tense.

After this, they can carry out the experiment. Again, the observations can be drawn first in a diagram and then, they have to write it using the suggested expressions with the present tense.

The conclusion has to be written using the explanation phrases *because of, due to* or *because.*

This experiment is the classical one, but sometimes doesn't work as we want because it depends mainly in the difference of density between air and gas inside of the balloon. A gas with more density than air should be used, for example, carbon dioxide.

An alternative experiment can be: measure the mass of a ball not completely inflated, then inflate it and measure the mass again. It will be increased because of the gas that we have introduced.

A4. This experiment is to check if gases take up space. The structure of the activity is similar to the previous one. Once they have understood the experiment, they have to make their predictions. After carrying out the experiment they will write their observations and then the explanation.

A5. Here students are asked for the conclusion of experiments in **A3** and **A4**. According to the results, they have to apply the statement in **A2** and justify if gases are matter or not.

A6. This activity should be carry out in pairs. Three transparent bottles will be given to the students: the first one with a wood piece, the second one with water and the last one empty (with air). According to what they can see and they know about the states of matter, students will complete the table.

To check the compressibility, they will have a syringe. They will put a stopper and try to compress the wood bloc, the water and the air.

To check the activity, the teacher will read all the properties for one state of matter. One student has to pay attention to the first two properties and the second one to the other two. So, at the end they have to ask to the fellow the other properties.

*Can **solids** change shape easily?*

No, they can't.

*Can **liquids** change volume easily?*

Yes, they can.

A7. This is a final revision activity. They have to complete the properties of the main three states of matter.

Timing
At least two sessions will be needed to complete the activities up to A7.

- Session 14: up to A3. This is a lab session. First two activities will be easily completed, but it can be assumed that the third one will be more difficult when students have to write down their sentences for prediction, observation and explanation. The experiment can be done like a demonstration for all the class.
- Session 15: (from A4 up to A7) This is also a lab session. It will be interesting that here the students have the opportunity to manipulate and do the experiment by themselves. If there's no time A7 can be set as homework.

Resources

- Equipment needed for A3 and A4.
- Three transparent bottles: the first one with a wood bloc, the second one with water and the last one empty.
- Syringes.

Assessment

- In this part of the unit, assessment will include:
- Observation in class, mainly in practical activities and speaking activities.
- The way all the activities are developed and completed.
- Lab reports.

Bibliography and other resources

- http://www.bbc.co.uk/schools/ks2bitesize/science/activities/gases.shtml interactive activity, classify some substances in liquid, gases or solids and then properties of gases
- Webquest: http://sciencespot.net/Media/statesofmatter.pdf
- http://www.harcourtschool.com/activity/states_of_matter/index.html

3.2. Why gases have this behaviour?

Aim: To look for a model that explains the behaviour of gases.

Teaching objectives

Content

- Properties of gases: compression, diffusion, expansion, pressure of a gas, atmospheric pressure.
- Particles model: a model to explain the properties of gases and to introduce the kinetic-molecular model of matter.

Communication

- Using sequencing phrases.
- Predicting using the future.
- Describing using the present.
- Explaining and giving reasons.

Cognition

- Making up a model to explaining the properties of gases.
- Explaining the properties of gases using the particle model.

Outcomes:

At the end of the lesson, students will be able to:

- Explain the properties of gases using the particle model.

Procedure:

A8. This is an introductory activity. Pictures are in the correct order, but not the instructions. First of all, the teacher will introduce the vocabulary of the instructions. Then, students have to match the pictures and the instructions. Once it has been corrected, they have to write a small paragraph with the sequencing phrases.

In the next part of the activity, students will predict what is going to happen after the last step. They have some predictions to choose, they have to complete with the future tense and then write what they think will happen. Once the experiment has been carry out, they will write also a sentence describing of the observations using the present. Finally, they have to explain what has happen and their ideas.

The teacher will ask them "*what's making the water stay in the glass?"*. Students would suggest suction or a vacuum as the cause. Suction as an explanation made sense to students because they'd had actual experience with it. Drinking a milkshake through a straw, for instance, felt like "sucking" liquid into your mouth.

Here, they still don't have a model to explain properties of gases. The teacher won't correct, this is their own explanation. Later on, in activity **A15**, they will re-explain this phenomenon with the particle model.

A9. First, students are ask to review what they have learnt about gases. This can be done as a brainstorm, but if no ideas come out, they can complete a mind map about it.

Then they are asked to imagine the structure of air. As in the previous activity, this is their own model, they will check in the next activities if their own model can explain some properties of gases. Probably, the particle model won't come out in this activity.

The models proposed by students of this age can be:

a) like a smoke.
b) like a sponge.
c) like an elastic substance.

Teacher will introduce it when the proposed model doesn't work to explain properties as compression or diffusion.

A10. Here, the students have to draw and write what happens to the gas when is compressed according to their model.

A11. In this activity, they have to explain the diffusion. This property is difficult to explain without the particle model. So, it's now when the teacher will introduce the idea of gases made of small particles. The teacher will encourage the students to explain the compression and the diffusion with this new model.

With the second question, the speed of particles will be introduced.

A12. Students have to write here the postulates of the particle model. They have first five minutes to try to complete the postulate. Then, the teacher will read the postulates and they have to take notes and check their answers.

MODEL TO EXPLAIN THE PROPERTIES OF GASES
(Postulates)

1. Gases are made of individual and very small particles.
2. There is empty and big space in between the particles.
3. All particles are in constant movement.
4. Particles are continuously colliding to other particles and walls of the recipient.
5. Speed of particles depends on the amount of energy that they have.

How far is the validity of this model? If the model is good it will explain the rest of properties of gases. Now, the vocabulary that will help us to explain the next properties is introduced in a match the opposite excersice.

A13. New vocabulary will be written on the board and explained by the teacher. Then the students will read the steps for the experiment to see what happens to a gas when is cooled or heated. The teacher will ask them to explain step by step what they have to do.

Then, as in the others POE activity, they will have to make their prediction using the future tense. After carrying out the experiment, they will write the observations using the present tense.

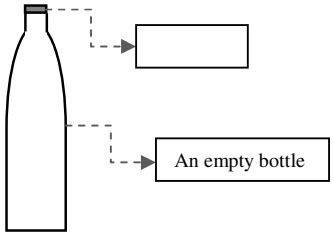
The last part will be the most difficult to the students. They have to explain the expansion of a hot gas and the contraction of a cold gas using the particle model. The teacher can remember the question about the smell of hot and cold meals to the students, so they can remember the relation between temperature and speed of the particles.

That we observe	That we imagine	That we observe
When the gas temperature <u>increases</u> ...	... then particles move <u>faster</u>, they collide <u>more</u> often to the walls of the recipient.	As the recipient is elastic, the volume <u>increases</u>.
When the gas temperature <u>decreases</u> ...	... then particles move <u>slower</u>, they collide <u>less</u> often to the walls of the recipient.	As the recipient is elastic, the volume <u>decreases</u>.

A14. In this activity, students will study the pressure of gases. The teacher will give them the instructions of a new experiment in different pieces of paper. They are not in order. They will try to order them. Then, the teacher will reproduce the experiment without saying anything. The students will observe and then check if their order is the correct.

The dancing coin

Material: *Coin, empty bottle.*



Instructions:

First of all, leave the bottle in the fridge so the air in the bottle will cool. After that, use your finger to spread some water over the lip of the bottle's opening. Then place the coin on the thin film of water. Finally, let the gas in the bottle warm and observe what happens.

Then, the students have to write using the sequencing phrases the instructions.

Once they carry out the experiment, they observe what happens and write it down. What has happen? *The coin starts to move up and down on the mouth of the bottle.*

Students have to make an explanation using the particle model introduced in A12 and the structure of the explanation in A13.

The students will read to the rest of the class their explanations. Then, the teacher will re-explain how the particle model explains the pressure of gases. Also it can be show an animation that represents the particle model of gases and how the increase of the speed of particles can push a piston.

A15. Once they have studied the particle model and they have explained different behaviours of gases, they return to the first activity of the lesson, A8 and make a new explanation with the particle model.

A16. DEFINITION BINGO. The students will choose 9 words of the list in the box and write them in the square in any order. Then, the teacher will read in random order the definition of the words. As in the bingo, students have to cross out the words in their square whose definition has been read. When they complete a line, then they say line and when they complete the square, bingo.

TO CONTRACT-To get smaller, often because of cooling
TO EXPAND-To get bigger, often because of heating
GAS-State of matter that can change shape and volume easily.
LIQUID-State of matter that can change shape easily but not volume.
MASS-How much stuff there is in a substance, measured in grams
MOTION-Another word for movement
PARTICLES-The very small objects that gases are made up of
SOLID-State of matter than cannot change shape and volume easily.
STATES OF MATTER-Solid, liquid or gas are
VOLUME-The amount of space something takes up
TO COMPRESS-To quash into a smaller space
TO DIFFUSE-To move of gases or liquids from an area to another with less concentration.

GAS PRESSURE-Caused by gas particles hitting a surface
MATTER-Anything that has mass and takes up space

A17. The last activity is a revision activity. First, students make in groups a list of the properties and behaviours of gases they have studied. Then, teacher will lead a brainstorm in the all group and he/she will help them to complete their list.

Properties and behaviours of gases that we have studied

1. Gases have mass.
2. Gases take up space.
3. The shape of a gas can change easily.
4. The volume of a gas can change.
5. Gases can flow.
6. Gases can be compressed. (COMPRESSION)
7. Gases can diffuse. (DIFFUSION)
8. Diffusion is quicker if the gas is hot
9. Gases expand when are heated. (EXPANSION)
10. Gases contract when are cooled.
11. Gases press equally in all directions.
12. Gasses pressure increase with temperature.

Students will work in small groups and choose two of the properties or behaviours of gases to study them. They will prepare a poster where they explain which are the macroscopic properties and give the microscopic reasons using the Kinetic Theory of Matter.

The students can hang the posters in the walls of the class. They have to prepare a small talk to explain to the rest of the class the property chosen and their microscopic explanation.

Timing

At least four sessions will be needed to complete the activities up to **A17**.

- Session 16: from A8 up to A11. This session should be done in the laboratory mainly for the first activity of the lesson.
- Session 17: from A12 up to A14. It's a lab session.
- Session 18: from A15 up to A17. It's not a lab session. It include the preparation of the poster.
- Session 19: Exposition of the posters.

Resources

- Equipment for lab activities **A8**, **A13** and **A14**.
- Set of cards with the steps for the dancing coin.
- Video or animation that explains the pressure of gases with the particle model.

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities and speaking activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

- **A8** and **A9** has been adapted from: http://books.nap.edu/openbook.php?record_id=11882&page=45

A14. Instructions for the dancing coin.

Leave the bottle in the fridge so the air in the bottle will cool
Use your finger to spread some water over the lip of the bottle's opening
Place the coin on the thin film of water.
Let the gas in the bottle warm and observe what happens.

A16. DEFINITION BINGO

TO CONTRACT	To get smaller, often because of cooling
TO EXPAND	To get bigger, often because of heating
GAS	State of matter that can change shape and volume easily.
LIQUID	State of matter that can change shape easily but not volume.
MASS	How much stuff there is in a substance, measured in grams
MOTION	Another word for movement
PARTICLES	The very small objects that gases are made up of
SOLID	State of matter than cannot change shape and volume easily.
STATES OF MATTER	Solid, liquid or gas are
VOLUME	The amount of space something takes up
TO COMPRESS	To quash into a smaller space
TO DIFFUSE	To move of gases or liquids from an area to another with less concentration.
GAS PRESSURE	Caused by gas particles hitting a surface
MATTER	Anything that has mass and takes up space

3.3. Boiling water for the tea.

Aim: To study changes of states.

Teaching objectives

Content

- Changes of states.
- Boiling point.
- Melting point.

Communication

- Making questions and giving answers.
- Using predicting structures.
- Using the past tense to describe how they did the experiment.
- Using comparatives and superlatives.
- Listening.

Cognition

- Recognising the state changes in quotidian processes.
- Making prediction about the change of temperature of water while is being heated.
- Looking for mistakes according to a diagram.

Outcomes:

At the end of the lesson, students will be able to:

- Recognise the different state changes.
- Record the data of the experiment and draw a graph with them.
- Know how to determine the melting point of substances.
- Recognise a pure substances or a mixture according to the changes of temperature during a state change.

Procedure:

A18. This is an introductory activity where the students will look for state changes they already know. Students will give examples in their own language in case they cannot say in English and the teacher will translate them.

A19. In this activity, the name of the different state changes is introduced to the students. The first part is an oral activity. Teacher will explain with short sentences each state change, then one student of each pair will ask to the fellow the name of the state change that the teacher has explained. The sentences to be read by the teacher are:

Melting is the process where ice turns into water.

Freezing is the process where water turns into ice.

Vaporisation is the process where water turns into vapour.

Condensation is the process where vapour turns into water.

Sublimation is the process where ice turns into vapour.

Inverse sublimation is the process where vapour turns into ice.

In the second part of the activity, a set of cards is given to each group of two or three students. Each card contains the letters of each state change. Students have to order the letters of word. Once he/she has finish, he/she will explain to the other members of the group and will write down in the correct place of the diagram.

A20. Here the students have to complete the table with the initial and final state of each change (this is a revision of the previous activity). And then, they have to think if heat is added or removed when this process is produced.

A21. This activity introduces a cooking technique where a state change is taking place. Moreover the Maria Bath will allow us to introduce another idea; temperature is constant during a state change. Here the students are asked to look for a recipe where this technique is used and a reason for using this technique.

A22. This is a lab activity where students will check if the temperature of water changes while boiling. At the beginning as in other previous activities, the students have to identify the equipment they are going to use and how is going to be the assembly. Then, they are asked to carry out the experiment. They have to record the temperature each minute while heating the water until it starts to boil and four or five minutes more. Then, they have to draw the graph temperature vs. time. If students are not used to draw graphs, extra time will be needed. To make an explanation, they have a jumbled sentence to order.

During the boiling point the temperature is constant because the heat is used for the state change.

A23. This activity introduces the fats we use in the kitchen for cooking and also a new state change (melting). Students are asked for the differences between the fats more used in Spain and UK. And also, what they now about the melting of these fats. Probably, the students will say that oil doesn't melt because is a liquid. The teacher will make them remember than when we put the oil in the fridge it solidifies.

A24. In this activity, the procedure to determinate the melting point of substances is introduced. First, in the diagram is shown the assembly of the equipment to carry out the experiment. The students will label the equipment and they will read carefully the steps of the procedure for the determination of the melting point of

substances. They have to underline the mistakes. Then, the teacher will read the correct steps and students have to correct the wrong sentences.

Determination of the melting point of fats.

1. Add 5 g of each fat to investigate to each **test tube**.
2. Introduce the **test tubes** in a beaker **with** water.
3. Put all in the fridge until the fats are completely solidified. ✓
4. Put the beaker **above** the tripod.
5. Introduce the thermometer in the water and hold it **without** touching the bottom of the beaker.
6. Record the first temperature. ✓
7. Start heating slowly. ✓
8. Record the temperature when each fat starts to melt and also how long it takes to be completely melted. ✓

A25. This is the lab activity where students will check their knowledge about fats. In the hypothesis, the students have to make the relation between the substance that melts first and which is temperature of its melting point. And next, they have to predict which substance will have the lowest or the highest melting point, as well as, which will melt the first or the last.

In order to carry out the experiment, the students follow the procedure given in the previous activity. To check their hypothesis, they have to decide the data they want to record, they should be the melting order of substances (which melts first, second and the last one), the temperature of water when starts to melt and the final temperature when finish melting. They will record this date in the table. Once they have finish they go back and write down what they have done in the past tense (they can use the steps of A24. Next, they complete the conclusions and answer the new questions. The last question introduces the fact that pure substances don't change the temperature during the state changes but mixtures do.

Timing

At least three sessions will be needed to complete the activities up to A10.

- Session 20: from A18 up to A22. This is not a lab session. A20 can be set as homework. It's interesting to introduce the A22 so they can carry out the experiment the next session.
- Session 21: from A22 up to A23. This is a lab session. Last activity can be set as homework if there is no time.
- Session 22: from A24 up to A25. This is a lab session. Test tubes can be previously prepared with the solid fats and it will be needed less time.

Resources

- The set of cards with jumbled words corresponding to the state changes for **A19** for each group of students.
- Equipment for lab activities (A22 and A25)

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities and speaking activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

Activity of determination of the melting point of different fats from:

- Eulàlia Albadalejo. *La química de la cuina.* Edicions de la Magrana. Barcelona, 1993.

Interactive activities:

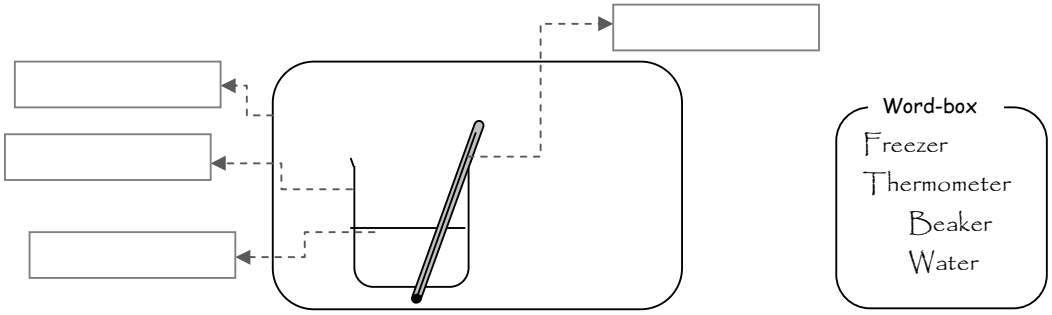
- http://www.bbc.co.uk/schools/ks2bitesize/science/activities/solids_liquids.shtml interactive activity, melting point of different solids
- http://www.bbc.co.uk/schools/ks2bitesize/science/activities/changing_state.shtml interactive activity, changing states in water
- Physical changes. BBC Information to be read
- http://www.harcourtschool.com/activity/hotplate/index.html interactive activity, finding the melting and boiling point of different substances

A19. State changes (jumbled words)

dsnainnoeotC	
rienFezg	
poanVositari	
aSilbiutmno	
vreesIn tubiimnosla	
gliMent	
ecI	
eatrW	
eSatm	

EXTRA ACTIVITIES

What happens when we freeze water? Does the temperature change?

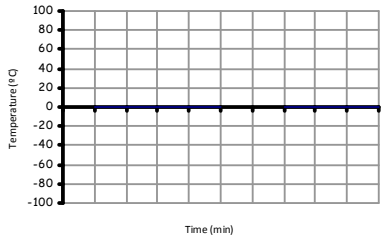


Predict: Write and make a graph of your predictions.

.....

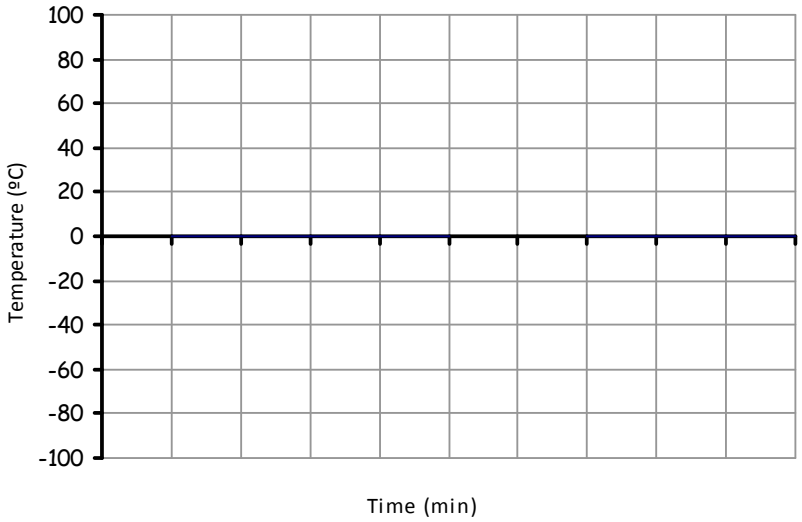
.....

.....



Observe: Start heating the water and write down the temperature each ten minutes. Record the temperatures in a chart and draw a graph.

Time (min)	
Temperature (ºC)	



1) What happens at the beginning when we cool the water?
2) When water starts freezing?
3) What happens with temperature while water freezes?
4) What happens with temperature once water has turned into ice?

✍ **Explain:** Write your explanations.

……

……

……

Which is the relation between the freezing and the melting point?

Predict: At what temperature do you think ice will melt?

I think that ……

Do the experiment: Remove from the freezer the container of ice with the thermometer in it that you made in the last experiment. Record the temperature of ice as you begin each 5 minutes. Wait until the thermometer bulb is no longer imbedded in ice.

At what temperature does ice melt?

How does this temperature compare with the freezing temperature of water?

✍ **Explain:** Write your explanations.

……

……

3.4. How does the pressure cooker and the coffeemaker work?

Aim: To explain the states of matter with the particle theory..

Teaching objectives

Content

- The Kinetic- Molecular Theory of matter.
- Macroscopic properties and microscopic explanations.

Communication

- Correcting false statements.
- Explaining macroscopic properties.
- Writing a text using other as a model.

Cognition

- Explaining the state changes of matter using the Molecular Kinetic Theory.
- Explaining the macroscopic properties of the different states of matter using the Molecular Kinetic Theory.
- Predicting other properties or behaviours of the matter with the Molecular Kinetic Theory.
- Applying the Molecular Kinetic Theory of matter to understand the working of a pressure cooker and a coffeemaker.

Outcomes:
At the end of the lesson, students will be able to:

- Explain the state changes of matter at a microscopic level using the Molecular Kinetic Theory.
- Explain the macroscopic properties of the different states of matter at a microscopic level using Molecular Kinetic Theory.
- Understand how a coffeemaker and a pressure cooker work.

Procedure:

A26. This is a revision activity. The students have to decide if the statements are true or not and modify them if they are false.

✓*Gases are made up of very small particles.*

✗*Particles in gases ~~don't move~~ are in constant movement.*

✗*Particles in gases are ~~touching each other~~ separated by a big space.*

✓*Gases can be compressed because particles are far apart.*

✗*The higher the temperature of a gas, the ~~lower~~ higher the speed of its particles.*

✓*Air pressure is caused by particles of the gas hitting objects and walls.*

A27. This activity is to make the students think about the particle model. Is it only for gases? What happens when a gas is cooled? The students have to read the text and complete the gaps. The text will help the students to argue why we can say that all states of matter are made up of particles.

*Gases are made up of **tiny particles** and gases can easily change into liquids or solids.*

*When a gas is cooled, particles move **slower**. The forces between particles are **bigger**. Therefore, the particles start to approach*

*Liquids are made up of **tiny particles**.*

*When a liquid is cooled, particles move **slower**. The forces between particles are **bigger**. The particles take a fixed position and lose their motion. From now, particles only vibrate.*

*Solids are made up of **tiny particles**.*

A28. Now, students have to apply what they have learnt by explaining the opposite processes. What happens at a microscopic level when a solid is heated and turns into a liquid? And with a liquid when it turns into a gas? A similar text will be written by the students. This activity is more difficult to the students because they have to create the text. Teacher can help them but also allow them to use the text in the previous activity.

A29. The following activity the students have to identify what they have learnt about the microscopic structure of the different states of matter. First, they have to identify the molecular representations and after, the explanations.

A30. If the Kinetic Molecular Theory is valid also for liquids and solids, it has to give an explanation to the properties of liquids and solids. In this activity, students are ask to use the Kinetic Molecular Theory of matter to explain the different properties of solids and liquids.

*Liquids can flow because **particles can move around.***

*Solids have a fixed shape because **particles are touching in a regular pattern.***

*Liquids cannot be compressed because **particles are touching.***

*Liquids don't have a fixed shape because **particles are touching and randomly arranged.***

Depending of the level of the students, the teacher can write on the board the different endings and ask the students to match with the beginnings.

A31. This is an application activity. Students have to apply what they have learnt to make up an explanation for the working of a pressure cooker and a coffeemaker.

Timing

At least two sessions will be needed to complete the activities up to A10.

- Session 23: from A26 up to A28. It's not a lab session.
- Session 24: from A29 up to A31. It's not a lab session.

Resources

- Revision activity that can be set as homework.

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities and speaking activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

- http://www.harcourtschool.com/activity/states_of_matter/index.html An interesting animation that shows how the different states are with the molecular model:
- http://mutuslab.cs.uwindsor.ca/schurko/animations/waterphases/status_water.htm animation states of matter and Kinetic Molecular Theory
- Particle model of matter. BBC revision
- http://www.harcourtschool.com/activity/states_of_matter/index.html animation, shows how the different states are with the molecular model
- http://www.harcourtschool.com/activity/science_up_close/408/deploy/interface.html animation, explains evaporation and condensation (equilibrium)

Revision activity: Fill the gaps of the next sentences.

1. A liquid and a _____ have a fixed volume.

2. Particles in a _____ are touching and randomly arranged.

3. The _____ a state of matter is, the faster the particles move.

4. A _____ can be compressed because the particles are far apart.

5. _____ and liquids can be poured because the particles can move around.

6. When a substance expands, the _____ move further apart.

7. _____ and _____ cannot be compressed.

8. Particles in a _____ are touching and in a regular pattern.

9. A _____ has a fixed shape.

10. Particles in a _____ are far apart and randomly arranged.

11. The smell of a perfume spreads through the air by _____.

12. A _____ has no definite volume.

13. Particles move in a solid by _____.

14. When a solid is heated up, it can change to become a _____.

15. A liquid and a _____ have a shape that changes.

16. A _____ does not flow.

17. Air pressure is caused by particles in the air _____ objects.

18. A _____ has the shape and volume of its container.

19. When particles are heated, they move faster because they have more _____

20. When a _____ is cooled, the particles move slower, they start to approach and it can change to become a liquid.

Word-box

gases	solid	solids	liquid
gas	vibration	hotter	diffusion
gas	solid	solid	gas
energy	liquid	gas	solid
hitting	gas	particles	liquids gas

3.5. Making ice-cream

Aim: To check that the freezing temperature of water decreases when salt is added.

Teaching objectives

Content

- The freezing point.
- The decreasing of the freezing point when salt is added to water

Communication

- Predicting or making hypothesis.
- Describing what you are going to do.
- Drawing conclusions.

Cognition

- Making hypothesis about what makes the melting point decrease.
- Recording the results of an experiment in tables.
- Drawing graphs to interpret the results of the experiment.
- Comparing hypothesis with the results of a experiment.

Outcomes:
At the end of the lesson, students will be able to:

- Understand why salt is added to ice to make ice-cream.
- Recognise a mixture because the freezing point has been modified.
- Compare student hypothesis with the actual results of a experiment.
- Determinate the temperature at which water freezes.

Procedure:

A32. This is an oral introductory activity. The teacher will ask to the students if they have ever done an ice-cream or ice pops before and what they needed. The aim of the activity is realise that they need something to cool the mixture, and this can be a fridge.

A33. This is also an oral activity. While students say their answers, the teacher will write on the board the keywords or main sentences that summarises the answer of the group. At the end, students will copy the answers. The aim of this activity is that they ask at home how ice-creams were made without freezer, just as an introduction to the lesson as also to increase their curiosity; how were ice-creams made without freezer? how does this procedure work? If they don't found how ice-creams were made without freezer, the next activity will do the same work of increase the curiosity.

A34. Students are going to prepare ice-cream in the classroom. What do they have to do? In this activity, they have the steps, but the sentences are broken. Students have to match the beginning of each instruction with the appropriate ending. Then, they complete the recipe for the ice-cream.

RECIPE: Ice-cream

Ingredients:

- One cup of milk
- One half-teaspoon of vanilla
- One teaspoon of sugar
- 6 tablespoon of salt
- Crusted ice

Equipment:

- Two zip lock bag (one of half litre and a smaller one)
- A plastic spoon

Procedure:

1. Add the milk, the sugar and vanilla to **the small bag and mix.**
2. Close zip lock carefully and **place the small bag in the larger bag.**
3. Surround the small bag with **ice to 1/2 large bag full and add the salt on ice.**
4. Carefully check that the small bag is **perfectly closed and close carefully the larger one.**
5. Shake the bag system for 5 minutes until **the mix hardens into ice cream.**

A35. Last activity of the lesson is a lab activity, the students have to plan theirs research: how can you make the temperature of melting ice lower than 0ºC? Students have to write their hypothesis, the material they need and the method they are going to follow. Once they have all this done, they show it to the teacher, and then they can start the experiment. They record the dada they need and interpret them with a graph. Finally they write their conclusions. If it's necessary, the teacher can write on the board the expressions and vocabulary that students can have.

Hypothesis:

If we add salt to the ice, the temperature of the water and ice will decrease, this means that the melting point has decreased.

Material needed:

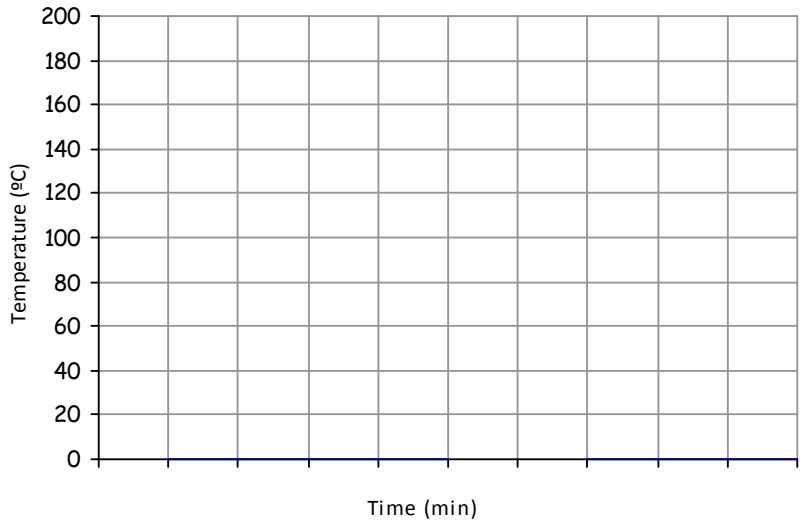
Ice cubes, beaker, salt and thermometers.

Method:

1. *Add about 2/3 ice and 1/3 water in the beaker.*
2. *Gently stir with a thermometer and record the temperature every 2 minutes for 6-8 minutes.*
3. *Add one teaspoon of salt and repeat the process.*
4. *Add one more teaspoon of salt and repeat the process.*

Results:

Time (min)	
Temperature (°C)	



- h o m e m a d e i

Conclusion:

When salt is added to ice, the temperature of the water and ice decrease, this means that the melting point has decreased.

Mixtures change their melting point.

Timing

At least three sessions will be needed to complete the activities up to A10.

- Session 25: from A32 up to A34. This session doesn't need to be held in the lab. If there is enough time, it will be interesting to ask to the students to start to plan their experiment for the next activity.
- Session 26: (A35) This is a lab activity. Students have to plan and carry out their experiment.

Resources

- Equipment and substances to prepare the ice-cream.
- Lab equipments and substances for the experiment in **A35.**

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities and speaking activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

- http://www.chatham.edu/pti/Kitchen_Chem/BCleveland_01.htm Frozing orange cubes
- http://www.chatham.edu/pti/Kitchen_Chem/Snodgrass_01.htm making ice-cream
- http://www.chatham.edu/pti/Kitchen_Chem/Zanetti_01.htm home made ice-cream
- http://www.york.ac.uk/res/sots/activities/redhotcool.htm#pagetop more icecream
- http://teachers.net/lessons/posts/4014.html making ice cream

Unit 4. Let's go to mix up the ingredients!

4.1. Breakfast with mixtures or classifying the mixtures.

4.2. Rock candy or how to crystallise a pure substance.

4.3. Vegetable soup or how to separate by filtration.

4.4. Salad dressing and mayonnaise or emulsions in the kitchen.

4.1. Breakfast with mixtures.

Aim: To know what a mixture is and what types of mixtures there are.

Teaching objectives:

Content

- Mixtures: homogeneous and heterogeneous.
- Solutions and suspensions.

Communication

- Listening to a text and organizing the main ideas.
- Giving instructions.
- Comparing and contrasting ideas.

Cognition

- Being able to differentiate between a homogeneous and heterogeneous mixture.
- Giving reasons to classify a mixture as homogeneous or heterogeneous.
- Identifying real mixtures according to the definitions.

Outcomes:

At the end of the lesson, students will be able to

- Know what a mixture is.
- Differentiate between a homogeneous and heterogeneous mixture.
- Know what a solution and a suspension are.

Procedure:

A1. The first activity is to encourage the students to think about common mixtures that they know and propose new ones. They have to do a first attempt of classification with their own criterion.

A2. The teacher will give out a set of cards with the key words of the text to each group of 3 or 4 students. First, these words will be commented and translated if necessary. Then, the teacher will read the next text about the differences between homogeneous and heterogeneous mixtures. While listening, the students will have to decide if the key words refer to homogeneous or heterogeneous mixtures.

A mixture is a combination of substances. There are different types of mixtures,

Homogeneous mixtures have the same uniform appearance. Homogeneous substances have one phase and uniform composition. If you observed a homogeneous mixture under a microscope, you would see that the particles of various components are equally distributed.

In **heterogeneous mixtures**, you can see more than one colour or type of matter. Heterogeneous substances have more than one phase and a non-uniform composition. If you observed a heterogeneous mixture under a microscope, you would see that the particles of various components are not equally distributed.

Adapted from http://www.saskschools.ca/curr_content/science10/unita/redon12.html

A3. With the information taken from A2, the student should be able to classify some of the mixtures of A1 in homogeneous or heterogeneous mixture. They will also write down which of them they cannot classify and the reason. One possible reason can be that they cannot appreciate the particles to the naked eye.

A4. A copy of all the text used in A2 will be given to the students to do this revision activity.

A5. The students should write a paragraph on the similarities and differences between homogeneous and heterogeneous mixtures using the given structures. http://www.scienceacross.org/index.cfm?fuseaction=content.showcontent&node=348

A6. This is a practical activity. The students will prepare four different solutions with the procedure given. They will describe the mixtures and decide if they are homogeneous or heterogeneous mixtures.

A7. This is an oral activity. They will be organised in groups of four. Each student will be in charge of one of the definitions. He will have to read it aloud while the other students listen to him. At the end, he will ask to the next member of the group which of the mixtures prepared previously is a solution, solution of liquids, suspension or emulsion? The students don't have to take notes, but at the end of the activity each student will have to memorise their own definition.

A8. This is also an oral activity, but in this case they have to take notes of the answers. They don't have to look at the definition cards, they should have memorised them and they should know the answers. The other members of the

group will ask to the person in charge of a definition the questions on the table and will take notes of the answer. At the end of the activity, the answers will be checked in groups.

A9. In this activity, we introduce a third kind of mixture, the colloids, and how to recognise it. Half of the students will read text A and the other half text B. Once they have answered all the questions they can, they will work in pairs (one student A and one student B) and each one will ask his/her own non-answered questions.

A10. In this activity, the students have to plan their own experiment to find which liquids are colloids and which ones are solutions.

Timing

At least three sessions will be needed to complete the activities up to A10.

- Session 27: up to A5. This session doesn't need to be held in the lab. The last activity can be set as homework.
- Session 28: It's a lab session. It will include experiment A6 and then the speaking activities A7 and A8.
- Session 29: It's also a lab session. The experiment is A10.

Resources

- The set of cards with the key words of **A2** for each group of students.
- A copy with the texts of activities **A2**.
- Copy of text A and B for **A8**.
- Lab equipments and substances for **A7** and **A10.**

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities and speaking activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

Text A and B from **A8** have been adapted from:

- Vicki Cobb, Science Experiments you can eat, Penguin Education 1974
- http://home.earthlink.net/~dmocarski/chapters/chapter8/main.htm

Fill gap activity about pure substances and mixtures
http://www.dontstoplearning.com/ks3science/8Fd_Pure_and_Mixtures.htm

Messing with mixtures: worksheet and teacher notes
http://sciencespot.net/Media/messingmixtures.pdf
http://sciencespot.net/Media/messingmixturesnotes.pdf

http://www.saskschools.ca/curr_content/science10/unita/redon12.html
Final test and some explanations

http://galileo.phys.virginia.edu/education/outreach/8thgradesol/MixSoln.htm
Experiments

Set of cards for A2.

UNIFORM APPARENCE	MORE THAN ONE COLOUR OR TYPE OF MATTER
ONE PHASE	MORE THAN ONE PHASE
UNIFORM COMPOSITION	NON-UNIFORM COMPOSITION
PARTICLES OF VARIOUS COMPONENTS ARE EQUALLY DISTRIBUTED	PARTICLES OF VARIOUS COMPONENTS ARE NOT EQUALLY DISTRIBUTED
HETEROGENEOUS MIXTURE	**HOMOGENEOUS MIXTURE**

Set of cards corresponding to A7

Name	Definition
SOLUTION	Mixture of a solid and a liquid in which the solid dissolves. It's stable. It doesn't change when left standing undisturbed.
SOLUTION OF LIQUIDS	Mixture of two miscible liquids (they dissolve). It's stable. It doesn't change when left standing undisturbed.
SUSPENSION	Mixture of a solid and a liquid in which the solid dissolves. It's unstable. Solid particles settle when left standing undisturbed.
EMULSION	Mixture of two immiscible liquids (they don't dissolve). It's unstable. The liquids separate when left standing undisturbed.

Text A corresponding to A8

The Tyndall Effect is an interesting effect that illustrates the sizes of particles in the various types of mixtures. The first person to describe this effect was John Tyndall in the 1800's.

We see most things because they reflect light. We can't see atoms and molecules because they are so small that light waves just pass over them without bouncing back.

If you pass a beam of light through a mixture like dusty air, you can see the beam and its path through the air. This is because the dust particles scatter and reflect light in many directions. Most people have seen this effect in a beam of sunlight in a dusty room or coming from car headlights on a foggy night.

✂.....

Text B corresponding to A8

There is a third kind of mixture with two phases, called a *colloid*. Particles in a colloid are bigger than molecules. They are small enough to remain in suspension permanently. The difference between a colloid and a solution is not obvious; both have a uniform appearance and can't be filtered. There is, however, a simple test that tells the difference. All you need is a glass and a torch.

The particles in a colloid and a suspension are big enough to reflect light. If you pass a beam of light through a colloid or a suspension, you can see the beam. These mixtures are always cloudy. This ability to scatter the light is called the Tyndall effect.

Solutions on the other hand are always clear. They do not show the Tyndall effect because the particles are the size of atoms and molecules and are too small to reflect the light.

4.2. Crystallisation (Rock candy)

Aim: To prepare a saturated solution and then separate solute from solvent just by crystallisation.

Teaching objectives

Content

- Components of a solution: Solute and solvent.
- Unsaturated, saturated and supersaturated solutions.

Communication

- Reading comprehension.
- Making sentences.

Cognition

- Difference between dissolution process and melting process.
- Recognise the solute and solvent in a real solution.
- Realise that solubility increases with temperature.

Outcomes:

At the end of the lesson, students will be able to

- Make the difference between solute and solvent in a real example.
- Know that solubility increases with temperature.
- Explain the process of dissolution.
- Recognise unsaturated, saturated and supersaturated solutions.

Procedure:

A11. This is an activity to introduce a possible misconception. The students have to explain the difference between the dissolving and melting process of sugar.

A12. The teacher will give out a set of cards with the steps for the recipe. He/she will encourage the students to put them in order. Then, the teacher will make a demonstration in silent of the recipe and the students will check the order of the instructions. The sentence in italics should be read when it is the moment. At the end, when all the students know the right order, they could stick the cards in the correct order.

Receipt for Rock Candy.

1. Tie one end of the piece of string around the middle of the stick or pencil. Cut the string, if necessary, so that it is a little shorter than your glass jar.
2. Moisten the string with a little water and roll it in the sugar.
3. Put the paper clip on the end of the string to help it hang straight down. Lay the stick over the top of the glass jar so that the string hangs down inside the jar. The end of the string should not touch the bottom of the jar.
4. Put one cup of water in a saucepan.
5. Add a spoonful of sugar in the water and stir. Use a wooden spoon.
6. Continue to add a spoonful of sugar at a time, stirring after each addition until the sugar dissolves. *This solution is now said to be a saturated solution.*
7. Put the saturated solution over a low heat for a few minutes, until the crystals are completed dissolved again.
8. Turn off the heat.
9. Add sugar again, spoonful by spoonful, to the hot solution. Stir after each addition until the sugar dissolves again.
10. When it doesn't dissolve anymore, pour all the remaining sugar from the cup into the pan.
11. Turn the heat on again and continue warming gently until all the sugar is dissolved.
12. Bring it to the boil and continue boiling for about a minute. The solution should be thick and clear and contain no sugar crystals.
13. Remove the solution from the heat, and then pour it into the jar carefully.
14. Gently suspend the prepared string in the solution and let sit at room temperature, undisturbed, for several days.

Adapted from http://www.exploratorium.edu/cooking/candy/recipe-rockcandy.html and http://www.michigan.gov/hal/0,1607,7-160-15481_19268_20778-52395--,00.html

A13. The students read the instructions again carefully and follow them in order to prepare the Rock Candy. They will have to answer the questions in each step or steps.

A14. Activity of reading comprehension.

A solution has two components: the solute and the solvent.

The solvent is the substance in greater amount. It is usually a liquid, although it does not have to be. It is usually water, but it does not have to be. The particles of the solvent are always touching each other.

The solute is the substance in lesser amount. It is usually a solid, although it does not have to be. The particles of the solute are separated by the solvent particles.

Adapted from http://dbhs.wvusd.k12.ca.us/webdocs/Solutions/Intro-to-Solutions.html and Vikki Cobb book

A15. Comprehension of the text in A11. They have to complete a diagram with the information of the text.

A16. In this activity, the students are supposed to apply the content of the previous text in order to draw a microscopic view of the solution.

A17. Revision of keywords. The teacher will encourage students to explain the meaning of the concepts in their own words. And then they will complete the diagram.

A18. In this activity they will match the keywords with their definition. First, they will have to order the sentences with the descriptions. The answers should be:

Solution: A clear and homogeneous mixture of two or more pure substances.

Solute: The component of the solution in lesser amount that is dissolved by the solvent.

Solvent: The component of a solution in greater amount that dissolves the solute.

Saturated solutions: Solutions that hold as much solute as is possible

Unsaturated solutions: Solution in which more solute can be dissolved.

Supersaturated solution: Solutions that have more than the normal amount of solute dissolved that are unstable and can

Aqueous solution: A solution of any substance in which solvent is water**.**

Timing

It will at least take two sessions to complete the activities corresponding to this part of the unit.

- Session 30: (A11-A13) It's a lab session. The session will be introduced by A11 then we will pass to the preparation of the experiment. Maybe an extra session is needed to carry out the experiment.
- Session 31: (A14-A18) It is not a lab session. The last activity can be set as homework.

Resources

- Set of cards for **A12**.
- Lab equipments and substances for **A13.**

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

Extra information about the process of solution in
http://www.chem4kids.com/files/matter_solution.html

Recipes to make the Rocky Candy have been obtained in:

- Vicki Cobb, Science Experiments you can eat, Penguin Education 1974
- http://www.exploratorium.edu/cooking/candy/recipe-rockcandy.html
- http://www.michigan.gov/hal/0,1607,7-160-15481_19268_20778-52395--,00.html

Set of cards for A12.

When it doesn't dissolve anymore, pour all the remaining sugar from the cup into the pan.
Turn the heat on again and continue warming gently until all the sugar is dissolved.
Turn off the heat.
Tie one end of the piece of string around the middle of the stick or pencil. Cut the string, if necessary, so that it is a little shorter than your jar.
Remove the solution from the heat, and then carefully pour it into the jar.
Put the saturated solution over a low heat for a few minutes, until the crystals are completed dissolved again.
Put the paper clip on the end of the string to help it hang straight down. Lay the stick over the top of the glass jar so that the string hangs down inside the jar. The end of the string should not touch the bottom of the jar.

Put one cup of water in a saucepan.
Moisten the string with a little water and roll it in the sugar.
Gently suspend the prepared string in the solution and let sit at room temperature, undisturbed, for several days.
Continue to add a spoonful of sugar at a time, stirring after each addition until the sugar dissolves. This solution is now said to be a saturated solution.
Bring it to the boil and continue boiling for about a minute. The solution should be thick and clear and contain no sugar crystals.
Add sugar again, spoonful by spoonful, to the hot solution. Stir after each addition until the sugar dissolves again.
Add a spoonful of sugar in the water and stir. Use a wooden spoon.

4.3. Vegetable soup

Aim: To know how to separate the components of a suspension and how the size of the particles separated depend on the size of the holes of the filter.

Teaching objectives

Content

- Separating the components of a suspension.
- Relation between the size of the particles to be separated and the size of the filter holes.
- Settling rates.

Communication

- Using comparatives and superlatives.
- Making predictions.
- Giving reasons.

Cognition

- Understanding the relation between the size of the filter holes and the particles that can be separated.
- Relating the size of the particle with the settling rates and also with the stability of the suspension.

Outcomes:

At the end of the lesson, students will be able to

- Know how to separate the particles of a suspension.
- Understand that suspensions with small particles are more stable.

Procedure:

A19. It's an observation activity. The aim of this activity is that the pupils get used to the suspension and revise again the concept of heterogeneous mixtures.

A20. It's a POE activity about the relation of the size of the filter holes and the size of the particles that have been separated. The students have to make a prediction to answer a simple question. Then they conduct the experiment and observe if their prediction was correct or not. Finally, they make an explanation of the result.

A21. It's another POE activity, but this time about the relation between the settling rate and the particles size.

A22. In this activity, the students have to analyse two different facts about the settling rate of three suspensions and their ability to be filtered and relate it with the size of the particles. They will use comparative sentences to write down the answers.

A23. This final activity is meant to make the students think about the size of the particles in a solution and a suspension again, now that they have studied this more in depth.

Timing

It will take at least two sessions to complete the activities corresponding to this part of the unit.

- Session 32: (A19-A21) It's a lab session. A20 will take longer, but A21 should not take long.
- Session 33: (A22-A23) It is not a lab session. They can finish their reports on experiments in A20 and A21 and do the final activities.

Resources

- Lab equipment for experiments A20 and A21. Also a vegetable soup will be needed.

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly in practical activities.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

Activities about separation of mixtures:

- http://www.harcourtschool.com/activity/mixture/mixture.html
- http://www.chatham.edu/pti/Kitchen_Chem/Pater_01.htm activities and experiments to separate salad dressing, the iron from cereals and chromatography.

4.4. Salad dressing and mayonnaise

Aim: To study a stabilized and un-stabilized suspension.

Teaching objectives

Content

- Unstable emulsions
- Miscible and immiscible liquids.
- Emulsifiers and stable emulsions.

Communication

- Using comparatives and superlatives.
- Writing a report.
- Giving reasons.

Cognition

- Relating the size of the droplets in an emulsion and its stability.
- Designing an experiment to check which substances are emulsifiers and which are not.
- Relating the chemistry of the emulsifiers with a quotidian substance (mayonnaise)

Outcomes:

At the end of the lesson, students will be able to

- Understand what an emulsion is and give quotidian examples.
- Use new concepts as miscible and immiscible.
- Explain the relation between the size of droplets and the stability of an emulsion.
- Understand what an emulsifier is and know how to recognise it.

Procedure:

A24. The first activity is just to introduce the vinaigrette. It could be prepared at school or asked to be prepared at home. Changes can be introduced also to the recipe. At the end just a question that can be answered to introduce the new mixture we are going to work with.

A25. This is an application activity. They have already studied the behaviour between oil and water. What can we expect of a mixture of oil and a water-based substance? They have just to complete the text. The answers are:

*Vinaigrette salad dressing is a mixture of **water**, **oil** and seasoning. Vinegar is a water-based substance and is also **immiscible** with oil. Vinegar **doesn't dissolve***

in water. In order for all flavours of the dressing to be evenly spread through the salad, it must be thoroughly mixed. To use the vinaigrette, you have to ***shake*** *it vigorously and immediately* ***pour*** *on a salad before the two liquids have a chance to* ***separate.***

A26. The proposed experiment can be something like this:

Material: oil, water, a jar with a tight cover, a watch with a second hand and a magnifying glass.

Procedure:

1. Pour the vinegar and oil in the jar.
2. Screw the lid and shake about 10 times. Use the watch to see how long it takes for the mixture to separate. Use the magnifying glass to examine the size of the droplets immediately after shaking.
3. Shake the jar hard about 15 times. Again, measure how long it takes for the mixture to separate and examine the size of the droplets immediately after shaking.
4. Shake the jar several times, measure how long it takes for the mixture to separate and examine the size of the droplets immediately after shaking.

Results: the table to record the results can be something like this,

Number of shakes	Size of the droplets	Time to separate

If the students have problems to design the experiment, we can give them the next help notes.

- the size of the droplets change when you shake more and more the mixture.
- the watch can be used for checking how long it takes for the mixtures to separate.
- the magnifying glass can be used to examine the size of the droplets.

A27. First, the teacher will write up any difficult words or phrases from the text and give the translation to the mother tongue. The teacher will ask students to listen and repeat the English words.

immiscible/miscible, milky or cloudy appearance, emulsion , emulsifier, droplets, stable/unstable, float to the surface, disperse, continuous/discontinuous phase

The students will get into circles of five. The teacher will give out one set of five slips for each group of five. These slips contain the text divided into 5 sections. The students will be asked to read their slip to each other and then to work out the correct order of the text. They must always keep their own slip of paper. They should know that slip number 1 has the beginning of the text. The student who has the first part of

the text has to read out their slip. Then the rest of the group has to read their slips in their chosen order to check that they are correct.

Once they are done, one of the groups will be chosen to read out their text in their chosen order. The whole class listens and checks.

Take in the slips and give out one copy of the text for each student. They will cut the text and paste in its place. Each student has to write down a question and its answer about the text.

EMULSIONS AND EMULSIFIERS

An emulsion is a mixture of two immiscible liquids. Emulsions have a milky or cloudy appearance, they are made up of small droplets of one substance (the discontinuous phase) dispersed in the other (the continuous phase). One example is vinaigrette. When you shake the vinegar and oil to make the vinaigrette, shaking causes the vinegar (the discontinuous phase) to break up into tiny droplets and disperse throughout the oil (the continuous phase). Vinaigrette is a non-stabilized emulsion because the mixture of vinegar and oil separates when left standing. In this process, the vinegar droplets grow larger and larger, and the oil droplets grow larger and larger. Then, the large oil droplets float to the surface or the vinegar. If the droplets are smaller, it takes longer to separate the mixture; we can say that the emulsion is more stable. But, if you add a certain third substance to a mixture of oil and water, you can stabilize the mixture and prevent the separation. The result is a stablilized emulsion of two immiscible liquids. The substance that stabilizes this mixture of two immiscible liquids is called emulsifier.

A28. The proposed experiment has been taken from:

http://www.practicalchemistry.org/experiments/intermediate/food/emulsifiers,125,EX.html

Material: Boiling tubes and stoppers, disposable teat pipettes, spatulas or small spoons, oil, detergent, sugar, flour, mustard, egg white and egg yolk.

Procedure:

1. Put about 2 cm^3 of oil into a boiling tube. Add about the same amount of water. Put a stopper into the top of the tube and shake it – it should be the same for all the substances, so a number of equal shakes should be accorded. Remove the stopper and leave the mixture to stand. Observe what happens.

2. Repeat the experiment but add a small quantity of one of the substances you are testing before you shake the tube. The quantity of substance should also be kept constant, as the number of shakes and the quantity of oil and water.
3. Test all the substances in the same way to find out which one acts as emulsifiers.

Results: the table to record the results can be something like this,

Substance	Number of shakes	Size of the droplets	Time to separate

A29. In this activity the students will apply what they have learnt to a something quotidian, the process of making mayonnaise. If the students haven't seen it before and they show an interest, it could be a good idea to prepare this dressing.

Timing

It will take at least two sessions to complete the activities corresponding to this part of the unit.

- Session 34: (A24-A27) Lab session. The first two activities shouldn't take very long, but A26, as they have to design the experiment and carry it out, maybe takes the last part of the session. If there's enough time A27 can be introduced.
- Session 35: (A27-A29) Lab session. Again the designing of the experiment can take some time. So, when A27 is finished then they can start to design the experiment. A29 can be set as homework; otherwise you will need an extra session to prepare the mayonnaise.

Resources

- Set of cards with the text of **A27**.

Assessment

- In this part of the unit, assessment will include:
  - Observation in class, mainly when students organise themselves to design the experiments and when they carry them out.
  - The way all the activities are developed and completed.
  - Lab reports.

Bibliography and other resources

The idea of the experiment in A26 has been taken from http://www.practicalchemistry.org/experiments/intermediate/food/emulsifiers,125,EX.html

Text used in **A27** has been adapted from:

- Vicki Cobb, Science Experiments you can eat, Penguin Education 1974

Video on how to prepare a Lemon Vinaigrette:
http://www.bbc.co.uk/food/get_cooking/main/index.shtml

Set of cards for A27

1 An emulsion is a mixture of two immiscible liquids. Emulsions have a milky or cloudy appearance. They are made up of small droplets of one substance (the discontinuous phase) dispersed
in the other (the continuous phase). One example is vinaigrette. When you shake the vinegar and oil to make the vinaigrette, shaking causes the vinegar (the discontinuous phase) to break up into
tiny droplets and disperse throughout the oil (the continuous phase). Vinaigrette is an non-stabilized emulsion because the mixture of vinegar and oil separates when left standing. In this process, the vinegar droplets grow larger and larger, and the oil droplets
grow larger and larger. Then, the large oil droplets float to the surface or the vinegar. If the droplets are smaller, it takes longer to separate the mixture; we can say that the emulsion is more stable. But, if you add
a certain third substance to a mixture of oil and water, you can stabilize the mixture and prevent the separation. The result is a stabilized emulsion of two immiscible liquids. The substance that stabilizes this mixture of two immiscible liquids is called emulsifier.