Unit 4: Teaching Science in English (Secondary)

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Topic: States of Matter. (Chemistry).

School: International Centre of an English public school.

Class: Year 7 to Year 9 students in Secondary Education (i.e. age 11-14).

Previous knowledge of L2: Students are in their third year of learning English or have just completed an immersion course. International students at Rossall entering the school with little or no knowledge of English (L2) will follow a total immersion course in English for two terms before starting a content subject. This lesson will be the first lesson in science that these students will encounter after completing the preliminary language course.

Previous knowledge of subject: None required.

Time allowed: Two lessons of eighty minutes each.

General Objective: to enable the students to gain preliminary knowledge of the concepts and terminology of the particle theory of matter.

Specific Subject Knowledge Objective:

Students will:

- recognise and understand the differences between solids, liquids and gases in terms of their properties.

Specific Linguistic Objectives

Students will:

- be able to read, understand and use simple adjectives;
- be able to read and understand subject-specific vocabulary;

- be able to take part in simple discussions, e.g. justifying, asking for repetition and clarification;
- be able to ask for definitions;
- be able to ask and answer questions orally relating to their own observations;
- be able to write simple sentences and definitions;
- be able to conduct a group experiment in English;
- become more aware of present, past and future tenses in English;
- be able to read and understand simple instructions.

General Language Support:

As in the other units, subject matter knowledge has formed the basis of our planning and we have then looked at the language input required to achieve the specific subject knowledge objective through teaching in the L2. Most language support in this unit appears in the appropriate column in the lesson plan. It focuses on enabling the students to perform the given task in the L2 and generally comprises visual support, ideas for differentiation, indications of the need to paraphrase and ideas for making the different tasks more purposeful, fun, challenging and motivating. Much of the linguistic input focuses on classroom interaction and structures required for general communication (e.g. discussing, giving opinions, agreeing, disagreeing, justifying, evaluating, etc.) which can embrace a whole range of subject-specific, not necessarily scientific, vocabulary. We accept that a limited amount of code-switching does have a role to play in certain circumstances, particularly if one student can quickly clarify a concept with one word of L1 (e.g. when international students at Rossal School have to complete an International GCSE syllabus under pressure of time). However, we feel that the teacher should introduce basic rules for code-switching from the very beginning. We have tried here to show ways of generally establishing a routine for using the L2, particularly in group and pair work. We have done this by integrating a limited number of techniques into the science lesson: e.g. team competitions (which could be ongoing and could be linked to awarding the use of L2), time constraints, encouraging students to speculate and guess, creating a sense of audience and "teach and test" pair work activities.[i] We have looked carefully at the language involved and realise that both lessons provide an excellent opportunity to revise present and past simple and continuous tenses. As with all aspects of the two lessons, teachers may wish to explore this in more detail. We have included all four skills; listening (to the teacher and each other), speaking (to the teacher and each other), reading (labels, visual support, putting the method of an experiment into the correct order) and, to a more limited extent, writing (with the necessary support).

States of Matter - Lesson 1 (80 minutes).

STAGE	TEACHER ACTIVITY	STUDENT ACTIVITY	MATERIALS AND RESOURCES	LANGUAGE SUPPORT
1. Identifying and categorising solids, liquids and gases. 1.1 Encouraging students to identify and categorise the different states of matter by deduction.	1. The teacher (T) sets up the activity; the class is divided into groups. Each group is given nine objects, placed randomly on the table or on a tray in front of them. T asks the students (S) to sort them into three groups with three items in each group using words on the OHT to help them. 2. T moves from team to team, paraphrasing any unknown vocabulary items (e.g. 'runny') and asking them to justify their choice. T:" Why is that one there?" T continues with the activity until the students have grouped the items into solids, liquids and gases. 3. This is a team competition; the winner is the team that	Group activity/team game. 1. S use OHT support and their own ideas to categorise the objects. S: "That's right." "No, that's wrong." "I think these objects go together because……" "What is runny?" 2. When a team is ready they must put up their hands and shout "Ready!" 3. The first team to make the correct choice with the correct justification wins. S: "These are all … so they go together."" Because it is hard/clear/runny, etc."	• The objects comprise: • three solids; • three beakers containing liquids of various colours; • three balloons filled with helium, air and carbon dioxide respectively. Increase the suspense by covering up these objects and stressing the idea of a race; "Ready, steady, go!" • An overhead projector is required throughout both lessons, largely for pre-prepared visual linguistic support. • OHT 1. • Scoreboard or chart for marking up the competition points.	• Language skills: • reading, understanding and using simple adjectives; • justifying, asking for definitions, simple group discussion. • OHT 1. • Depending on T's attitude to code-switching, the amount of English spoken could become an element of the team competition (i.e. if S use any other language than English they miss a turn at justifying their choice to the teacher). Some bilingual teachers would frown on this and see it as a penalty for using the L1 which is encouraged in some situations (see "Unit 3: Teaching History in French." However, in this particular context, it has the advantage of encouraging

	the winner is the team that categorises the objects correctly first. 4. T marks up the score appropriately.			advantage of encouraging the students to use the visual support to the full and to use the specific language that we are aiming at. T can also use this kind of L2 rule to begin setting up a classroom routine for L2 use in group work. .
1.2. Labelling the three groups.	1. T asks the teams to use the words on the OHT to select a name for each of the three groups.	1. S label each group of items.	• OHT 1. • It is a good idea to use pre-prepared labels; writing here can slow down the pace too much.	• S select vocabulary from OHT 1 if necessary.
1.3. Writing sentences to describe a solid, liquid and gas. Recording the result of S findings. This can again be done as a team game; giving points for content, accuracy and presentation.	1. T asks S in their teams to make up sentences using the words on the OHT to describe a solid, liquid and gas. 2. T asks each group to present their sentences and gets S to vote on which set is the best.	1. S write sentences in groups/pairs on an OHT, using the words on OHT 2 to describe a solid, liquid and gas. 2. S evaluate the OHTs and vote on which is the best.	• OHT 2. • Blank transparencies and OHP pens.	• Writing simple definitions using OHT support (OHT 2). • Possible discussion on accuracy: 'Good', 'Very good', 'Excellent', 'Average', 'Bad', 'That's wrong.' 'That's right', etc. (These words - or other appropriate evaluative phrases should be displayed as visual support as necessary).
2. Observing and identifying the	Solids: Solids keep the same volume and keep the same shape.		• Lego brick, balloon and two empty gas jars.	• Questions and answers. 'keeps the same shape', 'changes shape',

properties of states of matter. In this activity the T carries out a series of experiments enabling the students to record the properties of the different states of matter. 2.1 **Solids:** Solids keep the same volume and keep the same shape:	1. To enable S to deduce the above statement, T places: (a) a small lego brick in a balloon and then asks the question: "Does it change shape or does it keep the same shape?" (b) a small lego brick in the bottom of a gas jar with a flat glass lid and a second jar upside down on it. The lid is then removed and left for two minutes. T asks the question: "Does it change volume or keep the same volume?" "Is the volume of this room big or small?" Is the volume of this balloon big or small?" "Which has the largest volume, the balloon or the room?" Does the room change its volume?"	1. During each demonstration S watch, listen, answer questions orally, complete table on the OHP/Worksheet. (a) S should answer: "It keeps the same shape." (b)The students should answer: "It keeps the same volume." 2. Students choose the correct labels (OHT/Worksheet 3) to complete the table.		'keeps the same volume', 'changes volume'. . • During the two minutes T could ask S to speculate about what is going to happen. This is a good opportunity to get S using the language on the labels and starting a simple class discussion. (Extra visual support will be required: agreeing/disagreeing, etc.) • T will have to be prepared for getting the concept of 'volume' across; possibly using the 'volume of the classroom' as part of a paraphrase or perhaps in terms of 'taking up more or less space.'
2.2 **Liquids:** Liquids change shape and keep the same volume.	Liquids change shape and keep the same volume. 1. To enable the students to deduce the above statement, the T: (a) pours water into a balloon and moves it about; T asks the question: "Does it change shape or does it keep the	1. During each demonstration S watch, listen, answer questions orally, complete table on the OHP/Worksheet. (a) S should answer: "It changes shape."	• Beaker of water, balloon and two empty gas jars.	• Questions and answers. 'keeps the same shape', 'changes shape', 'keeps the same volume', 'changes volume'. • Again T could use a speculation activity during the two minute wait. E.g. a simple multiple choice worksheet, incorporating such language as: 'it changes shape' or even language that

	same shape?" (b) pours water into a gas jar with a flat glass lid and places second jar upside down on the top. The lid is then removed and left for two minutes. T asks the question: "Does it change volume or keep the same volume?"	(b) S should answer: "It keeps the same volume." 2. S choose the correct labels (OHT/Worksheet 3) to complete the table.		will crop up next lesson (E.g. Stage 4: 'leaves the beaker', etc.) • The labelling could be done as a team competition, e.g. who can label the OHT the quickest.
2.3 **Gases:** Gases change shape and change volume.	Gases change shape and change volume. 1. To enable the students to deduce the above statement, the T: (a) blows up a balloon T asks the question: "Does it change shape or does it keep the same shape?" (b) performs an experiment in a fume cupboard. Bromine is put in the bottom of a gas jar with a flat glass lid and a second jar is placed upside down on the first. The lid is then removed and left for two minutes. This time the bromine will spread out between the two flasks. T asks the question: "Does it	1. During each demonstration S watch, listen, answer questions orally, complete table on the OHT3. (This could be copied as a worksheet.) (a) S should answer: "It changes shape." (b) S should answer: "It changes volume." 2. S choose the correct labels (OHT 3) to complete the table.	• Balloon, two gas jars. One filled with bromine, with a lid. This must only be done in a fume cupboard. • OHT 3.	• Questions and answers. 'keeps the same shape', 'changes shape', 'keeps the same volume', 'changes volume'. • This stage is by far the most exciting and lends itself to more speculation during the two minute wait. S can speculate in pairs (do not forget to provide them with the necessary visual support).

	change volume or keep the same volume?"			
2.4 S summarise their findings by making up complete sentences to describe these properties of solids, liquids and gases.	1. T displays OHT 3 again (perhaps with the labels mixed up) and asks students to write complete sentences describing solids, liquids and gases. T should give a time limit and limit the number of sentences.	1. S write complete sentences from the information on the OHP.	• OHP, OHT 3 and labels.	• Depending on S ability the labels on the OHP can be muddled again, blurred, partly covered up, etc., in order to increase the challenge. • This could also be done as a team game against the clock.
3. **Relating properties to structure.** 3.1 The pupils perform an experiment in groups of four.	1. T hands out worksheets detailing how to do the experiment; asks S to identify and name all the apparatus to be used. T also reinforces the safety rules of the laboratory. 2. T observes, checks and questions students while they are carrying out the experiment.	1. S could label apparatus on Student Worksheet 1. 2. S (a) record the temperature of the ice; (b) heat it with a bunsen burner; (c) record the temperature every thirty seconds until two minutes after the water is boiling (T tells them when to stop); (d) complete the table of results: Time, Temperature, Observations. 1-2. One S measures the temperature and shouts it out in degrees. One S is responsible for the time and shouts it out in seconds.	• A block of ice in a beaker, a thermometer, tripod, gauze, bunsen burner and stop watch. • Student Worksheets 1 & 2.	• Student Worksheets 1 & 2. • Throughout the lesson T has paraphrases ready. • Language Support on OHT 4: '…….seconds', '…….degrees'. 'You said 10 degrees, is that correct/right/wrong?' 'Can you repeat that please?' 'What did you say?' 'Yes/No'. • The better linguist records the observations. If T wishes to differentiate the sentences on OHT 4 could also be put

		One S records results and may need to ask for clarification: "You said 10 degrees, is that right?" One S records the observations.		on labels which the S then places or sticks onto the table appropriately: 'It is solid ice'. 'The ice is melting'. 'It is all liquid'. 'Small bubbles of gas are forming'. 'Large bubbles of gas are forming'. 'The water is boiling'. 'Water is evaporating as steam'.
3.2 Preparing a graph.	1. T recaps on how to draw a graph, i.e. which readings are shown on which axis etc.	1. Either individually, in pairs or in groups, S complete a graph to display the results; plotting time on the X axis and temperature on the Y axis.	• Graph paper, rulers, pencils, rubbers.	
3.3 Recapping, summarising and explaining with more scientific vocabulary the findings from experimental data.	1. T then recaps by using a model graph showing changes of state on the OHP. T asks :"What is happening here?" T points to the relevant place on the graph. 2. T gives labels cut out of a transparency to S. T asks S if their graph is like this and asks volunteers to add labels to each plateau on the OHP graph.	1. S compare their graphs with the model and respond to T's questions: " The ice is melting.""Water is evaporating." Etc. 2. S decide in pairs or groups which label (displayed at random on the OHP) is appropriate to which plateau. Volunteers place the labels on the graph.	• OHT 4. • OHT 5: model graph (omit labels shown here when using it in this activity.) • OHT 5 (a): labels cut out of a transparency. • OHT 5 (b) gap-fill labels for activity 3.	• OHT 4 again as language support if necessary. • OHT 5 (a) Labels: these are the "observations" above (3.1) and also: 'Melting', 'Freezing', 'Condensing' (T needs to paraphrase here!) and 'Evaporating'. Or simply the latter, depending on the class. • T could blur these on the OHP as a hint if S have difficulty. S enjoy this kind

.	3. T asks S to label their own graphs. This could be done against the clock or as a team game.	3. S add labels to their graphs (blank copies of the model graph are available as necessary).		of guessing activity. • OHT 5 (b): when S are labelling their own graphs, place half complete labels on OHT 5 for S to fill in the gaps. This will provide visual support while maintaining a challenge and purpose to the writing activity.
3.4 Re-capping the method of the experiment. (Homework).	1. S are given a sheet containing a method of the experiment they have just done.	1. S do reading exercise for homework, re-arranging sentences into the correct order to explain what they did in the experiment.	• Student Worksheet 3.	• This could then be marked in class (with an OHT showing the correct order), as a team game whereby all the members of the group compare their findings (language of negotiation) and win points.

States of Matter - Lesson 2 (80 minutes).

4. **The particle structure of states of matter.** 4.1 Revising the results obtained in Lesson 1. Solids.	1. T marks out a square on the floor big enough for the class to stand in it and take up half the space. 2. T explains to S that they are now particles in the ice or in a solid inside the beaker. Question and answer session: T asks: "Did the ice take up all the space in the beaker?"	1-2. S are standing side by side and close together. Once they are in the square, S respond to prompts from the T with questions as necessary: S*:* "Yes it did/No it didn't".	• Tape to mark out square. • Suitable room. • OHP. • Student Worksheet 3 as an OHT to serve as a reminder.	• The past tense is more authentic here (i.e. referring to the previous lesson). • This could be done in the simple present instead. However, it is important to be consistent. • Team points could be awarded for correct answers in L2.
4.2 Revising the results obtained in Lesson 1. Liquids.	1. T asks S to pretend that they are melting (i.e. to behave as if they were particles in a solid as it becomes a liquid). Question and answer session: T: "What was made when ice or a solid melted?" T: "Did liquid fill up the whole space?" T: "Did the liquid leave the beaker? T: "Did the particles in the liquid fill up the whole space?"	1. S should spread out to fill the whole space. S: "A liquid?" S: "Yes it did/no it didn't." S: "No it didn't/yes it did." Etc.		• Questions and tag endings. Extra visual support on OHP or board needed: 'fill up the whole space', 'leave the beaker', 'particles'. • Again the competition element could be brought in here, i.e. there could be several squares and different teams could compete to be the best solid, liquid, gas particles.
4.3 Revising the results obtained in Lesson 1. Gases.	1. The T asks S to pretend that they are becoming a gas or evaporating**.** T: "What was made when the liquid evaporated?" T: " Did the gas fill up the whole space?" T: "Did the gas particles leave the container?"	1. S should spread out even more and some should leave the marked area. S: "Steam." "A gas." S: "Yes it did, no it didn't." S: "Yes they did, no they didn't."		

5. Demonstration of changes in particle behaviour in different states of matter 5.1 Particulate behaviour in solids.	1. T holds out an ice cream tub containing ping pong balls which are not moving very much. 2. T then elicits information from the pupils with the following questions: T: "These are particles. Are they close together or far apart?" "Can they change place or can't they change place?" "Are they arranged in rows or are they arranged in a random way?" T: "Are these particles solid, liquid or gas?" T: "Are they moving?" T: "They are vibrating but have they a lot of energy or little energy?" T: "What do we do to make the ice melt?" T: "Heat gives the particles more energy. What do you do when you have more energy?"	1. S watch, listen and answer questions appropriately. 2. S choose alternatives. S: "Solid." S: "Yes, a little." S: "We heat it." "We make it hotter." S: "Play football." "Move around more." Etc.	• OHT 6 with illustrative pictures and vocabulary that features in T's questions.	• T points to OHT 6 which provides illustrations of the necessary vocabulary. • T points to OHT 1 showing the S experiment in previous lesson.

5.2 Particulate behaviour in liquids.	1. T pretends that his or her arm is the extra energy and moves the box so that the particles move around more. 2. T: "Are these particles close together or far apart?" "Can they change place or can't they change place?" "Are they arranged in rows or are they arranged in a random way?" "Are the particles here moving around or not moving very much?" "Are they changing place or not changing place?" "Are they arranged in a random way or in rows?" "Are they further apart or close together?" "Have they got more energy or less energy?" T: "Are these particles solid, liquid or gas?" T: "How do we change a liquid into a gas?" T: "What do we give it when we heat it?" T: "What happens when the	1. S watch, listen and answer questions appropriately. 2. S choose alternatives and respond appropriately. S: "Liquid." S: "We heat it." S: "Give it more energy." S: "They move around more."		• Teacher points to OHT 6. • T needs to have paraphrases, mimes and simple everyday examples ready. • OHT of Student Worksheet 1 can be pointed to here to remind S of "heat".

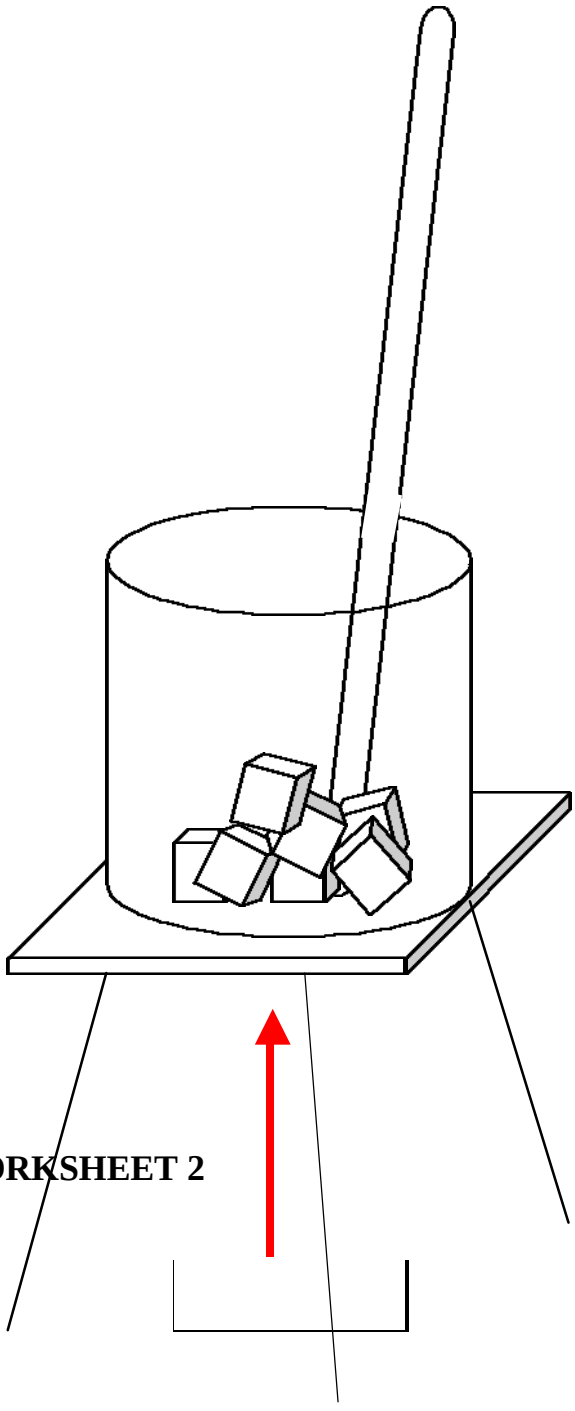
	particles have more energy?"			
5.3 Particulate behaviour in gases.	1. The teacher moves his or her hand sufficiently for the balls to fly out of the container. 2. T: "Are these particles close together or far apart?" "Are they arranged in rows or are they arranged in a random way?" "Are the particles here moving around or not moving very much?" "Are they changing place or not changing place?" "Have they got more energy or less energy?" 3. T: "Are these particles solid, liquid or gas?"	1. S watch, listen and answer questions appropriately. 2. S choose alternatives. 3. S: "Gas."		• Teacher points to OHT 6. • T needs to have paraphrases, mimes and simple everyday examples ready.
6. Recognising graphical representations of states of matter. 6.1 Using flashcards to try to identify the state of matter shown in diagrammatic form.	1. T sets up the pair work with a volunteer. Each person has three cards on which there is a graphical diagram of a state of matter. T shows it very quickly to his or her partner (quick flash) and asks: "Is this a solid, liquid or gas?" S must guess which state of matter is represented on the card. T says whether this is right or wrong and evaluates the S performance; i.e. "Very good!" "Excellent", "Not bad", etc.	1. Students watch and listen. 2. Students are put into pairs and each has three cards depicting a solid, liquid or gas. 3. Student A gives a quick flash of a card and asks, "Is this a solid liquid or gas?" Student B answers. Student A:" That's right/that's wrong", etc. Then Student B shows a card,	• Flashcards (use diagrams at the top of columns in Student Worksheet 5). showing diagrammatic representations of solids, liquids or gases. Three cards per S. • Board or OHP for supporting language of interaction.	• Language of interaction as visual support on the board: 'Is this a solid liquid or gas?', 'More slowly please.' 'Again please'. 'Can you repeat that, please?' 'That's correct'. 'That's right'. 'That's wrong'. 'You're cheating!' etc. • This "teach and test" activity can be extended and used to practice the language that occurred in

		etc.		Stage 5. S also have to justify *why* a card depicts a certain state of matter. (Use OHP 6 as visual support).
6.2 Combining graphical representations with descriptive sentences to describe states of matter at the particulate level.	1. Using an OHT transparency of Student Worksheet 4, T demonstrates what the S have to do, i.e. match descriptive sentences to the correct column. At the top of each column there is a graphical representation of the particles in a solid, liquid and gas. 2. T hands out the worksheet. 3. T circulates around. 4. T gathers feedback and completes correct version on OHP.	1. In pairs S complete the worksheet by putting stickers with descriptive sentences under the correct heading. 2-3. S discuss and stick. 4. S give feedback.	• Dictionaries are available. • Student Worksheet 4. • Copies of correctly completed Student Worksheet 4 to hand out as homework support.	• Language of interaction as visual support on the board: 'This is a solid'. 'I think this is a……', 'I think this goes here'. 'No, it doesn't'. 'Yes, it does'. 'That's right'. 'That's not right….' • The language on the stickers was already introduced briefly in Stage 5 (the ping pong ball question and answer session). See Student Worksheet 4. • Make this into a competition or race against the clock.
7. Identifying and describing different states of matter. (Written homework.)	1. T gives S three pictures of people engaging in activities which represent solids, liquids and gases. The task is to complete a caption for each picture using the sentences on Student Worksheet 4.	1. S have to compare an everyday scene to a state of matter and justify their choice.	• Examples: (a) Solids: a picture of a football crowd or a crowd in Trafalgar Square. (b) Liquids: picture of people running for a train or running a marathon. (c) Gases: a picture of players in a hockey match or a football match.	• Student Worksheet 4. • Captions: (a) "These people are like a solid because they cannot change place……etc" (b) "These people are like a liquid because……." (c) These people are like a gas because……"

[1] Further ideas for motivating students to use the target language (and easily adaptable to the bilingual classroom) can be found in: Alison, J and Bettsworth, B, *Motivating Students at the Early Stages of Learning a Modern Foreign Language*, Cilt in conjunction with the North West Comenius Centre (at St Martin's College, Lancaster), 1998.

STUDENT WORKSHEET 1

DIAGRAM OF CHANGES OF STATE EXPERIMENT



STUDENT WORKSHEET 2

RESULTS TABLE

INVESTIGATION OF CHANGES OF STATE

Time (seconds)	Temperature (^{o}C)	Observations

STUDENT WORKSHEET 3

Put the following experiment into the correct order:

1. Start the stop watch.
2. Record the temperature in the results table.
3. Light the bunsen burner.
4. Every thirty seconds record the temperature of the beaker's contents.
5. Measure the temperature of the ice with the thermometer.
6. Also make observations of what is happening to the contents.
7. Put the beaker on top of the tripod and gauze.
8. Put the ice in the beaker.
9. Heat the beaker using the bunsen burner.
10. Put the gauze on top of the tripod.

Solution: 10, 3, 8, 5, 2, 7, 9, 1, 4, 6.

Student Worksheet 4

The particles……	The particles…..	The particles…..
Correct Answer: **Solid:** the particles are close together, cannot change place, vibrate, are arranged in rows, have less energy	**Correct Answer:** **Liquid:** the particles are moving about, are changing places, are arranged in a random way, are further apart, have more energy	**Correct Answer:** **Gas:** the particles are far apart, are moving very fast, are moving in all directions, have lots of energy, are arranged in a random way

Solid

Liquid

are moving about

have more energy

are arranged in rows

vibrate (moving backwards and forwards)

Gas

are further apart

are arranged in a random way

have less energy

are moving very fast

are far apart

cannot change place

have lots of energy

are changing places

are arranged in a random way

are moving in all directions

are close together

• These are all • *No, that's wrong. I think these objects go together because they are……* • Why is that one there? Because it is • Excuse me, what is	*gases* *hard* a solid a liquid a gas soft clear a fixed shape runny heavy light wet *solids* *liquids*	so they go together. That's right. No, that's wrong ?

	hard
• A solid is • A liquid is • A gas is	soft clear a fixed shape runny heavy light wet

A solid		
A liquid		
A gas		

Labels

(Three of each required per team).

keeps the same shape

keeps the same volume

changes shape

changes volume

- **Time:** Two seconds, 5 seconds, 10 seconds, 20 seconds!

- **Temperature:** Twenty degrees, thirty degrees, forty degrees!

- **Recording results:** You said 10 degrees, is that correct/right/wrong?

Can you repeat that please? What did you say?
Yes/No

- **Observations:**

It is solid ice.
The ice is melting.
It is all liquid.
Small bubbles of gas are forming.

Large bubbles of gas are forming.
The water is boiling.
Water is evaporating as steam.

Labels (Activity 3.3.2. Lesson 1**).**

It is solid ice.
The ice is melting.
It is all liquid.
Small bubbles of gas are forming.
Large bubbles of gas are forming.
The water is boiling.
Water is evaporating as steam.
Freezing.
Melting.

Evaporating.

Condensing.

Gap-fill Labels.

The water is:

1. __ __ e __ z __ n__.
2. __ __ __ t __ __ g.
3. __ v __ __ __ r __ t __ __ __.
4. C __ __ d __ __ s__ n __.