

## MODULE CONTENT

**Module Title:** CHEMICAL SCIENCE

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**Module Description:** Sand flows so is it a liquid? This module explores the arbitrary nature of the rigid definitions associated with traditional approaches to teaching the topic "The States of Matter". In this module the focus of teaching and learning is to challenge, modify, or reconstruct students' existing intuitive ideas. The activities emphasise both the development of process skills in science and an environment of active engagement.

<b>Summary of Activities:</b>	<b>Title</b>	<b>Min</b>
1.0	What's My Rule?	20
2.0	The Problem With Flow.	30
3.0	How Are Gases Different?	40
4.0	Dew Drops and Popcorn	40
5.0	Making Links	20

**Module Outcomes:**

- Participants will reflect on and clarify their (science) education philosophy with a particular focus on learning in science and the importance of establishing realistic expectations for science education in a primary school setting.
- Participants will explore the importance of alternative perspectives and ways of developing students' concept building strategies, *eg.*
  - effective student engagement in science;
  - strategies for encouraging interchange of ideas;
  - recognising links and conflicts between ideas presented and those of students;
  - monitoring student thinking; and,
  - encouraging reflective thinking.
- Participants will identify and explore observable properties and variations in structures.

**Resources and Materials**

Activity 1.1: water, milk, Lemonade/cordial, cream, plasticine, cotton wool, rock, plastic cup.

Activity 2.1: water, milk, cream, honey, molasses/golden syrup, plasticine, talcum powder, sand, rice, cottonwool, ice cube, a piece of woollen material, cotton thread, rock, plastic cup.

Activity 2.2: cornflour, water, spoons, mixing bowls, newspaper strips, pens, blutac, perfume (strong)

Activity 3.1: strong perfume, stop watch or clock with second hand

Activity 4.1: glass jar with sealing top, ice, salt

Activity 4.2: Saucepan or beaker with lid, popcorn

Attachments 1.1, 2.1, 2.2, 2.3, 4.3, 5.1.

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**Activity 1.0: What's my Rule?**

**Purpose:** To explore the problems associated with the standard definitions used for the states of matter.

**Teaching Procedures:** Interpretive Discussion

**Time allocation:** 20 minutes

<b>What to do</b>	<b>FACILITATOR</b>	<b>PARTICIPANT</b>
	<p>1.1 Classification Task. Provide a selection of materials (see Attachment 1.1 for suggested materials). On the board/OHP draw two columns, under the first column write the word plastic cup, under the second column write the word water. Explain that the aim is to work out the rule for the two columns. Then place each material out one at a time <i>eg.</i> milk, cordial, rock, cotton wool, <i>etc.</i> After each item call for a vote and discussion as to which column it belongs to. After discussion announce the column the material belongs to and then put up the next one. When all materials have been classified ask the group if a heading can be given to each column. If needed encourage participants to consider the terms "solids" and "liquids" as the headings.</p> <p>1.2 What's My Rule: In small groups (groups of 5) ask each group to come up with one or two sentences which best describe what a liquid is, what a solid is and the difference between them.</p>	<p>1.1 As a group, participants observe, discuss and define the properties of each material in an attempt to establish the rule or pattern for the classifications.</p> <p>1.2 Work in small groups. Contribute to group discussion and write a group definition for both a solid and a liquid. Explain the difference between these.</p>

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FACILITATOR	PARTICIPANT
<p>1.3 Alternative Procedure to 1.2: Consider a Post Box activity as used in the Physical World Module. Each participant writes an individual response to these questions:</p> <ol style="list-style-type: none"> <li>1. What is a liquid?</li> <li>2. What is a solid?</li> <li>3. What is the difference between a liquid and a solid?</li> <li>4. List three things that are not a solid or a liquid.</li> </ol> <p>A fifth question is posed in activity 2.5.</p>	<p>1.3 Write answers to the questions and at this stage hold on to them.</p>

- Tips and Tricks:**
- A variety of materials need to be made available for this activity. If those listed are unavailable attempt to collect materials with similar observable properties.
  - When working in small groups appoint a reporter and a recorder.

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**Activity 2.0: The Problem With Flow**

**Purpose:** To develop an understanding of the arbitrary nature of classification.

**Teaching Procedures:** Interpretive Discussion  
Investigation

**Time allocation:** 30 mins

<b>What to do</b>	<b>FACILITATOR</b>	<b>PARTICIPANT</b>
	<p>2.1 Classification Task: Place a row of substances on a table (see Attachment 2.1 for some suggested substances). Place a clear example of a solid at one end and a liquid at the other, in the middle place any substances that may create problems, <i>eg.</i> sand, rice talcum powder, molasses, <i>etc.</i></p> <ul style="list-style-type: none"> <li>• Take votes and call for arguments as to whether each item should be classified as "solid" or "liquid".</li> <li>• Discuss the differences between these substances, particularly observable properties.</li> <li>• Attempt to tease out the "flow" idea - how do these substances differ in terms of flow? <i>Eg.</i> aided/unaided, flowing to a flat surface.</li> <li>• Revisit definitions written earlier; invite participants to make any changes or add any information to clarify.</li> </ul>	<p>2.1 Participants observe substances and contribute to discussion re classification of substances.</p>

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<b>What to do</b>	FACILITATOR	PARTICIPANT
	<p>2.2 Making Oobleck: Do all fluids behave in the same way? Work with participants to make some Oobleck (see <i>Attachment 2.2</i> for recipe). Allow time for participants to play with and explore the properties of the mixture.</p> <p>2.3 Raise the following:</p> <ul style="list-style-type: none"> <li>• Is it difficult to stir? Does the mixture appear thick or thin when you dribble it from a spoon?</li> <li>• Place your finger slowly into the mixture – describe what happens.</li> <li>• Tap the top of the Oobleck quickly what do you observe?</li> <li>• Compare Oobleck to normal liquids such as water. What happens if you did the same things to water, would water behave in the same way?</li> <li>• See Attachment 2.3 for information on Oobleck</li> </ul> <p>2.4 Ask the question: "Is Oobleck a solid or a liquid?" Then encourage participants to use the criteria they have established for each to assist them.</p> <p>2.5 Continue Post Box activity from 1.3. All participants write response to this question (5): What changes you would make to your definitions from 1.3.</p> <p>2.6 Accept all responses in the Post Box provided – to be reviewed in activity 3.1</p>	<p>2.2 Work in small groups and follow directions to make Oobleck. Play with and explore the mixture.</p> <p>2.3 Using the questions posed by facilitator as a guide, participants explore the properties of Oobleck and compare it to other liquids.</p> <p>2.4 Respond to the question</p> <p>2.5 Answer question 5 and post all responses in the box for review in the next activity.</p>

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**Discuss/Consider:**

- The observed difference in properties of a solid and a liquid.
- The arbitrary nature of the traditional definitions ie. changeable conditions influence properties of materials, *eg.* temperature, pressure, *etc.*
- Discuss confusing terms such as "pourability" leading to an over generalisation *eg.* sand can be poured.
- The difficulties these definitions create for children when observing and classifying.

- Tips and Tricks:**
- Have a container of water and towels nearby for quick clean up. You may decide to take the activity outside if this suits you.
  - Add food colouring.
  - Oobleck will keep for a couple of days if kept in a sealed container in a cool place. Simply stir again before using, as water will settle on the top.
  - Oobleck can block the pipes if placed down the sink so dispose of remaining mixture in a bin.

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**Activity 3.0: How Are Gases Different?**

**Purpose:** To explore the properties of gas and compare these to the properties of solids and liquids.

**Teaching Procedures:** Completing sentences  
Experiment  
Interpretive Discussion  
Postbox

**Time allocation:** 40 mins

<b>What to do:</b>	FACILITATOR	PARTICIPANT
	<p>3.1 Mapping Movement of a Gas: Provide each participant with a map of the room. As this will differ for each facilitator you will need to prepare your own. Facilitator will require a stopwatch or watch with minutes/seconds display.</p> <ul style="list-style-type: none"> <li>• Ask each person to mark on their map the location of their seat.</li> <li>• Explain that a container of perfume will be opened in the middle of the room, and as each person becomes aware of the fragrance they must raise their hand and record the time given to them by the facilitator.</li> </ul> <p>While this is happening the participants will be working on the following task (3.2)</p> <p>.</p>	<p>3.1 Participants mark their seating location on the map and using their sense of smell observe the fragrance of the perfume, indicate the time they become aware of the fragrance by raising their hand. Record the time on their sheet.</p>

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<i>What to do</i>	FACILITATOR	PARTICIPANT
	<p>3.2 Completing Sentences: Provide each participant with 4 strips of paper. Ask participants to complete the following sentences, one on each of the strips of paper. Explain that these sentences will be displayed and later referred to in discussion. (names not displayed but recorded on the reverse side)</p> <ul style="list-style-type: none"> <li>• Solids do.....</li> <li>• Solids don't .....</li> <li>• Liquids do.....</li> <li>• Liquids don't.....</li> </ul> <p>3.3 Alternative: complete the Post Box procedure from activities 1 and 2. (similar procedure to that used in The Physical World Module). If time permits, divide the group into 6 smaller groups. Give each group one or more of the sets of responses. In their group they then read and categorise the answers and prepare a presentation to the large group showing the range of views held about each question.</p> <p>3.4 Discussion to review the results of the perfume activity. On a large map of the room individuals record their times. Review this map with the group. Discuss and compare the times and locations in the room.</p>	<p>3.2 Complete the sentences using own words and ideas. Refer to any of the previous activities for ideas.</p> <p>3.3 Working in 6 groups, read and discuss all responses listed on chart. Identify the similarities and differences between these responses. Write a summary on a large A3 sheet of paper and use this to guide presentation. Contribute to a group presentation about these responses.</p> <p>3.4 Contribute to the discussion about the perfume experiment. Review their own findings and compare these to the overall findings. Complete sentences onto strips of paper. Blu tac strips of paper under the appropriate headings on display in the room.</p>

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**What to do**

FACILITATOR	PARTICIPANT
<p><b>Discuss:</b> Can you explain what was happening in this activity? How long did it take for the fragrance to reach the extremities of the room? What does this tell us about the movement of the fragrance? Is the perfume a solid? Is the perfume a liquid? What is it? Can you provide other examples of gases? Discuss in pairs and complete these sentences on strips of paper:</p> <ul style="list-style-type: none"> <li>• Gases do.....</li> <li>• Gases don't.....</li> </ul> <p>Place these strips around the room under the headings Solids, Liquids, Gases. Participants take a print walk and read the range of responses.</p> <p>3.5 Discuss and consider how an activity of this type might be useful in informing future planning and teaching on this topic? What might you do next and why?</p>	<p>Take a look at the range of responses for each sentence.</p>

**Discuss/Consider:**

- When the task is complete, discuss the role of the learner and the teacher in this task.
- Did you find the activity useful? Explain.
- How might this activity help to clarify some of the ideas we have covered so far.
- How might a teacher use information gained from such an activity?

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**Activity 4.0 Dew Drops and Popcorn**

**Purpose:** To explore some activities that demonstrate visible changes of state through the expansion which occurs as a liquids turns to a gas.

**Teaching Procedures:** Experiment  
Demonstration and Interpretive Discussion

**Time allocation:** 40 mins

<b>What to do:</b>	FACILITATOR	PARTICIPANT
	<p>4.1 Demonstration: Present a large sealed glass jar containing crushed ice and salt. Ask a participant to feel and describe the jar (wet). Provide another participant with a towel and ask them to dry the outside of the jar. Ask another participant to feel it again and describe it (wet again). Give someone else the opportunity to dry the jar and try again. Ask, "Where is the water coming from? Explain your response."</p> <ul style="list-style-type: none"> <li>Discuss common responses from children <i>ie.</i> "through the glass", "over the top" (if the jar is unsealed), "from the air". What are the implications of these responses for teaching such topics as the water cycle where many children believe that evaporating water goes straight to the clouds? What other aspects of this topic do we need to focus on in our teaching?</li> </ul>	<p>4.1 Participate and observe the demonstration.</p> <p>Contribute to discussion.</p>
	<p>4.2 Making Popcorn: Ask participants to predict what will happen to corn kernels if heated in a glass covered frypan or a 1 litre beaker over a bunsen burner (or hotplate). Ask participants to share their predictions. Make a batch of popcorn. Allow participants to observe the physical changes.</p>	<p>4.2 Consider the problem and share a response to the question. Observe the changes that take place when the popcorn is heated.</p>

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FACILITATOR	PARTICIPANT
<ul style="list-style-type: none"> <li>Reflect on the predictions, and ask the question: Were the results as you had expected? Explain. Invite explanations for the physical changes that occurred. Encourage participants to use a variety of communication modes to convey their thoughts as clearly as they can, <i>eg.</i> drawing, demonstrations, <i>etc.</i> To assist discussion, ask participants to consider any factors that may have contributed to the change, list these, <i>eg.</i> heat, pressure, <i>etc.</i></li> </ul>	<p>Reflect on predictions and Observations. Share reactions to Observed changes.</p> <p>Reflect on observations and attempt to explain why these changes occurred. Share explanations for observed changes with the rest of the group.</p>
<p><b><u>Background Information:</u></b>  <i>Water particles (molecules) present inside the corn kernel begin to move faster and faster when heated. At 100 °C, the boiling point of water, the water molecules move so fast and so energetically that they begin to collide with each other and the corn kernel that contains them. An enormous expansion occurs as the water molecules move further apart, taking up more space than the equivalent amount of liquid. This movement creates a pressure that builds up and eventually forces the kernel to expand and open. This colliding can cause the water molecules to break away from each other completely. The attractive forces are no longer strong enough to hold them together. The liquid vaporises into a gas (steam).</i></p>	

- Tips and Tricks:**
- If the popcorn activity is too abstract for younger children the same expansion concept can be demonstrated in a simple activity involving a chemical reaction. Place a teaspoon of bicarbonate soda into a balloon - this is easily done by inserting a funnel into the end of the balloon and using a straw to push the powder through the neck of the funnel. Then stretch the neck of the balloon over a narrow necked bottle containing approx 2 tablespoons of vinegar. Lift the balloon and allow the bicarb soda to fall into the vinegar – a gas called carbon dioxide is produced as a result. The gas will inflate the balloon. The children will be able to see that a gas has stretched and inflated the balloon. Although this was not the result of boiling a liquid, rather a chemical reaction, it is still able to demonstrate the movement of molecules in a gas.

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FACILITATOR	PARTICIPANT
<p>4.3 Distribute worksheet – see attachment 4.3. Participants work in pairs to rearrange sentences into an order that makes sense to them. Then they share their response with a group of six. Attempt to reach a consensus within the group. Invite groups to share responses with large group. Any difficulties? Explain.</p> <p>4.4 Composing a paragraph - Why do solids melt? Use the outcome from the last activity to create a paragraph explaining why solids melt. Use the wording of the last activity to assist. Share responses in a group of six.</p>	<p>4.3 Work in pairs, consider the problem and sequence the sentences to create a paragraph that explains why liquids boil. Share response with a group of six. Identify similarities and differences between arrangements. Attempt to reach a consensus of opinion about the arrangement. Contribute to group discussion.</p> <p>4.4 Work in pairs to create a new paragraph explaining why solids melt. Then share responses in a group of six.</p>

**Discuss and consider:**

- What is required of the learner in this activity?
- What is the teacher's role?
- How might this procedure be used with primary children?
- How might the students' work be used to inform future planning and teaching?
- What might you do next and why?
- What might you do with these paragraphs?

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**Activity 5.0: Making Links**

**Purpose:** To promote reflection on the purposes of the activities completed in this module.

**Teaching Procedures:** Concept Map  
Interpretive Discussion

**Time allocation:** 20 mins

<b>What to do:</b>	FACILITATOR	PARTICIPANT
	<p>5.1 Concept map: Provide each participant with 6 small pieces of paper each displaying one of these word: solid, liquid, gas, melting, evaporating, condensing (see Attachment 5.1).</p> <p>5.2 These pieces of paper may be moved around until the participant feels that they have arranged the words in a way that they feel is appropriate. Have each participant draw arrows to connect concepts in ways that they feel are appropriate and write connecting phrases to clearly indicate the nature of the relationship between the concepts. Encourage the alteration of initial ideas if individuals see ways to improve their map.</p> <p>5.3 Participants share and compare their concept map with one other person in the group, justifying the links they have drawn in. Each person must ask the other person at least two questions about his/her map, eg. Why have you put that there? Explain why you didn't link these together? <i>etc.</i></p>	<p>5.1 Collect materials</p> <p>5.2 Arrange the words in the most appropriate way. Draw arrows to connect concepts in ways that you feel are appropriate and write connecting phrases to clearly indicate the nature of the relationship between the concepts.</p> <p>5.3 Each person shares and compares their concept map with one other person in the group, justifying the links drawn in. Asks at least two questions partner about their concept map. Make them justify their ideas and examine their map more critically.</p>

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## Module Review

**Reflection:** On completion of the final activity review the unit design. Return to issues discussed during the module particularly the role of the learner in the activities, the role of the teacher and the strategies used to challenge thinking and to clarify and define concepts. Also consider the type of communication that was fostered through these procedures. Refer to planning, preparation and teaching issues listed in the reflection section of the Physical Science module .

**Between Session Tasks:** Attempt the concept mapping procedure with a group of children who have not used this procedure before. Collect at least five work samples that demonstrate a range of responses to this procedure. Share your responses with the group. Focus your comments on the skills required by a student to complete this task and any difficulties faced by the teacher and/or the students in your trial. Suggest any strategies that may make this procedure easier to implement for first timers. Comment on what you learnt about the children as they worked through the procedure.

**Support Materials:** Baird,J. Northfield,J. (Eds). (1992). *Learning From The PEEL Experience*. Melbourne: PEEL publishing.  
 Directorate of School Education, Victoria. (1995). *The Victorian Course Advice in Science*.  
 Fensham,P. (1994). Beginning to Teach Chemistry. In Fensham,P., Gunstone, R., White, D. (Eds) (1994) *The Content of Science - A Constructivist Approach to its Teaching and Learning*. London: Falmer Press  
 Grant,P., Johnson,L., Sanders,Y. (1990). *Better Links - Teaching strategies in the science classroom*. Parkville.Victoria: STAV Publishing  
 Hann,J. (1991). *How Science Works*. . London: Dorling Kindersley Ltd.  
 Stavy, R. (1994) States of Matter – Pedagogical Sequence and Teaching Strategies Based on Cognitive Research. In Fensham,P., Gunstone, R., White, D. (Eds) (1994) *The Content of Science - A Constructivist Approach to its Teaching and Learning*. London: Falmer Press.  
 White, R.T., & Gunstone, R.F.(1992). *Probing Understanding*. London: London: Falmer Press

**Web Sites:**

Chem4kids <http://www.chem4kids.com/>

Heaps of info for 5-11 year olds

Chemistry Central <http://www.satech.net.au/~rowanb/chem/index.html>

Loads of links to chemistry sites including animated sites

**MODULE CONTENT****Why do solids, liquids and gases look and behave differently?**

- The difference between these three states of matter lies in how much the particles within the substance are moving around and how tightly packed they are.
- In a solid the particles may be tightly linked together in an organised pattern. The particles may be able to vibrate gently but there may be very little room between them. This explains why many solids hold a definite shape and many are rigid.
- The particles in a liquid are further apart and not arranged in a regular pattern, these particles may move around in any direction constantly bumping into one another.
- The particles of a gas are often very far apart and zoom around at high speeds in all directions.

**What happens when a solid melts?**

- Every solid turns to a liquid at a certain temperature called its melting point.
- When particles are close together as they are in a solid, they attract one another. A lot of energy is needed to push them apart.
- Heat is a form of energy and when a solid is heated it gives the particles energy. They start vibrating a lot and the bonds between the particles begin to break, so the particles begin to move away from one another. This process is called melting.

**What is evaporation?**

- Evaporation occurs when a liquid changes to a gas by the escape of particles (liquid molecules) from its surface.
- It can happen at any temperature but speeds up at higher temperatures and lower pressures or if the surface area of the liquid is increased.
- If the air above the liquid approaches saturation (with the 'gaseous' molecules from the liquid) then the rate of evaporation slows down.

**What is condensation?**

- Condensation is when the molecules of a gas slow down due to a drop in temperature and the gas condenses to become a liquid.