Module 2 Kinetic particle model and specific heat capacity

Recommended total teaching time: 7.5 hours

• 5 × 60-minute periods of theory

• 2.5 × 60-minute periods of practical work

Planning support for this module

Yearly planner

<WEBLINK> Yearly planner: Product title

Lesson plans

Practical lessons

This module includes the following practical lessons:

* Lesson 2.2 Heating water on a hotplate – graphing and analysing data
* Lesson 2.7 Precision and accuracy of thermometers
* Lesson 2.10 Specific heat capacity of liquids – on a hotplate

Consult your lab technician on the minimum time prescribed by your school before you intend to run the practical lessons, so that materials can be ordered and prepared in time.

If your timetable does not allow enough time to complete all the practicals in this module, the following can be excluded without impact on student achievement of science understanding objectives:

* Lesson 2.7 Practical: Precision and accuracy of thermometers

It is suggested that you ask students to watch the practical demonstration videos as homework before the practical lessons occur.

Module subject matter

Lessons in this module

|  |  |  |
| --- | --- | --- |
| Lesson | Curriculum links | Recommended teaching time |
| Lesson 2.1 Heating and cooling  |  | X minutes(X period) |
| Lesson 2.2 Practical: Heating water on a hotplate – graphing and analysing data  | **Science inquiry*** Investigate the proportional relationship between heat and temperature change.
 | X minutes(X period) |
| Lesson 2.3 The kinetic particle model of matter  | **Science understanding*** Describe the kinetic particle model of matter.
 | X minutes(X period) |
| Lesson 2.4 Internal and thermal energy | **Science understanding*** Describe the kinetic particle model of matter.
* Describe the concepts of thermal energy, temperature, kinetic energy, heat and internal energy.
 | X minutes(X period) |
| Lesson 2.5 Kinetic energy and temperature | **Science understanding*** Explain that a change in temperature is due to the addition or removal of energy from a system (without phase change).

**Science inquiry*** Investigate the proportional relationship between heat and temperature change.
 | X minutes(X period) |
| Lesson 2.6 Measuring temperature | **Science understanding*** Use 𝑇𝐾 = 𝑇𝐶 +273 to convert temperature measurements.

**Science inquiry*** Consider the significance of using common units of measurement internationally.
* Investigate the precision and accuracy of different temperature measuring devices, such as analogue and digital thermometers, by determining measurement uncertainty.
* Use digital and other measuring devices to collect data, ensuring measurements are recorded using the correct symbol, SI unit, number of significant figures and associated measurement uncertainty (absolute and percentage); all experimental measurements should be recorded in this way.
 | X minutes(X period) |
| Lesson 2.7 Practical: Precision and accuracy of thermometers | **Science inquiry*** Investigate the precision and accuracy of different temperature measuring devices, such as analogue and digital thermometers, by determining measurement uncertainty.
 | X minutes(X period) |
| Lesson 2.8 Heat transfer | **Science understanding*** Explain heat transfers in terms of conduction, convection and radiation.
 | X minutes(X period) |
| Lesson 2.9 Specific heat capacity | **Science understanding*** Describe the concept of specific heat capacity.
* Solve problems involving specific heat capacity using 𝑄 = 𝑚𝑐∆𝑇.
* Interpret data from specific heat capacity experiments.

**Science inquiry*** Use digital and other measuring devices to collect data, ensuring measurements are recorded using the correct symbol, SI unit, number of significant figures and associated measurement uncertainty (absolute and percentage); all experimental measurements should be recorded in this way.
* Consider the energy contained within a cup of coffee versus a swimming pool.
* Explore the properties of water that makes it ideal for use as a coolant in car engines.
* Explore why it is possible to boil water in a paper cup on a campfire.
 | X minutes(X period) |
| Lesson 2.10 Practical: Specific heat capacity of liquids – on a hotplate | **Science understanding*** Solve problems involving specific heat capacity using 𝑄 = 𝑚𝑐∆𝑇.
* Interpret data from specific heat capacity experiments.
 | X minutes(X period) |

Advice for teaching this module

General teaching tips

The concepts covered in Unit 1, Topic 1 Heating processes is allocated 15 notional hours. From this, it is suggested that sub-topic Kinetic particle model and specific heat capacity be allocated 7.5 hours, and sub-topic Phase changes and energy conservation be allocated 7.5 hours. This includes time for conducting practicals and assessments.

No time is allocated for science inquiry skills. It is suggested that you integrate teaching of inquiry skills into your science understanding, science as a human endeavour and science inquiry teaching. Skill drills, worked examples, real-world science features and data drills placed throughout this module help to facilitate this.

It is suggested that students complete the Prior knowledge quiz for this module as homework before the module’s first lesson so that you have time to review the level of student background knowledge before commencing the new module. This information should inform your teaching throughout the module.

Recommended teaching strategies

Vocabulary practice: Module 2 introduces a number of physics concepts that will be used extensively in Module 3. It is recommended that you use a variety of literacy activities provided to help students develop skills towards understanding and long-term retention. The activities included can be adapted for other lessons if you have time.

Practical instructions: Identifying students who need assistance with following instructions on practical and problem-solving when issues arise with equipment is critical. As this topic may be your very first topic for your class it is vital to watch early labs carefully to see if students are having difficulty with turning instructional text into action. Some suggestions on how to help are below under Strategies for supporting students.

Realism of answers: Identifying with students where common sense answers can be used to check mathematical working can be useful for helping students spot small errors like missed negatives. For example, students should be able to predict that a hot and cold object put together should meet somewhere between the two values, so if they calculate that the combination of 80°C metal and 25°C water results in a 104°C mixture they should recognise that this is wrong, and is probably caused by missing a negative sign.

Unit check: Students who are also taking chemistry will be doing thermodynamics early in their chemistry study. A common mistake students make when calculating energy changes for materials is to use a specific heat capacity in J/g (e.g. water might use 4.18 J/g instead of 4.18 × 103 J/kg), so it is worthwhile to remind students to be careful of their units. Often more capable students have this issue as they will memorise a constant that they use often and make an easy mistake on a test or assignment.

Note taking and summarising: Spending some time at the beginning of the learning sequence to help students set out notes can be beneficial as many students will not have experienced preparing for a year long exam. If your work program does not include a year long exam for summative assessment, you may wish to give them one for formative purposes. Just don’t inform students that the assessment is formative until after it is completed so you get valid data on how well they are preparing. This will help students see the purpose of the note taking method.

Differentiation support

Ideas and strategies for supporting students

Algebra practice: Students often have difficulties rearranging equations such as $P=\frac{W}{t}$ and correctly solving for ‘*t*’. Helping students set up equation triangles to check their algebra can be an effective early assist, although pedagogically you should ensure this is being removed so that students are ready for the final exam.

Language practice: Helping students set up flash cards physically or digitally with a website like Quizizz or Kahoot can be an effective way to help them practice recalling terminology. Several different templates have been included in the lesson activities and these can be adapted into the other chapters as well.

Practical instructions: After identifying students who need assistance with practical lessons, using their group as the demonstration group can be a useful way to assist and develop confidence in conducting practicals.

Ideas and strategies for challenging students

Application of knowledge: Encourage students who are more capable and working through content faster than their peers to try to apply the learning to explain real world contexts as an easy extension task. An example for this module could be to consider how much heat is lost by a falling water drop from a hot shower before it hits your head.

In-text resources: The challenge tasks are an excellent way to extend students that are completing
in-class tasks quicker than their peers. You do not need to assign every task in the platform to them; however, it is worthwhile to ask students to explore them. You can then approach the student and ask them to ‘teach you’ about what they learnt, or if you feel more comfortable with the topic have a conversation about what the student has learnt and identify any errata in their thinking.

Starter activity: Temperature change in society

Approximate time: 5 minutes

Notes for the teacher

Ask students if they have ever seen condensation dripping off the side of the school buildings near the air-conditioning units.

Instructions for students

* 1. Identify three items in your day-to-day life where it is important to control the temperature.



* 1. Write down any observations you have made about those objects when they get hot, or cold, and what happens to them when they get hot or cold. E.g. do they work faster/slower? Do they break?
	2. Infer how their temperature is kept controlled.
	3. Share your thoughts about one object with the class.

Helpful hints

* You are probably looking at an object that needs temperature control right now.
* Is there something at home that needs to be kept cool?

Answers

<Note to production: restart numbering below at ‘a.’>

* 1. Student answers will vary. Examples include cars, computers, gaming systems, phones, fridges/freezers and houses.
	2. Student answers will vary. Most electronics break down when they get too hot. Cars need enough heat to work effectively but then break down at high heats. Fridges/Freezers need the right temperature or break down when too cold.
	3. Cars – radiator and coolant. Electronics – Fans, heat sinks, water cooling. Fridges/Freezers – heat dispersal system with coolant and fans. Houses – AC/insulation/fans.
	4. Student answers will vary.