# *The Penguin Project* Teaching and learning plan

## Learning intentions

Students will be able to:

* observe and explain that heat can transfer from one object to another;
* understand that scientists search for patterns in data and use these observations to explain everyday phenomena;
* make accurate observations;
* record and represent observations;
* identify patterns from observations.

## Suggested timeframe

The time needed to complete *The Penguin Project* CLE will depend on the depth of the prior knowledge of students, the time to perform the two investigations—‘The penguin huddle’ and the insulator test ‘What should a penguin “wear” to keep warm?'—and follow up with any further extension activities. Allow approximately 2–4 hours.

[**Planning ahead and equipment list**](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Planning%20and%20equipment%20list_Yr3_The%20Penguin%20Project.docx)

## Safety considerations

When you and your class are completing your Risk Assessment, consider the following safety points and add any other relevant ones to the list.

* Use water between 40–50 °C.
* Water spills make the floor slippery, mop up immediately.
* Use alcohol thermometers rather than mercury thermometers.
* Avoid metal cans with sharp rims that may cut through skin.
* Students need to use scissors (in good working order) safely when cutting various materials.

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## Introduction

This CLE focuses on heat transfer and heat insulators in the context of emperor penguins, who huddle together to reduce heat lost from their bodies to the surrounding cold air, and links to the Year 3 Australian Curriculum: Science.

### Equipment needed

* Student booklet

### What to do

1. Handout the student booklet.
2. Revise the topic, ‘Features of living things’ from year 1.
3. Introduce the ‘huddling’ behaviour of penguins by viewing either of the videos:

* ‘Emperor penguins unite for survival in Antarctica – David Attenborough – BBC wildlife’, YouTube (2:31 min) <http://www.youtube.com/watch?v=cgGL6SbMfKc>

**or**

* ‘Emperor penguins huddle for warmth – Nature on PBS’, YouTube (2:54 min) <http://www.youtube.com/watch?v=OL7O5O7U4Gs>

1. The David Attenborough video has an accompanying question sheet included in the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx). See questions 1–6 on the page ‘Let’s learn more about penguins…’

**The following activities provide examples of adjustments to illustrate how students with diverse needs can access and participate in this CLE.**

**Introduction**

* Invite students to take turns in verbalising the things they view in the *YouTube* videos (listed above) about the huddling behaviour of penguins. Introduce terminology that may assist them with oral language—penguin, huddle, huddling, Antarctica, wind, ice, freezing cold, keep warm, taking turns, temperature, heat loss.
* On page 2 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx), students are expected to circle the correct answers to the six questions after watching the David Attenborough video. It may assist some students for a teacher to, firstly, read questions aloud to the class and, secondly, work alongside and prompt students who need additional support with reading when responding to each question. Invite all students to predict their answers prior to viewing.
* Some students may require additional viewings of the video, or pausing at key points to discuss a pertinent question from page 2 of the student booklet.
* Challenge higher-performing students to devise some questions about the Nature on PBS or David Attenborough videos. These students’ questions may be presented to other members of the class for them to respond.

## Core

### Investigation 1: The penguin huddle

In this investigation, students model the behaviour of a group of penguins and investigate the benefits of huddling to reduce heat loss from the penguins’ bodies.

This investigation can be conducted as a whole class investigation or as a smaller group task. It is recommended that students work in small groups, however, this will depend on the equipment available.

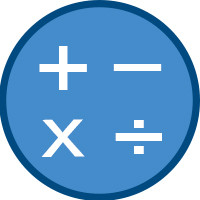
Ideally, one thermometer is placed in each of the 7 cans, however, as the number of thermometers available may be a limiting factor, the activity can be conducted with 2 or 3 thermometers per group. There is no need for absolute precision in measuring the 7 temperatures at the exact same moment as this would be impossible, but students can monitor all 7 in the lead up to the 5- and 10-minute marks.

### Equipment needed

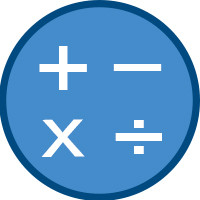
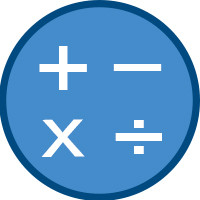
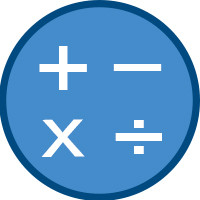
Per group:

* 7 empty metal cans (of the same size and made of the same material)
* warm water
* 7 thermometers
* 1 stopwatch
* 1 marking pen
* student booklet

### What to do

1. Demonstrate the equipment to be used and explain the task to students.
2. As a class, complete the ‘Planning’ and ‘What to do’ pages of Investigation 1 in the student booklet.
3. Set up equipment.

Students label their metal cans A–G then fill them with warm water and arrange them in a group ‘huddle’ to model the behaviour of emperor penguins. Can G should be in the centre with the others positioned around it. (It is essential that students arrange the cans correctly with can G at the centre of the group and that they are given time to practise safely reading a thermometer. This may be an unfamiliar task for some.)

1. Students place thermometers in the cans and measure the starting temperatures of the water in each can. Students record these temperatures on the ‘Recording’ pageof Investigation 1 in the student booklet.
2. Students re-read the thermometers at 5- then 10-minute intervals and record the temperatures of each can in the student booklet.
3. Students look at these temperatures and relate them to the position of the cans. Complete ‘Looking at the results’ page of Investigation 1 in the student booklet.
4. Follow up with a class discussion using these question prompts.

* Did any of the cans stay warmer than the others? Was it the same can for different groups?
* Why do you think this can stayed warmer?
* Which cans became the coldest? Why did they become colder than the can in the middle?
* How does this relate to the behaviour of the penguins?
* What did you do to make the tests fair?
* Is there anything we could do differently?
* What else could we investigate?
* Are there other animals that need to stay warm? How do they do this?

**The following activities provide examples of adjustments to illustrate how students with diverse needs can access and participate in this CLE.**

**Investigation 1**

* Higher-performing students derive many benefits when acting in a tutor role. Peer tutoring serves to significantly improve and strengthen the understandings and insights of the tutor in their own learning. This occurs as a result of teaching and supporting the learning of their peers.
* When demonstrating the equipment items that students will use, ask some students to lay them out on tables where groups of students are able to view and handle each item. Ask students to name and identify each item. Students may name and identify the pictures of each item on page 3 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx). A teacher may assist some students’ learning by projecting and displaying the student book on a digital whiteboard or similar.
* For students who are unfamiliar with a thermometer (that is, how to use and how to read), they will need to learn about how a thermometer functions and how we read a thermometer to determine a measure of temperature. Students will benefit from having time to practise these skills. In pairs, it is recommended that students perform all or some of these activities while handling and viewing a thermometer—read the numbers indicated, identify a number pattern, skip count by 10s from zero to 110, identify the temperature range of their thermometers (e.g., -20 to 110), read the ambient room temperature, add heat to the thermometer with their hands, predict and read the outside temperature. Spot-check student accuracy when reading a temperature indicated on a thermometer.
* Page 4 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx) is a reading Cloze task in which words are omitted from a passage of text and students are expected to fill in the blanks with the words provided. A teacher, teacher’s assistant or student tutor may assist another student who experiences difficulty with writing and/or reading. To assist this student, firstly, read the words aloud to them and have them repeat the words, secondly, read each sentence in turn requiring the student to respond with the best word from the list of words, thirdly, ask the student to attempt to write the word in the appropriate blank, and fourthly, praise their efforts.
* Page 5 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx) is a sequencing task, where students are expected to number, in order, the eight tasks to follow when conducting this investigation. Students with challenges involving memory and sequencing will need assistance with this task, which can be adapted. A teacher using ‘wait time’ offers students opportunities to think through and discuss a task prior to its commencement. Provide a loose copy of page 5 and ask students to cut out each of the eight tasks. Students will have eight strips of paper in front of them. With teacher assistance, rehearse each of the steps that students need to follow in this investigation. A teacher may need to repeat instructions for students. As each step is concluded, students identify the appropriate strip and place it under the previous step, e.g., 1) Collect all the equipment, 2) Label the cans A–G, 3) Fill the cans to the top with warm water, 4) Put cans in a group with can G in the centre, 5) Add the thermometers and so on.

### Expected results and explanations

Students are given 7 metal cans of warm water and arrange them in a group ‘huddle’ to model the behaviour of emperor penguins, who huddle together to reduce heat loss from their bodies to the colder surrounding air. There should be one can in the centre with the others positioned around it. Thermometers are used to measure the starting temperatures of the water in each can. The thermometers are read after 5 and 10 minutes and the temperatures recorded and related to the positions of the cans.

The can in the centre should remain the warmest of the 7 cans. The outer cans act as insulators and reduce the heat loss from the centre can, hence keeping it warmer.

### Investigation 2: What should a penguin ‘wear’ to keep warm?

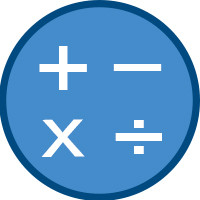
In this investigation, students are introduced to the concepts of conductors and insulators. It builds on students’ existing knowledge of warm clothes and why we wear them in winter.

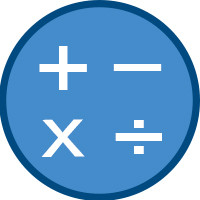
### Equipment needed

* 7 empty metal cans (of the same size and made of the same material)
* warm water
* 7 thermometers
* 1 stopwatch
* 1 marking pen
* materials to cover the exterior of the cans e.g., polystyrene foam or foam rubber, aluminium foil, cotton wool, wool, plastic wrap, mouse-pad, stubby holder, woollen scarf etc)
* scissors
* masking or sticky tape
* student booklet (1 per student)

### What to do

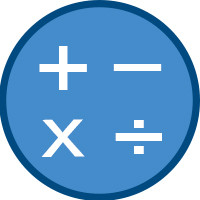
1. Introduce the concept of insulation and conduction through showing the article: ‘Emperor Penguins Keep Warm in a Cold Coat’ <https://www.washingtonpost.com/national/health-science/emperor-penguins-keep-warm-in-a-cold-coat/2013/03/11/ed966376-8808-11e2-999e-5f8e0410cb9d_story.html> and discuss with students.
2. Explain that students will investigate which material can be used that is similar to an emperor penguins’ winter coat, i.e. which material prevents or slows down heat loss from the warm water inside the can (heat moving from the warm water to the surroundings).
3. Introduce the terms, ‘insulator’ and ‘conductor’. For example say, “Look for the best insulator of heat”. *Note that a penguin huddle has the effect of insulating the penguin in the middle of the huddle, keeping that penguin warm.* Complete the 3 pages titled ‘Investigation 2: What should a penguin wear to keep warm?’in the student booklet.
4. Explain to the students that they will be conducting an investigation to answer the following question: “Which material acts as the best insulator?”*(Which material keeps the water inside the can the warmest after a length of time?)*
5. Collect various materials for covering the cans. Polystyrene cups could be broken up into pieces that can then be stuck onto the cans to form a covering layer. A wide range of materials is best for a comprehensive test.
6. Have the students make a prediction about which material they think will be the best insulator based on their observations of the collected materials and their prior knowledge. They can record their prediction on the ‘Investigation Planner’ for Investigation 2 in the student booklet.
7. As a class, complete the ‘Choosing variables’ section of the Investigation Planner in the student booklet. Ask students the following questions.

* What are we going to change?
* What are we going to measure?
* What are we going to keep the same?
* How are you going to make this a fair test?
* How are you able to answer the question, which material acts as the best insulator?

1. Have the students discuss what they are going to do to test the different materials. They can then complete the sequencing activity on the investigation planner. Revise this sequence before allowing them to start on the investigation. (*Students may have stronger input into experimental design for this investigation. Groups could have 1 can each which they cover, test, remove the covering and repeat with a different covering, or they can prepare as many cans as possible and test them together as a group*.)
2. Students work in their groups to carry out the investigation of at least three different materials. They record the temperature of the cans at the beginning, after 5 minutes and then after 10 minutes. They record their results in the table in the Investigation Planner.
3. Suggest to students that it is worth testing one can with NO covering. A can with no covering would be termed the ‘control’ and would illustrate how effective the materials are in preventing heat loss when compared to the heat loss from the ‘control’ can.
4. As the students conduct the investigation, encourage their inquiry and skill development by asking them questions about their process. The following are some example questions.

* What are you doing?
* What measurements are you recording?
* How are you keeping track of the time?
* What would you expect to happen if your prediction is right?

1. Encourage students to repeat the test for each different material in the SAME manner.

* Keep the volume of water the same i.e., fill all cans to the top.
* Place the can in the same place within the room each time.
* Ensure the timing is correct.

1. Discuss the results of their investigation as a class using the following question starters.

* Which materials did you use?
* Which can stayed the warmest?
* Which can lost most heat?
* Which material was the best insulator? How do you know?
* Did you find anything that surprised you?
* Which material would you wear to keep you warm? Why?
* What did you do to make the tests fair?
* How could you improve your investigation?
* How well were you able to answer the question for this investigation?
* What else could you investigate?

1. Have the students complete the ‘Discussing results’ section of the Investigation Planner. Here they make their claim as to which material they found to be the best insulator and support it with evidence from their investigation. In this way the students answer the investigable question that they started with.

**The following activities provide examples of adjustments to illustrate how students with diverse needs can access and participate in this CLE.**

**Investigation 2**

* Students are required to use a stopwatch. As stopwatch functions vary, a student at this age needs to learn how to use their specific stopwatch, prior to measuring and recording. It is highly advisable to devote time to practising and demonstrating how to use and read a given stopwatch accurately in share–pair groupings. Where a stopwatch proves too challenging, a clear, easily seen class clock with hands and a face showing 5-minute intervals may suffice for some students.
* Page 6 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx) outlines the recording tasks to be completed. Students are required to measure and record temperatures with reasonable accuracy in 5-minute intervals and complete a number of tasks. Some students may need assistance when 1) reading the temperature on a thermometer, followed then by 2) aligning this data with the appropriate can and 3) recording temperature data on the chart. A teacher may assist students with the successful completion of these tasks by repeating instructions.
* Page 7 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx) is a recording task. Some students may need to discuss the meanings of terms such as ‘warmest’ and ‘lost most heat’ in order to complete the first two recording tasks. ‘Wait time’ offers students opportunities to think through and discuss a task prior to its commencement. A teacher, teacher assistant or student tutor may assist another student who experiences difficulty with reading and/or writing. To assist this student, firstly, read the words aloud to them and have them repeat the words, secondly, read each sentence in turn requiring the student to respond with the best word from the list of words, thirdly, ask the student to attempt to write a word in the appropriate blanks, and fourthly, praise their efforts. The last recording task on page 7 could be completed orally or by an entire class viewing a whiteboard.
* Pages 8, 9 and 10 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx) contain reading and recording tasks. Some students may benefit from the assistance of a teacher, teacher’s assistant or student tutor with completing these tasks, particularly those tasks outlined on page 10. Students may need familiarising with the terms ‘predict’ or ‘prediction’.
* Page 11 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx) requires students to identify variables. These variables will relate to the materials used to insulate the cans. Some students will require assistance with this task. They need to understand that certain aspects of this investigation need controlling, e.g., the initial temperature of the hot water in each can.
* Page 12 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx) is a sequencing task where students are expected to number, in order, the six tasks to follow when conducting this investigation. Students with challenges involving memory and sequencing will need assistance with this task, which can be adapted. Provide a loose copy of page 12 and ask students to cut out each of the six tasks. Students will have six strips of paper in front of them. With teacher assistance, rehearse each of the steps that students need to follow in this investigation. As each step is concluded, students identify the appropriate strip and place it under the previous step, e.g., 1) ‘Dress up your can’, 2) Add the thermometer, 3) Fill the can with warm water.
* Page 13 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx) outlines repeat measuring and recording tasks as outlined on page 6. A teacher might follow the advice offered above for page 6.
* Page 14 of the [student booklet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20booklet_Yr3_The%20Penguin%20Project.docx) requires students to discuss their results. Some students may need the assistance of a teacher or student tutor to complete these tasks. A teacher, teacher’s assistant or student tutor may record a student’s verbal responses.

### Expected results and explanations

Students ‘dress up’ their cans with different materials and then measure the temperature loss of a can-full of warm water over 10 minutes. It is advised that they record the starting temperature of the warm water and then measure it again at 5-minute intervals, for say 10 minutes.

Different materials have different insulating properties. There may be one material that kept the warm water warmest over the 10 minutes or there may be several materials that achieve a similar result. The drop in temperature for each material could be recorded in a table and re-represented as a column graph.

The **discussion of results** could focus on which material was the best insulator (i.e., lowest temperature drop, least heat loss) and the properties of the material that might explain why it was best at trapping the heat.

For example, in the Investigation Planner the students make a **claim** in answer to their question – Which material is the best insulator? – *The X material*

They then support this with **evidence** – *Because the temperature remained higher than the other cans or because it lost least heat.*

**Evaluation** of the investigation could consider the extent to which the tests were fair.

## Conclusion

Following the two investigations these questions could be used to further probe student thinking.

* What is heat?
* Why don’t hot things stay hot?
* How can heat be prevented from escaping from hot objects?
* What makes a test ‘fair’?
* How could you tell whether you conducted fair tests in the ways you used the materials?

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### Additional lessons and activities about heat and insulation

Fries-Gaither, Jessica 2009, ‘Lessons and activities about heat and insulation’, Beyond Penguins and Polar Bears, The Ohio State University website <http://beyondpenguins.ehe.osu.edu/issue/keeping-warm/lessons-and-activities-about-heat-and-insulation>

### To extend student investigations or drama ideas

‘Penguins: a game and a poem’ in Doona, John 2013, *Drama Lessons for the Primary School Year: Calendar Based Learning Activities*, Routledge: Oxon.

Google Book result; <http://books.google.com.au/books?id=eGBkUGOyuHwC&pg=PA107&lpg=PA107&dq=penguin+game+stay+warm&source=bl&ots=MxeR8klLmC&sig=kRt26C9xeOiVb49fj6tzGeV1szg&hl=en&sa=X&ei=9txOVPKnCaHAmAX44YGQBA&ved=0CDAQ6AEwAw#v=onepage&q=penguin%20game%20stay%20warm&f=false>

### Assessment opportunities

Investigation 1 provides an opportunity to assess student understanding of the concepts related to the transfer of heat. In addition, the level of student achievement of the science inquiry skills,***observing and recording*** could be assessed.

The Investigation Planner used for Investigation 2 provides an opportunity to assess students’ proficiency in ***planning and conducting*** an investigation as well as ***analysing patterns in data to suggest possible reasons for their findings.***

[**Assessment rubric**](https://assist.asta.edu.au/sites/assist.asta.edu.au/files/Assessment%20rubric_yr3_The%20Penguin%20Project.docx)

Any part of this CLE can be used to develop an assessment task. In is envisaged that teachers will develop assessment that is directly aligned to what students have had an opportunity to learn based on the learning intentions.

A task-specific rubric has been developed to assist teachers to use evidence of student learning to assess student achievement against goals and standards.