### Learning objectives: strands 2–5

- To identify the environmental conditions on the Terra Nova expedition
- To describe how the human body responds to extreme cold
- To explain why exposure to extreme conditions resulted in disaster for Scott’s expedition

### Learning objectives: strand 1 (HSW)

- To analyse data and reach conclusions
- To discuss the impact of scientific advances on the explorers’ chance of survival

### PLTS

- Team workers: carry out practical activities cooperatively
- Creative thinkers

### APP

- AF2 – Thinking scientifically
- AF3 – Communicating and collaborating in science
- AF4 – Using investigative approaches

### Starter

**About Scott’s last expedition**

Use the video clip to introduce Scott’s expedition and ask the following questions:

- Who went?
- Where did they go?
- When did they go?
- Why did they go?
- What were the conditions like?

Provide a slideshow of images of the expedition to introduce the topic. Ask the students for their first impressions, such as where do they think it is based, do the men look happy and healthy?

### Differentiation

- Use a 5Ws question grid to structure responses: Who/what/where/why/when
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### Resources

- About Scott’s Last Expedition (Natural History Museum): http://www.youtube.com/watch?v=hcJ850gJdNc&feature=relmfu
- BBC slideshow http://www.bbc.co.uk/news/magazine-16628909

### Main

- **Activity 1 – Thermometer**
  
  To gain a sense of scale and extreme temperatures the students place different temperatures on a thermometer.

- **Activity 2 – Practical**
  
  Introduce students to the terms ‘core temperature’ and ‘external temperature’.

### Differentiation

**Help**

- Use pre-labeled sticky notes and a large A3 version of the worksheet, as well as concrete examples, such as a jug of ice water or a real thermometer.

**Extension**

- Pose challenging questions such as: Why is the temperature so different in Antarctic summer and winter? Why do we say ‘summer’ when the average temperature is −20°C?

**Help**

- Provide method sheet with table template to complete.

### Resources

- Teacher and Technician Notes
- Activity sheet 1

- Teacher and Technician Notes
- Activity sheet 2
**Scott of the Antarctic**

**Lesson Plan**

**Practical**
- Exploring what could happen to body temperature as external conditions change.

**Extension**
- Students complete *Activity sheet 3*
- Activity sheet 3

**Plenary**
- Ask a series of simple true/false questions relating to thermoregulation in humans (focus on dealing with drop in temperature).

**Differentiation**
- Use true/false cards.
- Use traffic-light cards for self-assessment:
  - Green: know
  - Amber: unsure
  - Red: don't know

**Resources**
- True/false cards
- Traffic-light cards

**Homework**
- Students complete *Activity sheet 4* to compare Scott’s 1912 expedition to Sir Ranulph Fiennes’s 2013 expedition.
- Support: provide cut-up answer sheet and ask students to place the statements in the correct column. For task 2, provide the beginning of sentences such as “Clothing that can be heated would help the explorers because…” and ask students to complete them.
- Resources:
  - [Guardian article](http://www.guardian.co.uk/uk/2012/sep/17/ranulph-fiennes-antarctica)
  - [BBC News](http://www.bbc.co.uk/news/health-17371543)
  - [NZAHT Library](http://www.nzaht.org/content/library/Extract_from_CR_Conservation_Plan_List_of_Supplies1.pdf)

**Learning outcomes**

**Level 3**
- Identify common responses in the human body to changes in temperature (using simple scientific language).

**Level 4**
- Describe what happens when there is a difference between the temperature of the object and its surroundings.
- Describe how the human body responds to extreme temperature.

**Level 5**
- Use the idea of energy transfer to explain why an object cools down.
- Analyse data to draw scientific conclusions that are consistent with the evidence.
- Indicate how scientific developments may affect different groups of people in different ways.

**Level 6**
- Use the idea of energy transfer to explain why Scott had little chance of survival.
- Describe how uses of scientific developments may be made in different economic, social, or cultural contexts.

**Level 7**
- Explain how thermoregulation, environmental factors, energy, and the properties of materials contributed to Scott’s death.
Scott’s expedition
This lesson is based around the centenary of Scott’s ill-fated expedition to Antarctica.

Equipment required per group:
3 boiling tubes
Access to hot water
Thermometer ranging from –10°C to 110°C
Stopwatch
Beaker (500 ml)
Measuring cylinder (100ml)
Plenty of ice

Please ensure you are aware of Scott’s expedition and why it went wrong before you start this lesson. Links to resources are provided in the lesson plan.

Health and Safety notes:
Glassware: Please ensure pupils are aware of how to handle and rest thermometers to minimise breakages and what to do if there is a breakage.
Please check CLEAPSS guidance on using mercury-filled thermometers if appropriate.
Note that a thermometer resting in a beaker is at risk of being knocked over.

Activity sheet 1

Answers
Activity sheet 2

Students carry out the practical using Activity sheet 2. Following the practical, students should draw a line graph; this may be quite challenging for some and they might attempt to draw a bar chart, which would be incorrect. The best type of graph should have time on the x axis and temperature on the y axis, with three different curves on it:
1. Room temperature (Captain Scott)
2. Iced water (Captain Evans)
3. Ice (Lt. Evans)

Below is a typical cooling curve:

This graph is for reference only; cooling curves are not being tested.

The Lt. Evans boiling tube should lose most heat in the 10 minutes as more energy is transferred to its surroundings.

Activity sheet 3
Answers

8. Normal body temperature is 35.6–37.8 °C.
4. There is a drop in the external temperature.
6. The body starts to cool.
10. Blood becomes cooler than the level required in the brain.
12. Part of the brain called the hypothalamus detects the drop in temperature.
1. The muscles start to contract and relax rapidly.
11. This is called ‘shivering’ and it generates heat.
2. Blood vessels in the skin start to narrow.
9. Less blood flows in the surface of the skin.
7 Less heat is radiated from the skin so less heat is lost from the body.

3 The temperature of the blood starts to rise.

5 The brain detects the rise in temperature and stops the body responding.

Discuss with students that when this response is not sufficient then hypothermia can set in.

Activity sheet 4

You will need to allow for some creativity in the students’ answers.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Scott’s expedition 1911/1912</th>
<th>Fiennes’s expedition 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of year and average</td>
<td>Summer</td>
<td>Winter</td>
</tr>
<tr>
<td>temperature</td>
<td>Approximately –20 °C</td>
<td>Approximately –60 °C</td>
</tr>
<tr>
<td></td>
<td>Constant light</td>
<td>Constant dark</td>
</tr>
<tr>
<td>Equipment for travelling</td>
<td>Ponies, sledges, and motor sledges</td>
<td>Tractors, with special materials that do not freeze, are light</td>
</tr>
<tr>
<td></td>
<td>On foot</td>
<td>and strong</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Skis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cabooses</td>
</tr>
<tr>
<td>Food</td>
<td>Pemmican, biscuits, butter, sugar, cocoa, pony meat,</td>
<td>High-calorie foods from freeze-dried supplies</td>
</tr>
<tr>
<td></td>
<td>seal meat</td>
<td></td>
</tr>
<tr>
<td>Clothing</td>
<td>Windproof outer layers, such as canvas trousers and</td>
<td>Specialist clothing containing battery-powered heating</td>
</tr>
<tr>
<td></td>
<td>hooded smocks</td>
<td>filaments</td>
</tr>
<tr>
<td></td>
<td>Reindeer-fur gloves</td>
<td>Special breathing apparatus</td>
</tr>
<tr>
<td></td>
<td>Strong boots with canvas wrappings to keep out the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>wind</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Woollen undergarments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Goggles</td>
<td></td>
</tr>
<tr>
<td>Shelter</td>
<td>Sleeping bags of reindeer fur</td>
<td>Specialist sleeping bags to withstand –60 °C</td>
</tr>
<tr>
<td></td>
<td>Tents</td>
<td>Cabooses</td>
</tr>
</tbody>
</table>

2 Answers should indicate that the Fiennes expedition is going to be much more challenging in conditions as it will take place during the Antarctic winter, rather than the summer months as in the case of Scott’s expedition, but that the explorers will be much better prepared for the conditions.

The technological advances in equipment are based on scientific understanding of the conditions and how the human body responds to extremes, for example, modern expeditions make use of freeze-dried foods with a high calorific value. This increases the chances of survival in a modern expedition because the food is able to replenish the energy the explorers expend in moving and keeping warm, whilst being lightweight to carry.
1 Look at the list of temperatures below the thermometer. Label the thermometer with these temperatures by drawing arrows in the correct position and adding a label.

The first temperature has been marked on for you.

Freezing point of water 0°C
Room temperature 20°C
Boiling point of water 100°C
Body temperature 37°C

2 The average summer temperature on land in Antarctica is −20°C and the average winter temperature is −60°C.

Add these temperatures to the thermometer.

3 Hypothermia was a serious worry for Captain Scott and his team. Hyperthermia sets in when the core body temperature reaches 35°C and below.

Add this temperature to the scale as well.
In this experiment you are going to model the effects of extreme cold on the human body; warm water will represent Captain Scott and two of his fellow explorers, Captain Oates and Lieutenant Evans, and air, ice, and icewater will represent different temperatures in Antarctica.

**Apparatus**

- 3 boiling tubes
- thermometer
- stopwatch
- beaker (500 ml)
- measuring cylinder (100 ml)
- plenty of ice
- warm water
- marker pen

1. Use the marker pen to label the three boiling tubes as Captain Scott, Captain Oates, and Lt. Evans (you can draw faces on too if you wish).

2. Place 50 ml of warm water into the Captain Scott boiling tube and place in an empty beaker. Immediately take the temperature of the water and the temperature of the air. Note these values in the starting row of the results table.

3. Leave the boiling tube in the empty beaker and take the temperature of the water at 1-minute intervals for 10 minutes. Record your results.

4. Now put 50 ml of fresh warm water into the Captain Oates boiling tube. Immerse the boiling tube of water in a beaker of ice. Take the starting temperature of the water and of the ice and record them in the table. Take the temperature of the water in the tube at 1-minute intervals for a period of 10 minutes. Record your results.
5 Now put 50 ml of fresh warm water in the Lt. Evans boiling tube. Immerse the boiling tube of water into a beaker of icewater (half ice, half water). Take the starting temperature of the icewater and of the water in the boiling tube and record them in the table. Take the temperature of the water in the tube at 1-minute intervals for a period of 10 minutes. Record your results.

<table>
<thead>
<tr>
<th>Captain Scott</th>
<th>Captain Oates</th>
<th>Lt. Evans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (min)</td>
<td>Temp (°C)</td>
<td>Time (min)</td>
</tr>
<tr>
<td>Start</td>
<td>air water</td>
<td>Start</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<td>10</td>
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<td>10</td>
</tr>
</tbody>
</table>

6 Plot the three sets of results on one graph, with time on the x axis and temperature on the y axis.

7 Which of the explorers lost the most heat?
How does the body respond?

Fortunately our bodies are not like the boiling tubes in the experiment and can respond to changes in external temperature. This is called thermoregulation.

Put the statements below in the correct order to explain how the body responds to a drop in temperature. The first two have been done for you.

| 1  | The muscles start to contract and relax rapidly. |
| 2  | Blood vessels in the skin start to narrow. |
| 3  | The temperature of the blood starts to rise. |
| 4  | There is a drop in the external temperature. |
| 5  | The brain detects the rise in temperature and stops the body responding. |
| 6  | The body starts to cool. |
| 7  | Less heat is radiated from the skin so less heat is lost from the body. |
| 8  | Normal body temperature is 35.6–37.8 °C. |
| 9  | Less blood flows in the surface of the skin. |
| 10 | Blood becomes cooler than the level required in the brain. |
| 11 | This is called ‘shivering’ and it generates heat. |
| 12 | Part of the brain called the hypothalamus detects the drop in temperature. |

Correct order: **8 4**
Scott of the Antarctic

Sir Ranulph Fiennes

Sir Ranulph Fiennes, a 68-year-old British explorer, will attempt a record winter Antarctica trek in 2013. He will have access to equipment and resources that are very different and technologically advanced compared to what Scott used 100 years ago.

1 Using the information from this lesson and the Internet complete the table below to compare the two expeditions.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Scott’s expedition 1911/1912</th>
<th>Fiennes’s expedition 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of year and average temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment for travelling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clothing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shelter</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2 Do you feel that Ranulph Fiennes will have a better or worse chance of survival than Scott? Use the evidence you have gathered in the table above to help explain your answer.