# Race to the South Pole

## Lesson Plan

### Learning objectives

- **Learning objectives strands 2–5**
  - Forces are interactions between objects and can affect their motion
  - Energy can be transferred usefully, stored, or dissipated but cannot be created or destroyed

- **Learning objectives: strand 1 (HSW)**
  - Use a range of scientific methods and techniques to develop and test ideas
  - Plan and carry out practical and investigative activities

- **PLTS**
  - Team workers: carry out practical activities cooperatively
  - Creative thinkers: link learning from different areas of science

- **APP**
  - AF4 – Using investigative approaches to collect reliable data
  - AF3 – Communicating science through graphs

### Starter

- **Introduction to Antarctica** Use pictures of Antarctica and interesting facts to set the scene.
- **Scott’s last days** Discuss energy content of food in relation to pulling a sledge in a cold climate. Students watch a video and answer questions.
- **Horrible Histories** Show the video to introduce some of the differences between Scott’s and Amundsen’s expeditions.

### Differentiation

- **Help**
  - Watch the video without doing the calculations.
- **Teacher and Technician Notes**
  - Bar of chocolate
  - Information sheet
  - Activity sheet 1
  - http://www.youtube.com/watch?v=M3RacvLulI

### Resources

- **Main**
  - **Which route?** Students analyse a map of the routes that Scott and Amundsen took to find out how many miles per day they walked.
  - **Practical – Effect of angle on force needed to pull a sledge** Students make a model sledge and investigate the force needed to get it to move when they vary the angle at which they pull. They measure the force needed by measuring the extension of a rubber band.

- **Differentiation**
  - Show the map, give students the times and distances, and ask them to work out speeds in kilometres per day.

- **Extension**
  - Ask students to design their own investigation into the effect of the angle.
  - Investigate the effect of the angle of the slope (given that the explorers would have to haul sledges up steep inclines).

- **Teacher and Technician Notes**
  - Activity sheet 2
**Race to the South Pole**

**Plenary**
- **Where should the harness go?** Students work out the best angle to use for pulling the sledge and discuss their findings in light of the evidence from pictures of the expedition.
- **Why did Amundsen win?** Students identify factors and prioritise them using the diamond-pattern activity. Show the Horrible Histories clip again for ideas.

**Differentiation**
- The actual angle for minimum force is about 30 degrees, which reduces the force required by about 10%.
- **Extension**
  - Use the **Information sheet** to investigate the angle for minimum force.

**Resources**
- **Teacher and Technician Notes**
- Powerpoint slides of Scott and team
- **Activity sheet 3**
- **Information sheet**

**Homework**
- Find out how recent expeditions on foot to the South Pole have differed from Scott’s expedition. Make a ‘before/after’ poster showing the main differences.
- How have plastics revolutionised the design of sledges? Make a timeline to show how designs have changed.

**Learning outcomes**

**Level 3**
- Describe some observations of the effect of changing the angle on the force required to move a model sledge
- Know that friction is a force that makes it difficult to make things move

**Level 4**
- Describe a link between angle on the force required to move a model sledge
- Describe some of the factors that affect friction
- Describe some foods that are energy dense

**Level 5**
- Use ideas about friction to interpret observations about the link between angle on the force required to move a model sledge
- Explain why there is a force of friction between two surfaces
- Explain why polar expeditions need energy-dense food

**Level 6**
- Use ideas about forces to explain information displayed on graphs relating angle to the force required to move a model sledge
- Know that the force of friction increases as you push a stationary object
- Do simple calculations involving energy and food in relation to polar expeditions

**Level 7**
- Explain why there is an angle where the force required is a minimum
- Explain why the sledge will only move when a force of a certain size is applied
- Do multistep calculations involving energy and food in relation to polar expeditions

© Oxford University Press 2012   This resource sheet may have been changed from the original.
Race to the South Pole

In this lesson, students investigate some of the reasons why Robert Falcon Scott was beaten to the South Pole by Roald Amundsen.

There are many aspects of the expeditions that students can consider. These include:

- the route that each expedition took; Amundsen took a different route to Scott, one that had not been tried before.
- the methods of transport chosen; Scott chose to manhaul sledges to the Pole but Amundsen chose to use dogs. The sledges that Scott used were heavier. How did these choices impact on the energy that was required by the explorers?
- the impact of hauling sledges on the food that would be needed. Could Scott’s men have changed the way they hauled their sledges to reduce the force needed to move them?

Students consider the energy requirements of an average person, and the energy density of food by watching a short video and answering some questions. They then make a model sledge and investigate the force needed to start the sledge moving when pulled at different angles. Finally, they identify the factors that may have brought about Amundsen’s success and use a diamond-9 activity to put these factors in order of importance.

**Equipment required per group:**

**Starter**
- **Information sheet** (optional)
- **Activity sheet 1** One per student, calculators
- Bar of chocolate

**Main**
- **Activity sheet 2** One per student, calculators
- **Practical**
  - **Practical sheet**
  - Block of wood or margarine tub
  - 100 g masses/1 kg masses
  - String
  - 3 short elastic bands looped together/one long elastic band (15 cm)/piece of elastic with loops at either end
  - White paper
  - Sellotape
  - Wooden skewer or similar stick

**Plenary**
- Poster-making equipment or access to PowerPoint
- **Information sheet**
- **Activity sheet 3**

**Health and Safety notes:**
- Students must use the elastic/elastic bands sensibly.
- Take care not to drop the masses.

**Starter**

1. **The race to the pole** Introduce the idea of the race between Scott and Amundsen with pictures from Antarctica using the websites below. Some interesting facts:
   - Antarctica really was the ‘last place on Earth’. It was the last place to be discovered and no-one set foot on it until 1821.
Race to the South Pole

- It’s the coldest and driest continent on Earth. There are only a few centimetres of rain a year so it is a desert. The record for the lowest temperature that has ever been recorded, \(-89.2\, ^\circ\text{C}\), is held by the Vostok Station, a Russian Antarctic research station that investigates ice cores.
- It has the world’s southernmost active volcano, Mt Erebus, which is found on an island on which Scott made his base (Ross Island). It has been active continuously since 1972.
- Amundsen was a Norwegian polar explorer who was the first to reach the South Pole, the first undisputed expedition leader to reach the North Pole, and the first to traverse the Northwest Passage. He disappeared in 1928 flying a rescue mission at the North Pole. The plane and his body were never found.
- Scott was a Royal Navy officer and explorer who led two expeditions to Antarctica. Unlike Amundsen’s, his expedition to the South Pole also had a scientific basis. He and four other members of his expedition died returning from the South Pole; they were only 18 kilometres from a base where there were supplies of food.

Alternatively, give out the Information Sheet for students to read.

2 Scott’s last days

Scott and his four companions ran out of supplies. All members of the expedition suffered from malnutrition. Show a chocolate bar and ask them how many you would need to eat a day to be able to make it to the South Pole.

Give out Activity sheet 1; watch the video here:

Students answer the questions on the sheet. Answers:

1 100 days
2 100 kg
3 Fresh food would go off
4 Suet/vegetable fat
5 27
6 135 g or 1.35 kg
7 No, doesn’t have enough kJ/kg, or the right balance of protein/fat, and lacks vitamins/minerals.

3 Introduce the main activity by showing video clip of Horrible Histories:
http://www.youtube.com/watch?v=M3RacavLuI

Main

1 Which route? Students use the map on Activity sheet 2 to work out the time it took each team to reach the South Pole, the distances they travelled, and how many kilometres they travelled each day.

Answers:

1 Scott took 78 days and Amundsen took 67 days.
2 Scott travelled 1381 km and Amundsen travelled 1285 km.
3 Scott travelled 17.8 km per day and Amundsen travelled 19.2 kilometres per day.

2 Did their choice of transport make a difference? Did the way that they hauled the sledges make a difference? Tell students that they are going to look at the physics of pulling sledges to find out.
**Practical** Pairs or small groups follow the instructions on the **Practical sheet** to obtain data to look at the relationship between the angle of the rope and the force needed to pull the sledge. In this experiment they use the position of the elastic band on the stick instead of angle and the extension of the band instead of force.

They plot a graph of the distance against the position of the elastic band on the stick.

This is a good opportunity to emphasise the importance of repeating experiments to obtain good data.

**Extension**

Demonstrate the ‘sledge’ and ‘harness’ and get students to design and complete their own investigation.

**Plenary**

1 **Analysing results** Groups discuss the results of their experiments. At this point they can look at actual pictures of Scott and his team hauling sledges (see links below) to estimate the angle that they were using to pull. They present their results to the class or as pairs to the rest of the group. This could include a poster or Powerpoint presentation if time allows.

**Extension** The actual minimal angle is 27°. The theoretical data for a sledge of mass 1 kg and graph is on the **Information sheet**. Students could use the data and the graph to work out the percentage difference in force at about 30°.

2 **Why did Amundsen win?** Groups discuss what they have learned in the lesson and produce a list of factors. They prioritise the reasons using the diamond-9 pattern activity on **Activity sheet 4**. As a class, discuss what is likely to have been the most important factor. Show the Horrible Histories video for ideas.

**Useful web links**

**Starter**
http://photolibrary.usap.gov/
http://lima.nasa.gov/
http://www.antarctica.ac.uk/images/index.php

**Main**
http://wintertrekking.com/equipment/sleds-toboggans/

**Plenary**
http://events.nationalgeographic.com/events/speakers/2011/06/13/amundsen-scott/
http://mp.natlib.govt.nz/detail/?id=37377&l=en

**Useful teacher background**
Interesting facts

- Antarctica was the last continent on Earth to be discovered and no-one set foot on it until 1821.
- It’s the coldest and driest continent on Earth. There are only a few centimetres of rain a year so it is a desert. The lowest temperature ever recorded on Earth, –89.2°C, was in Antarctica.
- It has the world’s southernmost active volcano, Mt Erebus, which is found on Ross Island, where Scott made his base camp. It has been active continuously since 1972.
- Amundsen was a Norwegian polar explorer who was the first to reach the South Pole, the first undisputed expedition leader to reach the North Pole, and the first to traverse the Northwest Passage. He disappeared in 1928 flying a rescue mission at the North Pole. The plane and his body were never found.
- Scott was a Royal Navy officer and explorer who led two expeditions to Antarctica. Unlike Amundsen’s, his expedition to the South Pole also had a scientific basis. He and four other members of his expedition died returning from the South Pole while only 18 km from a base where there were supplies of food.

Theoretical data

This is a typical set of data that you would expect for a ‘sledge’ of mass 1 kg.

<table>
<thead>
<tr>
<th>Angle (degrees)</th>
<th>Force (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10.00</td>
</tr>
<tr>
<td>10</td>
<td>9.30</td>
</tr>
<tr>
<td>20</td>
<td>9.00</td>
</tr>
<tr>
<td>30</td>
<td>8.96</td>
</tr>
<tr>
<td>40</td>
<td>9.20</td>
</tr>
<tr>
<td>50</td>
<td>9.75</td>
</tr>
<tr>
<td>60</td>
<td>10.72</td>
</tr>
<tr>
<td>70</td>
<td>12.32</td>
</tr>
<tr>
<td>80</td>
<td>15.01</td>
</tr>
</tbody>
</table>

Graph of force against angle

This is the graph of the typical data above.
**Modelling a sledge**

In this practical you will investigate how the position of the harness affects the force that you need to start a sledge moving.

To do this you will make a model sledge and harness using a piece of wood or a margarine tub, masses, and some elastic or a long elastic band.

**Making a sledge**

1. Tie a piece of string around the piece of wood or tub.
2. If you are using a tub fill it with a mass of 1 kg. If you are using a block of wood add masses to the top of the block until the mass of both is about 1 kg in total.
3. Tie a piece of elastic or a long elastic band to the string at the front of the block or tub.

**Moving the sledge**

1. Tape a piece of paper to the bench using sellotape to secure it on two sides.
2. Take a wooden stick and make marks 2 cm apart.
3. Loop the elastic band around the stick and hold the wooden stick vertically. Position the elastic band on the first mark on the stick (2 cm up from the bench).
4. Position the tub/block, stick, and band so that:
   a. the elastic band is just tight (not sagging)
   b. the stick is vertical and the bottom of it is on the white paper.
5. Make a mark on the paper. This is the Start position.
6. Slowly and carefully move the stick away from the tub/block until the tub/block starts to move. As soon as the tub/block starts to move you must stop moving the stick.
7. As you are doing this make sure that:
   a. you keep the stick vertical at all times
   b. you move the stick directly away from the block
   c. if necessary you hold the elastic band in place on the 2-cm mark as you move the stick.
8 Make another mark on the paper in the Finish position.

9 Measure the distance between the Start and the Finish positions. This distance, $d$, is a measure of the force needed to move the block.

10 Move the elastic band to the next mark and repeat the experiment.

11 Repeat the experiment 2 more times. This is important because of the uncertainty in working out the exact position of the Finish.

**Recording your results**

Record your results in a table.

<table>
<thead>
<tr>
<th>Position on stick (cm)</th>
<th>Distance, $d$ (cm)</th>
<th>Distance, $d$ (cm)</th>
<th>Distance, $d$ (cm)</th>
<th>Average distance, $d$ (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To work out the average distance, add all the three distances together and divide by three. Round up your answer.

**Displaying your results**

Plot a graph of distance against the position of the elastic band on the stick.

Your axes should look like the graph below:
Race to the South Pole

ACTIVITY SHEET 1

How much food do you need?

If you go on an expedition to the North or South Pole you need to take all your food with you. Watch the video about the food you need to take with you on an expedition that lasts 100 days.

Use the information on the video and the information in the box below to answer the questions that follow.

Normally an active adult needs about 12000 kJ (2800 kilocalories) of food energy per day. On an expedition you need about 27000 kJ (6400 kilocalories) to drag a heavy sledge and keep warm every day. We usually talk about calories but 1 calorie is actually 1 kilocalorie.

1 How many days does Dave’s journey last? ______________________________

2 How many kilograms of food did he take for each day? ____________________

3 Why didn’t he take fresh food? _______________________________________

4 Which food had the highest energy? ___________________________________

5 One chocolate bar will provide about 1000 kJ. How many chocolate bars would you need to eat each day on an expedition?

_________________________________________________________________

_________________________________________________________________

6 Each chocolate bar has a mass of 50 g. Will that number of chocolate bars have a mass that is more or less than 1 kg? (1 kg = 1000 g.)

_________________________________________________________________

_________________________________________________________________

7 Would it be sensible to just take chocolate? Use information that you have learned in science about food to explain your answer.

_________________________________________________________________

_________________________________________________________________
The year is 1911 and two teams are racing to be the first people to reach the South Pole in Antarctica. Amundsen set out on October 8th, 1911 and reached the Pole on December 14th, 1911. Scott set out on November 1st, 1911 and reached the Pole on January 18th, 1911.

1. How many days did each man take to reach the pole? ________________________________

2. Use a piece of string and the scale on the map above to work out the length of each route.
   - Scott ______________ km
   - Amundsen ______________ km

3. Calculate the number of kilometres per day that Scott and Amundsen travelled.
   - Scott ______________ km
   - Amundsen ______________ km
Why did Amundsen win?

Discuss the reasons you have found out about why Amundsen reached the Pole first.

Write one reason in each box.

Cut out the boxes and rearrange them so that the most important reason is at the top and the least important is at the bottom.