

EXPERIMENT WITH THE VIKINGS

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ACTIVITIES CLASSIFICATION

Activity Name	Biology	Chemistry	Physics	Technology	Maths	Demo
Which is the best cereal?	✓					
Growing cereal crops	✓					
What is the soil like in Scandinavia?	✓	✓				
Viking campsites	✓	✓				
What makes a longship long?			✓	✓	✓	✓
The Viking longship			✓	✓		
Longship shape			✓	✓		
Why do longships float?			✓	✓		
Which shape makes the best sail?			✓	✓	✓	
Can Viking longships tack?			✓			
How to find Polaris, the Pole or North Star			✓			
Show photos of star arcs around Polaris			✓			✓
Use the Pole Star to navigate			✓		✓	
Sun shadow board			✓		✓	
The sunstone			✓			
The shieldwall formation			✓			✓
Weapons – long vs. short cutting edge			✓	✓		
Armour			✓	✓		
Conical vs. round helmets			✓			
Padding under the helmet			✓			
Starting fires		✓				✓
Putting fires out		✓				
Cooking on fire		✓				✓
Making bread	✓	✓				
Growing yeast	✓	✓				✓
Extraction of salt from seawater		✓				
Extraction of salt from rock salt		✓				

ACTIVITIES CLASSIFICATION

Activity Name	Biology	Chemistry	Physics	Technology	Maths	Demo
Preserving cucumber with salt		✓				✓
Making butter		✓				
Making cheese		✓				
Spinning thread			✓	✓		
Which fabric keeps you warmest?			✓			
Which clothes keep you coolest?			✓			
Viking nappies		✓		✓		
Longship sails			✓	✓		
Dyeing with onion skins		✓				
Dyeing with mordants		✓				
Dyeing with red cabbage		✓				
Sheep	✓					
Identification of crops	✓					
Life cycles of domesticated animals	✓					
Life cycles of salmon or eels	✓					
Protection from snakes and elves	✓	✓				
Amber	✓	✓				
Furs and skins	✓					
Investigating (fake) Viking poo	✓					
How can items survive 1500 years or more in the ground?	✓	✓				

INTRODUCTION

Welcome to Experiment with the Vikings, a comprehensive resource to include STEM in your Vikings topic. People from Scandinavia (Denmark, Norway and Sweden) in the part of the Early Medieval Period from 793 to 1066, sometimes called the Viking Age, relied on their technology to survive. Many aspects of their lives can be investigated through STEM subjects. This resource contains over 40 activities that link directly to the Vikings, covering aspects of everyday life, weapons and warfare, travel and trade. It finishes with some activities linked to how archaeologists today use STEM to investigate life in Viking times.

Who were the Vikings?

"The Vikings" has become the name for people from Scandinavia who raided the British Isles, Northern and Central Europe, and into Russia between 793 and 1066. However, a Viking is not a race, but an occupation. Most people were farmers, fishermen, traders, craftsmen or warriors. Some of these people would sometimes take ships and raid coastal settlements or other ships, taking goods and slaves to be kept or sold elsewhere. Taking part in these activities was called going Viking. Just like people nowadays, people then identified themselves more as Dane, Norse or Svear.



Context: Our fictional hero, Leif Sigurdson, was one such person. The youngest son of a farmer from Borg in the Lofoten archipelago in Norway, Leif left home at the age of 14 to become a Viking. Rich from raiding in Scotland and Ireland, and with his own warship by the time he was just 20 years old, Leif settled in Copeland, on the west coast of Cumberland, in what is now England. A Norseman (Norwegian) by birth, Leif's was one of many Norse settlements in the area.



ACTIVITY STRUCTURE

All of the activities follow a similar structure featuring these sections:

	Key words	Identifies some of the key words that can be used during this activity.
	Context	A narrative to frame the activity.
	Teachers' note	Information for you to be aware of.
	What can we ask	Key questions that can be explored through the activity.
	Equipment list	What you, and the class, need in order to do the activity.
	Activity instructions	What you and your class do.
	Explanation	A brief explanation of the science explored in the activity.
	Health and safety	Where relevant, this is what you need to do to be safe. When doing any science experiment always do your own risk assessment.
	Related activities	Other activities, including cross-curricular links, you and your class can do based on the learning from the activity.

**KEY WORDS:**

Nutrition, cereal, energy, calories, protein, carbohydrate, fat, growth

WHY DID THE VIKINGS INVADE?

POPULATION PRESSURES

In parts of Scandinavia it was difficult to grow enough food for everyone to stay healthy. This meant that many young men, especially younger sons, decided to find somewhere else to live.



Context: Leif's family were farmers, growing crops and raising livestock in the cold north of Norway. Lacking many options at home, and with food often in short supply for such a large family, Leif decided to leave and make his own fortune elsewhere.

Which is the best cereal?



Teachers' note: Ordinary people in Viking times got most of their daily calories from cereals used to make beer and porridge and, sometimes, bread. In Norway barley was mostly used for making beer, while rye was used to make bread. Where it would grow, rich people liked bread made from wheat, while oats were used to make a savoury porridge.



What can we ask? Which cereals contribute best towards a balanced diet? What are different cereals used for?



Equipment list: Cards showing key nutritional information for each cereal.



Activity instructions: Use the nutritional information provided to decide which cereal grains you would use to make bread, porridge or beer. Beer contains carbohydrates with lots of calories, so it was drunk for energy. Porridge contains carbohydrates and a little fat for energy, and protein to help you grow. Bread contains carbohydrates for energy.

Barley
NUTRITION FACTS

Serving Size: 100 g or 3.5 oz

AMOUNT PER SERVING

Calories: 354 Calories from Fat: 19

% Daily Value*

Total Fat: 2 g 4%

Total Carbohydrate: 73 g 24%

Dietary Fibre: 17 g 69%

Sugars: 1 g

Protein: 12 g

Vitamin A: 0%

Vitamin C: 0%

Calcium: 3%

Iron: 20%

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

Nutritional data | SkipThePie.org

Wheat
NUTRITION FACTS

Serving Size: 100 g or 3.5 oz

AMOUNT PER SERVING

Calories: 327 Calories from Fat: 13

% Daily Value*

Total Fat: 2 g 2%

Total Carbohydrate: 71 g 24%

Dietary Fibre: 12 g 49%

Sugars: 0 g

Protein: 13 g

Vitamin A: 0%

Vitamin C: 0%

Calcium: 3%

Iron: 18%

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

Nutritional data | SkipThePie.org

Oats
NUTRITION FACTS

Serving Size: 100 g or 3.5 oz

AMOUNT PER SERVING

Calories: 389 Calories from Fat: 58

% Daily Value*

Total Fat: 7 g 11%

Total Carbohydrate: 66 g 22%

Dietary Fibre: 11 g 42%

Sugars: 0 g

Protein: 17 g

Vitamin A: 0%

Vitamin C: 0%

Calcium: 5%

Iron: 26%

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

Nutritional data | SkipThePie.org

Rye
NUTRITION FACTS

Serving Size: 100 g or 3.5 oz

AMOUNT PER SERVING

Calories: 338 Calories from Fat: 14

% Daily Value*

Total Fat: 2 g 3%

Total Carbohydrate: 76 g 25%

Dietary Fibre: 15 g 60%

Sugars: 1 g

Protein: 10 g

Vitamin A: 0%

Vitamin C: 0%

Calcium: 2%

Iron: 15%

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

Nutritional data | SkipThePie.org



Related activities: Devise a healthy menu for a person living in Viking times using only seasonal plants and fruits, and what they could raise and grow.

Find out what other ingredients available in Viking times could be added to make a nutritious savoury porridge.

**KEY WORDS:**

Temperature, sunlight, growth, crops, seasons, photosynthesis

Growing cereal crops



Context: After many years spent raiding, making a reputation for himself and accumulating wealth and men, Leif decided to settle in Cumberland. On the plains between the sea and the mountains the land was flat and fertile, unlike the icy lands in Norway that he used to call home. There he was able to raise many different crops, raise livestock and start a family. Life was much easier than in his old home.



Teachers' note: Parts of Norway have a much shorter growing season than Denmark or Britain because, being further north, the temperature is much lower. This means that some cereals don't grow well, with barley and rye the main cereal crops in the north, and rye, barley, oats and wheat in the south.



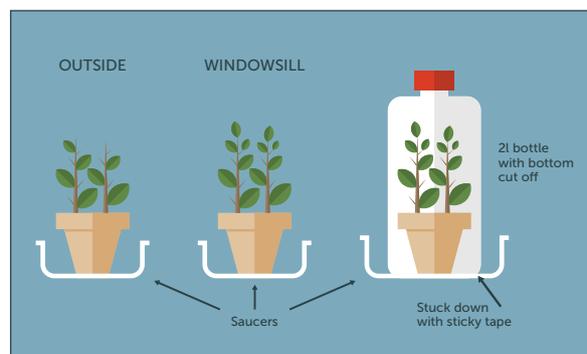
What can we ask? How does the temperature affect plant growth? Compare seeds from different crops. Do some crops grow better than others at a lower temperature?



Equipment list: Wheat seeds, plant pots, saucers, damp compost, ruler, empty 2-litre plastic bottle with lid, safety scissors, sticky tape



Activity instructions: Plant some wheat seeds in three pots (same number in each) and place the pots on saucers. Leave one pot outside in a place sheltered from wind, but in the light, and another pot on the windowsill indoors. With the third pot, cut the bottom from the 2-litre bottle and cover the pot, sealing the bottom to the saucer with sticky tape. This will keep the temperature slightly higher inside the bottle. Keep this on the windowsill, next to the other pot. Every day, once they have germinated, measure the height of the wheat plants.



Growing cereal crops



Explanation: The further north you go the shorter the growing season, due to lower temperatures. Photosynthesis is a chemical reaction, and chemical reactions run more slowly at lower temperatures, so plants have less time to grow at higher latitudes and elevations. The outdoor plant, during the winter, is less likely to germinate and will grow more slowly than the indoor plants. The plant in the bottle will have a slightly higher temperature, due to heat trapped within the bottle, so should grow slightly more than the plant without a bottle.



Related activities: How does the amount of light affect plant growth? Compare different cereals' growth at different temperatures.



KEY WORDS:
Acid, soil, growth, pH

What is the soil like in Scandinavia?



Context: When Leif remembered his homeland his main memories were of looking out over the fjords from the tops of the black, rocky hills and toiling in the thin, rocky soil. As a child one of his main jobs was removing the hard granite stones from the fields before ploughing. One time, he remembered, his father purchased some wheat seeds from a trader. Fewer than half of the seeds germinated, and those that did grew small and frail. They were all killed in the first frost, with nothing harvested. That was a bad year.



Teachers' note: Much of the bedrock in Scandinavia is igneous and metamorphic rock, plus lots of sandstone. This means the soil is often acidic, consisting of boggy land and heathland. This means that the area for growing cereal and other crops is limited, especially in Norway.



What can we ask? How does acid soil affect plant germination? Do some plants grow better than others in acidic soil?



Equipment list: Cress seeds, tissue paper, saucers, tap or distilled water, distilled vinegar



Activity instructions: Take two saucers and lay a few sheets of tissue paper on each. Count out and sprinkle the same number of cress seeds onto each piece of tissue paper. Pour 20 ml vinegar onto one set of seeds, and the same amount of water onto the other. Top up each day as necessary. After a few days count how many seeds have germinated on each saucer.



Explanation: Different plants prefer soils at different pH. Rye is more tolerant of acid soils than oats, wheat or barley, so was very widely grown in Norway. Soils can be made less acidic by treating with lime to raise the pH.



Health and safety: Wear eye protection when pouring vinegar. If vinegar does get in eyes, wash eyes under running water for at least 10 minutes and seek medical attention.



Related activities: Identify and classify rocks, test the hardness of rock samples, test the pH of soils from different areas. Does the concentration of vinegar affect plant germination?



**KEY WORDS:**

Nutrients, soil testing, pH

Viking campsites



Context: When he was a young man Leif managed to persuade the local Jarl to let him join the crew on one of his longships. There, he learned how to sail and navigate, took his turn on the oars, and learned the best spots to stay when they pulled in to shore at night. Many of these spots were well known by people, with large black areas where the campfires were built. Every year the first visitors had to clear the weeds, or start a new fire site, as many different plants grew in these places, fed by the ash of the old campfires.



Teachers' note: When on a raiding or trading expedition, at night Vikings would often beach their ship, make a campsite and build a fire. Some places were well-known stopping points with fires built in the same place for years. Wood ash contains potassium, which is an essential nutrient for plants. Stinging nettles often mark the sites of ancient campfires, as they like potassium rich soils.



What can we ask? What nutrients do plants need to grow? Do all plants need the same nutrients?



Equipment list: Soil testing kit (available from garden centres), soil samples, beakers, distilled water. Optional: outdoor clothing, strong boots, trowels, sample bags



Activity instructions: Optional – Collect soil samples from different areas and place them in labelled bags to test later. Note the plants growing in each soil sample.

Use the appropriate soil testing kit to test pH, nitrogen, potassium (potash), phosphorus and other nutrients in soil samples. Follow the instructions for your particular soil testing kit.



Explanation: As well as sunlight, water and carbon dioxide from the atmosphere for photosynthesis, plants need nutrients from the soil to help convert the glucose from photosynthesis into proteins and lipids for growth and metabolism. The most important nutrients are nitrogen, potassium, phosphorus and magnesium, with other trace elements also being important.



Related activities: Research the different plants that grow on acid and alkaline soils. Soil is made from a mixture of rock fragments and organic matter. Add some water to the soil and watch the air bubbling out (important for the growth of micro-organisms). Leave for a few minutes to settle. The organic matter will float, the rock and sand particles will sink.



THE VIKING LONGSHIP

Vikings were great ship builders and navigators. Their great longships were a revolution in ship design, as they invented a brand-new kind of keel that enabled the longship to cross open ocean rather than just hug the coasts. They had quite flat bottoms, which meant they could navigate up rivers to inland towns that they thought were safe.



Context: Eventually, as he grew more skilled and gathered wealth, Leif bought a longship with 30 oars. The Jarl of Møre allowed him to select 40 men for a crew and finally, soon after his 18th birthday, Leif set sail from Giske in Norway. The ship was named Wave Strider, with a dragon head at the prow and a serpent at the stern. Sailing to the Orkney Islands to resupply his food and water, Leif then began to ravage the Western Isles of Scotland and even rowed inland up the rivers. However, Leif wasn't always a Viking. When his ship was full of goods he would sail to Dublin, removing the dragon head so it wouldn't scare away the friendly spirits of the land, and trade his plunder for silver and essential goods.



**KEY WORDS:**

Viking longship, warship, ratio, data

What makes a longship long?



Teachers' note: A Viking warship was very long and thin, which made it able to skim across the top of the waves at sea. A common nickname for the Viking longship was the sea serpent. The longest Viking warship ever found is the Roskilde 6, which is 36 m long but just 3.7 m wide. Viking trading and fishing ships tended to be shorter and wider, for stability. Viking ships tend to have quite flat bottoms, which means they have a very shallow draught, ie they don't sink very much into the water.



What can we ask? What is the difference between a warship and a trading ship? What is a ratio?



Equipment list: Viking ship data table, calculators



Activity instructions: Viking ships were called longships. Some were used as warships and were very long and narrow. Others were used as trading and fishing ships and were shorter and wider. Use the data below to decide whether these old Viking longships were warships, or trading or fishing ships.

Calculate the width-to-length ratio by dividing the ship's length by its width. Any answer greater than 7 means it is probably a warship. Use the other data to help you decide and give additional reasons for your decision.

Ship name	Approx. date constructed	Length (m)	Width (m)	Draught (m)	Number of oars (Pairs)	Crew
The Ladby Ship	900	25.5	2.9		16	37–40
Haithabu Ship Burial	825	20	3.5			
Haithabu Harbour Ship	985	30.9	2.7		30	65–70
Puck 2	Early 10th C	20	2.2			
Roskilde 6	1025–30	36	3.7		39	80–90
Skuldelev 1	1030	15.84	4.8	1	1-2	6–8
Skuldelev 2	1042	29.28	3.76	1	30	65–70
Skuldelev 3	1040	14	3.3	0.9	2-3	5–8
Skuldelev 5	1024–40	17.3	2.5	0.6	13	30
Skuldelev 6	1030	11.2	2.5	0.5	7	5–15



Explanation: Viking warships were built to be long, manoeuvrable and fast. The narrow beam (width) meant that there was less drag through the water, so they were very fast. The shallow draught (depth in the water) meant they could beach and easily refloat the ship, and it could travel up rivers past points that were normally navigable by other large ships. However, this did make them quite unstable in the water unless they were travelling at speed, and they were prone to capsizing if hit beam-on by big waves. In a storm they could be blown far off course as they had to run with the wind to avoid being sunk. Trading ships had a much wider beam to hold more cargo, so were a lot more stable in the water.



Related activities: See floating and sinking activities.

**KEY WORDS:**

Keel, strake, hogging, sagging

The Viking longship



Teachers' note: The keel of the Viking longship was a simple, but revolutionary, design that made it the most sophisticated ship design for almost 600 years. Essentially, rather than a flat plank that made the ship prone to snap in half in rough weather, the Viking shipwrights used a T- or Y-shaped keel. This meant that the keel was much stronger and less prone to snap in rough seas. It also gave the ship flexibility in the hull, enabling it to flex as waves hit. A sailor in the prow or stern of the ship looking along the length would see the ship flexing and bending in the waves, thus the common nickname of sea serpent.



What can we ask? Why were Viking longships able to cross the ocean?



Equipment list: Metre ruler



Activity instructions: Demonstrate the strength and flexibility of the longship keel using a 1-m ruler. Hold it flat to show the old-style keel and how it can bend and snap in heavy seas (don't snap the ruler). This is known as hogging (bowed upwards) and sagging (bowed downwards). Try and flex it sideways and see how rigid it is. Old-fashioned ships needed very thick hulls to make them strong enough to withstand waves crashing against the side of the ship. Turn the ruler so its width is vertical. Try and bend it to show its strength in rough weather. Flex it sideways to demonstrate its flexibility, allowing the hull to absorb the energy of the waves crashing against the side of the hull. This flexibility made the hull very leaky, so there was always someone baling out water that leaked in between the planks.

**KEY WORDS:**

Friction, drag, pressure

Longship shape



Teachers' note: Viking longships were pointed at both ends to let them reverse easily after beaching the ship, or to avoid obstacles on a river. The pointed hull also allows the ship to cut through the water, reducing drag.



What can we ask? Why do pointed ships travel more easily through water?



Equipment list: Strong card about 6 cm x 12 cm, sink or bowl of water



Activity instructions: Put the card into the water vertically and push it through the water. Feel how hard this is. Now bend the card in half to an angle of about 60 degrees. It is much easier to push through the water.



Explanation: When you push the card vertically through the water the water has a large surface area to push back on, so it is hard to push through the water. When you angle the card you reduce the surface area the water can push on, so it is easier to push through the water. This force acting in the opposite direction to the movement through the water is known as drag.



Related activities: Investigate how drag varies with angle of point travelling through water.

**KEY WORDS:**

Float, sink, buoyancy, draught

Why do longships float?



Teachers' note: Viking longships tended to have flat bottoms. This made them very buoyant in the water as it had a larger surface area to push against. This meant that Viking longships had a very shallow draught, ie how far they sunk into the water, reducing drag, so they could travel very fast. It also meant that they could navigate relatively shallow rivers, as little as 1 m deep, allowing them to raid far inland away from the coast.



What can we ask? Why do things float? Why do Viking longships float so well?



Equipment list: Bowl or sink of water, plasticine, ruler



Activity instructions: Show that a lump of plasticine sinks in water. Make a solid boat shape and see if it floats. Make a hollow boat shape and see if it floats.



Explanation: An object will float if the amount of water it displaces weighs more than it does. A lump of plasticine displaces a relatively small volume of water, so it sinks. A hollow boat shape displaces a much larger volume of water that will weigh a lot more than it does, so it floats.



Related activities: Make different boat shapes to see which floats best: try flat bottomed or v-shaped hulls. Add stones, marbles, weights to see how much it can carry before it sinks.

**KEY WORDS:**

Sail, force, wind, pressure, shape

Which shape makes the best sail?



Teachers' note: The longship had square or rectangular sails made from wool or linen. These were mainly used when the wind was strong enough, and in the right direction, to travel longer distances. When there was no wind or not much room, like on a river, then oars were used for propulsion. Skilled captains were able to tack against or along the wind although, if the wind was in the wrong direction, most crews would use their oars.



What can we ask? Why do ships have sails? What shape sail is the best?



Equipment list: Flat wooden car with wheels, two sticks for mast and crossbeam, cotton thread, safety scissors, blu-tack, paper or other material for sails, fan or hairdryer, stopwatch



Activity instructions: Attach the mast to the car base with blu-tack. Make different shaped sails and attach them to the mast with the cotton and blu-tack, using the crossbeam if necessary. Use the fan or hairdryer to propel the car along a set length. Time how long it takes with each shape sail. Different shaped sails could include rectangular, square, triangular, circular, etc.

**KEY WORDS:**

Bernoulli principle, air pressure

Can Viking longships tack?



Teachers' note: Tacking is sailing across or against the direction of the wind. Square-sailed ships, like longships, cannot sail directly against the wind, but can sail across it. To tack against the wind you need lateen (triangular) sails. The main reason that tacking is possible is through the Bernoulli principle, which also helps aeroplanes fly. So, while Viking longships in the hands of a skilled captain can sail across the wind it is very difficult, and impossible to sail against the wind without the proper shaped sail.



What can we ask? How can I blow up a big bag with just one puff?



Equipment list: Safety scissors, sticky tape, nappy disposal system refill or long narrow plastic bag

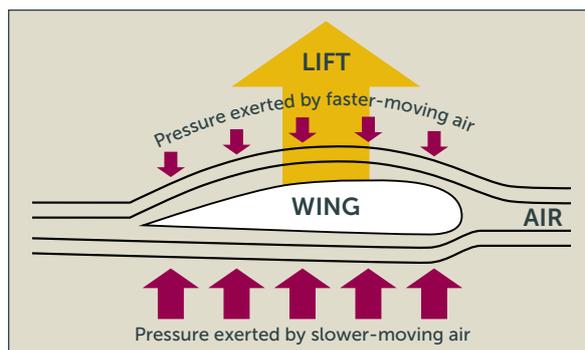


Activity instructions: Cut a 1–2 m length of the plastic sausage from a nappy disposal system and seal one end with sticky tape. Lay the sausage along a table. Hold the open end between 20 and 30 cm away from your face. Blow as hard as possible into the open end. See the sausage fill with air and quickly close the open end to prevent the air escaping.



Explanation: The Bernoulli principle (also called the Bernoulli effect) simply states that a fast-moving fluid, like air, has a lower pressure than slow-moving or still fluid. This is one of the effects acting upon an aircraft wing to produce lift.

If you try and fill the long sausage by blowing into it as you would a balloon, the only air going into it is from your lungs, so it would take several puffs to fill it with air. By holding it a few cm away and blowing into it you set up a stream of fast-moving air going into the bag. This, according to Bernoulli's principle, is at a lower pressure than the surrounding still air, so there is an area of low air pressure in the mouth of the bag. Pressure always moves from high to low, so the higher pressure still air in the room quickly moves into the bag, filling it up.



Bernoulli principle

In a tacking ship, as the wind hits the sail, filling it, it slows down. The air on the other side of the sail is moving faster, thus is at a lower air pressure. The resultant forces on the sail are perpendicular to the direction of the wind, thus enabling the ship to move against or across the direction of the wind.

**KEY WORDS:**

Navigation, Polaris, pole star

VIKING NAVIGATION

Vikings used to navigate using the stars and sun. When travelling long distances Vikings always navigated using latitude, ie how far north or south they were from their start or destination point. Sailors were unable to work out precise longitude until the 18th century as the time of day needs to be known very accurately. This means that they could not find their exact position but had to use experience and local knowledge of winds, tides, etc to navigate properly. The magnetic compass did not reach Europe until the 12th century.



Context: Leif got to know the waters of the Scottish Western Isles very well. He knew the currents, the effect of the tides, the direction of prevailing winds, the smell of the land, the taste of the water, the depth of the channels. When he went on longer journeys, to the Faroes, Norway or Iceland, he used the sun and stars to navigate. His navigation chest contained a sighting stick, a sun shadow board and a small sunstone.

How to find Polaris, the Pole or North Star



Teachers' note: As long as the sky is clear it is very straightforward to find your latitude. To do this at night, first you need to find Polaris, the Pole Star or North Star.



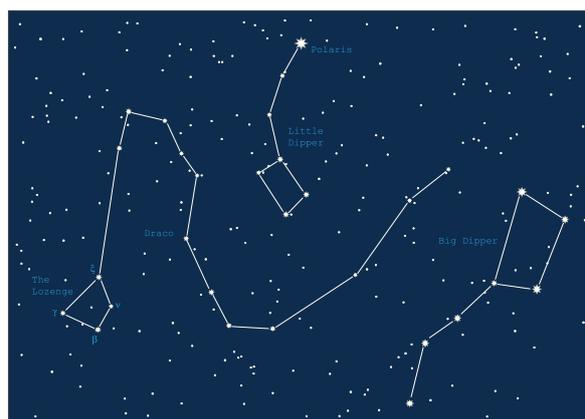
What can we ask? How do we find Polaris, the Pole Star?



Equipment list: Map of the constellations in the night sky.



Activity instructions: Find the asterism known as the Plough, sometimes known as the Big Dipper. Draw a line upwards between the two stars furthest from the handle and continue on until you find Polaris, at the far end of Ursa Minor. This bright star is the Pole Star, used to find geographical north.



The Big Dipper | Shutterstock

**KEY WORDS:**

North, rotation, axis, star trails

Show photos of star arcs around Polaris



Teachers' note: The North Star is directly in line with the axis of the Earth's rotation. This means that it is a fixed point showing True North. All of the other stars in the sky appear to move around this point, producing star trails when photographed with a very long exposure.



What can we ask? What is a star trail?



Equipment list: Photographs of star trails or DSLR camera with a long exposure timer and a tripod.



Activity notes: On a clear night, if there is not much light pollution, set up a camera on a tripod, facing the North Star. Set a long exposure time to photograph star trails. Alternatively, show the photograph and explain, or allow the children to use the internet to find photographs of star trails.



Explanation: A pole star is a bright star that is directly overhead at one of the poles. Currently only the North Pole has a pole star, known as Polaris or the North Star. The North Star is almost directly in line with the rotation of the Earth's axis and sits at the north celestial pole. Because of this, as the Earth rotates during the night, all of the other stars appear to rotate about this fixed point. A long exposure on a camera makes star arcs because the stars appear to move around the celestial pole while the shutter is open, leaving a light trail on the CCD.





Use the Pole Star to navigate



Teachers' note: The elevation of the North Star can be used to navigate on a clear night by showing your current latitude compared to a fixed starting point.



What can we ask? How can you use the stars to find your way?



Equipment list: 1-m ruler, ping-pong ball or marble, graph paper, pencil



Activity instructions:

1. Work in pairs. One person, the navigator, uses a 1-m ruler as a sighting stick. The other person holds the ping-pong ball, which represents the North Star.
2. Mark the starting point in the middle of the right hand (east) edge of the graph paper. Mark the ending point (destination) on the opposite (west) side of the graph paper.
3. On the other side of the room the person with the "star" holds it up.
4. The person with the sighting stick holds it upright at arm's length.
5. Slide the stick through the hand until the top is level with the "star" when you look at it. Note the reading on the stick where it goes through the hand, next to the start mark.
6. Mark five squares along on the graph paper towards the left (west). This is the expected position, where you hope to be at the end of your day's journey.
7. The "star" is held up again. It can be higher or lower, or the same as before.
8. Take another reading with the sighting stick as before.
9. Mark your new position, where you actually are, on the graph paper. For every centimetre higher than the last reading mark your new position one small square above your expected position. For every centimetre lower than the last reading mark your new position one small square below your expected position.
10. Draw a line between your start point and your new position, and write your reading next to your new position.
11. If the new position is too high (too far north) the navigator must call "Bear south". If the new position is too low (too far south) the navigator must call "Bear north".
12. If the navigator calls "Bear south" the "star" must be held lower down for the next reading. If the navigator calls "Bear north" the "star" must be held higher up for the next reading.
13. Mark the next expected position another five squares along, level with the start position.
14. Take readings again, as before, to work out your new position.
15. Draw a line between your last position and your new position.
16. Repeat this procedure until you reach the other side of the graph paper.
17. See how close you are to your destination.



Explanation: Sailors during the Viking age used the stars to navigate at night, as long as the sky was clear enough. To journey north or south you would usually just follow the coastline in the right direction. But if your destination was to the east or west you could still navigate well just by knowing your latitude. Your latitude is your position north or south on the Earth's surface, given by your angle from the equator (0°) to the pole (90°). On a globe, these are the horizontal lines showing lines of equal latitude. You can, however, work out your latitude relative to your starting point by measuring the elevation of the North Star using a sighting stick. After you have taken your initial reading at your starting point, you can compare further readings as you journey to see if you are staying on the same latitude. If a reading is too high, ie the North Star is higher in the sky, you are too far north, and need to bear more southward as you journey. If the reading is too low, ie the North Star is lower in the sky, you are too far south and need to bear more northward as you journey. The course of your journey will, therefore, tend to zig-zag towards the east or west as you correct your bearing as you travel. It is easy to travel to a destination north-east or south-west, just by making sure you bear north or south as you journey. If, when you reach the opposite coastline, you have missed your destination, it is an easy matter to just travel north or south along the coastline until you reach your final destination.



Related activities: Try using this procedure to reach a destination further north or south from the starting point.



**KEY WORDS:**

Sun, latitude, navigation, gnomon

Sun shadow board



Teachers' note: During Viking times sailors also used to navigate by the sun, when there were no clouds in the way. A reading could be taken at noon (not 12 pm, but when the sun is at its highest point in the sky) using a sun shadow board, which works in a very similar way to a sundial.



What can we ask? How can we use the sun to find our way?



Equipment list: Circle of polystyrene or card, short pencil or piece of dowel, bucket or bowl of water, bright torch or adjustable lamp, small ruler, graph paper

**Activity instructions:****Option 1**

1. Cut a circle from a piece of polystyrene or card big enough to comfortably fit in a bucket or bowl.
2. Draw a circle on the surface about halfway between the centre and the edge.
3. Fix a gnomon (pencil) in the centre.
4. Float in a bucket or bowl of water. Tip the bowl about to show how the board stays level (useful on the sea).
5. Use a torch or lamp to show the shadow of the gnomon touching the line.
6. Raise the torch to see the shadow shorten. This means you have gone too far south, because the sun is now higher in the sky.
7. Lower the torch to see the shadow lengthen. This means you have gone too far north, because the sun is now lower in the sky.



Sun shadow board

Option 2

1. Work in pairs. One person, the navigator, uses a sun shadow board, as detailed in option 1, and the ruler. The other person uses the torch to be the "sun at noon".
2. Mark the starting point in the middle of the right-hand (east) edge of the graph paper. Mark the ending point (destination) on the opposite (west) side of the graph paper.
3. The person with the "sun" shines it on the sun shadow board so that the shadow of the gnomon just touches the circle drawn on the board. This shows your starting latitude.
4. Mark five squares along on the graph paper towards the left (west). This is the expected position, where you hope to be at the end of your day's journey.
5. The "sun" is held up again. It can be higher or lower, or the same as before.
6. Measure the distance between the circle and the top of the gnomon's shadow with the ruler.
7. Mark your new position, where you actually are, on the graph paper. For every centimetre the tip of the shadow is past the circle mark your new position one small square below your expected position. For every centimetre the tip of the shadow is short of the circle mark your new position one small square above your expected position.
8. Draw a line between your start point and your new position, and write your reading next to your new position.

9. If the new position is too high (too far north) the navigator must call "Bear south". If the new position is too low (too far south) the navigator must call "Bear north".
10. If the navigator calls "Bear south" the "sun" must be held higher up for the next reading. If the navigator calls "Bear north" the "sun" must be held lower down for the next reading.
11. Mark the next expected position another five squares along, level with the start position.
12. Take readings again, as before, to work out your new position.
13. Draw a line between your last position and your new position.
14. Repeat this procedure until you reach the other side of the graph paper.
15. See how close you are to your destination.



Explanation: Sailors during the Viking age used the sun to navigate during the day, as long as the sky was clear enough. You can work out your latitude relative to your starting point by measuring the length of the shadow made by the sun at noon (when the sun is at its highest point in the sky). The sun shadow board is similar to a sundial. The gnomon casts a shadow across the circular board, which is usually floated in a bucket of water to keep it level on a ship. A circle drawn or carved into the board marks the tip of the shadow of the gnomon at the starting location. Every day, at noon, a reading is taken. If the shadow is too long, and goes past the circle, then you have drifted too far north, because the sun gets lower in the sky at noon the further north you go. If the shadow is too short, and doesn't reach the circle, then you have drifted too far south, because the sun gets higher in the sky at noon the further south you go. The course of your journey will, therefore, tend to zig-zag towards the east or west as you correct your bearing as you travel. It is easy to travel to a destination north-east or south-west, just by making sure you bear north or south as you journey. If, when you reach the opposite coastline, you have missed your destination, it is an easy matter to just travel north or south along the coastline until you reach your final destination.



Related activities: Make a sundial and use it to tell the time.

**KEY WORDS:**

Calcite, crystal, polarization, birefringent

Sunstone



Teachers' note: Hrafn's Saga mentions use of a crystal called the sunstone when the sky is overcast and the sun cannot be seen. Archaeologists and other scientists have debated whether the sunstone is real, but evidence is now starting to show that optical calcite, also known as Icelandic Spar, can be used to determine the azimuth (position on the horizon) of the sun in overcast conditions or when it is just below the horizon.



What can we ask? What happens to images when looked at through a crystal of optical calcite?



Equipment list: Optical calcite (Icelandic Spar) crystal (available on eBay), white paper, pencil, ruler



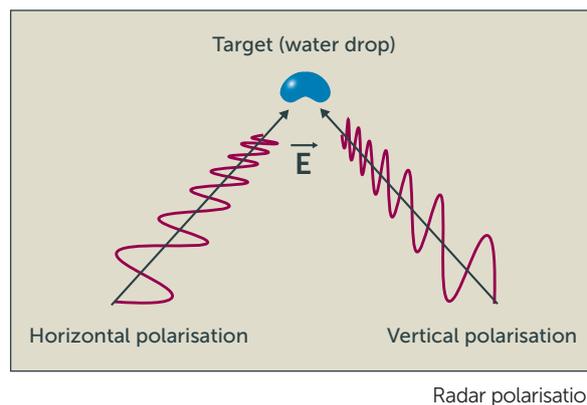
Activity instructions: Draw a straight line using a pencil and ruler. Put the calcite crystal on top of the line and look through it at the line. What do you see?



Explanation: Sunlight is polarized, which means some of the light waves in a ray of light vibrate in one direction and some light waves vibrate in a different direction.

Optical calcite (CaCO_3 , the same chemical as chalk or limestone, but crystallised in a way that makes it transparent) is called a birefringent material. Its refractive index (how much it bends light that passes through it), depends on the polarization of the light passing through it. As this polarized light passes through the crystal some is refracted more than the rest depending on its polarization, so you see two images instead of just one when you look through it.

Sailors in Viking times could use this property in several ways to find the azimuth of the sun if it was overcast or even just below the horizon. This fix on the rough position of the sun can then be used to find north.



Birefringence of Icelandic spar | Terry Harvey-Chadwick

VIKING RAIDS, WARFARE AND WEAPONS

Vikings used a variety of weapons, mainly depending upon what they could get their hands on. Professional warriors could use all weapons well but had their favourites. Different weapons had different effects depending upon the physics of how they worked.



Context: Leif could see the smoke just over the hillside that betrayed the settlement. While Leif donned his chainmail his men readied their weapons and shields. Many carried spears, either to be thrown or to be used in the shieldwall. Leif had his sword, Widowmaker, and most of his other men carried axes. Vandrad, the big Norseman, carried Deathsinger, his long-shafted Dane-axe. The men rowed hard into the shoreline and beached the ship, then jumped into the shallow water and gathered on the beach.





KEY WORDS:
Pressure, force

Shieldwall formation



Context: These Scots, however, were obviously wary and had posted lookouts near the beach. As Leif and his men started up the hill, suddenly a howling mob of clansmen crested the ridge and came hurtling towards them. Leif commanded his men to form the shieldwall. As the Scots approached his men overlapped their shields and braced themselves for the impact. Just as the front line of warriors struck, Leif's men, with their shoulders braced behind their shields, took a half-step forwards. The Scots reeled, and the largest warrior cried out as he rebounded off the solid line of shields and crumpled to the ground, his shoulder shattered.



Teachers' note: A shieldwall is a protective formation of interlocking shields. Your shield protects yourself and the man to the right of you. Shieldwall combat was, essentially, a shoving match, with the second rank of your formation trying to kill the front rank of the opposite formation. A gap in the opposing shieldwall would allow your side to break up their formation, giving your side a great advantage in the battle. Normally the side whose shieldwall broke first would lose. Although obsolete as a battle tactic in modern times, riot police still use it effectively today in crowd control situations.



What can we ask? How does a shieldwall protect people?



Equipment list: Corrugated card, scissors, blu-tack, garden skittles, ball



Activity instructions: Cut out squares of corrugated cardboard from a box. Stick the "shields" to the garden skittles, so the ball will hit the "shield". Line up the skittles with the "shields" edge to edge, not overlapping. Bowl the ball just hard enough to knock the middle skittle over. Now place the skittles close together so the "shields" are overlapping. Bowl the ball at the middle skittle again, at the same strength. The skittles should stay up.



Explanation: When the ball hits a skittle hard enough to knock it over the skittle is receiving the full force of the strike. When the "shields" overlap each other the force of the impact is spread out, reducing the pressure on the skittle, so it stays up.



Related activities: Investigate how the surface area of an applied force affects the pressure exerted by the force, eg add weights to different shoes and measure how far they sink into sand, like stilettos, high heels and ordinary shoes.



**KEY WORDS:**

Pressure, force, length, moment

Weapons – long vs. short cutting edge



Context: Just before the Scots hit Leif's shieldwall some of his men threw their spears at the oncoming warriors. Where they struck, the sharp-tipped weapons sank deep into the bodies of the enemies. Leif had chosen his position well, as his left flank was protected by slippery rocks. On the right, Vandrad swung his long axe in circles about his head, keeping the Scots at a distance, not allowing them to come at the Vikings from behind. In the centre of the line Leif struck low with his spear at the leg of the man facing him. The point sank deep and the warrior fell, dragging the weapon out of Leif's hand. The remaining Scots, meanwhile, had formed their own shieldwall and came forwards slowly. Leif drew his axe and, when the opposite shieldwall came close enough, hooked the top of the shield in front of him, bringing the shield down and allowing the spearman next to him to stab the Scot in the chest.



Teachers' note: All cutting or piercing weapons need to be kept sharp, as a sharp edge maximizes the pressure that applies the cutting force. Different weapons are better at different jobs, or handle differently because of their construction. Different weapons work differently because of their physics.



What can we ask? Is a long cutting edge better than a short one? Are pointy weapons better? Is a long handle better than a short one?



Equipment list: You can buy children's replica wooden weapons on the internet. Alternatively: sword – 1-m ruler with protractor taped to end, spear – 1-m ruler with pencil taped to end. Measuring ruler, slightly damp sand, 1-m long container for sand.



Leif fighting | Hamish Logie

**Activity instructions:**

1. Fill the 1-m long container to just past the brim with slightly damp sand.
2. Hold the "sword" upright and edge on at one end of the container.
3. Allow the "sword" to fall edgewise onto the sand.
4. Measure and record the deepest indentation in the sand made by the "sword". (You could also carefully draw the "sword" along the indentation to simulate a long slicing cut before measuring.)
5. Repeat for the "axe".
6. For the "spear" hold it point down, with the point 1 m above the sand and drop it point first.



Explanation: Different weapons cause different types of injury. A sword is a slashing/cutting weapon. Because the longer cutting edge means less pressure overall along the blade, a sword wound might be slightly less bad on the initial strike, but then the blade can be drawn through the wound to inflict even greater damage as it cuts, just like cutting meat with a knife. An axe has a shorter cutting edge, and most of the mass is concentrated at the far end. So the injury is much worse as the pressure from the shorter cutting edge is much greater. The increased momentum of the axe head, due to the concentrated mass, also means the axe acts like a smashing weapon, breaking bones through additional blunt force trauma, so even someone wearing chainmail can be seriously injured. A spear is primarily a thrusting weapon, with a very sharp point. This can penetrate deeply into the body, due to the massive pressure concentrated in its tip. It is very effective against chainmail as it goes through the holes between the links and can burst them apart. A long-handled axe is more effective than a short-handled axe because the longer length results in a greater momentum of the head at the point of impact (due to the greater velocity of the axe head), thus resulting in a much nastier wound.



Related activities: Hand axe vs. Dane axe. Use 30-cm ruler for handle of short "axe". Compare to longer "axe".



**KEY WORDS:**

Pressure, force, armour, chainmail

Armour



Context: Then, seemingly out of nowhere, a swordblade swung down and struck Leif on the head. Without his helmet the blade could have cut into Leif's skull and killed him, but instead the sword was deflected from the conical helm and struck him on the shoulder. The wound was painful, several of the metal links being driven into the flesh of his shoulder, but the impact of the blow was spread out and Leif struck back at his attacker.





Teachers' note: Most warriors during the time of the Vikings could not afford chainmail armour as it was extremely expensive. Even for those that could afford it, it was of only limited effectiveness. Worn on its own, just over clothing, a hard strike from a weapon could drive the links deep into the flesh, resulting in a very messy wound. Although a strike from a sword or axe could result in broken bones, internal bleeding or severe bruising when wearing mail, this is still much better than having a limb completely chopped off, your chest crushed or your belly opened up. So, wearing mail doesn't prevent injury in battle, but can reduce the severity of injuries so that you have a much better chance of surviving. Its other purpose is to show you are a warrior of very high status. Strangely there is no definitive evidence, either archaeological or in manuscripts, that warriors in Viking times wore any padding under their mail, despite the fact that this would make the armour vastly more effective.



What can we ask? How does armour protect you? Does padding make armour better?



Equipment list: 30-cm square of chain mail (available on the internet). Alternatively rabbit mesh works well, available from pet or garden centres. Woollen cloth, leather (optional), paper, box of damp sand, ruler, selection of known masses.



Activity instructions:

1. Fill the box with damp sand and smooth it out.
2. Drop different masses into the sand. Measure and record the depth of the indentation for each.
3. Cover the sand with the "chainmail" and repeat.
4. Add a layer of cloth, leather or paper underneath the "chainmail" and repeat.



Explanation: The chainmail links spread out the impact of the blow, thus reducing the pressure exerted by the weapon. The iron links also act as a physical barrier, preventing the sharp cutting edge from coming into contact with the skin. A layer of padding underneath the mail links, especially leather, will protect against the links being driven into the skin, and further reduce the pressure from the weapon strike by spreading the force of the impact yet again.



Related activities: Investigate which material makes the best padding underneath chainmail. Investigate which material (not including mail) makes the best armour. Investigate which weapon (see weapons activity above) is most effective against armour.



KEY WORDS:
Force, angle, deflect

Helmets

There has only been a single find of a complete Viking helmet in Scandinavia and north-west Europe, the Gjermundbu helmet, which has greatly confused historians and archaeologists alike. What pictorial evidence there is for helmets in manuscripts could often be interpreted as ordinary hats looking a bit like beanie hats today. Alternatively, maybe most helmets were made of leather, so they have rotted in the ground. Sagas rarely mention the wearing of helmets apart from in relation to kings and great chieftains.

Angled conical vs. flat round helmets



Teachers' note: Viking helmets started off as round helmets but evolved into the conical nasal helmet after the 9th century. The more sloping sides help to deflect a blow rather than trying to absorb the whole impact. Padding was usually worn underneath to further absorb the force of a blow.



What can we ask? What is the best angle of helmet to deflect a blow to the head?



Equipment list: Play dough or salt dough, 2-cm deep tray, 1-cm diameter marble or ball bearing, ruler, protractor



Activity instructions: Buy play dough or make salt dough (plenty of recipes on the internet), medium soft. Spread into a 2-cm deep tray. Drop a heavy marble or a 1-cm diameter steel ball bearing into the horizontal tray and measure the depth of hole made. Repeat while holding the tray at an angle. Try at different angles up to about 60° from the horizontal.



Explanation: A flat surface will take the full force of a blow, with a sharp cutting edge possibly penetrating the helmet if it is hard enough. As you angle the surface to the incident force some of the force is deflected away from the surface, resulting in less damage. The greater the angle the more force is deflected, although, for a helmet, more than about 45° is impractical as it would get too tall.



Related activities: Make a helmet using the dimensions indicated from your experiments.



Gjermundbu helmet | John Erling Blad

**KEY WORDS:**

Padding, force, impact, brain

Padding under helmets



Teachers' note: Even if a blow didn't penetrate the helmet you could still be killed by the force of the blow injuring the brain in a similar way to whiplash in a car accident. Padding, or a webbing liner, reduces the force of the impact on the skull and brain. Although no evidence has been found for padding or a liner, rivet holes in the helmet have indicated the possible existence of attachment points for some sort of lining.



What can we ask? Does padding in a helmet protect the brain?



Activity instructions: Put a raw egg into a sealable tin and drop it onto the floor. The egg will be broken inside. Stuff the tin with cotton wool or fabric with the egg in the middle. Drop it onto the floor and the egg should survive.



Explanation: When a weapon strikes the side of the helmet without padding the full force is directly transmitted to the skull, due to the very rapid deceleration of the weapon. This results in blunt force trauma to the head and brain. Even if the skull is intact the force of the blow can rupture blood vessels in the brain, causing a haematoma. Padding the inside of the helmet slows the deceleration of the weapon, resulting in much less force reaching the skull. Just like in a car crash, the crumple zones in the car slow down the deceleration of the impact, so the car and passengers receive a much smaller impact force.



Related activities: Throw a raw egg at a sheet held vertically by two people. No matter how hard you throw the egg, as long as it is caught in the sheet it will not break.

EVERYDAY VIKING LIFE



Context: Leif bought some land in the Copeland area of Cumberland and, with the help of his crew, built a farmstead for himself and his men. Soon afterwards he married an Anglian woman from the local area named Cuthswith. Together they had five children, three of them, two sons and a daughter, surviving into adulthood. In the spring and autumn Leif busied himself on the farm, planting and harvesting the crops. In the summer he went Viking, finishing the season with trade in Dublin. Winter time was always hard, but Leif was very successful and was able to feed his household, and even help neighbours when they fell on hard times. When Cuthswith wasn't preparing or preserving food or brewing beer, she and the other women spent most of their time spinning wool or flax into thread. This would be used to make fabric for clothing for the entire household.



**KEY WORDS:**

Fire, fuel, energy, evaporation

FIRE AND WARMTH

Starting fires



Teachers' note: One of the main requirements for survival in Viking times was fire. Without fire you cannot get warm in winter or cook your food. One of the main problems was keeping fuel dry enough to burn properly. Without dry tinder it is extremely difficult to start a fire. This activity should only be done as a demonstration.



What can we ask? How can we set fire to paper without it burning?



Equipment list: £5 note or similar sized piece of paper, lighter, kitchen tongs, 100-ml beaker of 50/50 mix of isopropyl alcohol (rubbing alcohol) and water.



Activity instructions: Soak your £5 note in the alcohol/water mixture so it is completely wet. Carefully, using tongs, remove it and spread it out, gently shaking any drips off the note. Quickly light the bottom edge with the lighter and watch it become enveloped in flames. The flames will go out leaving the £5 note intact. (Occasionally an edge or corner can ignite. Just blow it out.)



Explanation: A common misconception is that water puts out fire by smothering it, blocking the oxygen. With a large amount of water thrown on a fire that certainly occurs, but the main way it puts out fire is by removing the heat energy from the fuel. When you ignite the alcohol/water mixture the alcohol burns away. It also heats the water and the £5 note. As the water is heated it evaporates, removing the heat energy from the note, so it stays too cool to ignite. As long as the alcohol burns off before all the water evaporates the £5 note will remain unburnt as it doesn't get hot enough to ignite.



Health and safety: Wear eye protection. Always use the tongs to hold the £5 note, as isopropyl alcohol is a skin irritant and flammable. Never light the £5 note over the beaker of alcohol. Make sure no flammable materials are within 1 m of the burning £5 note. Always do as a demonstration only.

**KEY WORDS:**

Vinegar, sodium bicarbonate, acid, alkali, oxygen, carbon dioxide

Putting fires out



Teachers' note: With wooden buildings and thatched roofs fire was an ever-present danger in Viking times, especially as the hearth in the centre of the main room is where the open fire would be lit. Sparks from the fire could easily set fire to the thatch without proper precautions. In case of fire, buckets of water could be thrown onto the blaze to extinguish it, or cloaks thrown over smaller fires to smother them.



What can we ask? How can we use vinegar and sodium bicarbonate to make a fire extinguisher?



Equipment list: Vinegar, baking soda (sodium bicarbonate), 1-litre jug, spoon, tea light candles, lighter



Activity instructions: Light a tea light candle with the lighter. Measure approximately 100 ml of vinegar into the jug. Add a couple of teaspoons of sodium bicarbonate and wait until the fizzing stops. Carefully tip the jug over the candle, but don't let any liquid come out. The candle should go out.



Explanation: The vinegar and sodium bicarbonate react to produce carbon dioxide, an invisible gas which is heavier than air. When you tip the jug you pour the carbon dioxide over the flame, cutting off the oxygen and smothering the flame.



Health and safety: Wear safety glasses. Ensure no flammable materials are within 1 m of the candle flame.

**KEY WORDS:**

Convection, conductor, heat, energy

Cooking on fire



Teachers' note: Only quite wealthy people in Viking times could afford metal pots to cook in. Most people used pottery or pots carved from soapstone, a soft rock.



What can we ask? Can pots and pans be made of other things than metal?



Equipment list: Paper cup, tea light, tripod, lighter



Activity instructions: Fill the paper cup about a third to half full with water and place it on a tripod or similar holder. Light the tea light and place it so its flame is touching the base of the paper cup. The paper will blacken but probably not burn through and, eventually, the water will boil.



Explanation: As the candle flame heats the paper the heat energy is removed on the other side by the water. A convection current is set up, constantly replacing the heated water with cooler water and carrying the heat energy away from the paper. Even when the water is boiling, the paper does not get hot enough to ignite as the heat energy is constantly removed by convection.



Health and safety: Wear eye protection. Ensure no flammable materials are within 1 m of the candle flame. Make sure there is plenty of space between the audience and the cup when it is boiling to ensure nobody is scalded if the cup is tipped over or the paper does burn through. Do as a demonstration if you are not confident the children can do this activity themselves.



Related activities: Try a similar demonstration using a balloon with about 2 cm of water in the bottom. As long as you keep the candle flame under the water-filled part of the balloon it probably won't pop. For extra fun do it with the balloon over someone's head. An umbrella is recommended, just in case.

**KEY WORDS:**

Micro-organism, yeast,
fermentation, carbon dioxide

FOOD AND COOKING



Context: Leif could cook; he had to when his was out on a Viking expedition. At home, however, cooking was the work of Cuthswith and the other women. As well as the usual flatbread, Cuthswith loved making risen bread in her oven, which used the yeast from brewing to make it rise into loaves. She had a slave to grind the rye into flour, although it was often the task of the youngest daughter in some other households. Sometimes, when there were visitors, Cuthswith would make loaves from wheat, to show her high status. While most food was cooked in soapstone and pottery vessels on the fire, when she had guests Cuthswith would cook using her expensive iron cauldron.

Making bread



Teachers' note: Strangely, bread wasn't a staple food in many areas due to the amount of work involved in making it. Flour needed to be made afresh every day, a task that could take between two and five hours using a simple hand quern, depending on the amount of bread needed. This job was usually given to a young girl, or a slave in wealthier households. Many houses did not have an oven, with cooking mostly being done over an open fire, so it would not be possible to bake bread. If an oven was available it could have taken up to a couple of hours to prepare, as the fire was lit inside and the whole oven heated. This means that it could take up to eight man-hours just to make a few loaves of bread, a significant investment in time and energy.



What can we ask? How do you make bread? Why do we use yeast to make bread?



Equipment list: Mixing bowl, wooden spoon, measuring jug, greased baking tray

Ingredients List:

- 225 g plain wholemeal flour
- 1/2 teaspoon salt
- 1 level dessert spoon sugar
- 1 desert spoon vegetable oil
- 1 sachet (6 g) dried yeast
- 150 ml warm (hand-hot) water



Activity instructions: Wash your hands before starting. Mix the dry ingredients together in the mixing bowl then add the water. Stir until the mixture becomes too thick. Sprinkle flour on a clean dry surface and knead the dough until it becomes smooth (at least 15 minutes). Add extra flour if it becomes too sticky. Divide into six rolls and place on the baking tray in a warm place for 15 minutes to rise. Cook in a preheated oven at 170 °C (gas mark 3) for about 15 minutes, or until golden brown on top.



Explanation: Yeast is a micro-organism used in bread to make it rise. The yeast ferments the sugar and converts it to alcohol and carbon dioxide. The alcohol evaporates during cooking, while the carbon dioxide gas makes bubbles in the dough, causing the bread to rise. People in Viking times would use the same yeast for baking as they used in brewing beer.



Health and safety: If the bread made is to be eaten make sure all school hygiene procedures are followed.



Related activities: People in Viking times often made unleavened (flat) bread as a fast alternative or when yeast was not available. Follow the recipe above but leave out the yeast to see how the bread is different, or halve the ingredients to bake leavened and unleavened bread side by side.

**KEY WORDS:**

Micro-organism, yeast,
preserve, drying

PRESERVING FOOD

Food was preserved in Viking times by drying, pickling in whey or lactic acid (from milk) or by salting or smoking. Preserving food stops micro-organisms from growing and spoiling the food.

Growing yeast



Teachers' note: Drying food stops it spoiling because micro-organisms need water to live. Fish and meat would be left outside in the wind to dry on racks, then stored in a cool dry place.



What can we ask? How does drying food stop it from going off?



Equipment list: Two balloons, dried yeast, sugar, teaspoon



Activity instructions: Put a teaspoon of dried yeast and two teaspoons of sugar into two balloons. Add water to one balloon and tie the end of both. The one with water will blow up as carbon dioxide is produced by the yeast.



Explanation: Living things need water to live, grow and reproduce. The balloon containing water blows up as the yeast activates, starts fermenting the sugar and produces carbon dioxide gas. The yeast in the balloon without water remains dormant and does not start the fermentation process. By drying out food you remove the water so any micro-organisms cannot grow, so the food lasts much longer without spoiling.



Related activities: See the bread-making activity.

**KEY WORDS:****Dissolve, evaporate,
crystallise, solution**

SALTING

Salt can be used to preserve food by drawing the water out of it, also dehydrating any micro-organisms that try to grow in it. Salt was quite hard to come by in Viking times, so was unavailable to poorer households. It can be obtained by mining from salt mines, or extracting from sea water.

Extraction of salt from sea water



Teachers' note: You can easily make "sea water" by dissolving sodium chloride (common or table salt) in water. For best results make a saturated solution, ie keep adding salt until no more will dissolve. It can be very good to start the activity by dissolving the salt and asking the children where the salt has gone. Put the beaker of water on some electronic scales and ask what will happen to the reading on the scales when you add the salt. Many children will say the weight will stay the same because the salt disappears. Show how the weight increases as you add salt, despite it apparently disappearing as you dissolve it.



What can we ask? What happens to salt when you dissolve it? How can you get the salt out of salty water? Is dissolving salt a physical or a chemical change?



Equipment list: Bowl, electronic scales (optional), spirit burner or candle (optional), ceramic dish or saucer



Activity instructions: Dissolve the salt in water to make brine (saturated salt solution), stirring until all the salt has dissolved. Evaporate the water using a spirit burner or candle, or leave in a sunny place on a windowsill or on a heater (if safe to do so).



Explanation: When salt is added to water the ions that make up the crystals come apart from each other and are surrounded by the water molecules. If you measure the mass of the salt and water separately the mass of the solution will be the same as the combined mass of the salt and water. The salt appears to disappear when added to the water as it forms a colourless solution. When you heat the solution, or leave it in a warm place, the water evaporates much more easily than the salt, so the water evaporates and leaves the salt behind as new crystals.



Related activities: Compare the crystals produced when you boil the salt solution in one dish and leave it to evaporate slowly in another dish. Make a crystal garden.

**KEY WORDS:**

Dissolve, evaporate, crystallise, solution, soluble, insoluble, filter

Extraction of salt from rock salt



Teachers' note: Rock salt is a mixture of sand, gravel and salt. It can be bought from garden centres or online, or easily mimicked by mixing sand gravel and salt. This activity introduces an additional separation step to the previous activity, as the salt is mixed up with insoluble substances.



What can we ask? How can you separate a mixture of sand, gravel and salt so you end up with pure salt?



Equipment list: Rock salt, sieve (optional), filter paper (the filters from a coffee maker work well), funnel, ceramic dish, spirit burner or candle (optional), spoon



Activity instructions: Add the rock salt to water and stir until the salt has dissolved. Use the sieve to separate the sand from the gravel (optional). Put the filter paper in the funnel and filter the sand/gravel from the water. Pour the water (salt solution) into a dish and evaporate the water, either by heating it with a spirit burner or candle, or leaving it in a warm spot to evaporate overnight.



Explanation: The sand and gravel is insoluble, while the salt dissolves in the water. You can physically separate the sand from the gravel by size using the sieve. Larger fragments are caught in the sieve, while the smaller fragments pass through back into the water. You can physically separate the smaller fragments by filtering them with the filter paper. Finally, reclaim the salt by evaporating the water, leaving pure salt crystals in the dish. All of these separation methods are physical, based upon grain size (sand/gravel) and solubility (salt).



Related activities: Try using different physical properties to separate mixtures of substances, eg by using magnets to separate magnetic from non-magnetic materials, by whether things float or sink, etc.

**KEY WORDS:**

Salt, preserve, food, hygroscopic

Preserving cucumber with salt



Teachers' note: Preserving food using salt works because the salt draws water out of the food, dehydrating the food and any micro-organisms on it so they cannot spoil the food. Cucumber contains a lot of water so this activity shows the process very well. However, salt was quite expensive during Viking times, and it is unclear from the archaeological record how many people used this method to preserve food.



What can we ask? How does covering food in salt prevent it from spoiling?



Equipment list: Fresh cucumber, sharp knife, bowl or plate, table salt



Activity instructions: Cut a cucumber into thin slices and thickly cover with the salt. After an hour or so you can see the water has started to come out of the cucumber into the salt.



Explanation: Salt is hygroscopic; it attracts water. Covering fresh food, such as meat or fish, with salt extracts the water from it and prevents micro-organisms from growing on it and spoiling it.



Health and safety: If the cucumber is to be eaten afterwards follow all school hygiene procedures during the activity. Take care when using a sharp knife.



Related activities: To finish the preservation process, try pickling the cucumber in vinegar for a couple of weeks to make yummy pickled cucumber. The vinegar is too acidic for most micro-organisms to grow and spoil the food.

**KEY WORDS:**

Preserve, fat, lipid, emulsion

DAIRY PRODUCTS

Milk from cows, sheep, horses or goats can be preserved by making it into butter, cheese or skyr, a product similar to yoghurt. In Viking times animals would not be milked until they had weaned their young, then it became an important source of nutrition for people. Raw milk was not often drunk unless there was a large surplus, as the valuable calories and nutrients needed to be preserved for when the animals no longer produced milk.

Making butter



Teachers' note: Butter preserves cow's milk so it does not need to be drunk on the same day. It can go rancid after a few days, so butter can be preserved by salting or smoking it so it lasts even longer. For even greater preservation, butter can be wrapped in a cloth and buried in waterlogged peat to last for years. The buttermilk that remains can be drunk, as it is a very good source of calcium, or used in cooking or to preserve other foodstuffs.



What can we ask? How is butter made?



Equipment list: Double cream, jars with lids



Activity instructions: Add about 100 ml of cream to each jar and close the lid tightly. Shake hard until a solid lump of butter is formed, after about 10–20 minutes. Remove from the remaining buttermilk, add a pinch of salt to taste. Spread immediately on bread or a cracker.



Explanation: Milk is basically an emulsion of water and tiny globs of fat (lipids). As you shake the jar, churning the milk, the lipid globs stick together, getting larger and larger until, eventually, they quickly coalesce into a single lump of butter in the thin buttermilk. Normally you would use wooden paddles to squeeze the remaining buttermilk out and shape the butter into a block, but it is fine to spread on crackers or bread immediately, adding a pinch of salt to taste.



Health and safety: Before starting make sure you have washed your hands and all the jars and lids are sterile. Follow all the school's hygiene procedures if the butter is to be eaten.

**KEY WORDS:**

Coagulation, lactic acid, bacteria, rennet, acidic, curds, whey

Making cheese



Teachers' note: Cheese can be made from any type of milk, even buttermilk, and is an excellent way of preserving milk for a long time. Cheese is a very good source of fat, protein, calcium and phosphorus. Raw milk is acidified, usually through bacterial action that produces lactic acid, then curdled, or coagulated, using rennet, an enzyme extracted from the lining of a cow's stomach. This results in a solid rubbery gel, the curd. For a soft cheese the curds can now be cut up, salted and moulded into shape. Harder cheeses can be cut up into smaller pieces, so more of the whey can drain, and salted, so more of the whey will drain and to preserve it. It can then be processed further and moulded into shape. The whey contains lactic acid, so it can be used to preserve food by pickling, which prevents the growth of many micro-organisms due to the acidic environment.

Below is a quick recipe that acidifies the milk using lemon juice and causes the milk to curdle. Vinegar can also be used if preferred.



What can we ask? How is cheese made?



Equipment list: Pint of fresh full-fat milk, saucepan, lemon juice, sieve or colander, clean cheesecloth or tea towel, mixing bowl, salt

**Activity instructions:**

1. Heat the milk until just before it boils.
2. Take the milk off the heat and add the juice of two lemons.
3. Cover the milk and let it stand for 10 minutes.
4. Set up a strainer lined with a cloth (eg cheesecloth or a tea towel) over a mixing bowl and pour the contents of the saucepan into the cloth.
5. The curds will collect in the cloth and the yellow, watery whey will collect in the bowl.
6. Squeeze the curds gently in the cloth to remove any excess whey.
7. Open the cheese cloth and sprinkle a quarter of a teaspoon of salt over the curds.
8. Eat the curds as they are or press them into shape in a mould.



Explanation: The action of bacteria on lactose milk sugars is a type of fermentation, producing lactic acid. This produces the acidic environment for the enzyme rennet to denature the casein protein in milk and coagulate it to form curds. If lemon juice or vinegar is used the milk becomes acidic enough for it to curdle without rennet. Adding salt helps preserve the cheese by drawing more water out of it.



Health and safety: Make sure all school hygiene procedures are followed when making cheese, especially if it is going to be eaten.



Related activities: After the curds have been separated from whey add some sodium bicarbonate to the curds and mix well into a paste. This can be used as glue, and was used by people in Viking times. Use immediately.

Make yoghurt, similar to Skyr in Iceland, where the recipe has existed since Viking times.

**KEY WORDS:**

Spinning, thread, plaiting, twisting

TEXTILES



Context: Throughout the year the children would collect tufts of wool shed from Leif's herd of sheep. The women would spin it into thread, and this was one of the first tasks a girl learned from her mother, as miles of thread were needed every year. One year Leif informed his wife that he needed a new sail for his longship. That year even some of the young boys on the farmstead learned how to spin.

Vikings mostly wore clothes made from wool and linen. Wool is the hair from sheep and was mainly collected from natural shedding caught on twigs and fences throughout the year. Linen is made from flax fibres or, sometimes, fibres from the stems of nettles. Wool was worn by people of all statuses, while linen was worn more by high-status people.

Spinning



Teachers' note: Spinning with a drop spindle was a vital skill for women in Viking times, as this is how you make thread to use for weaving and sewing. Spinning fibres together makes a long thread and it also makes it much stronger. Each year every woman, from slaves to noblewomen, would need to make miles of thread.



What can we ask? How does spinning make thread stronger?



Equipment list: Long grass leaves or thin ribbon



Activity instructions: Take three leaves of grass or lengths of thin ribbon and try and snap all of them together. Take three more and plait them into a single piece. Try to snap it.



Explanation: Even if you cut three threads together with scissors they will still have very slight differences in their length. This means when they are placed under a load together, the shortest one will have slightly more tension placed on it and will snap first. When you twist or plait the threads together, you distribute the load evenly between the individual threads, so it is stronger overall.



Related activities: Suspend weights from a single cotton thread and record the mass at which it snaps. Tie three separate threads to a weight, and record the mass at which they all snap. Twist or plait three threads together. Record the mass needed to make it snap.



**KEY WORDS:****Natural fibre, synthetic fibre, insulator, conductor**

Which fabric keeps you warmest?



Teachers' note: Natural fibres tend to keep you warmer in the winter than synthetic fibres. Modern explorers who have visited native peoples in Alaska or Siberia often swap their modern warm clothing for the traditional clothing because it keeps them warmer, being made from natural fibres.



What can we ask? Which is the best fabric at keeping you warm? Are natural fibres better insulators than synthetic fibres?



Equipment list: Thermometers, kettle, plastic, glass or ceramic beakers, lids from disposable coffee cups, selection of cloths made from natural or synthetic fibres, eg wool, linen, cotton, rayon, nylon, polyester, etc.

**Activity instructions:**

1. Boil a kettle full of water.
2. Wrap each beaker in a different fabric, ensuring that the same amount of fabric is used on each one.
3. Fill each beaker with the same amount of hot water.
4. Put the disposable lid on the beaker and put the thermometer in the water through the lid.
5. Finish wrapping the beaker so it is completely covered.
6. Measure the drop in temperature in each beaker every 30 s or minute for 10 minutes.
7. Optional – Draw a graph of drop in temperature against time for each beaker.
8. Determine which fabric kept the water the warmest, and which temperature dropped most slowly.



Explanation: Natural fabrics, especially wool, trap a lot of air in the spaces between the fibres. Air is a poor conductor of heat; therefore it is a good insulator as it only allows heat energy to transmit through it slowly. Synthetic fibres tend to be much smoother and can be woven more tightly, so there are fewer air pockets, and heat escapes more quickly. Synthetic fibres, like polyester, also conduct heat themselves better than natural fibres like wool, leading to further heat lost by conduction through the material.



Health and safety: Take care when pouring hot water, and that the beakers are not knocked over when full.



Related activities: Try using other materials like bubble wrap, cotton wool, kapok, paper, aluminium foil, etc to find the best heat insulator.

**KEY WORDS:**

Natural fibre, synthetic fibre, evaporation, absorb

Which clothes keep you coolest?



Teachers' note: Not only can clothes made from natural fibres keep you warm in winter, but they can help keep you cooler in summer as well, and are often more comfortable to wear as they breathe when you sweat.



What can we ask? Do clothes made from natural or synthetic fibres keep you cooler in summer? Which clothes are more comfortable to wear when you are sweaty?



Equipment list: Thermometers, kettle, plastic, glass or ceramic beakers, lids from disposable coffee cups, selection of cloths made from natural or synthetic fibres, eg wool, linen, cotton, rayon, nylon, polyester, etc.

**Activity instructions:**

1. Boil a kettle full of water.
2. Soak each piece of fabric in lukewarm water and wring it dry.
3. Wrap each beaker in a different fabric, ensuring that the same amount of fabric is used on each one.
4. Fill each beaker with the same amount of hot water.
5. Put the disposable lid on the beaker and put the thermometer in the water through the lid.
6. Finish wrapping the beaker so it is completely covered.
7. Measure the drop in temperature in each beaker every 30 s or minute for 10 minutes.
8. Optional – Draw a graph of drop in temperature against time for each beaker.
9. Determine which fabric allowed the water to cool quickest, and which dropped to the lowest temperature.



Explanation: Natural fibres absorb water more easily than synthetic fibres, so when you sweat they soak it up. This means that you don't feel so sticky when you are hot, as more sweat is absorbed from the surface of your skin, so you feel more comfortable. As your body heats the air trapped between the fibres, so that heats the water and it evaporates, taking the heat energy away from your body and cooling your skin more rapidly.



Health and safety: Take care when pouring hot water, and that the beakers are not knocked over when full.



Related activities: Take your temperature using a strip thermometer on the forehead. Spray hand-hot water onto your forehead and try taking your temperature again.



KEY WORDS:
Hygiene, absorbent

Viking nappies



Teachers' note: How to keep babies bottoms clean and dry has been a problem as long as there have been babies. Nature, however, does provide several different absorbent materials.



What can we ask? How did mothers in Viking times make nappies?



Equipment list: Cloths or paper towels to use as "nappies", Komodo Reptile Habitat Sphagnum Moss (available on the internet or from pet shops), disposable nappies or water-absorbing crystals (from garden centres), measuring jug, digital scales



Activity instructions:

1. If you have bought some disposable nappies, cut open the water absorbent lining and remove the crystals that are inside.
2. If the sphagnum moss is damp, dry it out in an oven set to low.
3. Lay out two cloths or paper towels to use as "nappies".
4. Measure equal weights of moss and crystals and put one in the centre of each "nappy". These are your absorbent materials.
5. Slowly add measured amounts of water, about 10–20 ml at a time, to the absorbent material and carefully lift up each "nappy".
6. Record the total amount of water used for each absorbent material when the water starts to drip through.



Explanation: Sphagnum moss is a very common plant in Scandinavia and parts of the British Isles and is well known for its water-absorbing properties, which made it ideal for use in nappies. Mosses tend to lack a waxy cuticle on their leaves and so are prone to drying out so, for many, being able to absorb more water than they need is an advantage. Sphagnum moss also helps keep faeces away from the baby's skin, as it surrounds it and absorbs the water from it, drying it out and preventing bad smells. Modern nappies contain super-absorbent polymer crystals made from sodium polyacrylate. These can absorb between 90 and 500 times their mass in water, depending on the polymer used. The crystals can be reused either through gentle drying in an oven, or leaving in a warm place while the water evaporates, as can the moss.



Health and safety: Do not dispose of superabsorbent polymer crystals down the toilet or sink. Always dispose of in the rubbish bin. Do not eat the crystals.



Related activities: Investigate the absorbing powers of other materials, like different brands of paper towels, silica gel, table salt, etc.

Will the polymer crystals absorb anything other than water? Try other liquids, for example tomato juice, orange juice, vegetable oil, milk, rainwater, hot water, salt water, etc.

**KEY WORDS:**

Sag, weight, absorbent

Longship sails



Teachers' note: Longship sails were made of wool and, later, linen. Woollen sails absorb lots of water and tend to stretch and lose their shape over time, so Vikings strengthened the sails with walrus-hide leather strips.



What can we ask? Which material is best for making a sail? Is wet material stronger than dry material? How much water do different fabrics absorb?



Equipment list: Ruler, weights, 30-cm squares of different materials, eg wool, linen, cotton, polyester, nylon

**Activity instructions:**

1. Suspend the material horizontally tied at the four corners.
2. Add weights to the middle of the square. Measure and record the amount the material sags in the middle as each weight is added.
3. Soak each fabric in water, gently wring dry and repeat the experiment.
4. Compare the amount of sag between wet and dry materials.



Explanation: Wool should sag a lot, especially when it is wet. Most of the synthetic fibres will hardly stretch at all, even when wet, as they do not absorb much water. The main indicator of whether a fabric will stretch and sag a lot is the length of the fibres that make up the thread. A long thread of wool is made of many much shorter hair fibres twisted together. These threads can stretch when put under a load, like the wind in the sails. Linen is made from much longer fibres so, when twisted together, it is stronger, although it can still stretch. Synthetic threads tend to be made of single fibres, so the strength of the thread depends upon the material it is made from. When wool is wetted this reduces the friction holding the fibres in the threads together, so they slide past each other, lengthening and weakening the threads. This is why a woollen jumper that has stretched will not go back into shape again. Longer natural fibres, like linen, also suffer this effect, but not anywhere near as bad. Synthetic threads, being often made of just a single long fibre, do not tend to suffer from this effect.



Health and safety: Follow school health and safety procedures when doing practical activities. Be careful that weights do not fall onto children's toes.



Related activities: Sew strips of leather or a synthetic, non-stretchy fabric to the woollen fabric in a criss-cross pattern and repeat the experiment.



KEY WORDS:
Dye, colourfast

DYEING CLOTH



Context: One of the women on Leif's farmstead was skilled at dyeing. She dyed the cloth used to make Leif's new sail red and yellow. Cuthswith had a beautiful dress of the darkest blue, and Leif wore red and green that didn't fade over time, showing the high status of him and his family.

Many people think clothing in Viking times was all drab colours like various shades of brown. People have always loved wearing bright colours and that was no different in Viking times. Many people wore red, yellow, green, blue, even purple, and all the shades in between. The brighter the colours you wore the wealthier you were, as they took longer to dye and often used more expensive materials. Also, even if a poorer person and a wealthy person started out with new clothes the same shade of red, for example, the poorer person's colour would fade quite quickly, while the wealthier person's clothes would stay bright for much longer.

Dyeing with onion skins



Teachers' note: Many different plants can be used to dye with. This activity introduces children to the basic dyeing process.



What can we ask? How can you use plants to colour material? How long will the colour stay in a material when it is washed?



Equipment list: Three large stainless steel saucepans, ball of white 100% pure wool, tongs, colander or sieve, dried cooking onion skins, hob



Activity instructions:

1. Weigh out approximately 20 g of wool and 20 g of onion skins.
2. Put the wool and skins in separate saucepans, fill with water so there is about three times as much water as the materials and bring to the boil.
3. Simmer both for about 30 minutes. If not much colour has come out of the onion skins simmer for up to an hour.
4. Strain the onion skins into the third saucepan using the colander and bring the liquid back to the boil.
5. Use the tongs to transfer the wool into the dye-bath (coloured water).
6. Simmer the wool in the dye-bath for a further hour.
7. Remove the wool from the dye-bath and allow to cool.
8. Rinse the wool in lukewarm fresh water.
9. The wool should have been dyed by the colour from the onion skins. Is it the same colour as the onion skins?



Explanation: The coloured chemicals from the onion skins react with the proteins that make the wool. However, many natural dyes do not stick to the wool very well and the colour will fade after a few washes.



Health and safety: Follow all school health and safety procedures for practical activities. Wear eye protection. Be aware that natural dyes can stain clothes.



Related activities: Investigate how the colour varies with how long the wool is left in the dye-bath. Investigate how many times the wool can be washed before the colour fades. Try using red onion skins, or other dyes such as tea, coffee, turmeric, walnut shells or grass.

**KEY WORDS:**

Mordant, dye, salt, alum

Dyeing with mordants



Teachers' note: A mordant is a chemical used in dyeing to make the dye more colourfast, ie it doesn't fade as quickly, and also to adjust the colour of the finished material. Most natural dyes require a mordant to remain colourfast, apart from indigo.



What can we ask? How does a mordant affect dyeing? What does a mordant do to the colour? How colourfast does a mordant make the dye?



Equipment list: Three large stainless steel saucepans, ball of white 100% pure wool, table salt, alum (available from the internet. Search "buy alum".), tongs, colander or sieve, dried onion skins, hob

**Activity instructions:**

1. Weigh out approximately 20 g of wool and onion skins, and 10 g of alum.
2. Put the wool and skins in separate saucepans, fill with water so there is about three times as much water as the materials and bring to the boil.
3. Before heating add the alum to the wool saucepan and stir until dissolved.
4. Simmer both for about 30 minutes. If not much colour has come out of the onion skins simmer for up to an hour.
5. Strain the onion skins into the third saucepan using the colander and bring the liquid back to the boil.
6. Use the tongs to remove the wool from the water and allow it to cool, then rinse it in lukewarm water.
7. Transfer the wool into the dye-bath (coloured water).
8. Simmer the wool in the dye-bath for a further hour.
9. Remove the wool from the dye-bath and allow to cool.
10. Rinse the wool in lukewarm fresh water.
11. The wool should have been dyed by the colour from the onion skins. Is it the same colour as the onion skins? If you dyed without onion skins before is it the same colour as before?



Explanation: A mordant is a chemical that makes the dye more colourfast, and it can also change the colour after dyeing. The mordant reacts with the wool and binds more firmly to the protein molecules that make it up. The dye then reacts with the mordant and binds firmly to it. Sometimes the dye changes colour due to the reaction with the mordant. Different mordants often give different colours with the same dyes. For example, an iron mordant will give a green colour from onion skins. Alum (potassium aluminium sulfate) is one of the most common mordants used. Ammonia, from stale urine, was also a common mordant, resulting in dye-works often being on the outskirts of settlements due to the smell.



Health and safety: Follow all school health and safety procedures for practical activities. Wear eye protection. Read MSDS for use and disposal of mordants.



Related activities: Wash the wool several times and compare how colourfast it is to wool that was dyed without a mordant. Try different mordants, such as ferrous sulfate, copper sulfate or vinegar.

**KEY WORDS:**

Acid, alkali, neutral, pH

Dyeing with red cabbage



Teachers' note: Not only are some dyes affected by different mordants but the colour you get can also be affected by the pH (how acidic or alkaline it is) of the dye-bath. The turnsole plant, also known as folium, produces a range of reds, purples and blues depending on the pH of the solution, but a much easier to obtain alternative is red cabbage.



What can we ask? How does the colour of red cabbage dye change in acid or alkali?



Equipment list: Three large stainless steel saucepans, ball of white 100% pure wool, alum (available from the internet. Search "buy alum"), tongs, colander or sieve, a red cabbage, sharp knife, distilled water (optional, available from car autocentres or local garages), teaspoon, white distilled vinegar, baking powder (sodium bicarbonate), hob



Activity instructions:

1. Coarsely chop up the red cabbage and heat it without boiling in a saucepan of distilled water for about 30 minutes (you can use tap water, if it is pH 7, or neutral).
2. While the cabbage water is being prepared weigh out approximately 100 g of wool and 10 g of alum.
3. Fill a second saucepan with water, add the alum and stir to dissolve.
4. Add the wool to the alum solution and simmer for about 30 minutes.
5. Use the tongs to remove the wool from the water and allow it to cool, then rinse it in lukewarm water.
6. Strain and collect the coloured water from the red cabbage with the colander.
7. Dispose of the alum solution down the sink and wash the saucepan, making sure it is properly rinsed.
8. Divide the red cabbage water into three equal parts, one-third in each saucepan. Divide the wool into three equal parts with scissors.
9. Into one saucepan pour in two teaspoons of vinegar and stir well. The water should turn a reddish pink colour.
10. Into another saucepan pour a heaped teaspoon of baking powder and stir until dissolved. The water should turn a bluey green colour.
11. Transfer a hank of wool into each dye-bath.
12. Simmer the wool in the dye-baths for a further hour.
13. Remove the wool from the dye-baths and allow to cool.
14. Rinse the wool in lukewarm fresh water.
15. You should now have three hanks of wool all dyed different colours by the same red cabbage dyestuff.



Explanation: Red cabbage, as well as other plants, contains a type of coloured compound known as anthocyanins. These change colour depending on whether they are in an acidic (red/pink) or an alkaline (blue/green) solution. By changing the pH of the dye-bath it is possible to get more than one colour using the same dyestuff.



Related activities: Try using other red dye plants, such as red onion skins or plums, and see whether they are also affected by whether the water is alkaline or acidic.



FARMING AND HUNTING



Context: Leif had purchased very good land in Copeland including flat fertile land for growing crops, and into the hills of Wasdale for raising sheep. The rich land, far better than what his family owned in Norway, meant that he was able to produce a surplus almost every year. He would sell some and gift some to poorer neighbours to increase his reputation. The land was also rich in wildlife and sealife. Leif owned two fishing boats and enjoyed hunting in the hills.

Most people were farmers in Viking times, growing crops and raising livestock. Most only produced enough food for their own families, but some farmers grew rich by selling their surplus, enabling them to buy more land and grow even more crops and raise more animals.

Sheep



Teachers' note: Sheep are thought to have been first domesticated between 9,000 and 11,000 years ago. They are important for meat, milk and wool. Old breeds like Faroese sheep or Old Norwegian (Viking) sheep are similar to sheep kept by people in Viking times.



What can we ask? What were sheep like in Viking times? How were Viking sheep different from sheep today?



Equipment list: Computer with internet access, library books, notebook



Activity instructions: Research the characteristics of Faroese sheep and Old Norwegian (Viking) sheep. Explain how they were adapted to living on Viking farms in Scandinavia.



Explanation: Sheep have been bred for thousands of years. Farmers select and breed certain sheep with characteristics they think are valuable so more of the offspring have these characteristics. This is called selective breeding, and has resulted in the wide variety of different breeds we have today.



Related activities: Compare the old Viking sheep breeds to more modern breeds like Merino sheep.



Leif's land in Cumberland | Terry Harvey-Chadwick

**KEY WORDS:**

Crops, plants, identification, life cycle

Identification and life cycles of crops



Teachers' note: The main cereals grown in Viking times were barley, rye and oats. Some wheat was grown in southern Denmark, but it was considered a luxury crop. Other important crops grown were beans, peas, cabbage, onions and some other root vegetables.



What can we ask? How can we tell cereal crops apart? What is the life cycle of a crop plant? Do different plants have different life cycles?



Equipment list: Photographs, pictures or specimens of whole barley, rye, oat and wheat plants. Notebooks, coloured pencils (optional), identification keys



Activity instructions: Use or make a key to identify the four cereal crops grown in Viking times. Identify the parts of the plants.



Related activities: Research the life cycle of one of the crop plants, including sowing, growing and harvesting times.

**KEY WORDS:**

Life cycle, animal, domesticated

Life cycles of domesticated animals



Teachers' note: The main domestic animals kept on farms during Viking times were sheep, goats, cattle and, in richer households, horses. Goats and cattle were raised for milk and meat and, in the case of cattle, as beasts of burden. Sheep were raised for wool, meat and milk, and horses mainly as riding animals and meat. Chickens were also often kept for meat, eggs and feathers.



What can we ask? What is the life cycle of a farm animal?



Equipment list: Computer connected to the internet, notebook, coloured pencils (optional).



Activity instructions: Research the life cycle of an animal kept by farmers in Viking times.

**KEY WORDS:**

Life cycle, fish

Life cycles of salmon or eels



Teachers' note: People living by the coast or by rivers in Viking times ate a lot of fish and shellfish. Common fish were salmon and eels.



What can we ask? What is the life cycle of a fish?



Equipment list: Computer connected to the internet, notebook



Activity instructions: Research the life cycles of salmon and eels, and how they were caught.

**KEY WORDS:**

Belief, superstition, spell, medicine, fossil

BELIEFS



Context: Although many of the Saxons (called Angles in this area) who lived in the area were Christian, Leif still clung to the old gods: Thor, Odin, Frey and others. In his pouch and around his neck he carried his talismans to protect him from harm and help cure illnesses.

Protection from snakes and elves



Teachers' note: Snake stones were believed to protect people against snake bites and, if actually bitten, help cure them. Although they look like curled up snakes they are actually fossil ammonites, a type of sea creature that lived between 400 million and 65 million years ago.

Belemnites are fossilised parts from extinct squid-like creatures that lived between 175 million and 200 million years ago. They were believed to protect against being elf shot, sharp stabbing pains caused by things like appendicitis, muscle stiches, cramps, arthritis or rheumatism.



What can we ask? How are fossils formed?



Equipment list: Computer connected to the internet, notebook



Activity instructions: Research and write a story describing how an ammonite or belemnite died, was fossilised and then found millions of years later by a person living in Viking times.



Protective charms | Terry Harvey-Chadwick

TRADE



Context: At the end of the Viking season Leif would sail across to the Isle of Man, visible from his farm, and to Dublin in Ireland. Here he would trade slaves captured in raids, and wool from his farm. From Scotland he would also pick up skins and furs. These he would trade for essentials like salt, but also glass beads and jewellery for his wife and daughter.

Scandinavian people in Viking times were great traders. Their ships travelled all over the known world. The people from Sweden headed eastward rather than north and west, like the Norwegians and Danes, down the Volga River, founding the cities of Novgorod and Kiev in Russia and Ukraine. They were known to the people there as the Rus. The Rus controlled the trade routes to the Black Sea and the city of Constantinople, where they brought luxury items back from the Byzantine Empire.





KEY WORDS:
Fossilize, tree resin

Amber



Teachers' note: Amber is fossilised tree resin. The richest sources of amber in Viking times, and even today, are the Baltic coasts. Amber was highly sought after and used to make jewellery. It was highly prized in the Byzantine Empire.



What can we ask? What is amber and how is it formed?



Equipment list: Computer connected to the internet, notebook



Activity instructions: Amber is fossilised tree resin. Research where it comes from and how it is formed.



Related activities: Research the properties of amber and how it can be made into jewellery.



KEY WORDS:
Adaptation, environment

Furs and skins



Teachers' note: Many animals were hunted and trapped for their skins, as well as meat. Furs and skins of wolf, fox, reindeer, arctic hare, marten, squirrel, seal, sheep, beaver, boar, bear and deer were used and traded in Viking times. They were highly sought after in the Byzantine Empire, especially furs from arctic animals.



What can we ask? How are animals adapted to their environment?



Equipment list: Computer connected to the internet, library books, notebook



Activity instructions: Choose an animal used by Vikings for its skin or fur and research how it is adapted to its environment.

**KEY WORDS:**

Archaeology, faeces, preservation, measurement, recording, evidence

ARCHAEOLOGY

Leif and his family are long gone now, but signs of Viking farms have been found all over Copeland and the west coast of Cumbria. Archaeology is a multidisciplinary subject, using many of the sciences and humanities in order to decipher the clues about how people used to live. Digging things up out of the ground is only one way that archaeologists find out about the past. From looking at archaeological finds, reading old manuscripts and looking at carvings and monuments left by the people who lived in Viking times, it has been possible to put together the story of Leif, his family and his men, and get a glimpse of what it may have been like to live in the Viking Age.

What did people eat in Viking times?

How do we know what people ate in Viking times? From their poo, preserved in their old toilet pits.

Investigating (fake) Viking poo



Teachers' note: Preserved faeces contain a wealth of information about the diets of people who lived in Viking times. They are usually quite safe to handle as the micro-organisms will be long dead. Preserved in the faeces are the remains of food that the people have eaten. The fake faeces will need to be made in advance of the activity.

People in Viking times did not use knives and forks to eat their meals. Larger chunks or lumps were cut up with knives. Solid food would be eaten with the fingers; sloppier food would be eaten with a spoon. There were no forks. People mostly ate savoury porridge with fish or meat, and vegetables added, plus fruit in season. Fish and meat were sometimes salted, or hung to dry in the open air, or smoked over fires to preserve food for over the winter. Most food was cooked over the fire in a clay or soapstone pot or, sometimes, an iron cauldron. Poorer people would add shredded pine-bark to their meals to help bulk them out, and also as a source of vitamin C (although they wouldn't have known that).

Grinding grain to make flour, using a quern, often meant that small fragments of stone were eaten when the flour was used to make bread. Sometimes remains of parasites are also found in the faeces, such as roundworms and tapeworms.



What can we ask? How do archaeologists find out what people in Viking times used to eat?

**Equipment list:**

Poo ingredients (for 20 poos):

- 300 g plain flour
- 300 g salt
- 2 tablespoons bicarbonate of soda
- 2 tablespoons vegetable oil
- 250 ml hot water
- 10 stock cubes (or brown poster paint or brown food colouring)
- Mixing bowl
- Measuring jug
- Cooked spaghetti or tagliatelle (optional)
- Evidence – fish bones, barley grains, apple pips, peas, cherry stones, small stones, small pieces of chipped wood bark

Activity equipment per group or pair: Fake poo, wooden scraper (lollypop stick or blunted cocktail stick), paper plate, ruler, vinyl gloves, pencils and paper

Preparation: Mix the hot water with the stock cubes (or other poo colouring), so the water is a good brown colour. Put the flour, salt, bicarbonate of soda and vegetable oil in the mixing bowl and slowly add the water until it is a firm but flexible dough. To make it darker add more food colouring, but make sure the poo does not end up runny. Add the evidence as follows, per poo:

- Two fish bones
- Plenty of barley grains
- Five peas
- Three apple pips
- Ten small stones (small gravel sized)
- One cherry pip
- To make it extra disgusting, add a length of cooked tagliatelle as a tapeworm and/or spaghetti as a roundworm.

If unable to make the poo using the ingredients above, you can use soft brown play dough.



Activity instructions: Hand out the equipment to the groups or pairs. Give each group their poo on a paper plate. The children should record the dimensions of the poo, such as length and thickness. They then use the wooden scraper to pull the poo apart and extract and record the evidence of the person's diet.



Related activities: Make a menu for the day based upon the food remains discovered.

**KEY WORDS:**

Archaeology, preservation, organic, soil, acidic, oxygen

How can items survive 1500 years or more in the ground?



Teachers' note: While some items are easily preserved for long periods of time, especially inorganic materials like rock, metal or ceramics, the preservation of organic materials depends upon the conditions of the soil it is buried in.



What can we ask? What are the best soil conditions to preserve objects from Viking times?



Equipment list: Three large tubs (from garden centre), garden soil, peat or ericaceous compost (from garden centre), a variety of organic and inorganic objects



Activity instructions: Prepare three tubs, either somewhere safe or buried in the school grounds. Fill the first tub with ordinary soil, the next tub with damp peat or ericaceous compost and the final tub with ericaceous compost or peat which is waterlogged. Make sure all are very well packed with soil material. Bury a variety of items: leather, wool, linen, cotton fabric, wood, food items like fruit, meat, butter or cheese wrapped in cloth, metal items made of iron, copper, silver, gold. Perhaps add synthetic fabrics as a contrast. Leave for several weeks then unearth and examine the condition of the items from each tub.



Explanation: Some items are naturally preserved in the ground as they are made of imperishable materials, such as rock, ceramic, minerals, silver or gold. Organic materials such as leather, fabric, hair, wood, food and bones can be preserved if the conditions underground are suitable. Generally, waterlogged, acidic conditions with very little oxygen are best for the preservation of organic materials.



Health and safety: When digging the items back up again ensure that gloves and eye protection are worn, especially when examining foodstuffs. When full, the tubs will be very heavy. If they need to be moved ensure proper manual handling precautions are taken.



Related activities: Vary other conditions, such as oxygen content, pH of soils, amount of water, using smaller containers. Use garden kits to test variables.

GLOSSARY

Acid (adjective is acidic)	Sour things like vinegar and lemon juice are acids.
Acid rain	When rainwater has acids dissolved in it usually as a result of pollution.
Adaptation	Changes that allow living things to survive and breed as the environment changes.
Air pressure	The gases in air moving around and bouncing off things exert a pressure.
Alkali (adjective is alkaline)	Cleaning things are alkalis – soap, washing soda, cleaners. These are the opposite of acids.
Draught	How deep a ship sinks into the water.
Environment	Surroundings that affect living things eg temperature, water, light.
Evaporate	Liquid turning into a gas, usually when warmed.
Gas	Expands to fill the whole container.
Growing season	The period of time in a given year when the climate is suitable for the most plant growth.
Igneous rock	Rock formed from the cooling and solidification of lava or magma.
Indicator	Something that changes colour depending on whether it is in acid or alkali. Many plants do this. Red cabbage juice is a good example.
Irreversible reaction	A change that cannot be reversed – you cannot easily get the original materials back. Chemical reactions, cooking and burning are all examples of irreversible changes.
Keel	A beam running the length of a ship providing structural strength to the hull.
Liquid	Flows and takes the shape of the container.
Metamorphic rock	Rock that has been changed through high temperature and pressure.
Micro-organism	Tiny living things that you can only see with a microscope.
Momentum	A quantity of the motion of a moving body, the product of its mass and velocity. So a larger object moving at the same speed as a smaller object will have more momentum because of its greater mass.
Organic	Living or from things that were alive.
pH	A measure of how acidic or alkaline a substance is. A pH less than 7 is acidic, pH 7 is neutral, pH over 7 is alkaline.
Photosynthesis	The process in plants that uses energy from sunlight to convert carbon dioxide from the air and water from the soil into glucose.
Rennet	An enzyme used to curdle milk when making cheese.
Reversible reaction	A change that can be reversed – you can get the original materials back. Dissolving, evaporating, melting, condensing are all reversible.
Soapstone	A rock soft enough to carve easily, so used for jewellery and containers. Can feel soapy, hence the name.
Solid	Keeps its own shape.
Solvent	A substance, usually a liquid, that dissolves things.
Strake	A plank making up the hull of a ship.
Synthetic	Man-made material as opposed to natural fabric.