Science@School | Book 4C

Keeping warm and cool

Teacher's Guide

Support material for the pupil book
can be found at the dedicated web site:

www.science-at-school.com

You can also consult our web site:
www.AtlanticEurope.com
to view our on-line catalogue

Peter Riley

1

Teacher's sheet: comprehension

See **pages 4 and 5** of *Keeping warm and cool*

Answers

1. **The metal.**
2. **It draws more heat from the foot than the other material.**
3. **From a warm place to a colder one.**
4. **(1) Go into the shade.**
   (2) Take a swim in cool water.
5. **Temperature.**
6. **We lose heat faster than our bodies can replace it.**

Complementary work

(a) Show the children a selection of materials such as a piece of metal (no sharp edges), ceramic tile, stone, brick, cork, linoleum, carpet, balsa wood and bath towel. Ask them to write down if each one will feel cold or warm. Let the children feel the materials and test their predictions.

Teaching notes

The purpose of this unit is to establish that, although we think we can tell the temperature of something by feeling it, our senses are not always reliable. In the introduction to the unit on page 9 of this book, and in Picture 2 of the pupil book, it is shown that the nature of the material can affect the way we assess its temperature.

Metals are very good conductors of heat, so when we touch them large amounts of heat pass from our body to the metal. This makes the metal feel cold even though it is at the same temperature as other objects. Linoleum and ceramic tiles also feel cold for the same reason. Cork feels warmer because it is a poor heat (or thermal) conductor, and less heat leaves our skin when we touch it.

Children should be familiar with the thermometer as an instrument which measures temperature from earlier work on weather studies or from Unit 7 of *3C Properties of materials* in the Science@School series.

Children often raise the thermometer from the object they are testing when they read the thermometer. They do this to bring the scale nearer to their eyes. In doing this, the thermometer bulb loses contact with the object it is measuring and the liquid column inside the thermometer will either rise or fall. Taking temperature is introduced in the first activity so that you can check their technique before they try other activities in this book.

Some children may have had their temperatures taken by a clinical thermometer containing mercury which had to be shaken to reset it. The reason for this is that when the thermometer was removed from the body, the thread of mercury was trapped so that it stayed in place. This allowed an accurate temperature to be taken even though the thermometer was removed from the body.

1

Teacher's sheet: activity

Based on **pages 4 and 5** of *Keeping warm and cool*

Introducing the activity

(a) Tell the children that there are parts of the skin which are sensitive to temperature, just as there are parts which are sensitive to touch. We can test this skin sense with a simple experiment.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form then go through tasks 1 to 6 (see note (i)).

(c) Let the children complete tasks 1 to 3 then go through task 4 again.

(d) Let the children try task 4 (see note (ii)).

(e) Let the child who is trying the tasks complete tasks 5 and 6.

(f) Go through tasks 7 and 8 then let other children in each group try them. All members of each group should record the results in a table (see note (iii)).

Completing the activity

(g) Let the children compare their written statements and data in the tables (see note (iv)).

Conclusion

The skin is not very reliable at assessing the temperature of water. The hand immersed in very warm water felt cool when placed in lukewarm water, and the hand immersed in cold water felt warm when placed in lukewarm water.

The bulb of the thermometer must remain in the liquid while the temperature of the liquid is being taken.

Teaching notes

(i) Prepare the bowls of water just beforehand and work out a way to distribute them if you are going to have several groups trying this at the same time. Make sure that the bowls are deep enough for the children to immerse their hands in the water. The very warm water should just be hand-hot, the lukewarm water is made by mixing warm and cold water from the taps. The cold water is just from the cold tap water.

(ii) Only one child from each group should carry out the task at a time. Another child can keep a record of the time the hands are immersed. The experiment should be repeated with other members of the group, as this helps to reinforce the practice of obtaining more reliable results.

(iii) The table should have a left-hand column labelled 'Water' and a right-hand column labelled 'Temperature °C'.

(iv) Any anomalous results may be checked by asking each group to demonstrate their technique of reading thermometers in liquids. Some children will take the thermometers out to read them and this will result in the temperature of the thermometer rising or falling.

2 Teacher's sheet: comprehension

See **pages 6 and 7** of *Keeping warm and cool*

Answers

1. **A is 100°C – the boiling point of water. B is 0°C – the freezing point of water.**
2. **Alcohol.**
3. **(a) Mercury, (b) a metal.**
4. **(a) Anders Celsius, (b) Sweden.**
5. **Degree.**
6. **Put the bulb of the thermometer in the liquid and wait for the level of the liquid in the thermometer to become steady.**

Complementary work

(a) Each child can use a thermometer to find out the temperature in their closed hand, the temperature of their breath when they blow on the thermometer, the temperature of tap water and the temperature of the room.

(b) Let the children use secondary sources to find out about Anders Celsius.

Teaching notes

Temperature is a measure of the hotness or coldness of a substance. It is measured on a scale which has two fixed points. In the Celsius scale the two fixed points are the freezing point and the boiling point of water. In between these two fixed points the scale is divided up into a hundred units called degrees. The scale can be extended above and below these fixed points. For example, many school thermometers have a scale going from –10°C to 110°C.

The thermometer compares the temperature of the substance it is touching with the freezing point or boiling point of water. For example, if the thermometer is left in the air in the classroom, it may record a temperature of 20°C. This means that the air temperature is 20° above the freezing point of water.

Temperature is often mentioned when heat is being discussed. They are not the same thing but are linked. Every substance is made up of particles which are moving. Solids are made of particles which hold tightly together but vibrate. Particles in liquids have a greater degree of movement, and particles of gas can move freely. All the particles move because they possess movement energy, or kinetic energy. When a thermometer is dipped into warm water the bulb is struck by fast moving particles which pass on some of their energy to the liquid in the thermometer. The particles in this liquid begin to move faster and cause the liquid to expand and move up the scale. The glass in the thermometer also expands, but not as quickly as the liquid.

2 Teacher's sheet: activity

Based on **pages 6 and 7** of *Keeping warm and cool*

Introducing the activity

(a) You can link the activity directly to the unit by saying you want the children to investigate water temperatures and to use the advice given on page 7 of the pupil's book to help them.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form then go through tasks 1 to 4.

(c) Let the children work through tasks 1 to 4 (see note (i)).

(d) Let the children carry out task 1 (see note (ii)).

(e) Let the children carry out tasks 2 to 4 (see note (iii)).

(f) After the children have completed task 5 let them try task 6 (see note (iv)).

Completing the activity

(g) Let the children compare their data. Look for anomalous results and seek explanations for them (see note (v)).

Conclusion

Cold water increases in temperature until it reaches room temperature. Warm water decreases in temperature until it reaches room temperature. Tap water may change temperature a little to come to the temperature of the room, or it may already be at room temperature.

After a day, the temperature of the water in the three bowls will be the same, assuming they are in identical conditions in the classroom.

Teaching notes

(i) You may like to melt some ice cubes in the cold water prior to the lesson. The warm water should be hand-hot.

(ii) Check each set of bowls to see that they are labelled correctly.

(iii) Go round the groups and ask the children to demonstrate their use of the thermometer, to check on their technique.

(iv) The children could make bar graphs, or line graphs, according to their ability. Alternatively, you could use the results of one group to make a line graph for the whole class.

(v) Anomalous results are most probably due to faults with technique. Bowls left in a sunny window, or in a cool, draughty place, may show some differences from bowls in other sites in the class.

Teacher's sheet: comprehension

See **pages 8 and 9** of *Keeping warm and cool*

Answers

1. **In the top poker, most of the poker is shaded. In the middle poker, a third of the poker is shaded. In the bottom poker, a quarter of the poker is shaded.**
2. **Coal.**
3. **Allowing heat to travel through them.**
4. **Copper is the best conductor and iron is the worst.**
5. **It conducts heat poorly.**
6. **The skin is an insulator. The heat cannot be carried away quickly, and so the surface of the skin gets hot enough to burn.**

Complementary work

(a) Let the children look at a selection of pans. Some of the pans may have wooden or plastic handles, some may not. There should be a copper-bottomed pan and a cast iron pan. Ask the children which handles will not get hot (the wood and plastic handles); which pan may transfer heat the most quickly (the pan with the copper bottom); and which pan may take longest to heat up (the cast iron pan).

(b) Let some of the children model the action of conduction in the following way. Line up six children. Give the child at one end of the line six large red cards. These symbolise heat. Ask the child to pass the cards one at a time up the line. The rest of the class should see the heat being transferred from one particle of a substance (a child) to another (a child further along the line).

Teaching notes

Conduction is a familiar way in which heat is transferred. When we touch anything to feel if it is hot or cold, we find out by the conduction of heat between the object and ourselves. In conduction, the particles can be thought of as passing the heat energy from one to another, as the second complementary activity shows. In reality, the particles at the hot end of a solid object are vibrating quickly and knock against more slowly vibrating particles further along. This makes the more slowly vibrating particles speed up and knock into particles further along the object.

Asking the children to mime this process could result in mayhem, so the simple demonstration (in complementary work (b)) is safer and shows the passage of heat more clearly. Similar demonstrations are also used to show the passage of heat in convection and radiation so you may like to try all three units on heat transfer then let the children do the three mimes together as a revision exercise.

3

Teacher's sheet: activity

Based on **pages 8 and 9** of *Keeping warm and cool*

Introducing the activity

(a) Ask the children if they have ever touched a spoon in a drink and found the spoon too hot to hold. Tell the children that this is an example of conduction. The metal has conducted the heat from the drink to your hand. Say that the children are going to test how three spoons made of different materials conduct heat. Instead of using their skin to make the test, the children are going to use margarine.

Using the sheet

(b) Give out the sheet and let the children fill in their name and form then go through tasks 1 to 6 (see note (i)).

(c) Let the children perform tasks 1 to 6.

(d) Go through tasks 7 to 11 with the children then let the children try them (see note (ii)).

Completing the activity

(e) Let the children compare their observations to the first part of the investigation, then let them compare predictions, reasons and results.

(f) Ask for suggestions on how the test could be made fairer (see note (iii)).

Conclusion

The margarine melts faster in the metal spoon than the plastic spoon. This difference is due to metal being a better conductor of heat than plastic. The margarine melts faster in the metal spoon than the wooden spoon. This is due to metal being a better conductor of heat than wood.

Teaching notes

(i) Make sure the spoons are approximately the same size and thickness. They could be teaspoon or tablespoon size. The amount of margarine should be between one half and one centimetre across. They should use a plastic knife to cut up the pat of margarine.

If the children have done the previous activities in this book you could now let them collect hot water for themselves. Make sure that the water is only hand-hot.

(ii) When the children compare their result and predictions they should say whether their prediction matched or did not match the result. They should not uses phrases like, "It was O.K.".

(iii) If the spoons do not have exactly the same dimensions, the children could suggest that spoons of identical size are found.

Teacher's sheet: comprehension

See **pages 10 and 11** of *Keeping warm and cool*

Answers

1. **An arrow should rise from the heater and bend to the right. Another arrow should point down by the opposite wall and bend to the left. The arrows may also be shown as in the pupil's book.**

2. **No, they are very poor conductors.**

3. **They both flow easily.**

4. **Electricity.**

5. **A dye.**

6. **At the bottom. This allows the greatest movement of warm water. If the heater was placed at the top, only water at the top of the tank would become hot. This is because the hot water is lighter in weight than cold water and would keep above it.**

Complementary work

(a) Stand eight children in a line. Give the child at one end fourteen large red cards. They symbolise heat. Let the child give one card to the next child in the line. This child then walks to the end of the line, puts the card on a table and joins the end of the line. The next child in the line is given a red card and also goes to the table, puts down the card and joins the back of the queue. This procedure is repeated with all the other children in the line. The first child can give out the 'heat' more quickly so that the 'convection current' moves faster.

Teaching notes

Convection occurs in liquids and gases. When one part of these substances receives heat, the molecules in the substance move further apart. This makes that part of the substance less dense than the surrounding cooler parts. The less dense part then rises through the cooler parts and takes the heat with it. A cooler part moves in to take its place. This part also becomes hot, less dense and rises. A convection current is set up by the rising warm parts of the substance and the sinking cooler parts of the substance. As the warm part rises, it loses heat and eventually cools. When this happens, it can sink back down to the source of heat to be warmed again.

In the demonstration in complementary work (a), each child is part of a pan of water or the air in the room. They are not particles like the particles in the conduction demonstration, but are groups of particles. The child who receives 'heat' represents a part of the air where the particles have spread out and the air is less dense (or weighs less). The child then 'floats' past the other cooler parts of the air to the table. This can represent either the water surface, or the ceiling of a room which receives the heat. The child then 'cools down' and joins the line of other 'cooler parts' of the substance that are waiting to be warmed.

4 Teacher's sheet: activity

Based on **pages 10 and 11** of *Keeping warm and cool*

Introducing the activity

(a) You may ask the children if they have seen hot air rising. They may say they have seen it at a camp fire or bonfire. In these places, the rising air can make objects on the other side of the fire difficult to see. Tell the children that they are going to make a fan which can detect rising hot air.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 to 7 (see note (i)).

(c) Let the children perform tasks 1 and 2 then check their work.

(d) Let the children try task 3 then check their work.

(e) Let the children perform task 4 or do it for them.

(f) Let the children try tasks 5 to 7 (see note (ii)).

(g) Go through tasks 8 to 10 then let the children try them.

(h) Go through tasks 11 and 12 then let the children try them (see note (iii)).

Completing the activity

(i) Ask the children to predict what might happen if they held their convection detectors over a radiator, then let them try it (see note (iv)).

Conclusion

When the fan is lowered quickly through the air it spins. This is caused by the air passing upwards through the fan blades. When the fan is held over a table it does not spin because no air is rising through it. When the fan is held over a lamp it spins. This is caused by the hot air rising between the fan blades.

Teaching notes

(i) You need to go through each stage slowly and carefully. Perhaps you may like to make a fan first as a demonstration.

(ii) You may need to provide the knotted threads for some groups of pupils. Make them up before the lesson. The thread needs to be about 15 centimetres long. When the ball of knots is in place, the length of thread above the fan should be about 12 centimetres.

(iii) The fan may need to be about 10 centimetres above the lamp bulb to spin well.

(iv) If the radiator is a panel radiator (i.e. it does not have an open grill in the top like the convector on page 11 of the pupil book) all the children could hold their detectors over it. If the radiator is a convector heater like the one shown in the pupil book, you may like to perform the test to make sure that no fans fall through the grill into the heater. Alternatively, more responsible children could wrap the thread around their finger so the fan and thread will not fall.

5 Teacher's sheet: comprehension

See **pages 12 and 13** of *Keeping warm and cool*

Answers

1. **The rays should be in straight lines. The reflected heat rays from the wall should be shown.**

2. **Light rays.**

3. **Heat rays are not found in the shade. They only travel in straight lines and cannot go around an object that gets in their way.**

4. **A shiny surface such as a mirror.**

5. **(i) A radiator, (ii) It gives out most of its heat by radiation.**

6. **Light colours reflect more heat away than dark colours. They soak up less heat than dark colours.**

Complementary work

(a) Let two children demonstrate how heat travels by radiation. The children stand four or five metres apart. One child has some red objects (cushions, bags or balls) and throws them one at a time to the other child (the red objects are heat rays). The second child must catch them and then keep holding onto them, or put them in their pockets. In this way the second child simulates getting hotter.

Teaching notes

When heat moves by radiation, particles are not involved. The rays are made from waves that behave a little like magnets and a little like electricity. They are called electromagnetic waves. There is a huge range of waves. Each kind has a particular wavelength. The major groups of waves are radio waves, microwaves, infra-red waves, visible light, ultra-violet, X-rays and gamma rays. Heat rays are infra-red rays.

As particles are not needed to transfer the heat, radiation can take place in a vacuum, or in places where there are few particles – like outer space. All objects give out infra-red rays. The hotter the object the more rays it gives out. Some infra-red rays can pass through glass. They have short wavelengths. When they pass through the glass, into a greenhouse, for example, they are absorbed by the ground and rays of a longer wavelength are produced. These cannot pass through the glass and remain in the greenhouse where they warm up the air.

5

Teacher's sheet: activity

Based on **pages 12 and 13** of *Keeping warm and cool*

Introducing the activity

(a) You can introduce this activity after the children have read about bouncing heat rays on page 12.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form. Go through tasks 1 to 6 then let the children try them (see note (ii)).

(c) Go through tasks 7 to 9 then let the children try them (see note (ii)).

(d) Go through tasks 10 to 12. If the children are having trouble thinking of a prediction, go through picture 2, and the caption on page 13 of the pupil book.

(e) Let the children try tasks 10 to 12 (see note (iii)).

Completing the activity

(f) Let the children compare their work.

Conclusion

The margarine in the black sheets melted and the margarine in the white sheets did not melt.

The margarine in the sheets in the cardboard shade did not melt because the heat rays could not reach the sheets. The margarine in the sheets in the light melted because the heat rays reached them.

Teaching notes

(i) The lump of margarine should be between one half and one centimetre across. The children should use a plastic knife to cut up the margarine.

(ii) The cardboard should be about 15cm by 13cm. The shorter sides should be bent over to make 3cm walls, as the diagram shows.

(iii) When the children compare their result and predictions they should say whether the prediction did or did not match the result. They should not uses phrases like, "It was O.K.".

Teacher's sheet: comprehension

See **pages 14 and 15** of *Keeping warm and cool*

Answers

1. **(i) The narrow walls around the central liquid should be shaded in.
(ii) Cork or plastic.**

2. **Conduction, convection and radiation.**

3. **It loses heat to the air.**

4. **Sir James Dewar, Scotland.**

5. **Heat cannot pass through the vacuum by conduction.**

6. **It prevents heat from outside entering the flask. The heat is stopped by the same features that keep heat in. They are the vacuum, reflective silver walls and insulating properties of the glass and cork.**

Complementary work

(a) The children can use secondary sources to find out about the life of Sir James Dewar.

Teaching notes

This unit gives you an opportunity to revise the content of the previous three units about conduction, convection and radiation. The study of the vacuum flask is also useful as part of a technology project on keeping foods warm or cold.

Children seem readily to grasp that heat can be prevented from escaping an object that is wrapped up, but they have difficulty in understanding the effect of wrapping up a cold object. They may think the wrapping keeps the coldness in. Coldness does not flow out of the wrapping to a hot place. Instead, the wrapping prevents the heat passing in from outside and warming up the wrapped-up object.

Teacher's sheet: activity

Based on **pages 14 and 15** of *Keeping warm and cool*

Introducing the activity

(a) At the end of the unit in the pupil book, it is mentioned that the vacuum flask can be used to keep its contents cool as well as hot. Ask the children if they think that materials that we use to keep things warm could also be used to keep things cold. Challenge them to test their ideas by trying to stop ice cubes from melting.

Using the sheet

(b) Give the children the sheet and let them write their names and form on it, then go through tasks 1 to 3 with them (see note (i)).

(c) Let the children carry out tasks 1 to 3.

(d) Go through tasks 4 and 5 (see note (ii)).

(e) Let the children carry out tasks 4, 5 and 6 (see note (iii)).

Completing the activity

(f) Let the children try task 7 and compare their results.

Conclusion

Generally, ice cubes wrapped in thin materials will melt more quickly than ice cubes wrapped in thicker materials. Ice cubes wrapped in materials containing air pockets, such as bubble wrap, will melt more slowly than ice cubes wrapped in materials without air pockets.

Teaching notes

(i) Provide a selection of materials such as aluminium foil, cling film, bubble wrap, polythene sheeting, foam sheeting and cloth. Less able children may use only two or three materials, while more able children could use the full range. You may have to prepare materials cut to size for less able children, while more able children could use scissors to cut out the materials they need.

The wooden or plastic block should be about the size of the ice cubes you are going to use. They give the children a chance to have a 'dry run' – to see how they will fit the materials around the ice cubes.

You may use bowls or pots to hold the ice cubes in their wrappings.

(ii) The children need to write down, or draw a picture of, how they will set up the experiment and how often they will look at the ice cubes. They will need a clock to time the interval between inspections. Some children may wish to measure the tops of the ice cubes to give an indication of how much the cube has melted.

You may ask the children to predict the order in which the ice cubes will melt. You could also ask for reasons for their predictions.

(iii) The children may present their results in a table, or as a written report.

7 Teacher's sheet: comprehension

See **pages 16 and 17** of *Keeping warm and cool*

Answers

1. **A = central heating panel, B = double glazed window, C = cavity insulation, D = fibreglass insulation.**

2. **Yes. Wood conducts less heat than brick.**

3. **Near the ceiling. Hot air rises.**

4. **The heat from the lower rooms can be used to heat the rooms above them.**

5. **Through the windows.**

6. **(i) In time, the air becomes stale and unhealthy. (ii) By opening and closing doors and windows. Some fresh air is let in by draughts.**

Complementary work

(a) The children can use secondary sources to find out about how homes around the world are designed to keep the occupants warm or cool.

Teaching notes

You may wish to extend this work and give it an economic or an environmental dimension.

If you wish to consider the economics of insulating the home you may introduce the children to fuel bills. You can make the figures simple, to help them follow how insulation can save money. For example, you could say that the cost of heating a home was £400 per year. When one method of insulating the home was used the fuel bill fell to £300 a year, so there was a yearly saving of £100. The children would also need to know that the method of insulation also cost money. For example, say it cost £200 to install the insulation, in order to save £100 a year. Balancing the cost of insulation against the yearly saving is called the payback time. In this simple example it would take two years to pay back the money spent on installing the insulation. This means that the payback time is two years. The payback time for installing each kind of insulation varies. Wall insulation, for example, may have a payback time of less than two years, while double glazing, which is the most expensive form of insulation, may have a payback time of 25 years.

If you wish to consider the environmental benefits of insulating the home, you may tell the children about how an insulated home takes less fuel to keep warm. This means that supplies of fuel are not used up as quickly, and less fuel is burnt so there is less pollution, and possibly less chance of global warming which could change the environment throughout the world.

Teacher's sheet: activity

Based on **pages 16 and 17** of *Keeping warm and cool*

Introducing the activity

(a) Begin by telling the children that sometimes, when scientists want to investigate something, they make a model. In this activity the children are going to investigate the effect of wall insulation using two model rooms. Tell the children that when scientists use models, they like to make the models as simple as possible. In this investigation, beakers filled with very warm water are models of rooms in a home.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through task 1 (see note (i)).

(c) Let the children perform task 1.

(d) Go through tasks 2 to 4 with the children (see note (ii)).

(e) Let the children try tasks 2 to 4.

(f) Go through task 5 then let the children try it.

Completing the activity

(g) Let the children compare their results.

Conclusion

The 'room' with insulation material in the wall cavity did not lose heat as quickly as the 'room' without insulation.

Teaching notes

(i) You may use small beakers to hold the water, and larger beakers to represent the outside wall. Make sure that the children realise that the space between the wall of the smaller beaker and the larger beaker is the wall cavity. Let the children pack the cavity of room B with cotton wool or a similar material.

(ii) Remind the children that they must make the test fair. They could use a measuring jug to collect the very warm water from the tap. The bulb of the thermometer should be placed at the same depth in each container when the temperature is being read. The children may need to be reminded to wait until the liquid in the thermometer has stopped rising before they take the temperature.

8 Teacher's sheet: comprehension

See **pages 18 and 19** of *Keeping warm and cool*

Answers

1. **The diagram should show the raised hairs and goosebumps.**
2. **37°C**
3. **Blood.**
4. **Fat.**
5. **When it evaporates from the skin it takes heat away and cools down the skin and blood.**
6. **They shiver because they are cold. When we shiver the muscles work and release heat which is used to warm the body.**

Complementary work

(a) The children can use secondary sources to find out about how blood circulates round the body and how muscles work.

(b) The children can use secondary sources to find out about how muscles work.

Teaching notes

The body has a range of mechanisms which help it to regulate itself. For example, when we exercise we breathe faster to take in more oxygen for our muscles. Our heart also beats faster so it can speed up delivery of oxygen-rich blood to the muscles. When we rest, our breathing rate and our heart rate slow down. We also need to keep our body temperature at 37°C for good health. All the life processes in our body are geared to work best at this temperature. Although this may seem to be a human biology topic, you can explain it in terms of physical science.

Blood carries heat around the body. If there is too much heat, the blood vessels in the skin open and allow the blood to flow close to the surface. Heat can then pass to the surface by conduction, and some leaves the body by radiation. When sweat is produced, it takes away large amounts of heat as it evaporates, and this cools the blood.

When the body is too cold, the blood vessels in the skin close. This makes it more difficult for the body to lose heat by conduction and radiation. Sweating also slows or stops, so less heat is lost by evaporation. In mammals and birds, the other animals which have constant body temperatures, the fur and feathers rise in cold weather to trap air and form an insulating layer. We possess this mechanism, which can be seen in our ability to produce goosebumps, but we have so little hair on our bodies that it fails to make a useful insulating layer so we use clothes to help us keep warm.

8 Teacher's sheet: activity

Based on **pages 18 and 19** of *Keeping warm and cool*

Introducing the activity

(a) If the children have done the previous activity, you can tell them that this activity also involves scientific modelling.

If the children have not done the previous activity, begin by telling them that sometimes when scientists want to investigate something, they make a model. When scientists use models they like to make the models as simple as possible. In this investigation beakers will act as models.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 to 4 (see note (i)).

(c) Let the children try tasks 1 to 4.

(d) Go through task 5 then let the children try it.

(e) Let the children try task 6.

Completing the activity

(f) Let the children compare their results and answers.

Conclusion

A large body cools down more slowly than a small body of the same shape because its surface area to volume ratio is greater. This is also true of living things and, for example, small creatures tend to have to use more of their energy keeping warm than large ones.

Teaching notes

(i) The difference in the size of the beakers or other containers should be as large as possible in order to get a more striking result.

The thermometer bulb should be dipped into the centre of the water in each container.

Teacher's sheet: comprehension

See **pages 20 and 21** of *Keeping warm and cool*

Answers

1. **(i) Air, (ii) moisture.**
2. **Stop cold air or water moving past our bodies.**
3. **They would trap moisture leaving the skin and this would make the plastic clammy, then wet.**
4. **Fibres woven together into a fine net.**
5. **Air.**
6. **They are made from curly and bulky fibres, which trap a lot of air when they are woven together.**

Complementary work

(a) Let the children use secondary sources to find out about the clothes people wear to keep warm in different parts of the world.

(b) Let the children use secondary sources to find out about weaving and knitting.

Teaching notes

If the children worked through Unit 7 of *3C Properties of materials*, you may like to remind them of their work now. In the earlier book the topic was more general. It was called 'Keeping the heat in' and referred to all materials, not just fabrics. It also dealt with keeping drinks warm, as well as keeping bodies warm. You may like to tell the children how the work in this topic deals with the subject again and gives them more detailed information.

There are several factors which are important in the design of clothes. For example, clothes need to be reasonably light in weight, otherwise it would be exhausting to wear them. They also need to be flexible, or the clothes would be uncomfortable. For example, a suit of armour was not worn for its comfort. Another aspect of comfort is the ability to dissipate body moisture in the form of sweat, so the material needs to let moisture pass through it. Finally, when clothes are made for warmth, the other factors must be considered too, so warm clothes must also be made of lightweight, flexible materials, which let moisture pass through them and also prevent heat escaping too quickly.

Many people think that it is the cloth fibres that form the insulation, but most of it is provided by the air trapped between the fibres. In the complementary work in Unit 7 of *Properties of materials*, an experiment was suggested in which two hot-water bottles were filled, a string vest was wrapped round one and both were then wrapped in a cotton or nylon material. After an hour the temperature of the bottles could be checked to demonstrate the insulating effect of the air in the string vest. If this work was not done in the past perhaps you may like to demonstrate it now.

9 Teacher's sheet: activity

Based on **pages 20 and 21** of *Keeping warm and cool*

Introducing the activity

(a) Show the children a variety of different cloths. Tell the children that they are going to compare how the different cloths let heat pass through them.

Using the sheet

(b) Give out the sheet and let the children write their names and form then go through tasks 1 and 2 (see note (i)).

(c) Let the children try tasks 1 and 2.

(d) Go through tasks 3 to 6, then let the children try them (see note (ii)).

Completing the activity

(e) Let the children try task 7 (see note (iii)).

(f) As different groups may have used different cloths, let each group present their results to the rest of the class. Some groups may have used one or two of the same cloths. They could compare their results and assess each other's accuracy.

Conclusion

The cloths which are thickest and have the most air spaces will tend to lose heat most slowly. The cloths which are thin and have few air spaces will tend to lose heat most quickly.

Teaching notes

(i) The cloth could come from a selection of old clothes which have been cut up.

(ii) If the children have done several of the previous investigations, you may let them read the instructions and try the experiment for themselves. Keep a close watch to see that they can manage without your going through the tasks first.

(iii) The children should say whether their predictions match, do not match or partly match the results.

10 Teacher's sheet: comprehension

See **pages 22 and 23** of *Keeping warm and cool*

Answers

1. **The one on the left is spraying itself with water. The one on the right is wafting its ears to and fro.**
2. **Alligator, crocodile and lizard.**
3. **By sunbathing in the first part of the day.**
4. **Hunt for food.**
5. **(i) The tropics (near the equator). (ii) Hot.**
6. **They gently waft their ears to and fro. This makes more air flow over them and carry away heat from the blood in their ears.**

Complementary work

(a) Many animals use burrows in the ground to escape from the heat of the day. Take the chidren outside and let them dig a hole and compare the temperature there with the temperature at ground level. They should find that it is cooler in the hole.

(b) Let the children use secondary sources to find out how an animal's temperature changes when it hibernates.

Teaching notes

Animals generate heat in their bodies when they use food. The liver and muscles use large amounts of food and generate heat. This circulates round the body in the blood. Some animals (mammals and birds) can conserve this heat and use it to keep their body temperature constant. These animals are often called warm-blooded animals. All other animals cannot conserve heat, and their body temperature changes with the temperature of their surroundings. These animals are often called cold-blooded animals, but the description is not accurate. In the tropics, when an animal has warmed up its body to that of its surroundings, it can have blood as warm as birds and mammals.

The advantage of having a constant body temperature is that the body can remain active in a wide variety of weather conditions. The disadvantage of a constant temperature is that the body only works within a small temperature range, and if the body temperature falls outside this range for any reason, the animal will die.

The advantage of having a body temperature which varies with the surroundings is that large amounts of food are not needed to provide the energy to heat the body. Small mammals like shrews lose a great deal of heat, especially in cold weather, because of their size, and can only maintain their body temperature by eating almost constantly. Lizards by comparison simply rest in cold weather. All the life processes slow down and food stored as fat is used slowly. The disadvantage of not having a constant temperature is that in cold weather, cold-blooded animals move slowly and are more easily caught by warm-blooded predators.

Teacher's sheet: activity

Based on **pages 22 and 23** of *Keeping warm and cool*

Introducing the activity

(a) The children should do this activity after they have done one or more of the activities in Units 7 to 9 (see note (i)). The children should now be aware of the use of scientific modelling and this activity will allow them to add a little individuality to the investigation.

Tell the children that most mammals have a thick coat of fur, while reptiles are covered in scales (see note (ii)).

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 to 4 (see note (iii)).

(c) Let the children try tasks 1 to 4.

(d) Go through task 5 and 6 then let the children try them (see note (ii)).

(e) Go through tasks 5 to 7 then let the children try them (see note (iv)).

(f) Go through task 8 then let the children try it.

Completing the activity

(g) Let the children try task 9 and then compare their results.

Conclusion

The model reptile cools down faster than the model mammal. The model reptile skin is not as good an insulator as the model mammal fur.

Teaching notes

(i) This will give them experience in planning the investigation, making a table for results and producing a line graph.

(ii) If your school policies permit, you may be able to obtain a moulted snake skin from a zoo. This has a papery feel to it and will help the children realise that grease-proof paper is slightly similar.

(iii) Check that the containers are suitable for holding very warm water. The children may use pots, beakers or bottles.

The children must realise that the heads are not just for decoration, but help to stop heat loss by convection, just like the stopper in the vacuum flask on page 15 of the pupil book.

(iv) The plan should mention using equal volumes of water that are at the same temperature, taking temperature readings at regular time intervals. The table should have three columns headed 'Time (mins)', 'Reptile °C' and 'Mammal °C'.