

Activity 2

Investigating Housing in Saudi Arabia

Timings: 2 x 45 minutes

National Curriculum Criteria, Key Stage 3, Pupils should be taught:

- Sc 0.2b to consider the benefits and drawbacks of scientific and technical developments, including those related to the environment, health and quality of life.
- Sc 0.2f about *Scientific enquiry* through contexts derived from the programme of study for *Life processes and living things, Materials and their properties and physical processes*.
- Sc 0.2g to carry out different kinds of scientific investigation.

This activity contains:

Teacher Notes
Pupil Worksheet
Information sheet
Answer Sheet

Teacher Notes...

◆ Prior knowledge required

- Students should know that heat is transmitted by conduction, convection and radiation.
- Students should know that some materials are good and some are bad conductors of heat energy.
- Students should know that the amount of internal (heat) energy within an object depends on the mass of the object.
- Students should know about specific heat capacity.

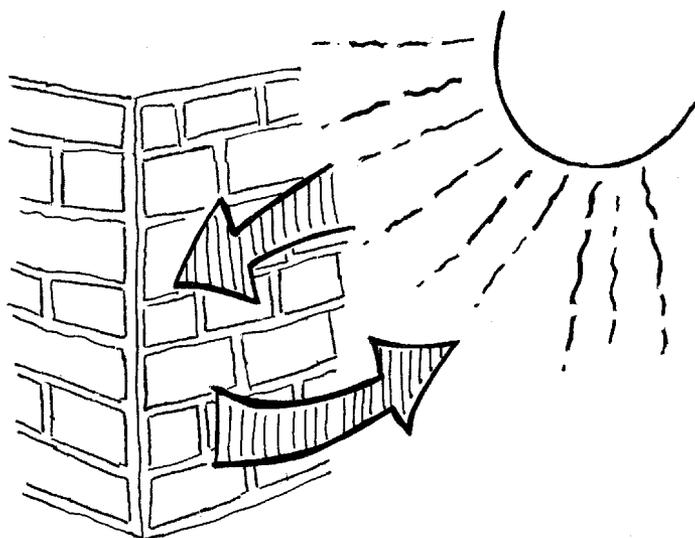
◆ Materials and Resources needed

- Pupil Worksheet 1 'Houses in Saudi Arabia'.
- Information sheet 'Hot Days and Cold Nights - Houses in Saudi Arabia'.
- An Atlas and a copy of the world map to mark Saudi Arabia on.
- Demonstration apparatus for thermal capacity.
- Demonstration apparatus for convection currents.

This is an activity for students to apply their understanding of heat transfer to a practical situation. Students should read the worksheet 'Houses in Saudi Arabia' and then answer the questions on it. The activity can be followed up by looking at the information sheet 'Hot Days and Cold Nights - Houses in Saudi Arabia'. Pupils should be able to explain the design of a Saudi Arabian house. They should also be able to explain how house design in other countries depends on the climatic conditions prevailing there.

Points for Discussion

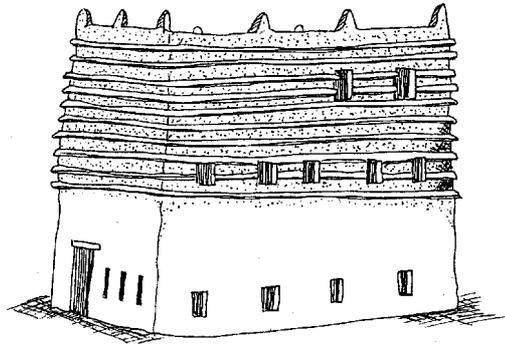
- ◆ For some students the idea of the walls absorbing and then re-radiating the heat energy can cause confusion.
- 1. As a structure heats up (increases in temperature) heat energy is absorbed. Any structure which has heat energy will radiate energy away from it. As the body gets hotter, more heat energy will be radiated away from it.
- 2. When the structure reaches the same temperature as its surroundings, a point of 'thermal equilibrium' is reached where the amount of heat absorbed is equal to the amount of heat radiated away. Temperature changes also involve other heat transfer mechanisms such as conduction and convection.
- 3. As the temperature of the surrounding environment drops, the temperature of the hot structure drops as heat is radiated away from it. Structures with a high thermal capacity, e.g. thick mud walls, take longer to warm up (reach thermal equilibrium) and take longer to cool down (they have more heat energy to radiate away).



- ◆ It may be interesting to consider implications of building a 'self-heating' house and the value of this for the environment.
- ◆ The small projecting stones on the outside of the walls direct rain water away from the walls. The purpose of this is to stop water collecting close to vulnerable walls and weakening them. Rain could wash away the outer layers of plaster if the stones were not used. In the UK we have gutters for the same job.

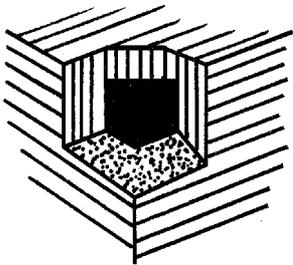
Pupil Worksheet 1

Houses in Saudi Arabia

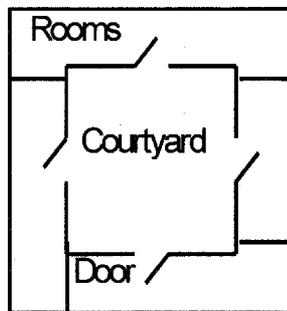


Saudi Arabia has a hot dry desert climate. During the day the temperatures are very high, during the nights it is very cold.

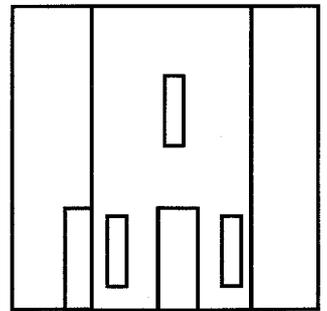
The challenge for house builders in Saudi Arabia is to produce a house that is cool during the day and warm at night. This is done by using the effect of convection currents on the walls and roofs, since they have high thermal capacities.



A section of the walls and roof showing their thickness



Aerial view showing the lay out of the rooms and courtyard.



Side-on view section showing the windows and doors opening onto the courtyard

Questions: Please answer the following:

1. In Saudi Arabia, night-time temperatures are often as low as 2°C . or 3°C . At what time of year would you expect to have temperatures like that in the UK?
Daytime temperatures are sometimes as high as 40°C . Think of a place in Europe where temperatures are as high.
2. Suggest why the windows on the outside of the house are very small?
3. Suggest how thick mud walls keep the house cool during the day.
How do the thick mud walls keep the house warm during the night?
What is the similarity between mud walls and night storage heaters (these are radiators which contain a form of stone inside. This is heated at night using electricity costing less than normal).
4. During the day, the floor of the courtyard becomes very hot and the air above it rises. Why does the air rise and where does the cold air come from to replace the rising hot air? How does this help to keep the house cool during the day?

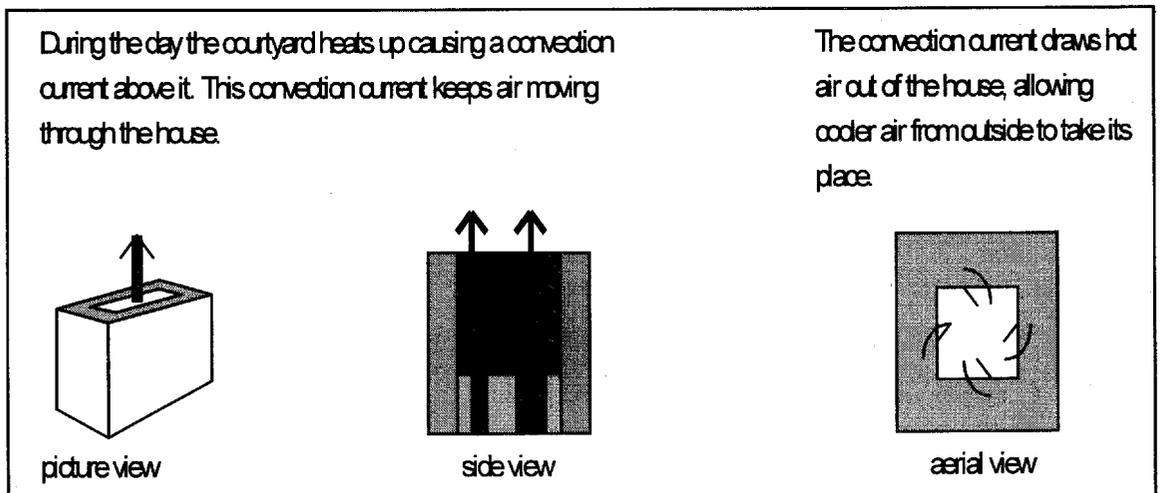
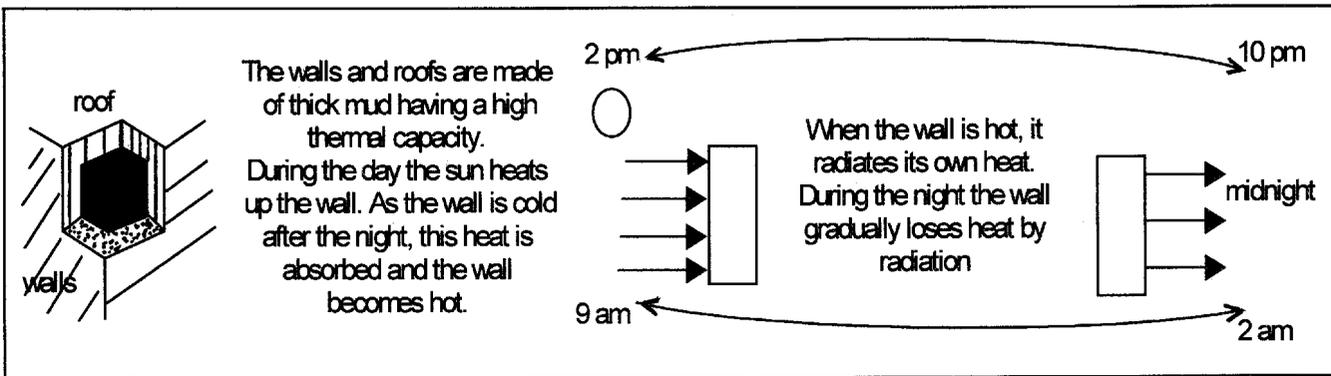
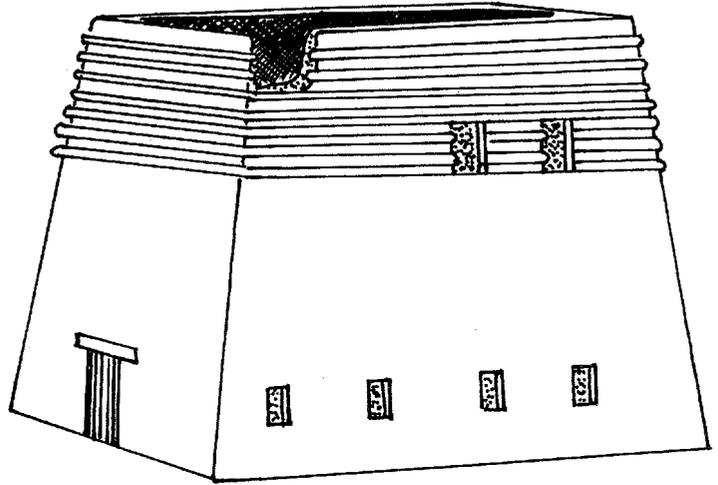
Information Sheet 1

Hot Days and Cold Nights - Houses in Saudi Arabia

Saudi Arabia has a hot dry desert climate. There is very little rainfall, the days are very hot and the nights are cold. The challenge is to make a house that stays cool during the day and warm at night.

This is achieved by the clever use of convection currents and walls with a high thermal capacity.

Small windows prevent excess radiation from the sun entering the house.



Activity 3

Thatch or Tin - Comparing Different Materials for Roofs

Timings: 2 x 45 minutes

National Curriculum Criteria, Key Stage 3, Pupils should be taught:

- Sc 0.2f about *Scientific enquiry* through contexts derived from the programme of study for *Life processes and living things, Materials and their properties and physical processes.*
- Sc 4.5d the difference between temperature and heat, and that differences in temperature can lead to transfer of energy.
- Sc 4.5e ways in which energy can be usefully transferred and stored.
- Sc 4.5f how energy can be usefully transferred and stored; convection and evaporation and that energy is transferred by radiation.
- Sc 4.5g that although energy is conserved, it may be dissipated, reducing its availability as a resource.

This activity contains:

Teacher Notes
Pupil Worksheets
Answer Sheet

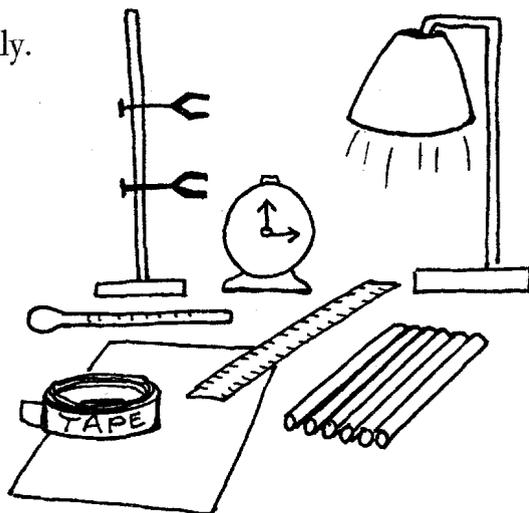
Teacher Notes...

◆ Prior knowledge required

- Pupils can carry out a 'fair test'
- Pupils can collect data and represent it graphically.

◆ Materials and Resources needed

- Metal sheet (zinc pan)
- Drinking straws or dry straw (joined/stuck together to make straw sheets)
- Thermometers
- Clamp stands
- Rulers
- Stop clocks
- Heat lamps (i.e. electric lamps)
- Extra equipment for investigations: card, sellotape, blue tack.

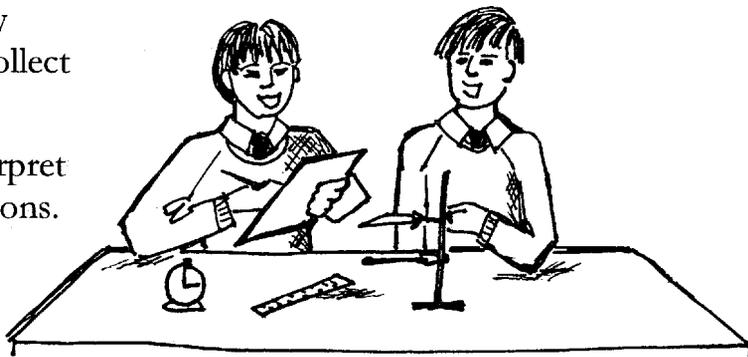


Teacher Notes...

There are two ways to approach this task: as a data collection activity or as an investigation.

1. Data Collection and Data Analysis Activity

- Students perform a practical activity following instructions in order to collect data.
- Students then plot a graph and interpret the data to answer a series of questions.
- See worksheet 2 for data collection instructions and questions.



2. Investigative Work (procedural science)

- Students solve the practical problem by their own design of investigation.
- See worksheet 3 for investigation task.

THE TEACHER SHOULD FORM A LIST OF CRITERIA FOR ASSESSMENT OF THE ACTIVITY, DEPENDING ON WHICH CRITERIA THEY WANT TO ASSESS.

The data obtained from these activities can be used as an introduction to learning about radiated and conducted heat transfer. Knowledge of heat transfer by radiation and conduction would make the activity much more meaningful. It is possible for groups to perform one half of this experiment and then by co-operating compare the effect of the two conditions.

Points for further discussion/ Answers to questions on the worksheet

- Students should know that different materials conduct heat at different rates and know how this fact is useful for constructing houses.
- The metal sheet should be dull as it would be weathered in practice. This reduces reflection.
- Important control variables are: The power of the lamp and the distance of the thermometer from the sheet.
- Points of experimental practice: The thermometer should be close to, but not touching the sheet. Students should make sure they can read the thermometer easily before starting the experiment.
- It may be useful to use the resource sheet 'Traditional and Colonial Houses in Sudan' as an extra resource for the context of the task.

Pupil Worksheet 2

Thatch or Tin - Comparing Roof Building Materials

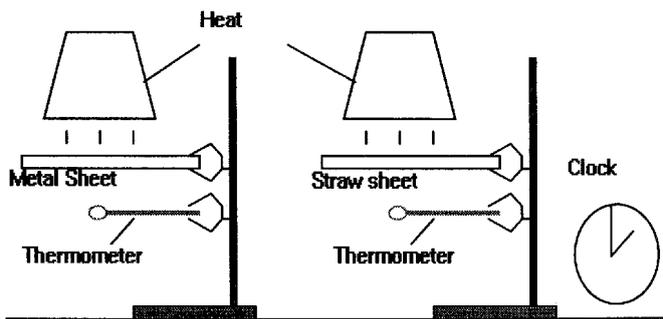
Introduction

In many parts of the world, such as Saudi Arabia, houses used to be made with thatched roofs. Industry has made corrugated metal ("wiggly tin") more available. Hence today people make roofs from either corrugated metal or thatch. For people living in hot climates the roof provides shelter from the sun's heat. Which type of roof do you think would make the best shelter from the sun's heat?

AIM Find out which materials gives best protection from radiated heat of the sun

- 1) Set up the apparatus in the diagram below.
- 2) Before you start, answer the following questions:
 - a) If you are comparing the two sets of results, what must be kept the same?
 - b) When reading the thermometer, should you move it? Give your reasons.
- 3) Take a reading of the thermometer once every 2 minutes for ten minutes.
- 4) Record your results in a table like the one below.
- 5) Using the same axes, plot a graph of the temperature below the metal sheet and below the sheet of drinking straws.

Apparatus



Results Table

Time (mins)	0	2	4	6	8	10
Temp for metal roof °C						
Temp for thatch roof °C						

Discuss your results answering the following questions:

1. Were there any problems with the set-up of the apparatus shown?
2. Could you/did you make any changes to improve the conditions of the experiment?
3. Which house would get hottest during the day?
4. Explain how you know this is the answer.
5. How much difference is there between the two roofs?
Do you think you would notice the difference in an actual house?
6. If you had a choice of these two types of roof, which would you choose?
Explain your answer.

Pupil Worksheet 3

An Investigation on the Effect of the Sun's Heat on Different Roofing Materials.

Chimwemwe lives in a village in Malawi in East Africa. For most of the year the climate in Malawi is very hot and Chimwemwe goes into her home to keep cool during the day.



Traditionally, people living in Chimwemwe's village made roofs for their houses from thatched grass. Although thatch roofs are cheap, it is difficult to make a good thatch roof. Each year they must be repaired. Also some insects live in the thatch and it is expensive to treat thatch against insects.

These days some people use corrugated metal for their roofs. Corrugated metal lasts longer, it does not take skill to make a roof from corrugated metal, and insects cannot live in it.

Chimwemwe is thinking of getting a new roof for the house, but she is not sure which type of roof to use. She needs a roof which will keep her house cool during the hot days.

Your Task

By doing an investigation, find out what happens to the temperature in a house if metal or thatch roofs are used.

Write a report for Chimwemwe, showing her what you have found so that she can see your evidence and decide for herself which material her new roof should have.

