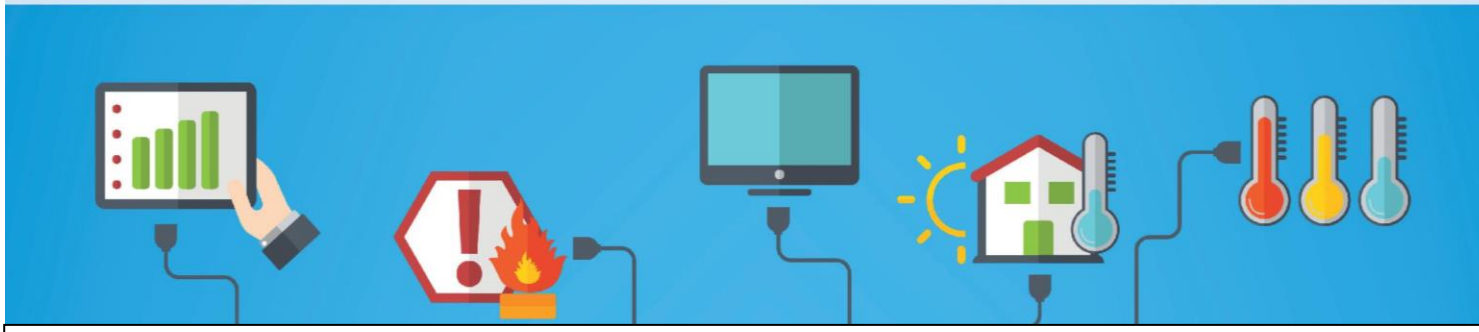
STUDENT BOOKLET

ATSE STELR PROJECT

MATHEMATICS



Sustainable Housing

Heating and Cooling

NAME _____ CLASS _____

CONTENTS

PASSIVE HEATING AND COOLING INVESTIGATIONS

INTRODUCTION

House design and situation can have a massive impact on heating and cooling costs for the occupants. They can also have an impact on the environmental footprint of the home.

Buildings account for 40% of worldwide energy use — which is much more than transportation. Furthermore, over the next 25 years, CO_2 emissions from buildings are projected to grow faster than any other sector (in the USA), with emissions from commercial buildings projected to grow the fastest—1.8% a year through 2030 (*USGBC*).

One way in which costs and emissions can be lowered is through Passive Solar Heating. This involves trapping solar energy directly in the home and using it to maintain fairly constant room temperatures.

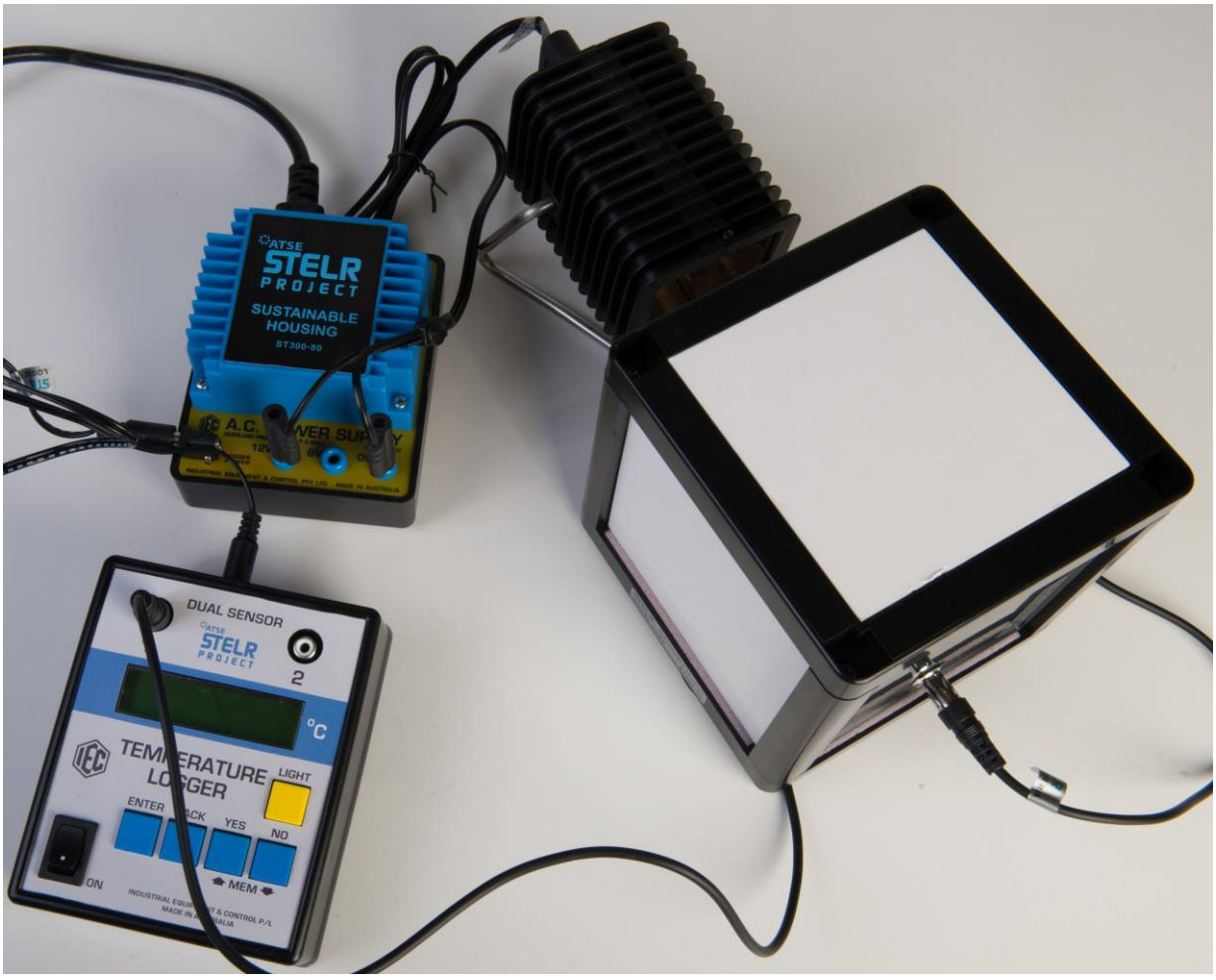
Passive solar heating uses free heating direct from the sun to dramatically reduce the estimated 40% of energy consumed in the average Australian home for space heating and cooling (DEWHA 2008).

The figures given in the two statements above and information relating to passive design can be found on the Australian Government web site Your Home.

http://www.yourhome.gov.au/passive-design

Over the following exercises, you will be researching and investigating some of the details to be found within the links on these pages.

To help you in your tasks you will be using the Sustainable Housing Kit. Try to familiarise yourself with this kit before you start your investigations.



Remember:

Sometimes there may not be any right or wrong answer. What will be important is the methods you use in your research.

TASK A: DEFINITIONS

Some of the following words or terms are used on the Passive-Design web pages and associated documents. Your task is to give the definitions for these words or terms.

Absorbed:

Convection:

Orientation:

Thermal mass:

Re-radiated heat:

Greenhouse principles:

Stratification:

Temperature differential:

TASK B: CLAIM INVESTIGATION – GUIDED INQUIRY

Within the document Passive Solar Heating the following claim is made:

'...33% more heat is flowing through higher level building elements than lower ones because the temperature differential is 33% higher.'

You are now going to investigate this claim using the Sustainable Housing Kit (SHK)

1. Using the materials items from the kit set up the following building

Note:

The side of the house facing the light has a window on each floor.

There are two temperature probes.

Ensure you are familiar with the operations of the data logger and how to download the data to your computer.

If required ask your teacher to assist you.

Once this is set up and the probes are connected to the data logger run the logger for 20 minutes without the light being turned on.

Why do we need to do this?

_____

_____

2. You are now going to run the logger for another 20 minutes with the light on.

The light represents_____.

Record the following information before turning on the light and starting the logger.

Distance of the light from the house _____.

Angle of depression of the light _____.

Why is this information important?

_____

_____

Now start the logger.

3. After the second part is complete transfer your data from the data logger to your computer.
4. Using excel produce two graphs relating to part 1 and 2 of this task. Paste the graphs below.

See Appendix 1: Collecting and retrieving data

5. With reference to your graphs comment on your results, for instance are there any patterns in your data.

_____

Think about this activity. How do you think we could improve the activity?

_____

_____

TASK C: CLAIM INVESTIGATION – STUDENT INQUIRY

Still with the following comment in mind:

'...33% more heat is flowing through higher level building elements than lower ones because the temperature differential is 33% higher.'

and with your results and ideas for improvement to Task B. Carry out another investigation using the materials in the kit.

Ensure:

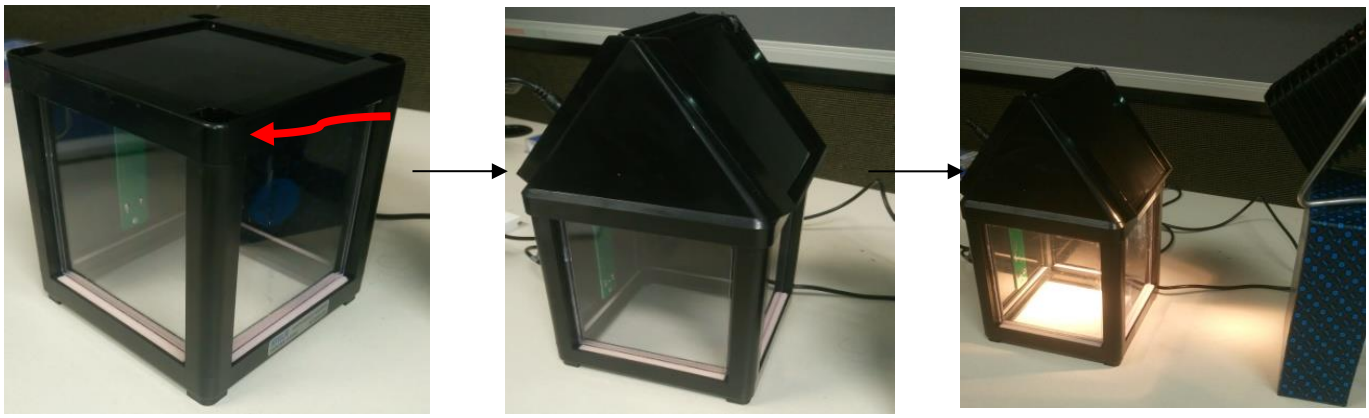
1. You record your method
2. You are consistent with your workings
3. You record and log all details
4. You explain the changes made from Task B and why you made them
5. Don't confine yourself to one method. Be prepared to change your parameters.
6. Remember the kit contains lots of different materials, but you could add more.
7. Be inventive.

TASK D: CEILINGS AND ROOF SPACES

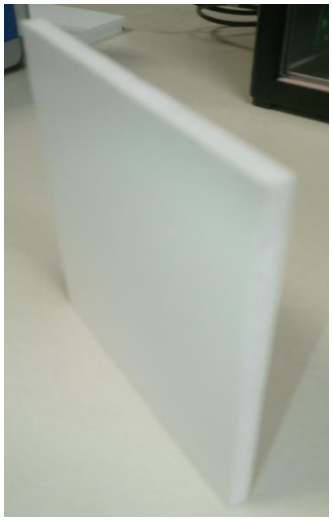
Another comment found in the Passive Solar Heating document is:

'Ceilings and roof spaces account for 25–35% of winter heat loss and must be well insulated'.

a) Set up the SHK as in the picture below:



b) Record and work out the following:



Dimensions of ground floor:

_____

Volume of ground floor:

_____

Dimensions of roof:

_____

Volume of roof space:

_____

Distance of light from house:

_____

Angle of depression of the light to the house:

_____

c) Run the data logger for 20 minutes

d) Within the SHK there are components (see picture to the left) that can be used to act as insulation for a building.

You are now going to change the configuration above. Remove the ceiling from the room and insert the insulation component as the new ceiling. Then re-assemble the house as in the first part of the activity.

e) Before you start the data logger, what parameters must you ensure are the same as in the first part of this task?

Check your answer with your teacher.

f) Now run the data logger for 20 minutes.

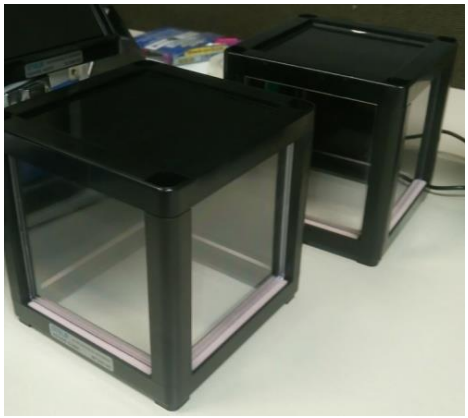
g) Download both sets of results to your computer

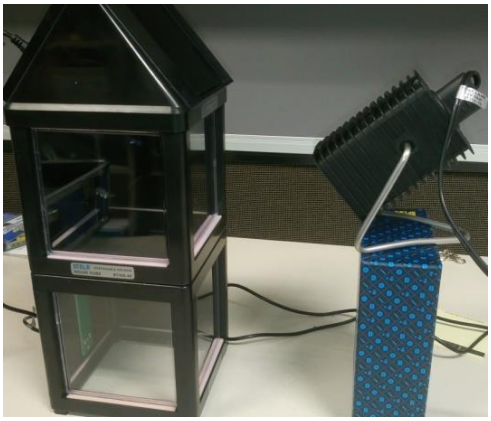
h) Comment on the results from both parts of this task:

i) Think of ways in which you could investigate the claim further.

TASK E: HEAT TRANSFER BETWEEN FLOORS WITH AND WITHOUT INSULATION

Set up the SHK as shown below





Note – the level dividers are black plastic, no insulation is used and there are two windows on each floor.

Record and work out the following:

Dimensions of ground floor: _____

Volume of ground floor: _____

Volume of living space: _____

Dimensions of roof: _____

Volume of roof space: _____

Distance of light from house: _____

Angle of depression of the light to the house: _____

Run the logger for 20 minutes.

Now re-assemble the house with insulation between the first floor and roof space.

Run logger again for 20 minutes. Ensure your parameters are the same.

Now re-assemble again. This time have insulation between the ground floor and first floor and between first floor and roof space.

Run logger again for 20 minutes. Ensure your parameters are the same.

Comment on your results:

_____

_____

TASK F: DESIGN FOR CLIMATE

The 'Your Home' website has information on how the design of homes is influenced by the climate of the region in which the home is to be built.

http://www.yourhome.gov.au/passive-design/design-climate

Research:

Using the above link and its associated pages answer the following questions.

What are the two components of human thermal comfort?

_____

_____

What are the main factors that influence these components?

_____

_____

Give the common ways in which a body can lose or gain heat.

_____

_____

A breeze of 0.5 metres per second can provide a temperature reduction of?

_____

How many climate zones does the Building Code of Australia define for Australia?

_____

Name the three major Australian cities in climate zone 5 (warm temperate).

_____

_____

In which climate zone are Canberra and Hobart?

_____

What town is situated on a latitude of 25° South and what type of climate does it experience?

_____

Which climate zones are in Queensland and which, if any, are not?

_____

_____

What are the design considerations for housing in Zone 1?

_____

_____

To be effective, passive cooling techniques need to cool both the house and the people in it. What are the three elements that can contribute to successful passive cooling?

_____

_____

TASK G: THE QUEENSLANDER

The house pictured to the right is called a Queenslander design. A large number are of houses are built to a similar design to accommodate for the types of climate experienced in parts of Queensland. Two main characteristics of this type of design is the open under house space and the large open verandas.

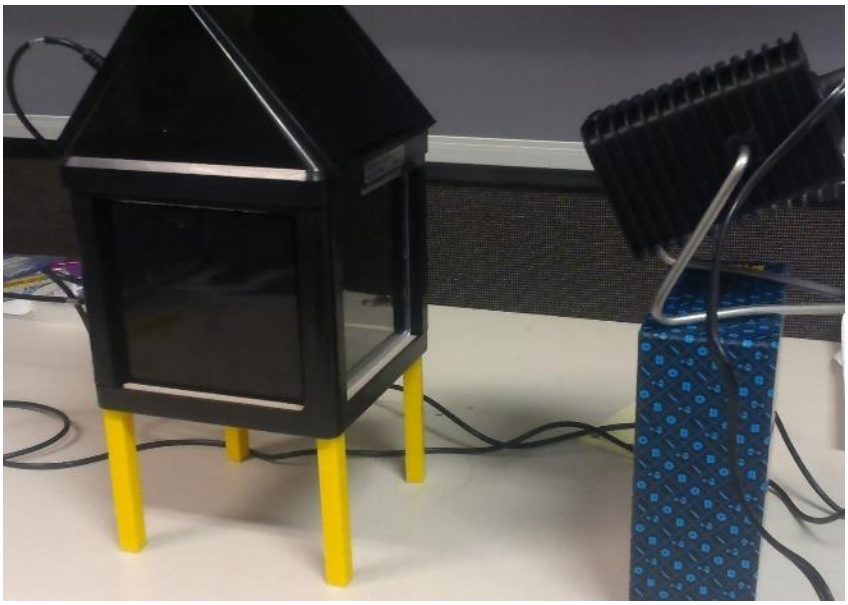
With regards to design for climate considerations give reasons for these two characteristics.

_____

_____

There is a trend to utilise the space under the Queenslander house for storage space. Your next task is to investigate whether the use of the under house space for storage has an effect on the reason why this space is used in the design.

The picture below gives an idea of how you could use the SHK to assist in this investigation.



Discuss with your team the types of investigation you could carry out. Then discuss your ideas with your teacher. Write down your ideas and plans on the next stage. Try to come up with at least 4 ideas that could be investigated.

Ideas and plans for Task G part 2

Results, Observations and Conclusions for Task G

TASK H: SHADING AND COOLING

The document

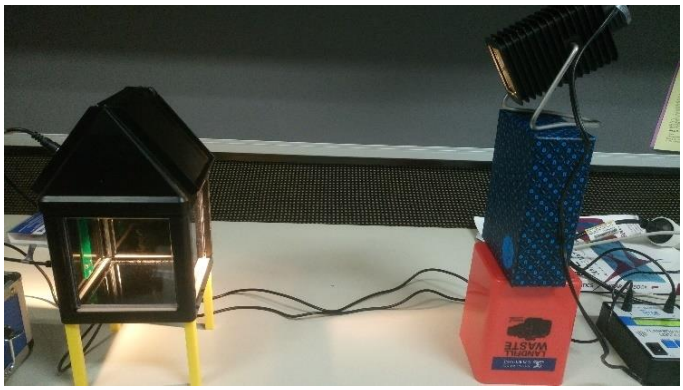
http://www.yourhome.gov.au/passive-design/design-climate

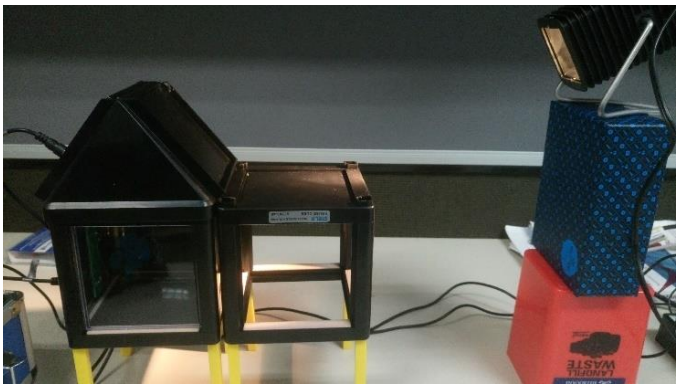
gives suggestions for the design of buildings in each of the climate zones experienced in Australia.

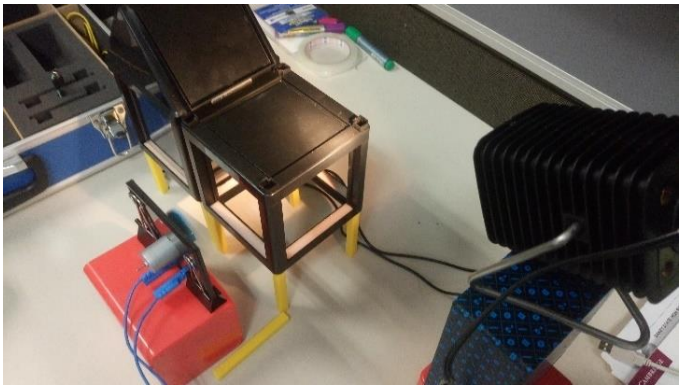
One of the common design elements for all zones is the use of shading to assist with cooling.

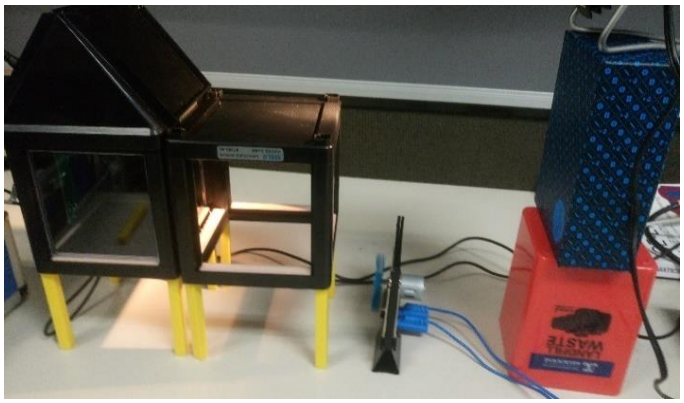
Design an investigation using the SHK that looks at the effects of shading to cool down living areas. The pictures below may assist you with ideas for your investigation.

Remember: You are not limited to the materials in the SHK!









TASK I: INSULATION

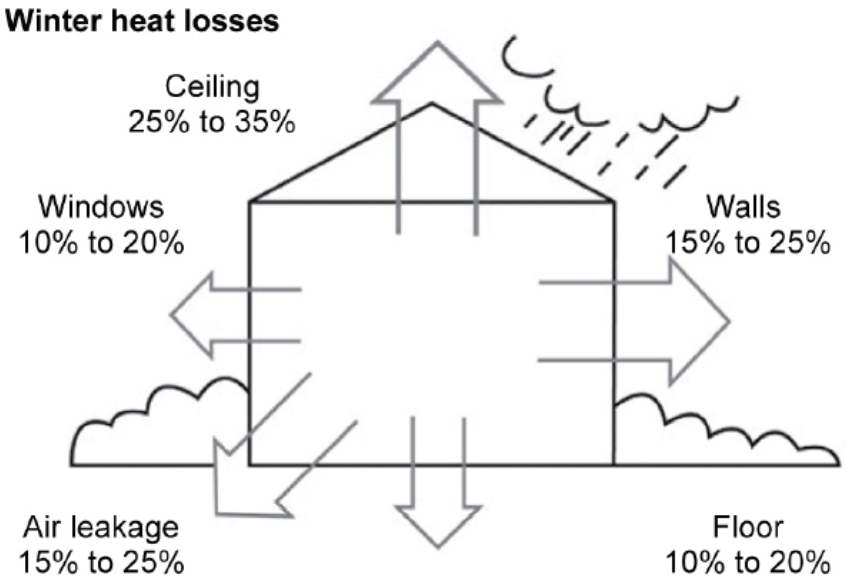
This task relates to information found in the PDF document 'Your Home- Passive Design: Insulation'. A copy of this document can be found using the following link.

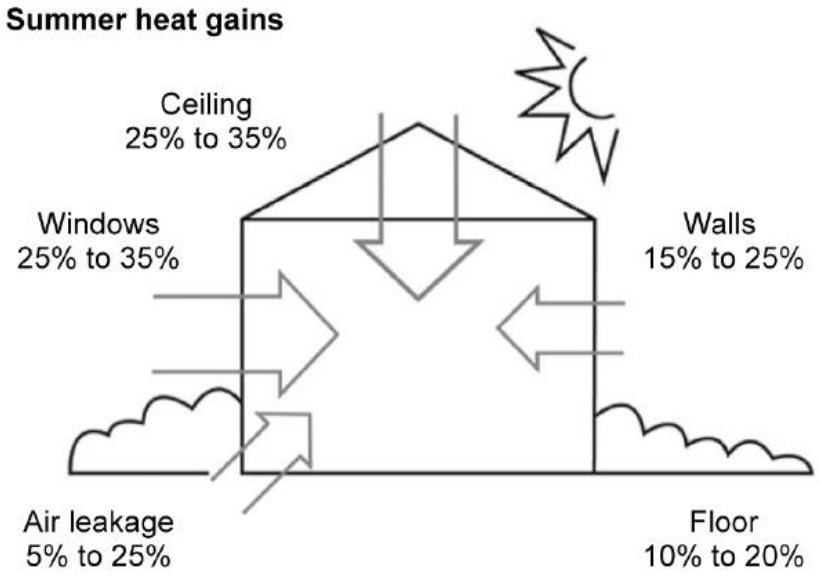
http://www.yourhome.gov.au/passive-design/insulation

The document starts with the following statement:

'Insulation acts as a barrier to heat flow and is essential for keeping your home warm in winter and cool in summer. A well-insulated and well-designed home provides year-round comfort, cutting cooling and heating bills by up to half. This, in turn, reduces greenhouse gas emissions.'

These pictures from the document highlight the losses and gains in heat during winter and summer:





Questions

a) The largest winter heat loss is experienced on which part of the house?

b) In winter what is the range of loss experienced through the floor?

c) If the walls, ceilings and floors where well insulated and the room temperature was brought up to 22°C. What would be the temperature drop be if the windows of the room were experiencing maximum losses?

d) Consider the losses found in question 'c'. Explain why these losses would contribute to higher heating bills and impact on the environment.

TASK J: DOUBLE GLAZING (PERCENTAGES)

In lab tests, using the SHK, a single story house was constructed. The heating element was placed in a wall section.

In run 1, the house had 2 single glaze windows and a slab floor (bench top) as in the picture below. The house was heated to 29.1^{o}C then cooling was monitored over a 20minute period. In this time the room temperature dropped from 29.1^{o}C to 24.3^{o}C.

In run 2, the SHK was configured with two double glazed windows. Once again the temperature was brought up to 29.3^{o}C then allowed to cool over a 20minute period after this the temperature of the room was recorded as 24.9^{o}C

Data

Run 1 Temp inc.		Run 1 Temp dec.		Run 2 Temp inc.		Run 2 Temp dec.	
TEMP 1	TEMP 2	TEMP 1	TEMP 2	TEMP 1	TEMP 2	TEMP 1	TEMP 2
23.3	22.8	29.1	24.8	23.8	23.7	29.1	25.3
23.5	22.8	28.7	24.8	24	23.7	29..1	25.3
23.8	22.9	28.6	24.8	24.2	23.8	29.1	25.3
24.1	22.9	28.4	24.9	24.4	23.8	29.2	25.4
24.3	22.9	28.2	24.9	24.7	23.8	29.1	25.4
24.5	22.9	28.1	24.9	24.9	23.8	28.9	25.4
24.8	23	27.8	24.9	25.1	23.8	28.7	25.4
25	23.1	27.6	24.9	25.3	23.8	28.5	25.4
25.3	23.1	27.5	24.9	25.6	23.8	28.3	25.4
25.4	23.1	27.3	24.9	25.8	23.9	28.1	25.4
25.6	23.2	27.1	24.9	26	23.9	27.9	25.4
25.8	23.3	26.9	24.9	26.2	23.9	27.8	25.4
26	23.3	26.8	24.9	26.4	24	27.6	25.4
26.1	23.4	26.6	24.9	26.6	24	27.4	25.4
26.3	23.4	26.5	24.9	26.8	24.1	27.3	25.4
26.5	23.4	26.3	24.9	26.9	24.1	27.1	25.4
26.6	23.5	26.2	24.9	27.1	24.1	27	25.4
26.8	23.6	26.1	24.9	27.2	24.2	26.9	25.3
26.9	23.6	25.9	24.9	27.3	24.3	26.8	25.3
27	23.7	25.8	24.8	27.5	24.3	26.6	25.3
27.2	23.8	25.7	24.8	27.6	24.4	26.5	25.3
27.3	23.8	25.6	24.8	27.8	24.4	26.4	25.3
27.4	23.8	25.5	24.8	27.9	24.4	26.3	25.3
27.5	23.9	25.4	24.8	28	24.5	26.1	25.2
27.6	23.9	25.3	24.7	28.1	24.5	26	25.1
27.7	24	25.3	24.7	28.2	24.6	25.9	25.1
27.8	24.1	25.1	24.6	28.3	24.6	25.9	25.1
27.9	24.1	25.1	24.6	28.4	24.7	25.8	25.1
28	24.2	25	24.6	28.5	24.8	25.7	25.1
28.1	24.2	24.9	24.6	28.6	24.8	25.6	25
28.1	24.3	24.8	24.6	28.6	24.8	25.5	24.9
28.2	24.3	24.8	24.5	28.8	24.9	25.4	24.9
28.3	24.4	24.8	24.5	28.8	24.9	25.3	24.9
28.3	24.4	24.7	24.4	28.9	24.9	25.3	24.9

28.4	24.4
28.4	24.5
28.5	24.6
28.6	24.6
28.6	24.6
28.6	24.7
28.7	24.7

24.6	24.4
24.5	24.4
24.4	24.4
24.4	24.4
24.4	24.3
24.3	24.3
24.3	24.3

28.9	25
29	25.1
29.1	25.1
29.1	25.1
29.2	25.1
29.2	25.2
29.3	25.3

25.3	24.9
25.1	24.8
25.1	24.8
25	24.8
25	24.7
24.9	24.7
24.9	24.7

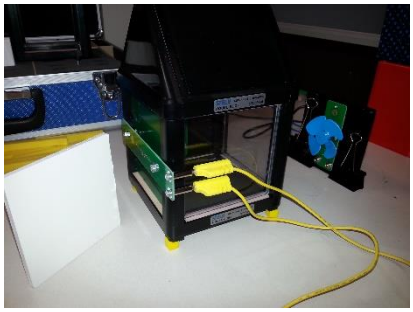
Analysis

a) Using the recorded temperatures, calculate the percentage drop in temperature and state how these compare to the stated vales in the pictures on Task I page.

b) Using a technology package, CAS calculator/excel, place these results in a spreadsheet. Combine the increase and degrease values for Run 1 (Yellow) and do the same for Run 2 (Green). Graph both runs separately. Investigate and comment on these graphs. Are there any regression equations that can model these graphs?

Use the SHK to conduct your own investigation with the same house design but instead of double glazed windows try different types of materials over the windows to act as curtains. Does this give a different result to the percentage temperature drop?

TASK K: STUMPS AND UNDER-FLOOR INSULATION



Certain areas of Australia experience very hot summers and very cold winters. One such area is Melbourne, Victoria. In such areas house design and insulation is very important. It needs to ensure that house stay warm in winter and cool during the summer months.

In certain parts of Melbourne houses can be found built on stumps. This enables a flow of air underneath the house. In this task you are to investigate how this type of house cools in winter with and without insulation.

a) After first heating your SHK house design to 30°C each time record results for:

Cooling of a house on stumps with single glaze windows and wooden floor over 20minutes

Cooling of a house on stumps with single glaze windows and wooden floor over 20minutes with a fan (to mimic the cooling assistance of wind)

Cooling of a house on stumps with double glaze windows and insulated floor over 20minutes

Cooling of a house on stumps with double glaze windows and insulated floor over 20minutes with a fan (to mimic the cooling assistance of wind)

Record and comment on the temperature changes you see over this investigation. Compare these with the figures given in the Passive Design document on insulation.

_____

_____

_____

_____

Think of other areas of the house that could be insulated and other types of insulation that could be used. Carry out your own investigation of these ideas.

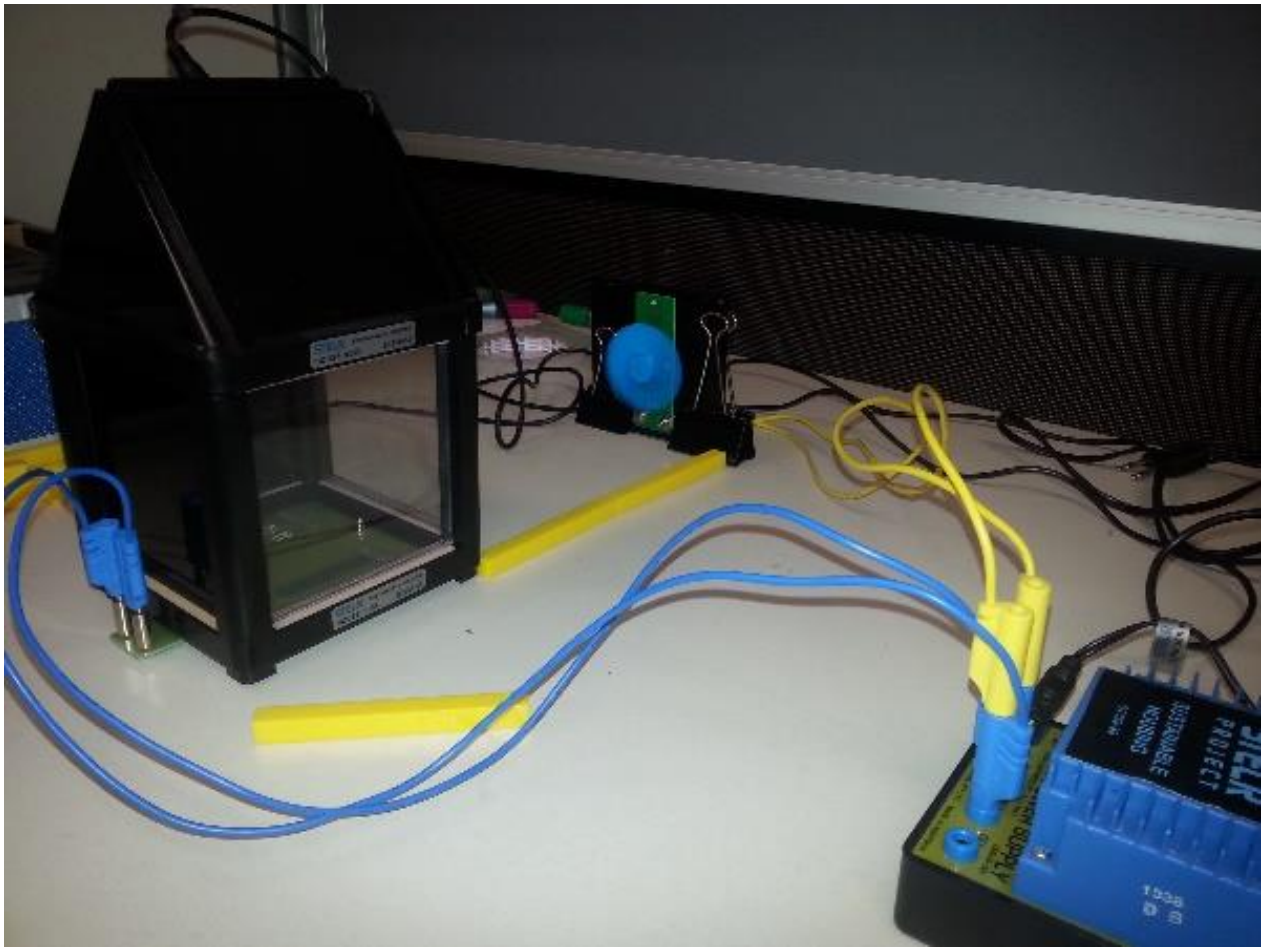
b) Record your results and draw graphs.

TASK L: INTERPRETING DATA

The SHK was set up so that the room was heated from floor level, as shown in the photo below.

The following runs were carried out:

1. 2 single Perspex windows with standard walls; no breeze
2. As above with a breeze.
3. 2 Double glazed windows; standard walls and a breeze.
4. 2 Double glazed windows and 1 wall insulated; with a breeze
5. 2 Double glazed windows; 1 wall and the ceiling were insulated.



For each the data logger ran for 40 minutes. The results were then downloaded to a computer. From the spreadsheet the data was reduced, deleting rows, to measurements taken every 30 seconds. These results are given below. Temp 1 being the ground floor temperature and temp 2 being the attic temperature.

	1			2			3			4			5	
Time (min)	TEMP 1	TEMP 2		TEMP 1	TEMP 2		TEMP 1	TEMP 2		TEMP 1	TEMP 2		TEMP 1	TEMP 2
0	24	22.5		24	23.4		24	22.8		24	22.8		24	22.1
0.5	24.2	22.6		24.2	23.4		24.1	22.8		24.2	22.8		24.7	22.1
1.0	24.4	22.6		24.4	23.4		24.3	22.9		24.3	22.8		25.4	22.1
1.5	24.6	22.6		24.5	23.3		24.4	22.9		24.5	22.8		26.3	22.1
2.0	24.8	22.7		24.8	23.3		24.4	23		24.6	22.8		27	22.1
2.5	24.9	22.8		24.9	23.4		24.5	23.1		24.8	22.7		27.8	22.1
3.0	25.1	22.8		25.1	23.4		24.6	23.2		25	22.7		28.5	22.2
3.5	25.3	22.8		25.3	23.4		24.7	23.2		25.2	22.8		29.3	22.2
4.0	25.4	22.9		25.5	23.4		24.8	23.3		25.3	22.8		29.9	22.3
4.5	25.6	22.9		25.7	23.4		24.8	23.3		25.5	22.7		30.6	22.3
5.0	25.8	22.9		25.8	23.4		24.9	23.4		25.7	22.8		31.3	22.3
5.5	26	23		26	23.4		24.9	23.4		25.8	22.7		32	22.4
6.0	26.1	23		26.2	23.4		25.1	23.4		25.9	22.8		32.6	22.4
6.5	26.3	23.1		26.3	23.5		25.1	23.5		26.1	22.8		33.3	22.5
7.0	26.4	23.1		26.5	23.5		25.2	23.6		26.2	22.8		33.8	22.6
7.5	26.6	23.1		26.6	23.5		25.3	23.6		26.4	22.8		34.4	22.6
8.0	26.7	23.2		26.8	23.5		25.3	23.6		26.5	22.8		34.9	22.8
8.5	26.9	23.2		27	23.6		25.3	23.7		26.6	22.8		35.4	22.8
9.0	27	23.3		27.1	23.6		25.4	23.8		26.8	22.8		35.9	22.9
9.5	27.1	23.3		27.3	23.6		25.4	23.8		26.8	22.8		36.3	23
10.0	27.1	23.3		27.4	23.7		25.5	23.8		26.9	22.9		36.8	23.1
10.5	27.3	23.4		27.5	23.7		25.6	23.9		27.1	22.9		37.2	23.2
11.0	27.4	23.4		27.6	23.7		25.6	23.9		27.2	22.9		37.6	23.3
11.5	27.4	23.5		27.7	23.8		25.6	23.9		27.3	22.9		38	23.4
12.0	27.6	23.5		27.8	23.8		25.7	23.9		27.4	22.9		38.4	23.4
12.5	27.7	23.6		27.9	23.8		25.7	23.9		27.5	22.9		38.8	23.6
13.0	27.8	23.6		28	23.9		25.8	24		27.6	23		39.2	23.7
13.5	27.8	23.6		28.1	23.9		25.8	24		27.6	23.1		39.5	23.8
14.0	27.9	23.7		28.1	23.9		25.8	24.1		27.8	23.1		39.8	23.9
14.5	27.9	23.7		28.2	23.9		25.9	24.1		27.9	23.1		40.1	24
15.0	28	23.8		28.3	24		25.9	24.1		27.9	23.1		40.4	24.1
15.5	28.1	23.8		28.3	24		25.9	24.1		28	23.1		40.8	24.2

16.0	28.1	23.8		28.4	24		25.9	24.1		28.1	23.1		41	24.3
16.5	28.2	23.8		28.4	24.1		26	24.2		28.2	23.1		41.3	24.4
17.0	28.3	23.9		28.5	24.1		26	24.2		28.3	23.2		41.5	24.4
17.5	28.3	23.9		28.6	24.1		26.1	24.2		28.3	23.2		41.8	24.6
18.0	28.4	23.9		28.6	24.2		26.1	24.2		28.4	23.3		42	24.7
18.5	28.4	24		28.6	24.2		26.1	24.3		28.5	23.3		42.3	24.8
19.0	28.5	24		28.7	24.2		26.2	24.3		28.6	23.3		42.5	24.9
19.5	28.5	24.1		28.8	24.3		26.2	24.3		28.6	23.3		42.7	25
20.0	28.6	24.1		28.8	24.3		26.2	24.3		28.6	23.4		42.9	25.1

a) Place these results into tour CAS calculator or excel spreadsheet.

b) Produce graphs for each data set. Ensure you use an appropriate scale and label your axis and give the graph a title.

c) For each graph investigate the regression models that best represent the data. Choose the regression equation that best fits with the results.

_____

_____

d) Comment on the results from each trial and show how the regression equation that you selected is the best for this data.

_____

_____

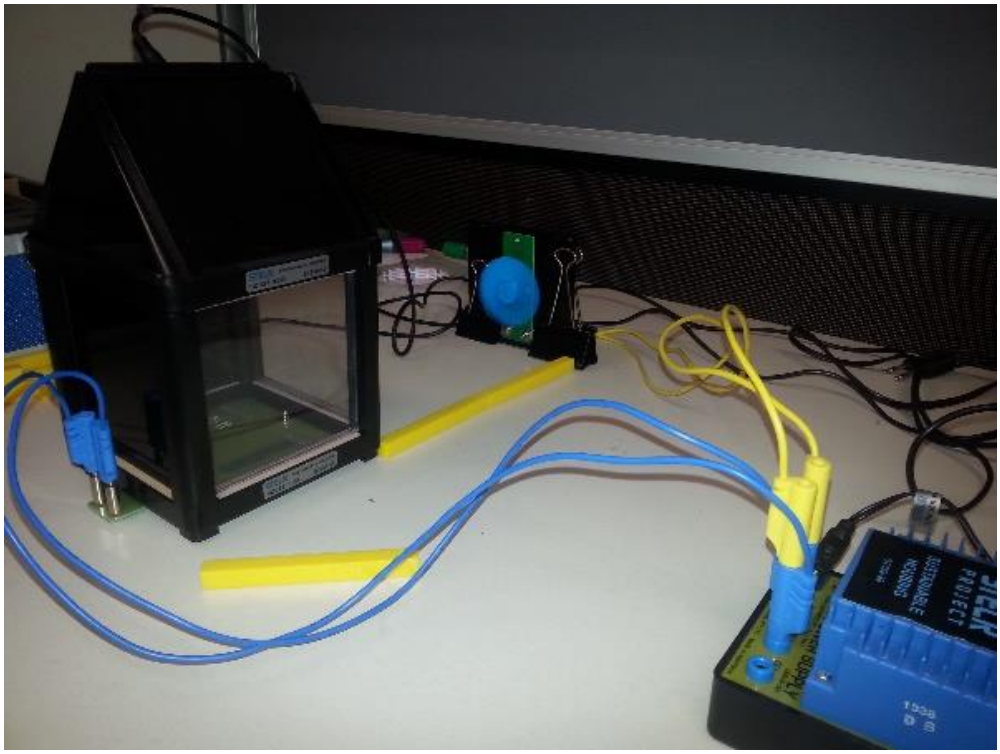
Think about how this investigation could be improved and extended. Using your ideas carry out your own investigation. Compare your results with those given.

TASK M: INTERPRETING DATA PART 1

The SHK was set up so that the room was heated from floor level, as shown below. The following runs were carried out:

1. 2 single glaze windows with standard walls. No breeze
2. 2 Double glazed windows. Standard walls and a breeze.
3. 2 Single glaze windows and 1 wall and ceiling insulated. With a breeze.
4. 2 Double glazed windows 1 wall and ceiling insulated.

For this activity for each run the temperature of the house was brought up to 30^{O}c. Then the temperature of the house was monitored over a 20 min run with the logger. The results were then downloaded to a computer. From the spreadsheet the data was reduced, deleting rows, to measurements taken every 30 seconds. These results are given below. Temp 1 being the ground floor temperature and temp 2 being the attic temperature.



Time (min)	TEMP 1	TEMP 2		TEMP 1	TEMP 2		TEMP 1	TEMP 2		TEMP 1	TEMP 2
0	30.1	23.8		30	24.4		29.9	24.8		30	24
0.5	29.8	23.7		30	24.4		29.7	24.8		30.1	24
1.0	29.4	23.8		29.9	24.4		29.5	24.8		30	24
1.5	29.1	23.9		29.8	24.4		29.3	24.8		29.9	24
2.0	28.8	24.1		29.6	24.4		29.2	24.8		29.8	24.1
2.5	28.6	24.1		29.4	24.4		29	24.8		29.6	24.1

3.0	28.3	24.1		29.3	24.4		28.8	24.7		29.5	24.1
3.5	28.1	24.1		29.1	24.4		28.6	24.7		29.3	24.1
4.0	27.9	24.1		28.9	24.4		28.4	24.7		29.2	24.1
4.5	27.7	24.1		28.8	24.5		28.3	24.6		29	24.1
5.0	27.5	24.1		28.6	24.4		28.1	24.6		28.9	24.1
5.5	27.3	24.1		28.4	24.4		27.9	24.6		28.8	24.1
6.0	27.1	24.1		28.2	24.4		27.8	24.6		28.6	24.1
6.5	26.9	24.1		28	24.4		27.6	24.5		28.4	24.1
7.0	26.8	24.1		27.9	24.4		27.4	24.5		28.3	24.1
7.5	26.6	24.1		27.7	24.4		27.3	24.4		28.1	24.1
8.0	26.4	24.1		27.5	24.4		27.1	24.4		27.9	24
8.5	26.3	24.1		27.4	24.3		27	24.4		27.8	24
9.0	26.2	24.1		27.2	24.3		26.9	24.4		27.6	24
9.5	26.1	24.1		27.1	24.3		26.8	24.3		27.5	24
10.0	25.9	24.1		26.9	24.3		26.6	24.3		27.4	24
10.5	25.8	24.1		26.8	24.3		26.5	24.3		27.3	23.9
11.0	25.7	24		26.6	24.3		26.4	24.3		27.1	23.9
11.5	25.6	24		26.6	24.3		26.3	24.2		27	23.9
12.0	25.4	24		26.4	24.2		26.1	24.1		26.9	23.9
12.5	25.4	24		26.3	24.2		26.1	24.1		26.8	23.9
13.0	25.3	23.9		26.2	24.1		25.9	24.1		26.6	23.9
13.5	25.2	23.9		26.1	24.1		25.9	24.1		26.5	23.9
14.0	25.1	23.9		25.9	24.1		25.8	24.1		26.4	23.8
14.5	25	23.9		25.8	24.1		25.7	24		26.3	23.8
15.0	24.9	23.9		25.7	24		25.6	23.9		26.2	23.8
15.5	24.8	23.9		25.6	24		25.5	23.9		26.1	23.8
16.0	24.8	23.8		25.6	23.9		25.4	23.9		26	23.8
16.5	24.7	23.8		25.4	23.9		25.3	23.9		25.9	23.7
17.0	24.6	23.8		25.4	23.9		25.3	23.8		25.8	23.7
17.5	24.5	23.8		25.3	23.9		25.2	23.8		25.7	23.7
18.0	24.4	23.7		25.2	23.9		25.1	23.8		25.6	23.6
18.5	24.4	23.7		25.1	23.8		25.1	23.8		25.5	23.6
19.0	24.3	23.6		25.1	23.8		24.9	23.8		25.4	23.6
19.5	24.3	23.6		25	23.8		24.9	23.7		25.3	23.6
20.0	24.2	23.6		24.9	23.7		24.8	23.7		25.3	23.6

1. Place these results into tour CAS calculator or excel spreadsheet.

2. Produce graphs for each data set. Ensure you use an appropriate scale. Label your axis and give the graph a title.
3. For each graph, investigate the regression models that best represent the data. Choose the regression equation that best fits with the results.

4. Comment on the results from each trial and show how the regression equation that you selected is the best for this data.

5. Think about how this investigation could be improved and extended. Using your ideas carry out your own investigation. Compare your results with those given.

TASK N: INTERPRETING DATA PART 2

For this investigation, the SHK was constructed as a single story house with two windows and no insulation. With the kit being set up outdoors underneath a covered veranda. The temperature of the house was brought up to 22.5 degrees and allowed to cool to 20 degrees. And then kept between 22.5 and 20 degrees. The data recordings were culled and the results are given below:

	T1	T2		T1	T2		T1	T2		T1	T2		T1	T2
1	19.2	18.1	42	23	20	83	20	19	124	22.3	19.4	165	20.1	19
2	19.4	18.1	43	23	20	84	19.9	19	125	22.3	19.4	166	20.2	19
3	19.4	18.2	44	23	20	85	19.9	19	126	22.1	19.4	167	20.3	19
4	19.6	18.3	45	23	20	86	19.9	19	127	22.1	19.4	168	20.4	19
5	19.7	18.3	46	23	20	87	19.9	19	128	22	19.4	169	20.6	19
6	19.8	18.3	47	23	20	88	19.9	19	129	21.9	19.4	170	20.7	19
7	19.9	18.4	48	23	20	89	19.9	19	130	21.8	19.4	171	20.8	19
8	20.1	18.4	49	22	20	90	19.9	19	131	21.7	19.3	172	20.9	19
9	20.1	18.4	50	22	20	91	20	19	132	21.6	19.3	173	21.1	19
10	20.3	18.5	51	22	20	92	20.1	19	133	21.5	19.3	174	21.1	19
11	20.4	18.6	52	22	20	93	20.1	19	134	21.4	19.3	175	21.3	19
12	20.5	18.6	53	22	20	94	20.2	19	135	21.3	19.3	176	21.4	19
13	20.6	18.6	54	22	20	95	20.3	19	136	21.3	19.3	177	21.5	19
14	20.8	18.7	55	22	20	96	20.4	19	137	21.2	19.3	178	21.6	19
15	20.8	18.7	56	22	20	97	20.4	19	138	21.1	19.2	179	21.7	19
16	20.9	18.8	57	22	20	98	20.6	19	139	21.1	19.2	180	21.8	19
17	21	18.8	58	22	19	99	20.6	19	140	20.9	19.2	181	21.9	19
18	21.1	18.8	59	22	19	100	20.8	19	141	20.9	19.2	182	22	19
19	21.2	18.9	60	22	19	101	20.9	19	142	20.8	19.1	183	22.1	19
20	21.3	18.9	61	22	19	102	21	19	143	20.8	19.1	184	22.2	19
21	21.4	18.9	62	21	19	103	21.1	19	144	20.6	19.1	185	22.3	19
22	21.4	19	63	21	19	104	21.1	19	145	20.6	19.1	186	22.4	19
23	21.6	19.1	64	21	19	105	21.3	19	146	20.5	19.1	187	22.4	19
24	21.6	19.1	65	21	19	106	21.3	19	147	20.4	19.1	188	22.5	19
25	21.8	19.1	66	21	19	107	21.4	19	148	20.4	19	189	22.6	19
26	21.8	19.1	67	21	19	108	21.6	19	149	20.3	19	190	22.7	19
27	21.9	19.2	68	21	19	109	21.6	19	150	20.3	19	191	22.8	19
28	21.9	19.3	69	21	19	110	21.8	19	151	20.3	19	192	22.8	19
29	22	19.3	70	21	19	111	21.9	19	152	20.2	18.9	193	22.9	19
30	22.1	19.3	71	21	19	112	21.9	19	153	20.1	18.9	194	22.9	19
31	22.1	19.3	72	21	19	113	22	19	154	20.1	18.9	195	23	19
32	22.2	19.3	73	21	19	114	22.1	19	155	20	18.9	196	23.1	19
33	22.3	19.3	74	21	19	115	22.1	19	156	20	18.9	197	23.1	19
34	22.3	19.4	75	21	19	116	22.1	19	157	19.9	18.9	198	23.2	19
35	22.4	19.4	76	20	19	117	22.2	19	158	19.9	18.9	199	23.3	19
36	22.4	19.4	77	20	19	118	22.2	19	159	19.8	18.8	200	23.3	19
37	22.4	19.4	78	20	19	119	22.2	19	160	19.8	18.8	201	23.4	19
38	22.6	19.4	79	20	19	120	22.3	19	161	19.8	18.8	202	23.4	20

39	22.6	19.5	80	20	19	121	22.3	19	162	19.7	18.8	203	23.5	20
40	22.6	19.5	81	20	19	122	22.4	19	163	19.7	18.8	204	23.6	20
41	22.6	19.5	82	20	19	123	22.4	19	164	19.6	18.8	205	23.6	20

1. Why do you think that the SHK was constructed outside?

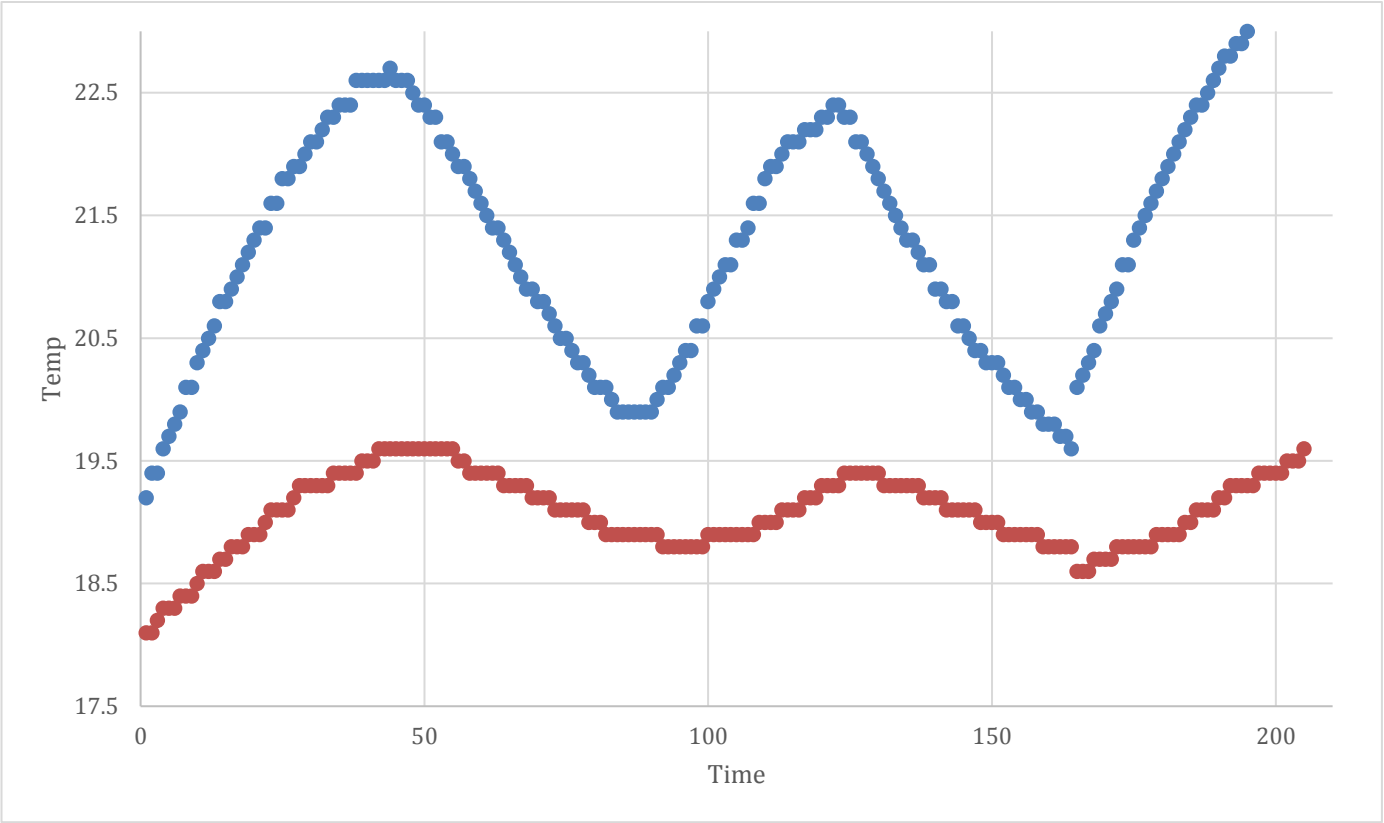
2. Using graph paper graph these results.

3. Comment on the graphs produced.

4. Think of ways in which this investigation could be taken further. Write your ideas here. Discuss them with your teacher.

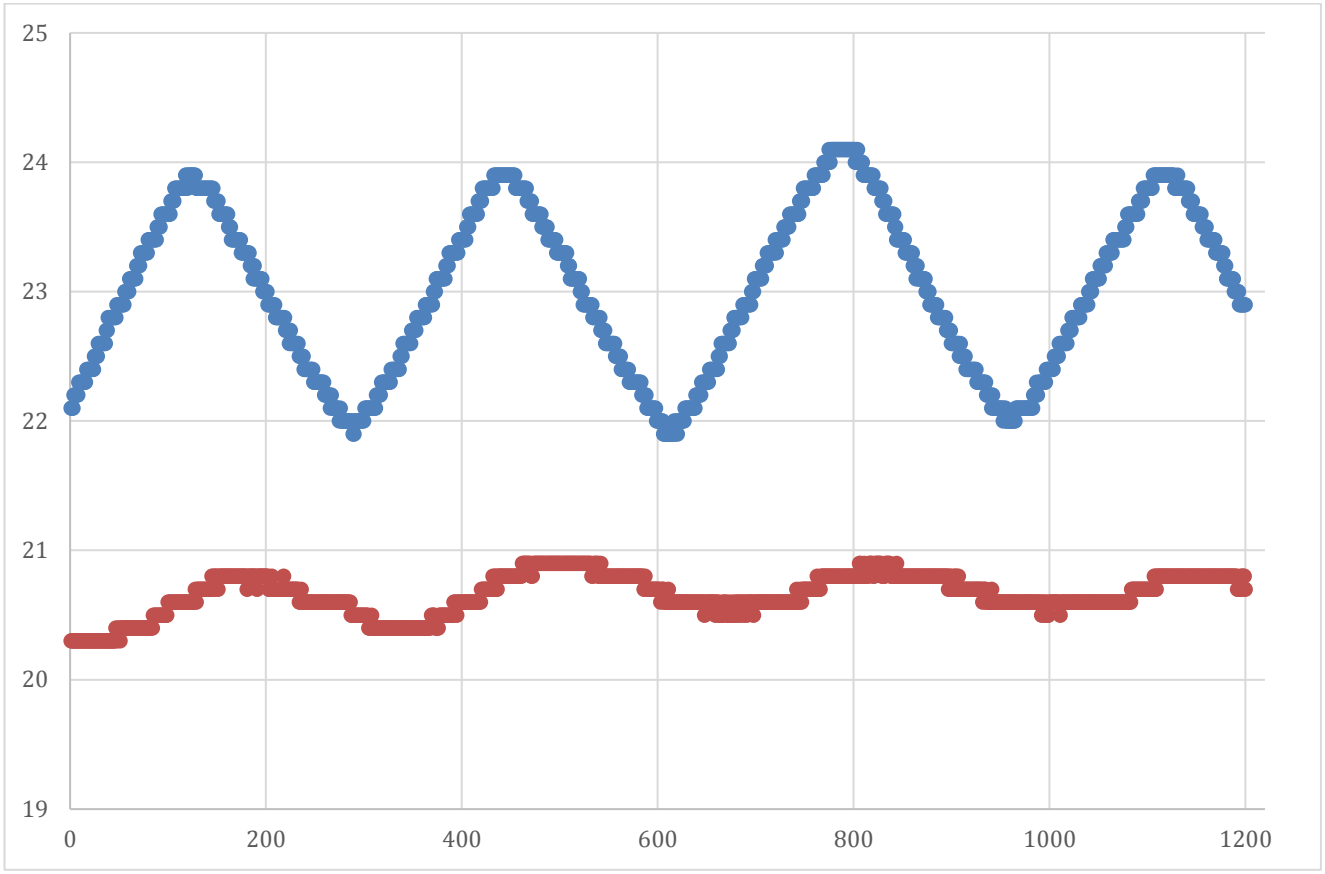
Now investigate your ideas. Do not forget to plan your work.

Task N Graphs



How to use: Click on the graph, three symbols will appear to the right of the graph page. Click on then select the data set(s) that you would like to graph and investigate. Once selected, click on 'Apply' from the drop down list.

Follow on to Task N - Run 1 a single story house with two windows. Wall heater and no insulation Run 2 as above but with two double glazed windows and ceiling insulation.



How to use: Click on the graph, three symbols will appear to the right of the graph page. Click on then select the data set(s) that you would like to graph and investigate. Once selected, click on 'Apply' from the drop down list.

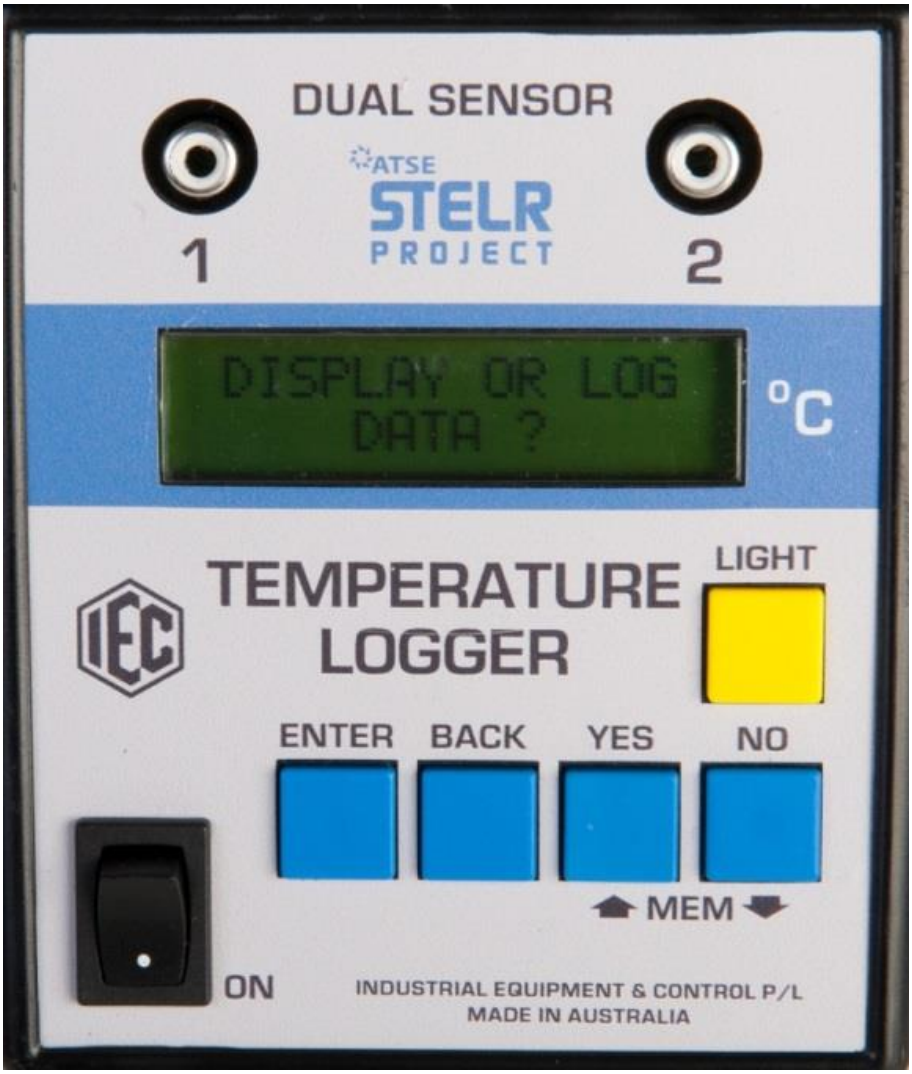
GLOSSARY

Term	Meaning

APPENDIX 1: COLLECTING AND RETRIEVING DATA

SETTING UP THE DATA LOGGER

1. Connect the data logger input(s) to a temperature sensor using the long RCA cable(s).
2. Turn on the data logger using the switch.



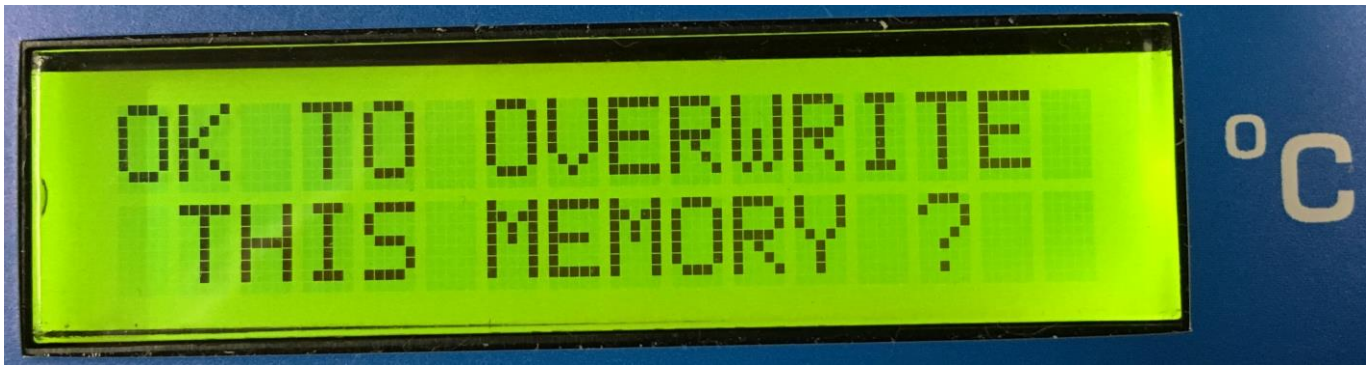
3. You will be asked ”display or log data?” . Press the “NO” button

4. You will be asked to “Select Memory”. Use the up or down arrow buttons to scroll up and down through the five available memory files. Press the “ENTER” button when you have the memory file you want.

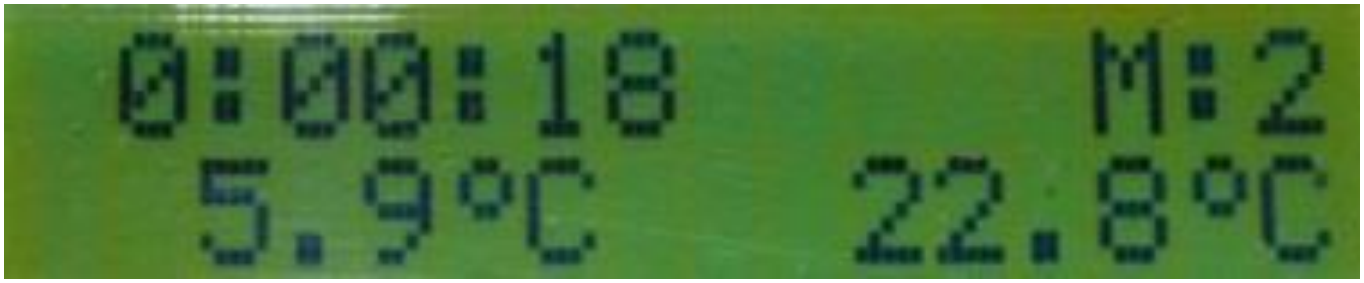
5. You will be asked if you want to recall memory of that file. Press the “NO” button.

6. Next choose the time interval for taking readings. Use the up or down arrow buttons to change the interval. You can choose between 1 sec, 3 sec, 15 sec, or 60 sec. Press the “ENTER” button when you have the time interval you want.

7. You will be asked if you want to “OK to overwrite the Memory”. Select “YES” – data will immediately start being recorded to the memory location you selected.

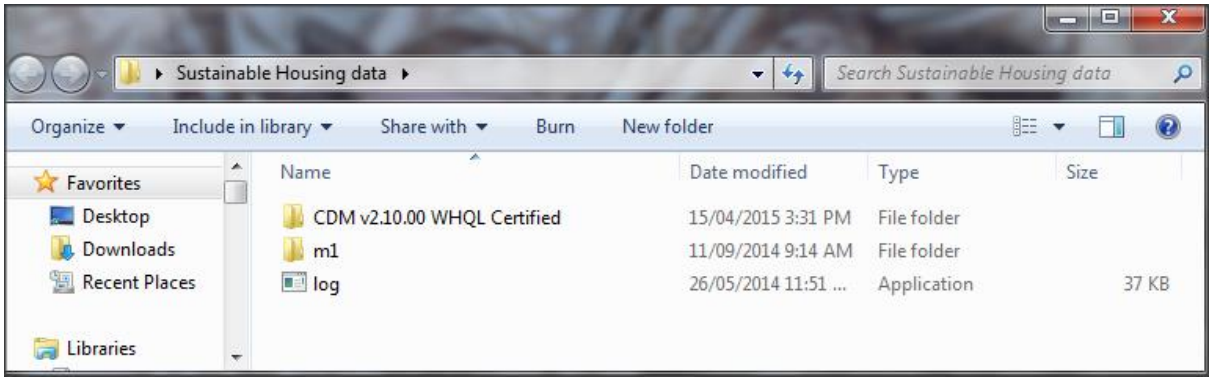


8. Data will be recorded. Time and temperatures will be displayed on the screen.

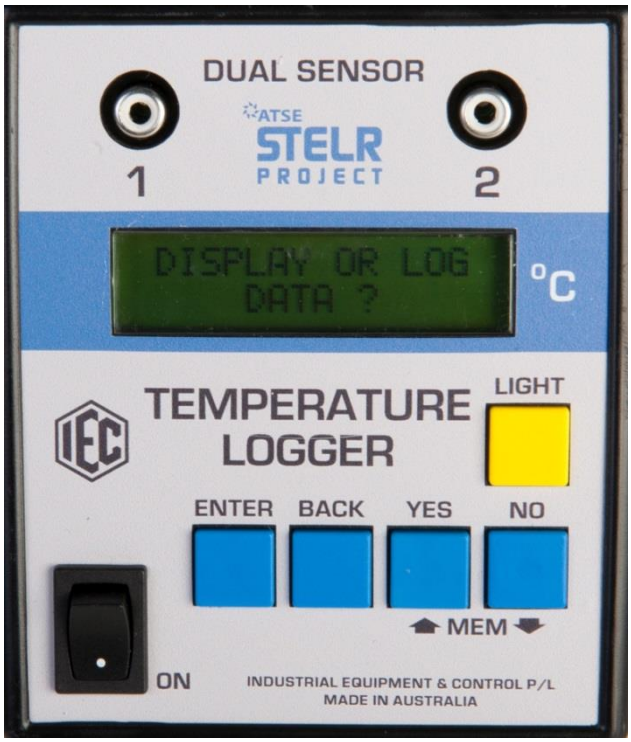


DOWNLOADING DATA FROM THE LOGGER

1. Set up a folder called “Sustainable Housing data” on the desktop.
2. Transfer the files on the USB into this folder.



3. Plug the data logger into a USB port on the computer using the cable provided.
4. Open the file you created on the desktop.
5. Double click on the “log” file.
6. Turn the logger on.



7. You will be asked ”display or log data?” - press the “yes” button
8. Five (one for each memory) files will be downloaded to your folder.
9. If you used memory 1, open the file LOG0001.
10. Rename and save this file.
11. Record the start and end temperatures for your investigation.
12. Turn off the data logger to save the battery.

TEACHER NOTES:

These activities are related to the Australian Curriculum Science F-10 documentation. Examples of the content descriptors that can be associated with these activities:

Year 5 and 6

Science as a Human Endeavour

Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)

Use and influence of science

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science Inquiry Skills

Questioning and predicting

With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS231)

Planning and conducting

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Processing and analysing data and information

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090)

Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Evaluating

Reflect on and suggest improvements to scientific investigations (ACSIS091)

Year 7 and 8

Use and influence of science

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE121)

Questioning and predicting

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS124)

Planning and conducting

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125)

Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS126)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)

Evaluating

Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS131)

Use scientific knowledge and findings from investigations to evaluate claims based on evidence (ACSIS132)

Communicating

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

Year 9 and 10

Use and influence of science

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE160)

Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)

Questioning and predicting

Formulate questions or hypotheses that can be investigated scientifically (ACSIS164)

Planning and conducting

Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS165)

Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACSIS166)

Evaluating

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS171)

Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems (ACSIS172)

Communicating

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174)

TASK A

This task may be used to introduce students to the document/web site from which the claims being investigated are taken. The teacher may choose not to use this or to change the words being defined to cater for different year levels or abilities. It could also be a good starting point to instigate discussions regarding the ideas being investigated.

TASK B

This task is designed as a guided task that will introduce students to the Sustainable Housing Kit and the Data Logger and its use. Once again the teacher can alter the task and the amount of guidance given dependent on Year level and ability. The results from the data logger may not be great and depend on ambient room temperature, distance of light from house, length of time the data logger runs, etc. However, this is not of major importance. From the results students need to draw conclusions regarding the statement being investigated and most importantly think and comment on how the task could be improved.

TASK C

This is a follow on from Task B and is designed to be less guided than Task B. Students should be using their conclusions and ideas for improvement from Task B to inform them on how to proceed with this task.

TASK D

This task investigates the affects another claim in the document and looks at the affects of insulation. Ensure students have set up the house as per the pictures in set one. Dependent on the age and the ability of students' guidance may be needed with regards to the measuring and calculating the dimensions and angles in step 2. For step 5 check that students have set the distance and angle of the light to the house as they did in step one. Also ensure that the orientation of the house is the same.

Students may find that for the first part of the task that there is no major heat loss to the roof space. However, when using the insulation, they should notice that the ground level temp stays constant as may the temperature in the roof space.

TASK E

This investigation looks at the difference between heat transfer in a two story house with and without insulation. Students should be encouraged to think about how the insulation could be improved. For example floor insulation and double glazing for windows, reduce the number of windows etc.

TASK F

This is a research task relating to the Your Home web site and the section relating to 'Design for climate' all answers can be found in the associated PDF document and also in the 'Passive design' PDF document

Answers:

Psychological and physiological

Temperature, humidity, air movement, exposure to heat sources and exposure to cool surfaces

Radiation and conduction

3ºC

8

Sydney, Adelaide and Perth

Cool temperate (Zone 7)

Carnarvon. Hot dry summer and warm winter

6. No Zone 7 and 8

Orientate housing for cooling breezes

Position landscaping and outbuildings to funnel breezes over, under and through buildings

Prioritise design for night-time sleeping

Shade outdoor living spaces

Locate pools and spas on northern side of building

Install ceiling fans

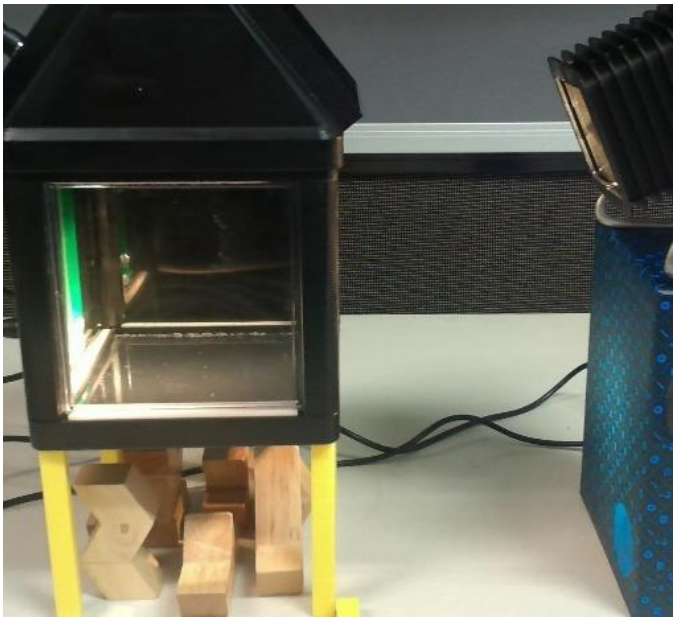
Air Movement, evaporative cooling and thermal mass

TASK G

This task uses information from Task F and looks at the Queenslander design of house.

Reasons would be to increase air flow under the house to assist with cooling, the verandas give shade to the house and force air flow across certain areas of the house. Also, the house being raised from the ground assists with flood prevention in certain areas.

For the investigations students will come up with numerous ideas. Just guide the students in how they could carry out an investigation of these ideas. They should however at some stage investigate the cooling of the house with a breeze underneath and then with storage (see picture below). They could try altering the distance of the fan, the height of the house from the ground, the number of windows and different types of shading.



TASK H

This task should have less guidance from the teacher, with students using their experience from previous tasks. The pictures included on the task page could also be removed for more able students. Or the spaces next to each picture could be used by the students to describe what they think is being investigated in each picture

Let their imagination guide them.

The only advice should be to be organised and to keep accurate records of methods and techniques used.

TASK I

Students may need to read through the PDF or website information before the first lesson on this task. This may be worth giving as homework with students writing down any questions they have regarding details of the document. These could then be clarified at the start of the first lesson.

More questions could be added to the first part of the task and types of questions can be altered depending on year level and ability.

Ceiling

10% range

4.4^{o}C

The heating would be working harder and longer to maintain the set temperature. This would increase the amount of wasted heat entering the nearby environment and also increase the use of fossil fuels.

TASK J

For the single glazed windows there is a 16.5% drop in temperature. For the double glazed windows there is a 15% drop in temperature.

Let the students come up with their own ideas. Once again with this part of the task it is their organisation and recording of their work that is important.

TASK K

The picture given should help guide the students in this task. Once again monitor that the students are being systematic in their approach and working.

Students may notice how quickly the house heats up to the required temperature when insulation is being used.

For part b students could investigate roof or ceiling insulation. They could try curtains with double glazed windows. They may want to consider different materials for the roof.

TASK N

For this task the SHK was set up as described in the task. The logger was run over 20 minute intervals and the results were culled and then brought together to make a continuous data set.

The students are asked to sketch the graph for this data set. However, there is also an interactive graph of the same data that the students can use if required.

Also included is another interactive graph relating to Task N. This is data taken over two 60 minute runs.

Run 1 -a two story house, with 2 windows and a wall heater. The temperature was maintained between 22 and 24 degrees. This would involve students constantly monitoring the logger and turning the heater on and off at the required temps.

Run 2 – as above but with 2 double glazed windows and ceiling insulation.

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