SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Highly Commended

Science Investigation

Year 5 - 6

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Government of South Australia
Department for Education

SASTA South Australian Science Teachers Association

Which insulation is the best?

Edwardstown Primary School - Year 6

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Contents

1. Introduction and Background

We decided to investigate which type of insulation is best at reducing heat transfer. We chose this topic because insulation is all around us in everyday life, from the walls in our homes to lunch boxes that keep our food warm or cool. We thought it would be interesting to learn more about something we use every day without always noticing it. Understanding how insulation works can help us make better choices in the future and learn more about the science behind keeping things at the right temperature.

What is insulation?

Insulation helps reduce the transfer of heat, keeping things warm or cold for longer. In our experiment, we investigated how different insulating materials helped keep heat from escaping. Insulators are materials that are poor conductors of heat, meaning heat does not move through them easily. Examples of insulating materials include foam, wool, and bubble wrap. Some insulators can also reduce the flow of electricity, but in this experiment, we focused on heat insulation.

2. Questioning and prediction

Aim

Our aim was to investigate which insulation material was most effective at reducing heat loss from hot water. And learn more about insulation because insulation is everywhere in the walls, food preservers, Esky's we thought that if we learnt this it would help a lot in day-to-day life.

Hypothesis

We predict that foam will be the best insulator out of all the materials we are testing.

According to our research, heat moves from areas of higher temperature to lower temperature. This means that good conductors of heat, such as metals like aluminum foil, will not be effective insulators because they allow heat to escape easily. Because of this, we think materials like cloth will perform better than metals.

Overall, we believe foam will be the most effective insulator because it is expected to trap air and slow down heat transfer more than the other materials.

At first, we thought aluminium foil might be the best insulator because it is often used with hot food. However, we later learned that aluminium is actually a good conductor of heat, and we did not yet understand the difference between conduction and insulation at that time.

Notes

This is from our research.
-The three basic forms of how heat flows mechanisms are conduction, convection and radiation
- conduction- the heat moving through things
- convection- how heat moves through air
- radiation - the process of energy using electromagnetic radiation travelling through space
- most insulators work by slowing down the process of conduction through the material. Effectively keeping heat in.
- temperature move from higher areas of temperatures to lower ones until the temperature is equal
- in homes the heat will escape into colder areas such as outside, making the living areas lose heat. To prevent this people have developed insulation
- In thermals they use vacuum-insulating panels to keep heat in. (we can use this to understand why some materials work better than others)

1. The air-filled cells help prevent heat transfer due to the fact the air is in the bubbles wrap
2. The reason air is a good insulator is because the only way for heat to transfer through air in through convection and it is a gas so the molecule in the air is quite far apart

3. Experimental Method

Equipment and Materials

- Thermometer
- Timer
- Kettle
- Tap water
- Plastic measuring cylinder
- 2 Litre Ice cream container
- Empty 375ml soft drink can
- Insulation/variables (x5)
    1. Paper
    2. Cloths
    3. Foam
    4. Bubble wrap
    5. Aluminium foil

Procedure

Before starting our investigation, we needed to make sure our experiment was fair and reliable. To do this, we set up a control test where we did not add any insulation around the can. This gives us a clear starting point to compare all other results against. We also kept every other condition exactly the same, such as using the same container, the same soft drink can, and the same volume of hot water (70 mL) each time. The only thing we changed was the type of insulation material. This is important because it means that any differences in temperature change can only be explained by the insulation itself, making our results more accurate and fairer.
Our **Independent variable** is the type of insulation material used. This is because it is the one thing we are deliberately changing to see how it affects heat loss.
The **dependant variable** is the temperature of the water (or how much heat is lost over time)
This is what you are measuring to see which insulation material works best.
And the **control variable** is all other parameters.

This is our step-by-step procedure:

1. Boil approximately half a kettle worth of water (with proper adult supervision.)

2. Set up a clean ice cream container with a clean and empty soft drink can inside. Do not place any insulation variable around the can. (This is the control step).

3. Measure out 70ml of boiling water into a plastic measuring cylinder and keep your hands away to prevent burns. (with proper adult supervision).

4. Pour the 70ml of boiling water into the soft drink can, ensure hands are kept safe (with proper adult supervision) to prevent burns.

5. Place thermometer into the boiling water in the soft drink can
    a. Record the temperature.
    b. Start timer.

6. Record the temperature every 30 seconds until an elapsed time of 2 mins has been reached. (4 readings total).

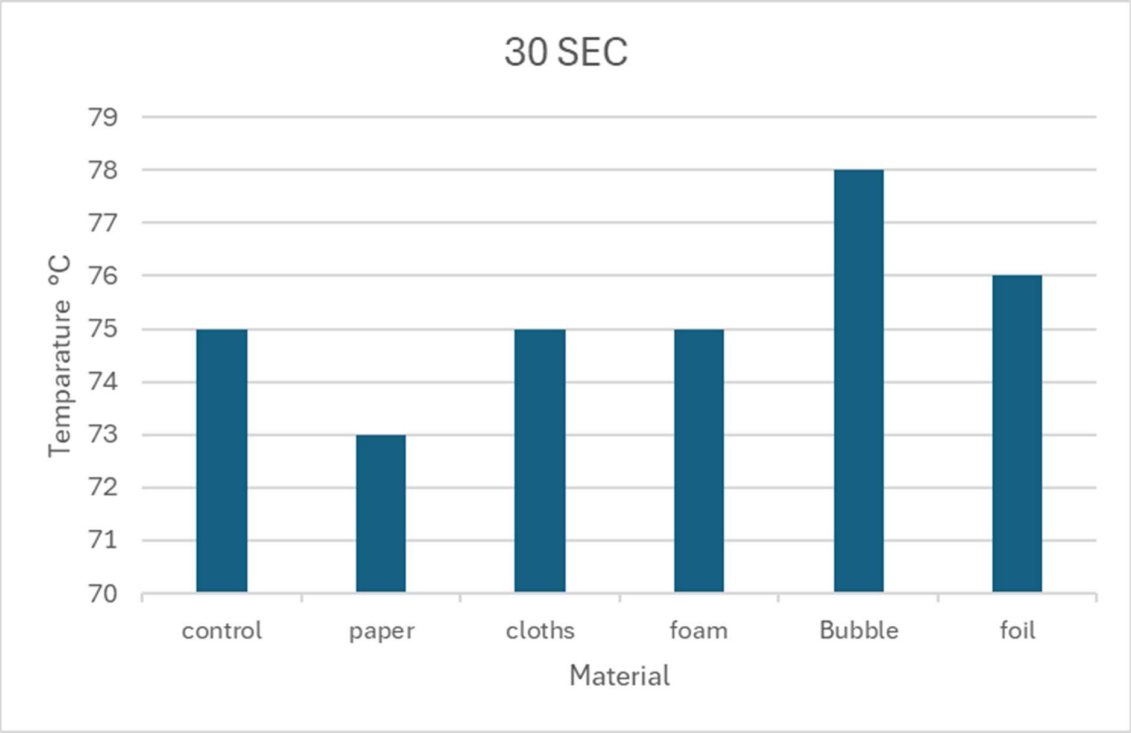
7. Place an insulation variable #1 into the ice cream container around the soft drink can and redo steps 1 to 6.
8. Repeat steps 1 to 6 with each of the remaining insulation variables.

Note: Maintain the same volume of water (70ml) for each insulation variable.

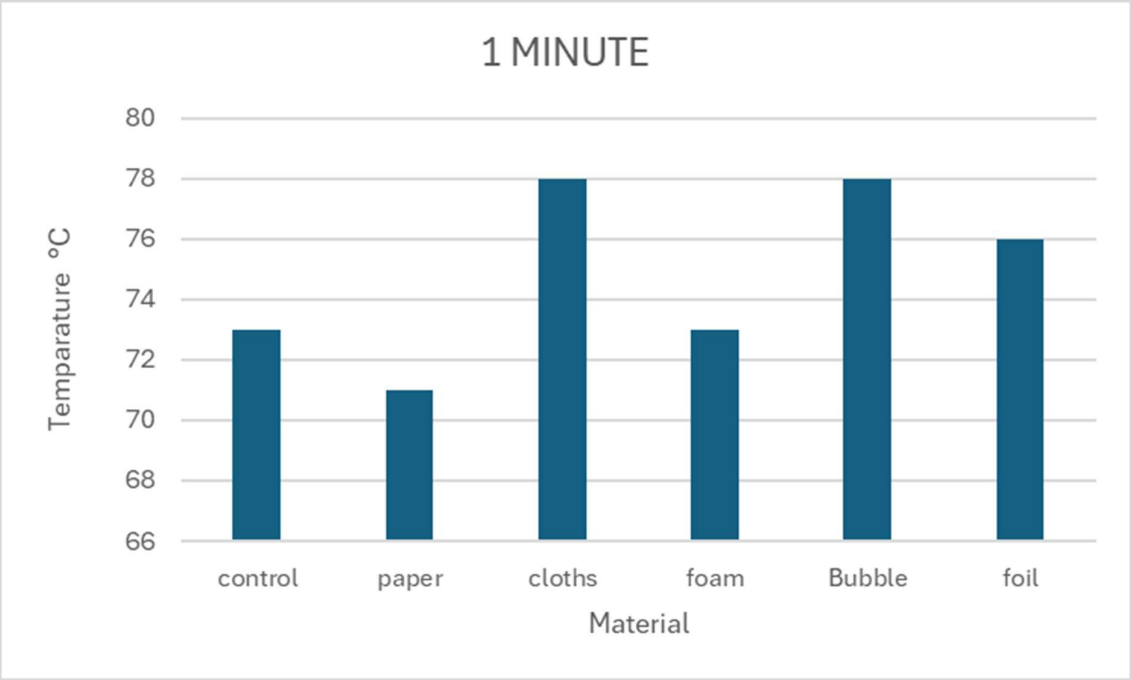
Test Results

MATERIAL	INITIAL	30 SEC	1 MINUTE	1 MIN 30	2 MINUTES	DIFFERENCE
control	78 °C	75 °C	73 °C	71 °C	70 °C	8 °C
paper	74 °C	73 °C	71 °C	70 °C	69 °C	5 °C
cloths	79 °C	75 °C	78 °C	77 °C	75 °C	4 °C
foam	76 °C	75 °C	73 °C	72 °C	71 °C	5 °C
Bubble wrap	79 °C	78 °C	78 °C	76 °C	75 °C	4 °C
foil	78 °C	76 °C	76 °C	75 °C	72 °C	6 °C

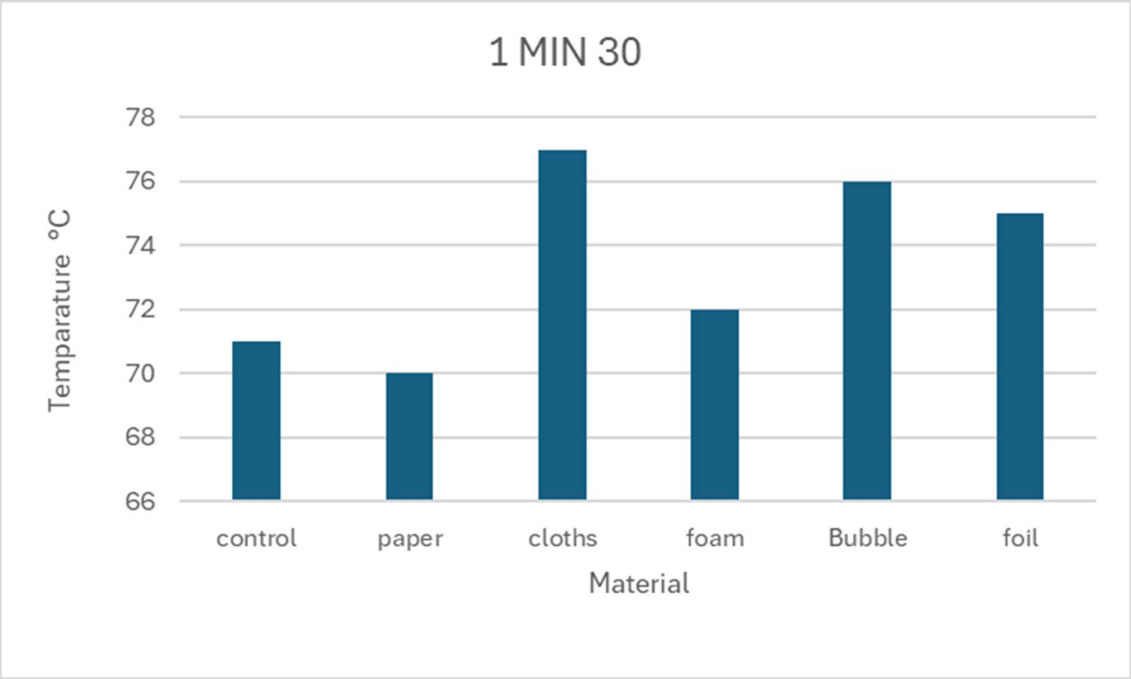
Analyse of the result by graphs



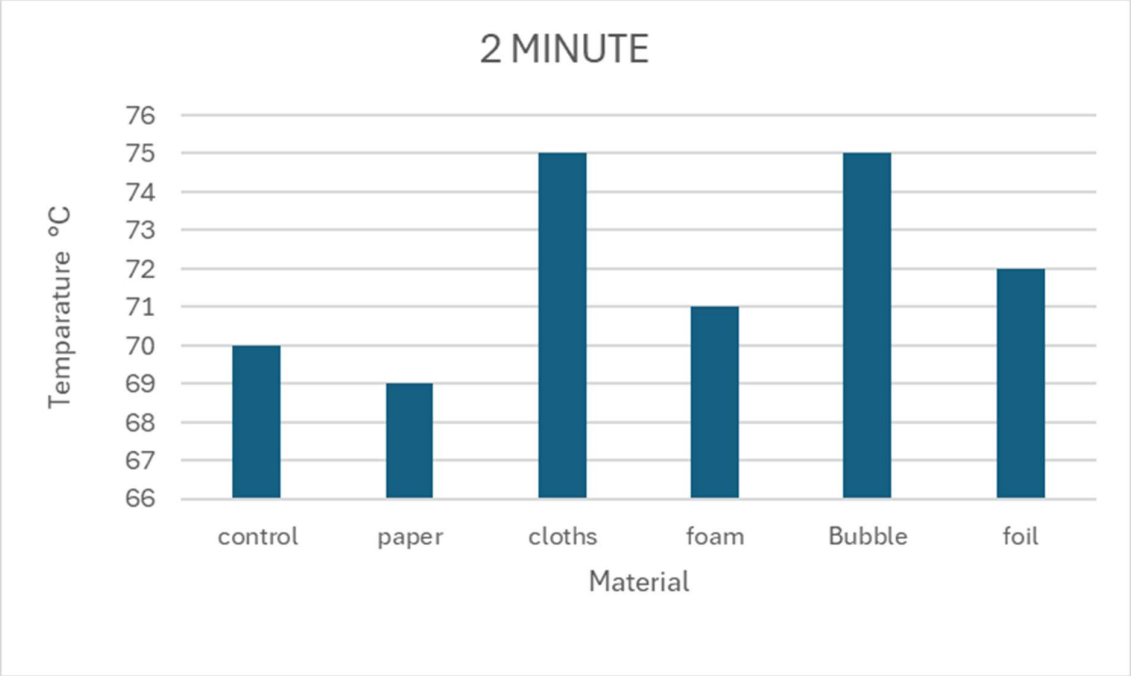
Graph 1: This is how hot the thermometer is when heated for thirty seconds.



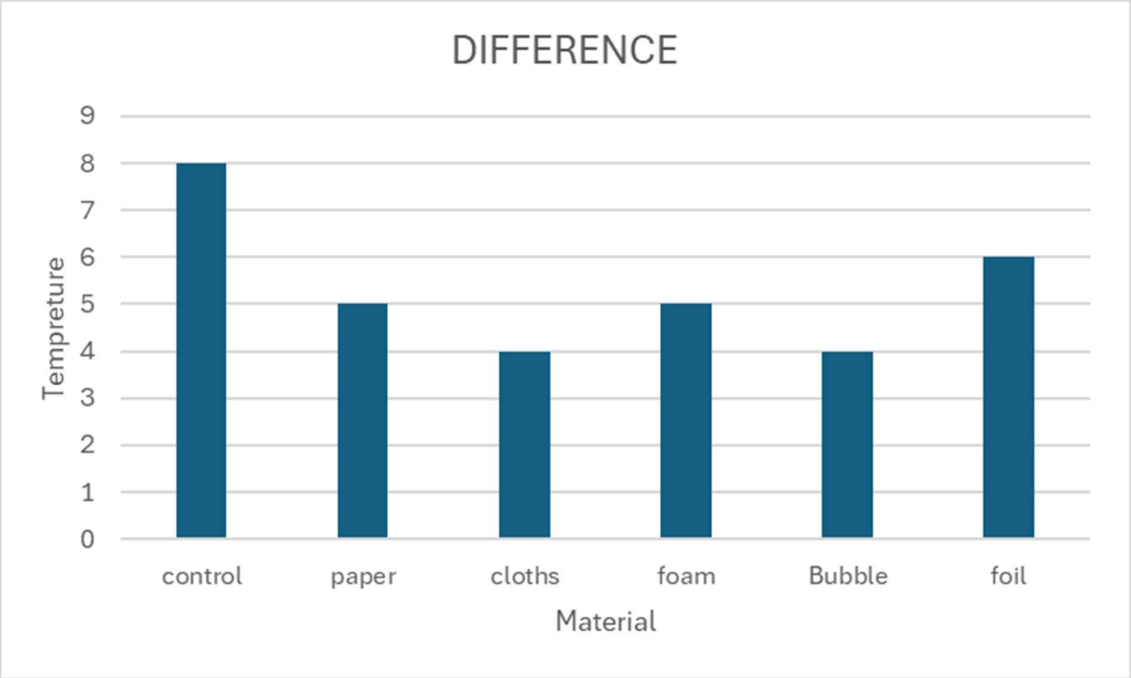
Graph 2: This is how hot the thermometer is when it is for 1 minute



Graph 3: This is how hot the thermometer is when it is for 1 minute and 30 seconds



Graph 4: This is how hot the thermometer is when it is for 2 minutes



Graph 5: Temperature difference according to the insulation material

4. Findings

The results showed that bubble wrap was the most effective insulation material. After checking our graphs and data carefully, we found that bubble wrap consistently kept the water at a higher temperature than the other materials.

Bubble wrap worked well because it contained many small pockets of trapped air. Air is a poor conductor of heat, so it slows down heat transfer from the hot water to the cooler surroundings.

Cloth also performed well because the fibers trapped small pockets of air. Foam and paper provided some insulation but were not as effective as bubble wrap. Aluminum foil performed less effectively because metal allows heat to transfer more easily than the other materials tested.

5. Conclusion

Our investigation found that bubble wrap was the most effective insulation material for reducing heat loss from hot water. This supported our understanding that trapped air is an excellent insulator because it slows down heat transfer.

Although we originally predicted that foam would be the best insulator, our results showed that bubble wrap performed slightly better. Therefore, our hypothesis was only partly correct. This investigation helped us understand how different materials affect heat transfer and why insulation is important in everyday life.

6. Discussion

The purpose of this investigation was to identify which insulation material is most effective at reducing heat loss. After carefully analyzing our results, we found that bubble wrap was the best insulator.

Bubble wrap performed the best because it contains many small pockets of trapped air. Air is a poor conductor of heat, meaning it slows down the transfer of thermal energy. This allowed the hot water to stay warmer for longer. Cloth also showed good insulating properties, as its fibers trap air and form a barrier that reduces heat loss.

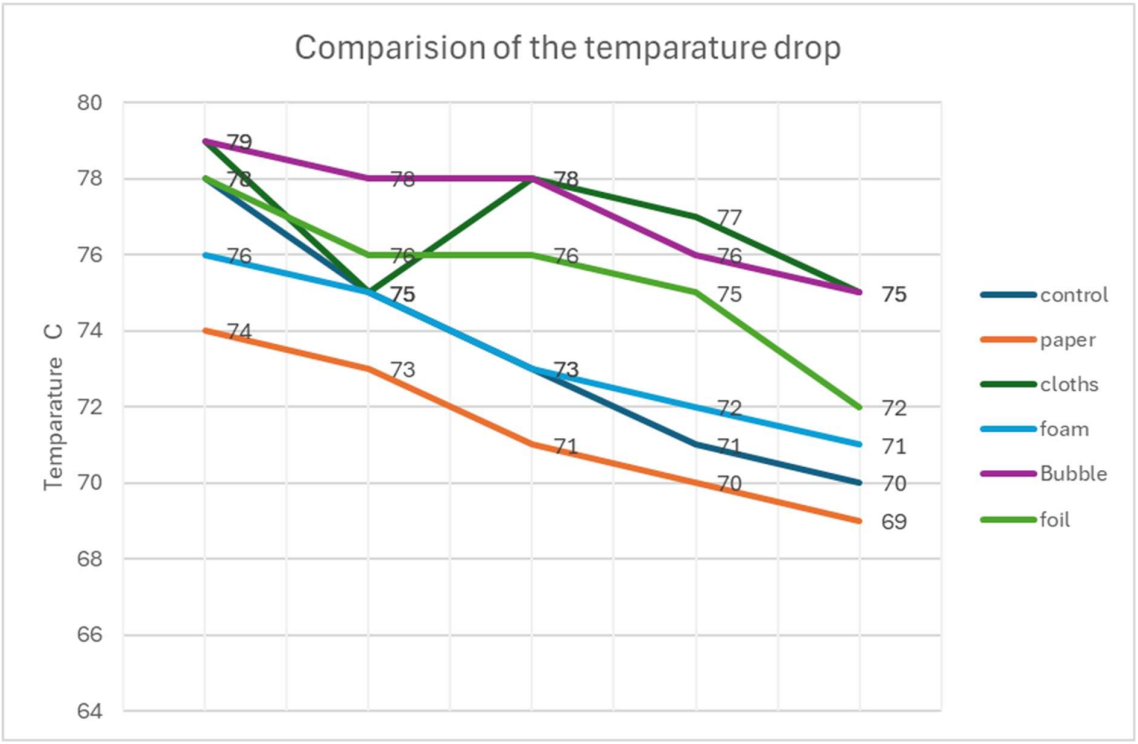
Through this investigation, we developed a clearer understanding of the difference between conductors and insulators. Before starting the experiment, we predicted that aluminum foil might be the most effective insulator, as it is commonly used with hot food. However, we learned that aluminum is actually a good conductor of heat. While foil can reflect some heat radiation, it does not prevent heat transfer as effectively as materials that trap air.

One limitation of our investigation was that each material was only tested once. Repeating the experiment multiple times and calculating an average would improve the reliability of the results. Another limitation was that the starting temperatures were not exactly the same for each trial, which may have influenced the outcomes.

If we were to repeat this investigation, we would ensure all tests begin at the same starting temperature and conduct several trials for each material. This would make the experiment fairer and improve the accuracy of the results.

During our data analysis, we also identified an error in our initial results. After plotting a line graph, we discovered that the cloth data had been recorded incorrectly. This correction confirmed that bubble wrap was indeed the best insulator. We would not have detected this error using only column graphs for the other materials, as the line graph made the inconsistency more visible. Initially, we also hypothesized that aluminum foil would be the best insulator due to its association with heat-related applications. However, further investigation showed that aluminum is a good conductor rather than an insulator, which explained its lower performance in the experiment.

The findings of this investigation have real-world applications, as insulation is used in houses, lunch boxes, thermos flasks, refrigerators, and clothing. Understanding which materials reduce heat transfer can help improve energy efficiency and maintain temperatures for longer periods.



Graph 6: Comparison of the temperature drop

7. Bibliography

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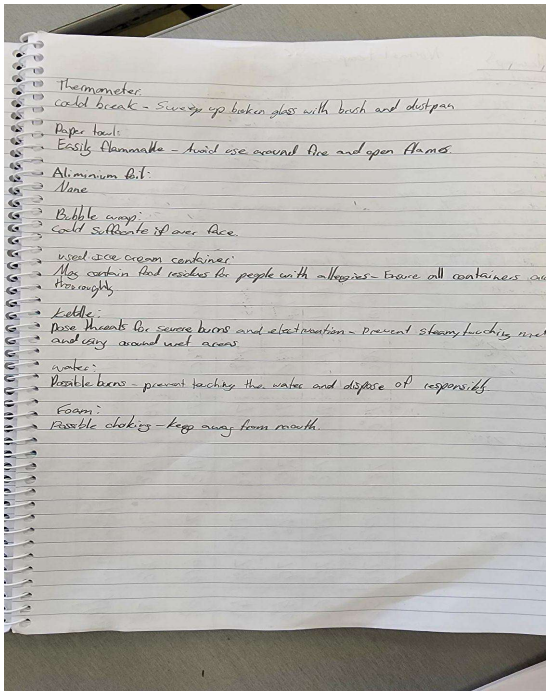
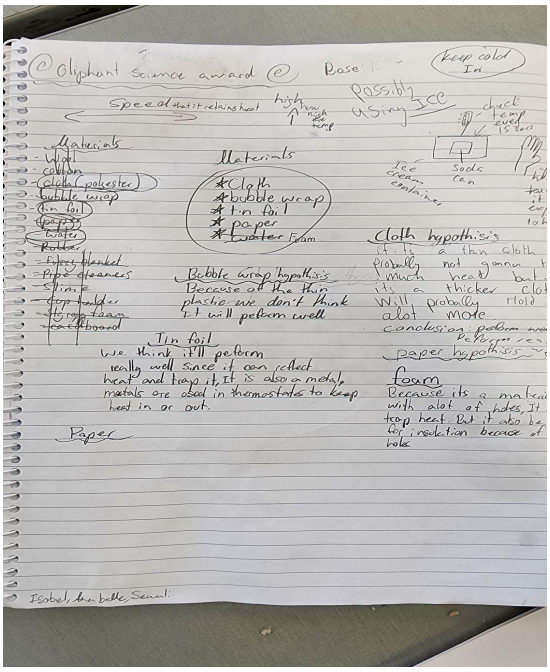
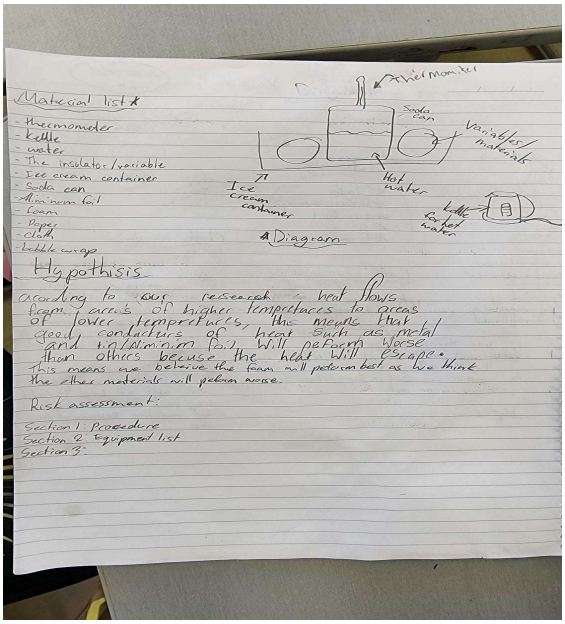
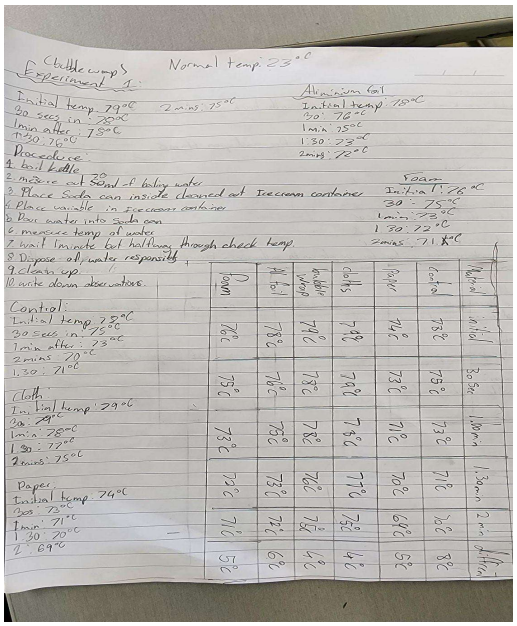
Serway, R. A. (Year unknown). Physics Textbook. Heat transfer and insulation.

8. Logbook


Thermometer:
could break - Sweep up broken glass with brush and dustpan
Paper towl:
Easily flammable - Avoid use around fire and open flames
Aluminium foil:
None
Bubble wrap:
Could suffocate if over face
used ice cream container:
May contain food residues for people with allergies - Ensure all containers are thoroughly
Kettle:
Pose threats for severe burns and electrocution - Prevent steamy touching and using around wet areas
water:
Possible burns - prevent touching the water and dispose of responsibly
Foam:
Possible choking - keep away from mouth.


@Oliphant Science award @
Base
Keep cold In
Speed that it retains heat
Materials
Cloth
bubble wrap
tin foil
paper
Foam
Cloth hypothisis
Bubble wrap hypothisis
Because of the thin plastic we don't think it will perform well
Tin foil
We think it'll perform really well since it can reflect heat and trap it, it is also a metal, metals are used in thermostates to keep heat in or out.
Paper
foam
Because its a material with alot of holes It trap heat But it also be for insulation because of hole
Isabel, Ava, Bella, Samuel


Material list
Thermometer
Kettle
water
The insulator/variable
Ice cream container
Soda can
Aluminium foil
Foam
Paper
Cloth
Bubble wrap
Thermometer
Soda can
Variable/ insulator
Ice cream container
Hot water
Kettle for hot water
Diagram
Hypothisis
According to our research & heat flows from areas of higher temperatures to areas of lower temperatures, this means that good conductors of heat such as metal and aluminium foil will perform worse than others because the heat will escape. This means we believe the foam will perform best as we think the other materials will perform worse.
Risk assessment:
Section 1 Procedure
Section 2 Equipment list
Section 3:


Bubble wrap's Experiment 1
Normal temp: 23°C
Initial temp: 79°C
30 secs in: 75°C
1min after: 73°C
1:30: 70°C
2 mins: 75°C
Aluminium foil
Initial temp: 75°C
30: 76°C
1min: 75°C
1:30: 73°C
2mins: 72°C
Procedure:
1 boil kettle
2 measure out 200ml of boiling water
3 Place Soda can inside cleaned out Ice cream container
4 Place variable in ice cream container
5 Pour water into Soda can
6 measure temp of water
7 wait 1minute but halfway through check temp
8 Dispose of all water responsibly
9 Clean up
10 write down observations
Foam
Initial: 76°C
30: 75°C
1min: 73°C
1:30: 72°C
2mins: 71°C
Control:
Initial temp: 23°C
30 secs in: 23°C
1min after: 23°C
2mins: 20°C
1:30: 21°C
Cloth
Initial temp: 79°C
30: 79°C
1min: 78°C
1:30: 77°C
2mins: 75°C
Paper
Initial temp: 74°C
30: 73°C
1min: 71°C
1:30: 70°C
2: 69°C
Foam | Al foil | Bubble wrap | cloths | Paper | Control | Variable
76° | 78°C | 74°C | 79° | 74°C | 73°C | Initial
75°C | 74°C | 73°C | 79° | 73°C | 73°C | 30 sec
73°C | 73°C | 78°C | 78°C | 71°C | 73°C | 1min
73°C | 73°C | 72°C | 77°C | 72°C | 71°C | 1:30min
71°C | 72°C | 72°C | 75°C | 69°C | 70°C | 2 min
69°C | 71°C | 69°C | 74°C | 68°C | 68°C | Final

9. Risk Assessment Form

OSA RISK ASSESSMENT FORM

for all entries in (✓) ☐ Models & Inventions and ☐ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

STUDENT(S) NAME: senali, Isobel, Anabelle ID: D149-011

SCHOOL: Edwardstown primary school

Activity: Give a brief outline of what you are planning to do.

we are doing an experiment on which Insulation is the best. We did an experiment testing this. We got an ice-cream container and put a soda can in the middle. We added some hot water and the insulator around the can and put the thermometer in and collected the data by checking the initial, 30sec, 1 min, 1 min 30 sec, and 2 min.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Risks	How I will control/manage the risk
Thermometer - Could break	sweep up broken glass with brush and dustpan
Paper towels - Easily flammable	avoid use around fire and open flames
Bubble wrap - Could suffocate if over face	keep away from the face
Used ice cream container - May contain food residues for people with allergies	ensure all containers are washed thoroughly
Kettle - Pose threats for severe burns and electrocution	Prevent steam from touching skin and use around wet areas
Hot Water - Possible burns	prevent touching the water and dispose of responsibly
Foam - Possible choking	keep away from mouth

(Attach another sheet if needed.)

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Senali, Anabelle, Isobel

SIGNATURE(S): Anabelle Senali Isobel

☐ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: Erin Hodges

SIGNATURE: DATE: 17/6/26

9. Appendix

This is how we did our little experiment.