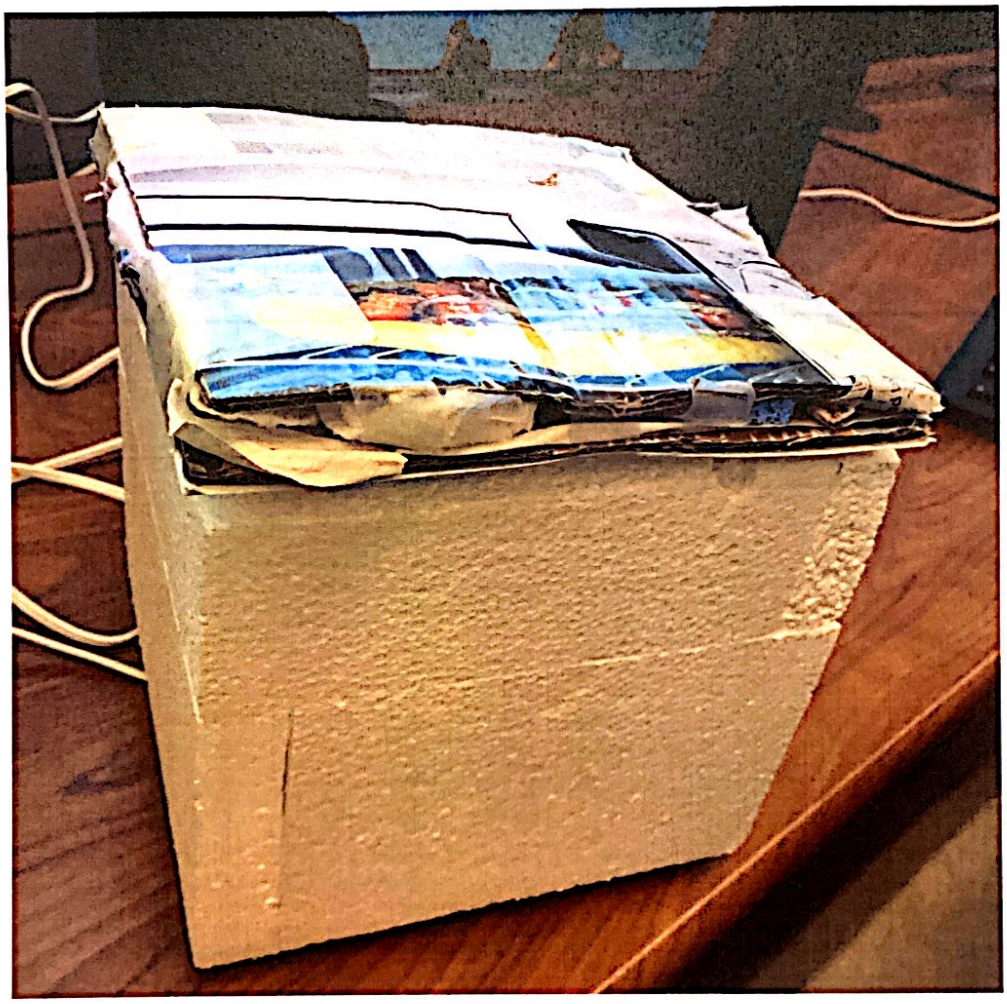
# 1.3.4 Renewable Insulation



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## Introduction

In this activity, students will comprehend the concept of renewable insulation. Using recyclable household materials they will create their own insulation and try to make it work in the most efficient way as possible.

## Design Brief

**Client:** PLTW

**Target Consumer:** Homeowners

**Designer(s):** Nicole Posada and Keyur Rana

**Problem Statement:** The advancement of internal material is brought up from the demand for insulation material which has a positive impact on health and the environment.

**Design Statement:** Build a model of an insulation system utilizing various household materials.

**Constraints:**

- Recyclable
- Economic
- Environmentally friendly
- Consistent internal composition

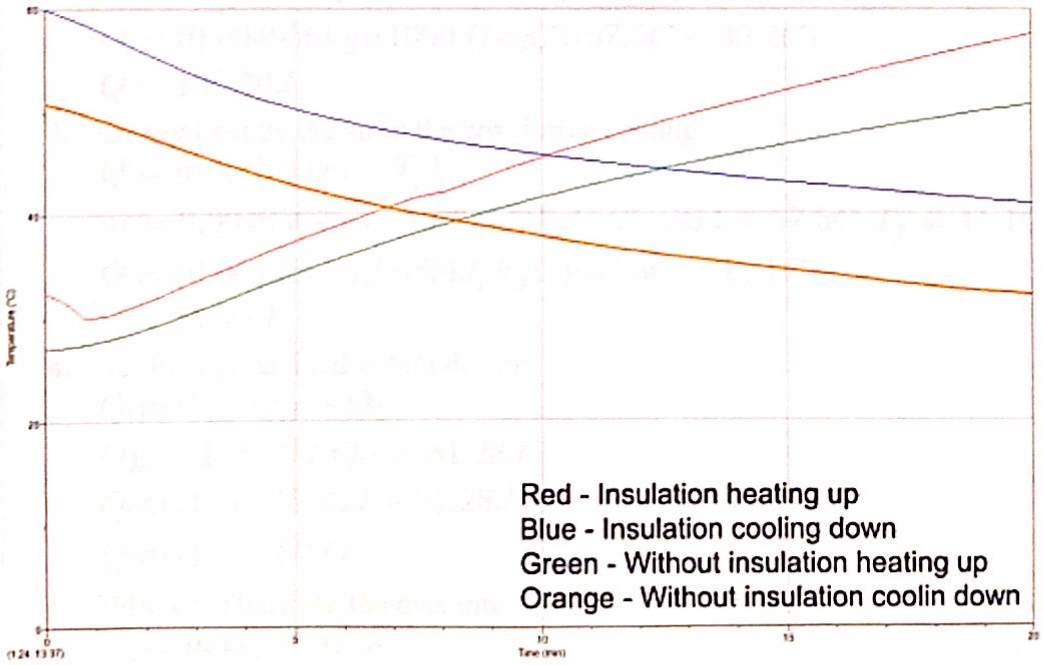
## Procedure

In this project, students will design renewable composite insulation materials. The first step in this process is to create an insulator using house materials that are recyclable, economical and environmentally friendly. Then record the inner dimension of the box with a light bulb and calculate the volume of the air. In the activity procedures, it states to use two Stainless steel temperature probes connected with GoLink connectors. However, we did the steps differently. Instead of using two probes, we only used one for both tests. After we had plugged the end of the temperature probe into the box, we started recording the data. We configured the Logger Pro program so it would record 4 samples every minute for 20 minutes (Start->All Programs-> Vernier Software-> Logger Pro 3.8). Then we turned the light bulb on and let the Logger Pro software record data for 20 minutes (Click Collect). After 20 minutes, we turned the light bulb off and let it cool for another 20 minutes. Record the data and repeat these steps with insulation on. Finally, analyze the data.

## Materials

| Quantity | Part Name | Part Number |
|---|---|---|
| 1 | Heat Box | 25 W |
| 1 | Logger Pro | Software |
| 1 | Temperature Probes | Stainless steel |
| 1 | Tape | N/A |
| 1 | Ruler | Standard |
| 9 | Cotton pads | N/A |
| 3 | Sponges | N/A |
| 2 | Poster Paper | N/A |
| Assorted | Newspaper | N/A |

## Picture



## Calculations

| | |
|---|---|
| 4. Heat source light bulb wattage | P = 25 W |
| 5. Initial internal temperature (°C) | $T_{initial\,1}$ = 30.2 C |
| 6. Maximum internal temperature (°C) | $T_{Max\,1}$ = 57.5 C |
| 7. Final internal temperature (°C) | $T_{Final\,1}$ = 41.1 C |
| 8. Initial room temperature (°C) | $T_{initial\,2}$ = 21.3 C |
| 9. Maximum room temperature (°C) | $T_{Max\,2}$ = 22.0 C |
| 10. Final room temperature (°C) | $T_{Final\,2}$ = 21.7 C |
| 11. Heating time(s) | $t_1$ = 1200 s |
| 12. Cooling time(s) | $t_2$ = 1200 s |

*With Insulation Material

1. Mass of air being heated

$$Mass = Volume(V) * Density(\rho)$$
$$M = (0.00413m^3)(1.20kg/m^3)$$
$$M = 0.004956kg$$

2. Energy gained by the air in the box during heating

$$Q = mc(T_f - T_i)$$
$$m = 0.004956kg, c = 1000J/kgC, T_f = 57.5C, T_i = 30.2C$$
$$Q = (0.004956kg)(1000J/kgC)(57.5C - 30.2C)$$
$$Q = 135.30J$$

3. Energy Lost by the air in the box during cooling

$$Q = mc(T(max) - T_f)$$
$$m = 0.004956kg, c = 1000J/kgC, T(max) = 57.5C, T_f = 41.1C$$
$$Q = (0.004956kg)(1000J/kgC)(57.5C - 41.1C)$$
$$Q = 81.28J$$

4. Net Energy retained within the box

$$Q(net) = Q_H - Q_C$$
$$Q_H = 135.30J, Q_C = 81.28J$$
$$Q(net) = 135.30J - 81.28J$$
$$Q(net) = 54.02J$$

5. Difference between the max internal temperature and max surrounding temperature

$$T_{(in)}(max) = 57.5C$$
$$T_{(out)}(max) = 22.0C$$
$$\Delta T(max) = 35.5C$$

6. Compare your results with those of some other teams

| | Team 1 | Team 2 | Team 3 |
|---|---|---|---|
| $Q_{(net)}$ | 82.0 J | 63.5 J | 58.96 J |
| $\Delta T(max)$ | 41.5 °C | 27.2 °C | 38.7 °C |

## Issues

While doing the experiment, some of the issues my team encountered were very minor. This included messing up the data graph while recording the temperature of the box with and without the insulation material. The graphs overlapped instead of showing a single line. However, we were able to understand the graphs regardless.

## Conclusion

1. Explain how your house might lose energy through radiation, convection, and conduction.

- Energy in a home might be lost through radiation by lights inside shining towards the outside through the windows.
- Energy might be lost through convection if either the door or windows are opened, allowing the warmer air inside the house to move toward the outside cooler air.
- Conduction may cause energy to be lost in a house when cold air on the outside goes onto the window and it seeps through to the inside.

2. What modifications could be made to your team's insulation design that allows for more energy efficiency?

- One of the many modifications that my team could make to our insulation design that would allow more energy efficiency is to put more foam or materials like cotton. This is because they can help trap more heat inside the insulation without letting the heat escape. The more heat energy escapes, the less the efficiency of energy becomes.

3. Which beverage would be more beneficial for cooling you on a hot summer day - a cup of ice cold water or a cup of hot cocoa? Justify your choice.

- A cup of ice cold water is more definitely more beneficial to use for cooling on a hot summer day compared to the hot cocoa. This is because the beverage is cold and when it entered your body, your body heat temperature will transfer into the liquid. Meanwhile, if you were to drink the hot cocoa, it will make your body temperature higher if it's hotter than your body temperature and making you uncomfortable on a hot summer day.

4. How do birds insulate their bodies to prevent energy loss on the skin's surface?

- Birds use feathers to insulate their bodies. The structure of the feathers allows for air to be trapped within them. This causes their bodies to warm up that air, preventing energy loss on the skin's surface.

5. Suppose that you are sitting close to a campfire. You decide to clean your glasses and notice that your eyes feel warmer without your glasses. Explain this phenomenon.

- Before taking them off, the glasses were working as an insulating barrier between the fire and your eyes. The glasses protected against radiation heat from the campfire. After you take off your glasses, your eyes feel warmer due to direct heat radiation from the fire to your eyes.

6. We wear winter coats and cover with blankets to stay warm in the winter. If the coats and blankets are not a source of energy, how do we stay warm?

- The coats and blankets we wear may not be sources of energy, but they are great insulators for us in the winter. What they do is they trap your own body heat within. They also prevent it from mixing with any cold air on the outside.