Activity 4.1 How to maintain warm your house model

The Problem:

In winter we need energy to maintain warm our house. By using suitable designed house models, it is possible to analyse how much energy it takes to warm each house model 5°C warmer than the air around it.

Learning aims:

The main objectives of such activity are to:

- design an experiments to measure the heating an cooling of different house models by using the same heating procedure;
- identify the different factors that can influence the heat dispersion and control them in the design.
- measure how much energy is necessary to warm each house model 5°C warmer than the environment.

Materials:

- Boxes of different materials (styrofoam, wood, glass, aluminum, plasterboard) and equal dimensions, modeling different kinds of houses.
- Temperature sensors to put in the wall opposite to the heater.
- Heaters (light bulbs covered by aluminium sheets)

Suggestions for use:

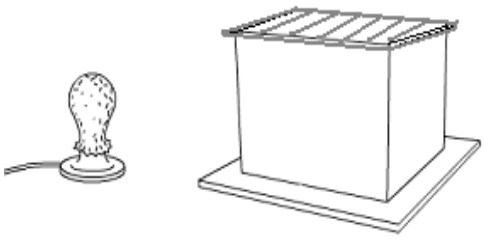


Figure 1_1a

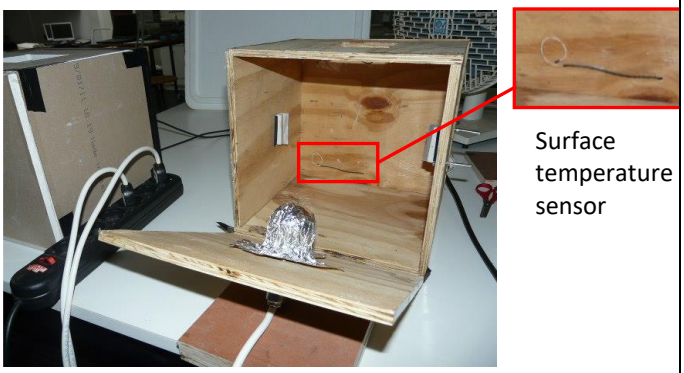


Figure 1_1b

Different groups of students can be supplied with different house models having the same dimensions and constructed using different materials. The heater and the sensor are placed as reported in Fig 1:1b.

The main problem is to test how fast their house models heat up and then cool down with a known power source (the heater).Students are asked to :

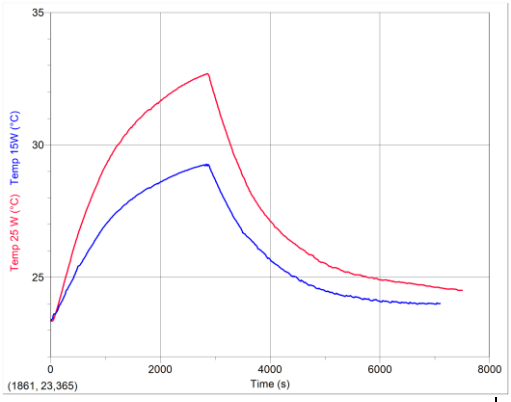
- turn on the heater and register the temperature until it reaches approximately the value of T_{env} +5°C.

- Then, turn off the heater so that the temperature lowers until Tenv.
- Record the times in which the heater is turned on and off.
- Calculate the time amount the heater has to be on to keep the house warm (T_{env} +5°C).

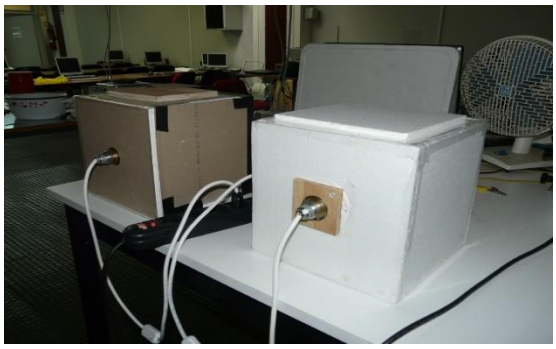
Each group will report to the whole classroom its results in order to point out what model is better for saving energy.

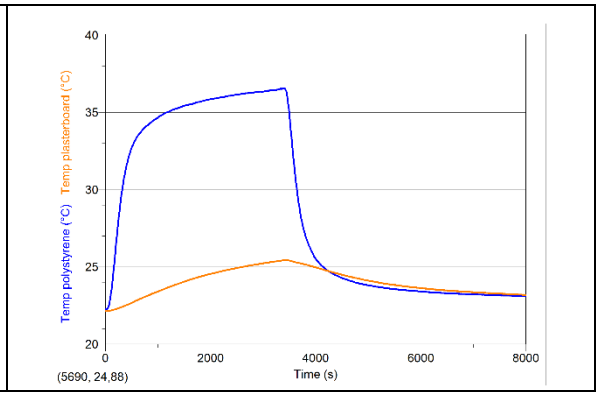
The following images show some temperature data from different houses under different thermal conditions.

1. Heating-cooling cycle of the wooden house model warmed by a 15 W lamp (blue line) and 25 W lamp (red blue line):



2. Heating and cooling curves of house models constructed with plasterboard core vs. polystyrene with a 25W heater.





NOTE

In this activity the teacher can introduce students to the different types of thermometers. Starting from the familiar mercury-in-glass one, the teacher can present and discuss the use of modern digital thermometers, based on semiconductor probes, and infrared ones, that allow to measure the temperature of distant objects, without having to have a "physical" contact with it.

Then, microcomputer based temperature sensors can be presented and, in particular, the surface type one, that will extensively used in this and in the following activities.

As a last step, photos of thermograms can be shown, in order to introduce students to thermal/colour analysis, a subject that will be deepened in the fourth sub-unit.

Possible questions:

How do you think you could reduce the power necessary to maintain warm the house ? What would you change about your house to minimize the necessary power to keep the house warm and why?