

Activity 4_1: Light heats up objects. Why and how?

General problem:

Building a low energy house needs a very accurate planning Step in which all possible heat dispersion phenomena must be carefully investigated in order to realize appropriate devices to save the thermal energy produced both by traditional heating systems and/or from direct exposure to the Sun.

The design of a thermodynamically efficient house needs knowledge and competences in several topics. In particular, it is important to know the characteristics of the building materials for what concerns the storage of thermal energy and even more important the understanding of all those factors which contribute to the collection of thermal energy available from the surrounding environment.

Introductory questions:

1) Describe some cases of heating produced by a light source:

2) How is it possible to measure the effects produced by the light incident on an object surface?

3) Can the same light source, placed at the same distance from two different objects, produce heating up to different temperatures?

YES, because:

NO, because:

4) Think about an experiment you could realize in your classroom in order to give an experimental answer to the previous question:

Sketch your experimental setup of measurement in the following:

Target of your experiment:

Construction of an home-made radiometer

Material needed for each group:

- 2 aluminium cans;
- 3 surface temperature sensors, with PC interface;
- White and black paint;
- Scissor, scotch tape and ruler.

Procedure:

Use the scissor to cut an aluminium can and make three rectangular plates having the same dimensions (7 cm) x (4 cm), measured by the ruler. Paint of black one of the plates and white another one and leave unpainted the third. As soon as the paint dries, scotch the tip of the surface temperature sensor to the back of each plate and fix them on a polystyrene support suitably shaped (see figure). Connect the temperature sensor to the PC through the laboratory interface and you will be ready to start your measurements of light radiation.



A 400 W halogen lamp, as that one shown in figure, can be used as light source to be placed at a certain distance from the plate of the home-made radiometer.



Experiment:

Required: home-made radiometer, halogen lamp, ruler, chronometer.

Procedure: Place the unpainted radiometer at an horizontal distance of 30 cm from the halogen lamp switched off, with the surface of the plate placed vertically and centred in front of the lamp. Start the measurement of the surface temperature of the radiometer plate and wait 10 seconds before switching on the lamp for further 30 seconds, illuminating the radiometer. Then switch off the lamp and remove it from the view of the radiometer. Continue the measurement until the temperature of the radiometer does not reach again the initial temperature.

Question n. 1: Why the radiometer increases its surface temperature?

Question n. 2: Which transport mechanisms of light energy do you think could be responsible of the rise in temperature observed during this experiment?

Question n. 3: Which is, in your opinion, the most relevant transport mechanism of light energy during this experiment?

Question n. 4: How is it possible to distinguish between the several transport mechanism of light energy during this experiment?
