# Dress for Success:
# Light Absorption and Light Reflection

## Challenge

Imagine you are going on a summer hike up the side of a sunny mountain with no shade in sight. What color clothing will keep you the most comfortable? Explain why you think so.

## What will we investigate?

In this investigation we will explore **light absorption** and **light reflection**. We will investigate how the color of a box influences the temperature of the air inside. You will work in pairs – each pair of students will use two identical boxes, one white and one black. All the groups will share their results for comparison.

## Equipment and Materials

- einstein™Tablet+ or einstein™Labmate+™ paired with a tablet
- 2 cardboard boxes, identical in size, big enough to hold the einstein™ device
- Masking tape
- Black paint
- White paint
- Paint brush

**Note**: Make sure your tablet and LabMate are fully charged before beginning the experiment

## Experimental Setup

### Group Work

1. Turn on the einstein™Tablet+ or einstein™Labmate+™ paired with a tablet.
2. Tap the MiLAB ( ) icon to open the application.

## Sensor Setup

Tap the **Setup** cog ( ) and use the table below to set up the measurement parameters:

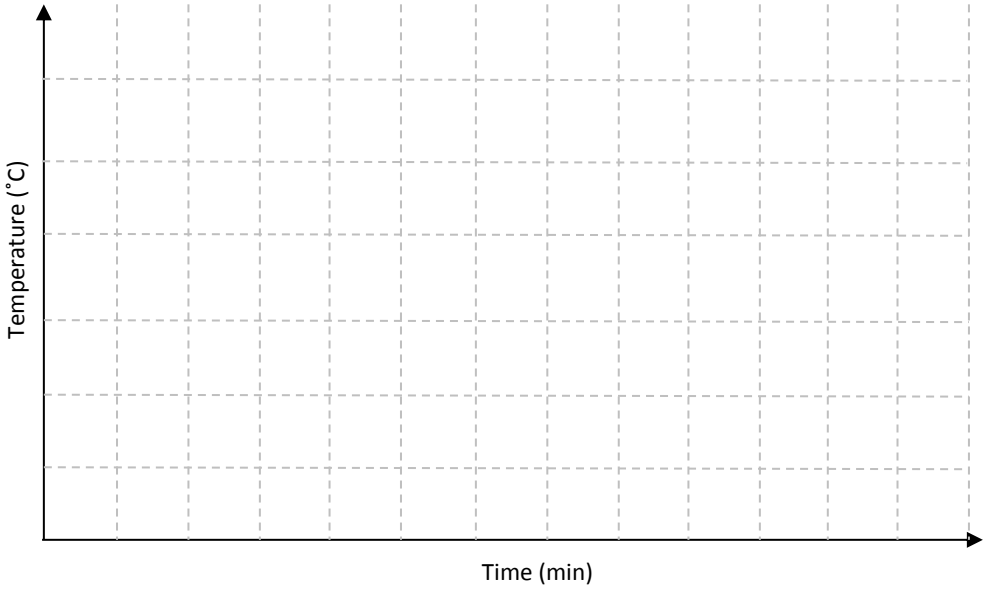
| | |
|---|---|
| **Sensor:** | Temperature (-30 to 50 ˚C) |
| **Rate:** | 1/Sec |
| **Duration:** | 30 Minutes |

## Before You Begin

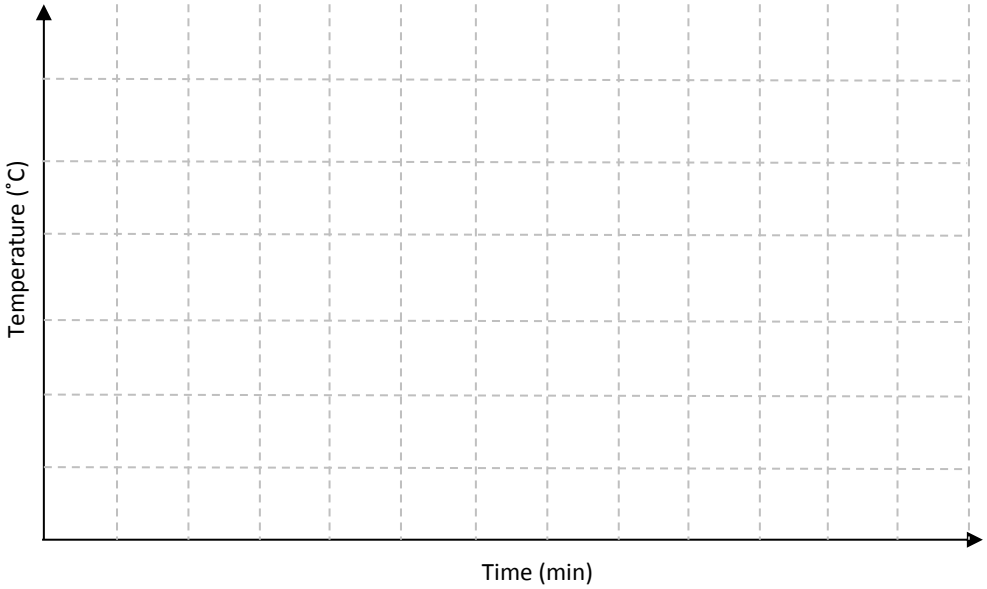
Do you think there will be a change in temperature in the white box? Do you think there will be a change in temperature in the black box? How will the temperatures of the two boxes compare? Explain your answer.

Sketch how you think the temperature may (or may not) change over time when the boxes are placed in the sun.

### White Box

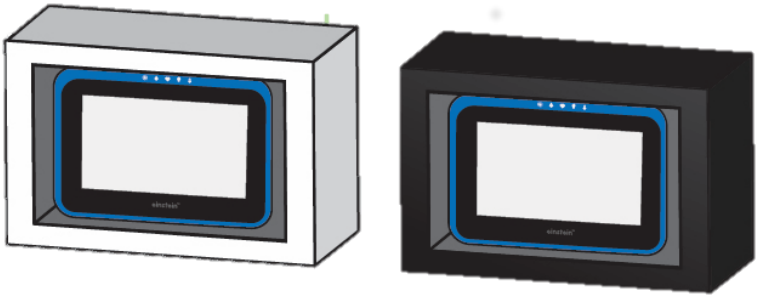


# Black Box




## Experimental Procedure

1. Use the paint and paintbrush to paint one box white and set it aside to dry.
2. Use the paint and paintbrush to paint the second box black and set it aside to dry.
3. *Optional: If you are using an einstein™Tablet+, you may want to cut open a window which will allow you to observe the measurements as you go along.*
    a. *Carefully cut open a window on the faces of the boxes. Get a grown-up's help to do this.*
    b. *Cover the window with clear plastic and seal it well with tape.*
4. Place your einstein™ devices into the black and white boxes. Use tape to secure them.
5. Use tape to seal the two boxes.
6. Take the boxes outdoors. Set them up so that the backs of the boxes (opposite the window if you have one) are facing the sun.
7. Choose both graph and meter displays. *(Note: If you are using an einstein™ Tablet you should do this before inserting the Tablet+ into the box)*
8. Tap the **Run** ( ) button to begin measuring and then seal up the boxes and position them so that the sun is shining directly on the back of the boxes. *(Note: If you are using an einstein™ Tablet you should do this before inserting the Tablet+ into the box)*
9. Follow the temperature changes of the air in the boxes on the screen of your tablet.
10. After the data is collected, give the file a name and save your data.



## Understanding the Measurements

1. On a warm sunny day it is possible that the air inside one or both of the boxes will heat up so much that it will be warmer than the maximum temperature which the internal sensor can measure (50 ˚C).
2. If this is the case, use the cursor on the graph to determine the time at which the temperature sensor reached its maximum value.
3. Next, look at the tablet in the second box. Use the cursor on the graph to read the temperature at this same time during the experiment. Use this temperature as your value for “Final Temperature” for this box.
4. If the tablets in both boxes reached the maximum temperature of the internal sensor (50 ˚C), determine which box reached the maximum temperature first. Use this time to read the temperature from each graph.
5. Create a data table like the one below which will allow you to compare the data from all the pairs of lab partners.

### Sample Data Table

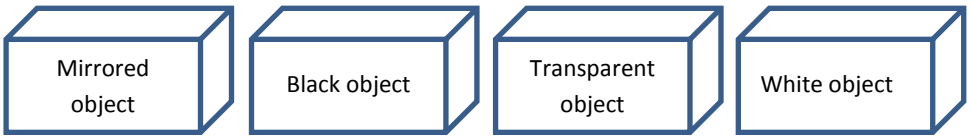
| Run | | Starting Temperature (˚C) | Final Temperature (˚C) | Temperature Difference (˚C) |
|---|---|---|---|---|
| Run #1 | White | | | |
| | Black | | | |
| Run #2 | White | | | |
| | Black | | | |
| Run #3 | White | | | |
| | Black | | | |

Examine the results in the shared data table.

## What just happened?

1. In which box did the air warm up more?
2. Why did the temperature rise more in one box than the other?
3. What happened to the light that reached the black box? What about the light that reached the white box?
4. Did your prediction agree with the results of the experiment?

## Using What You Learned




1. What will happen to light that shines on each of the surfaces above?
2. Return to the challenge question: What color clothing will keep you most comfortable on your hike? When making your argument use evidence from your experiment to back up your claim.
3. What color would you choose for a hike on a cool day in the sun?

## Understanding the Science

The sun is a natural source of light. Light from any source has common characteristics: Light travels in a straight line. It travels very quickly – 300 000 km/s when travelling through a vacuum. When light encounters an object, it is either reflected by the object, absorbed by the object or transmitted through the material it encounters. What happens depends on the properties of the material the light encounters. An object which is dark appears that way because it is absorbing much of the visible light shining on it and reflecting very little. An object which is light in color, appears that way because it is reflecting much of the visible light shining on it and absorbing very little. The light which is absorbed by an object transfers some of its energy in the form of heat. So, an object which absorbs more light, heats up more than one which reflects more light.