ScienceCube

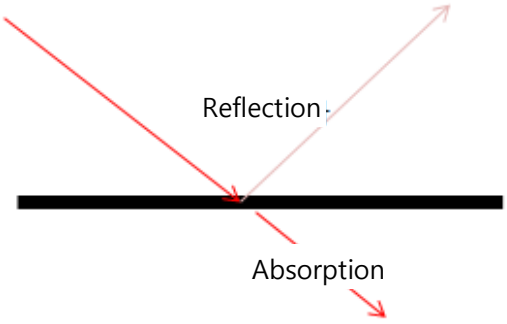
Albedo of Earth

Measure the albedo of papers of different colors and explain the albedo and temperature differences of the Earth's surface.

Fundamental Concept

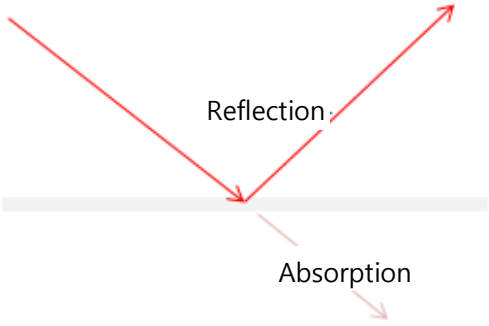
1. Light Reflection Based on Color

[Black Paper]



Absorption Rate > Reflection Rate

[White Paper]



Absorption Rate < Reflection Rate

2. Earth's Heat Balance

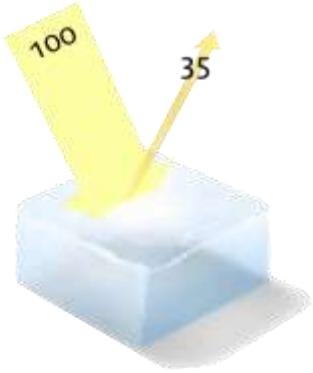
1) Albedo

Albedo refers to the reflectivity of the Earth's surface in response to solar radiation passing through the atmosphere. It is generally expressed as a percentage (0-100%), with Earth's average albedo being about 30%..

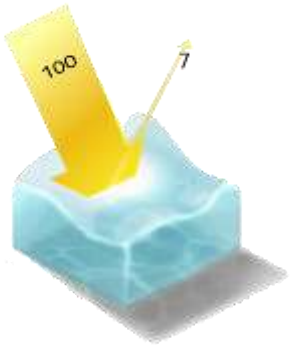
*Albedo based on surface material

Surface Material	Clean Snow	Grassland	Concrete	Forest	Dark Soil	Ice	Water
Albedo (%)	85	15-25	17-27	5-10	3	35	1

[Grassland]



[Ice]



[Water]

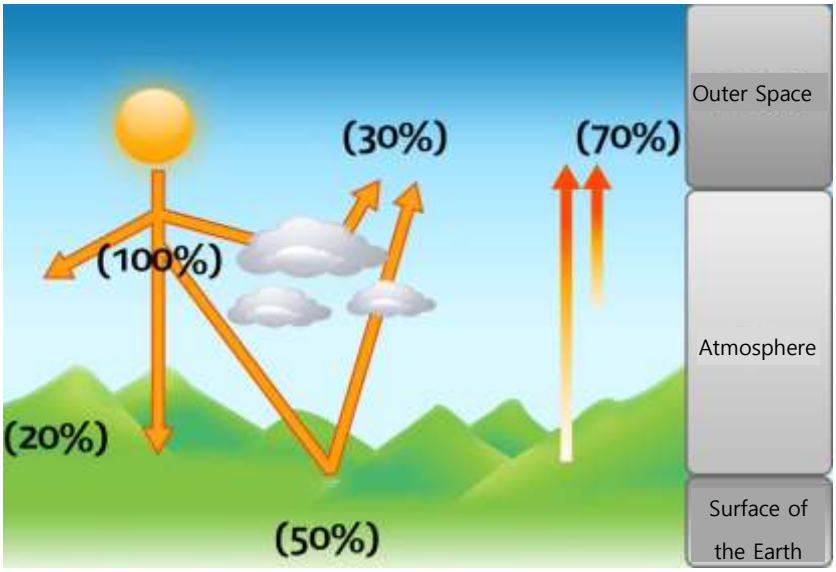
*Albedo of different celestial bodies

Since light primarily scatters in the atmosphere, planets with atmospheres have much higher albedos than those without.

Celestial Body	Moon	Mercury	Earth	Venus
Albedo (%)	0.12	0.142	0.367	0.67

2) Earth's Radiation Balance

The Earth's average annual temperature remains constant due to the balance between absorbed solar radiation and emitted terrestrial radiation..



[Earth's Radiation Balance]

Experiment

Materials Needed

Interface, Science# Program, Pt Temperature Sensor, Light Sensor, Thick Straw, Incandescent Lamp (100W or more), Aluminum Foil, Black Paper, White Paper, Stand, Clamp, Cellophane Tape, Ruler

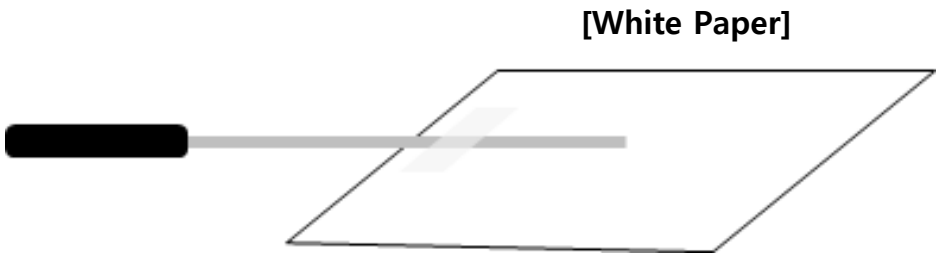
Preparation of Experimental Setup

1. Cut the thick straw to about 4 cm and tape it to the bottom to fix it.

2. Insert the temperature sensor deeply into the straw, ensuring the tip does not touch the bottom.

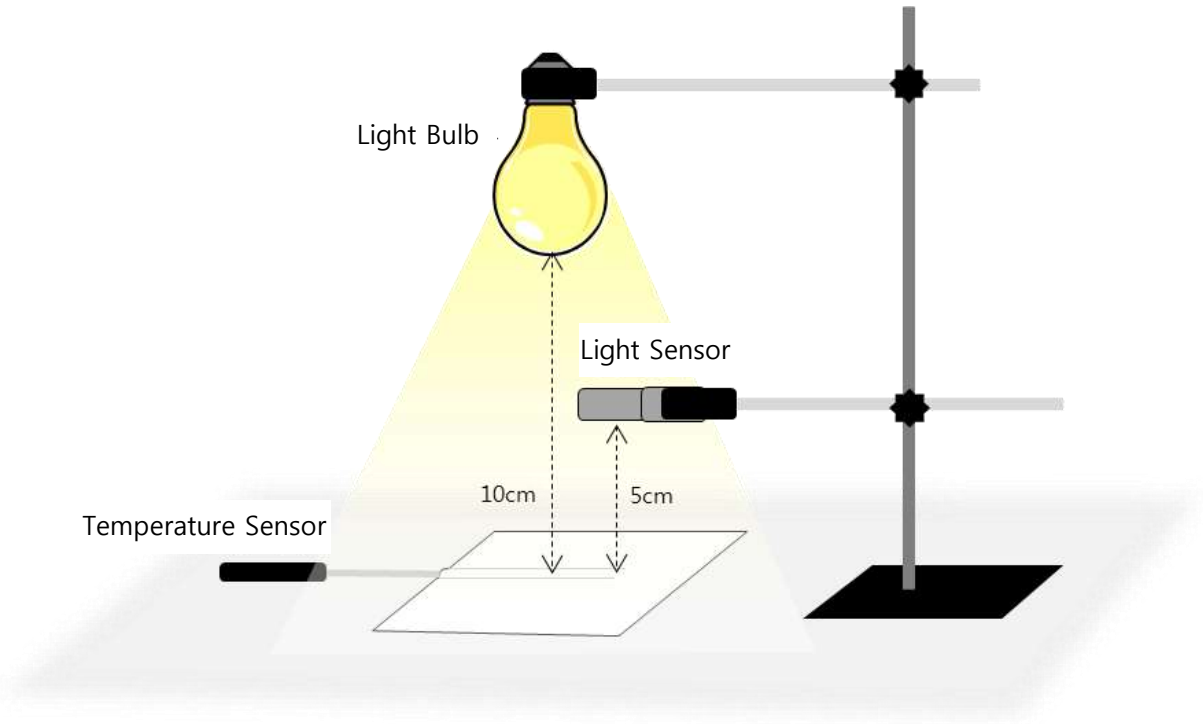
3. Cover the temperature sensor with white paper.

4. Alternatively, tape the temperature sensor to the paper and place it upside down as shown below.



5. Use the stand to position the lamp and light sensor towards the white paper. Adjust the height so that the lamp is 10 cm and the light sensor is 5 cm away from the paper.

6. Ensure the surrounding environment is bright..

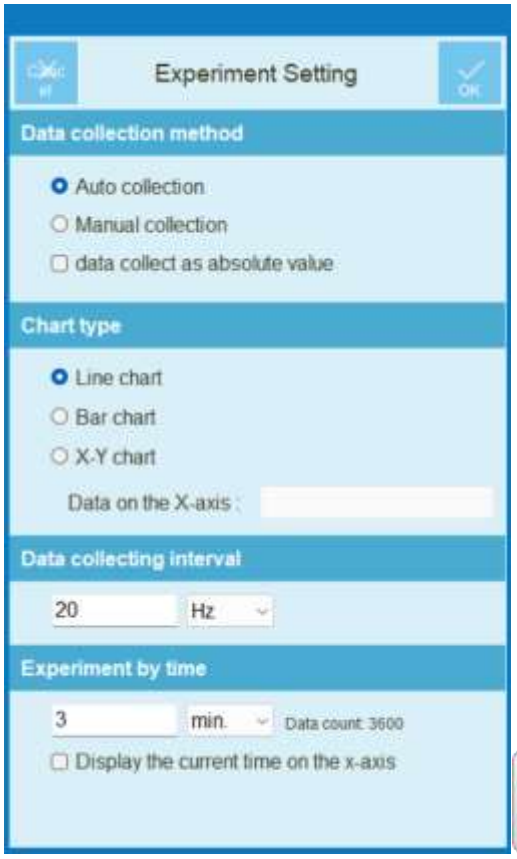


Interface Setup

1.  Launch the Science# program.

2. Connect the temperature sensor and light sensor to the interface.

3. Press  to set up the experimental environment as shown below, or use the automatic setting option.. 



 [Automatic setup]

Data Collection

1. Turn on the lamp and press  to start data collection, recording the initial temperature.
2. After data collection, turn off the lamp, and record the final temperature and light intensity over a set period.
3. Repeat the experiment with black paper and aluminum foil instead of white paper.

(To control the initial temperature of the temperature sensor, place it in room temperature water after each use.)

Data Analysis

Recording Data

1. Plot graphs of the measured temperature and light intensity for different colored papers.

2. Compare the light intensity graphs for different colored papers.

3. Compare the temperature change graphs for different colored papers.

4. Record the initial temperature, final temperature, temperature change, and light intensity (reflection value) for different colored papers in the table below.

5. Calculate the albedo for each color paper using the reflection formula and record it in the table.

$$(\text{Reflectivity})(\%) = \frac{(reflection\ value\ for\ aluminun)}{(reflection\ value\ for\ aluminum)} \text{ X } 100$$

Data Application and Extension Activities

1. Based on the experiment results, list the colors in order of the largest temperature change.

2. Based on the experiment results, list the colors in order of the highest albedo.

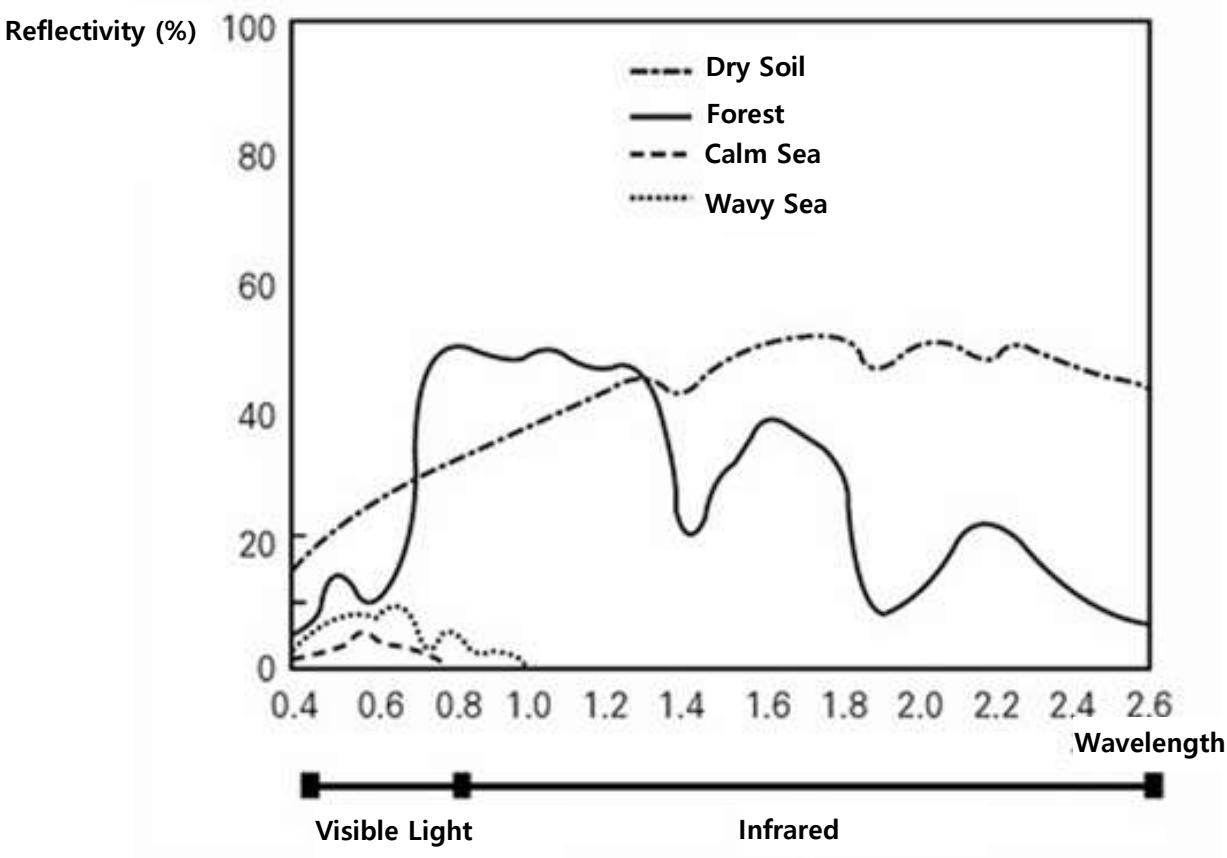
3. Explain the relationship between temperature change and albedo.

4. Considering various types of Earth's surfaces, predict which surface will have the highest albedo and estimate the Earth's albedo..

[Types of Earth's Surface]

Snow	Forest	Farmland	Sand	Ice	Ocean

5. The following image shows the albedo of various states of Earth's surface. Based on this data, predict the expected change in Earth's temperature if the surface state changes.



1) If deforestation increases dry soil areas, will Earth's average temperature increase or decrease?

2) If sea levels rise and ocean areas increase, will Earth's average temperature increase or decrease?