ScienceCube

Radiative Equilibrium

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1. **Observe temperature changes in an aluminum cup when exposed to light over a set period and explain radiative equilibrium.**
2. **Compare temperature changes in aluminum cups of different colors.**

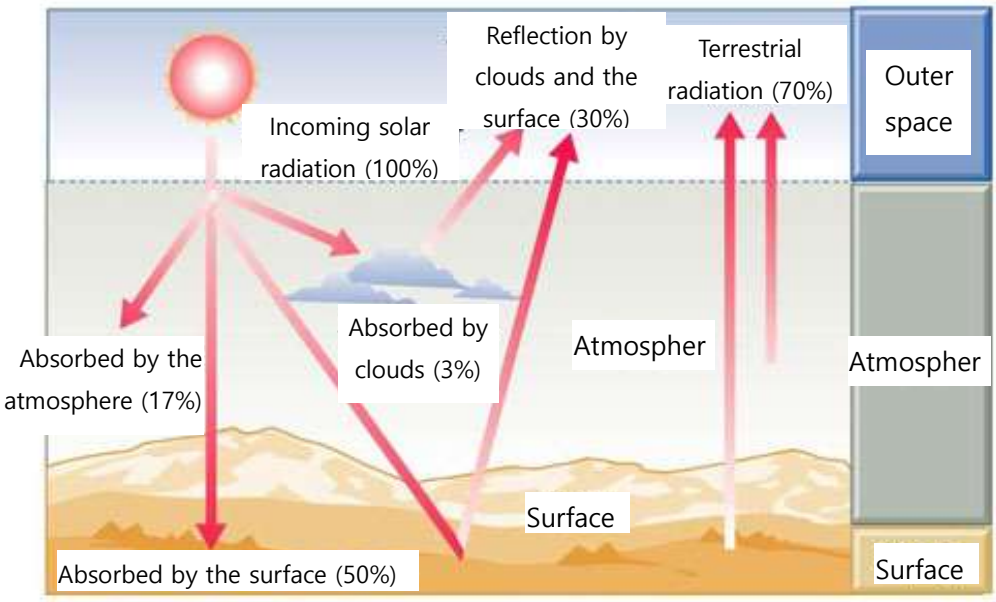
Fundamental Concept

1. **Radiative Energy**

   (1) Solar Radiative Energy: Radiative energy emitted by the sun, in the form of visible light, infrared, and ultraviolet rays → mostly emits visible light

   (2) Earth's Radiative Energy: Radiative energy emitted by the Earth, mostly in the form of infrared radiation

2. **Earth's Heat Budget** : Comparison of the amount of heat energy absorbed by the Earth and the amount of heat energy emitted by the Earth.

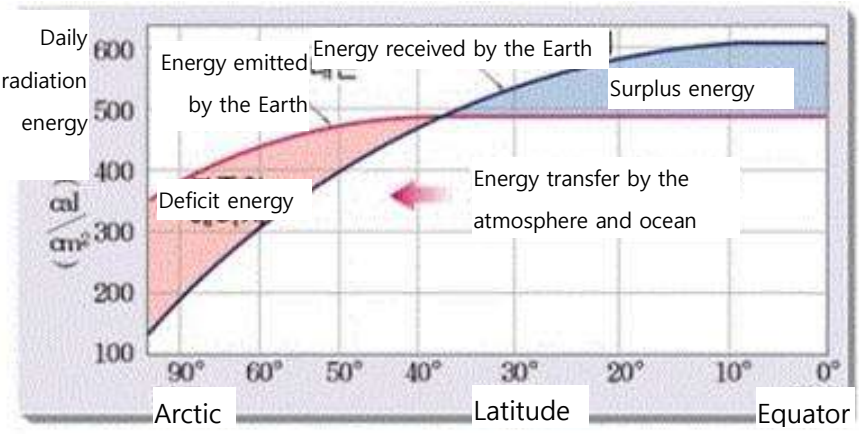


Earth's radiation balance

(1) Earth's Radiative Equilibrium: The state in which the amount of solar radiative energy absorbed by the Earth (70%) is equal to the amount of radiative energy emitted by the Earth (70%), maintaining a constant average global temperature

(2) Greenhouse Effect: The phenomenon where some of the Earth's radiative energy emitted from the surface is absorbed by greenhouse gases in the atmosphere and re-radiated back to the surface, keeping the Earth warm

3. Distribution of Radiative Energy by Latitude



Latitudinal distribution of solar and terrestrial radiation energy

(1) Low Latitude: Absorbed solar radiative energy > emitted Earth's radiative energy → energy surplus

(2) High Latitude: Absorbed solar radiative energy < emitted Earth's radiative energy → energy deficit.

(3) Reason for nearly constant annual average temperature by latitude: Energy surplus at low latitudes is transported to high latitudes through atmospheric and oceanic circulation.

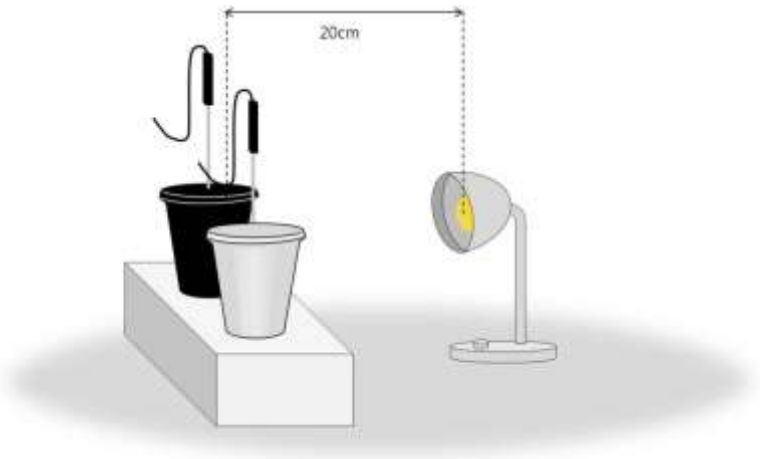
Experiment

Materials Needed

Interface, Science# program, Two temperature sensors, Black and white aluminum cups, Lamp, Ruler, Stand (for height adjustment), Teflon tape (or clay)

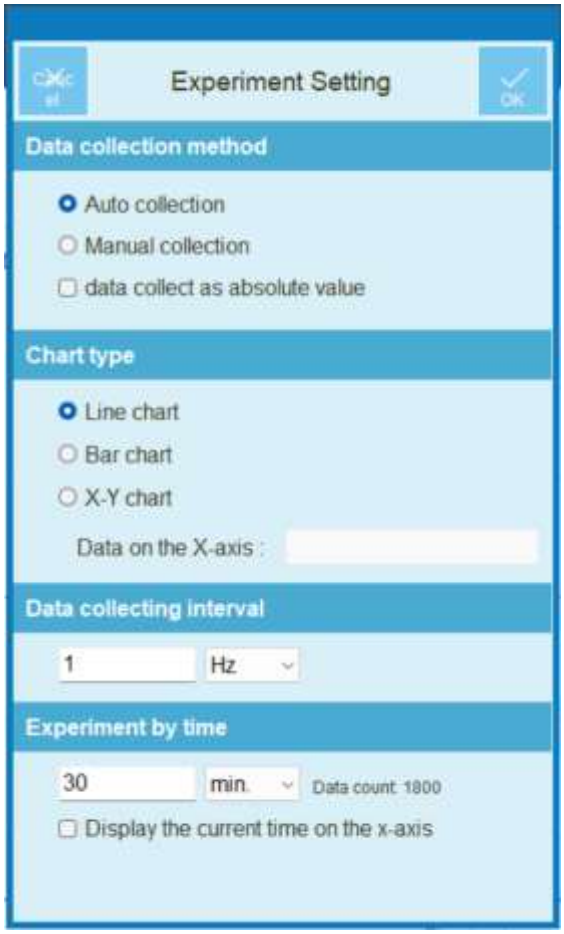
Experiment Setup

1. Insert temperature sensors into the aluminum cup lids and seal any gaps with Teflon tape or clay.
2. Adjust the height of the temperature sensors in the two aluminum cups so that they are at the same level and place them side by side.
3. Position the lamp 20 cm away from the aluminum cups, directing it towards the cups.
4. Adjust the height of the aluminum cups so that they are level with the lamp.



Interface Setup

1. Run the Science# program.
2. Connect the two temperature sensors to the interface.
3. Press to set the experimental environment as shown below or press for automatic setup.



[Automatic Setup]

Data Collection

1. Press and turn on the incandescent lamp.
2. Measure and record the temperature changes inside the aluminum cups over a set period. (Ensure that factors affecting the temperature change of the aluminum cups are removed before the experiment.)

Data Analysis

Recording Data

1. Draw a graph showing the temperature changes in the two aluminum cups.

2. Record the temperature differences in the two aluminum cups over a set period in the table below.

Category	Initial Temperature (°C)	Final Temperature (°C)	Temperature Difference (°C)	Equilibrium Temperature (°C)
White Aluminum Cup				
Black Aluminum Cup				

Data Application

1. Explain how the temperature inside the aluminum cup changes over time.

2. Explain the reason for the observed phenomenon.

3. Describe the significance of each experimental setup component..

Category	Aluminum Cup	Lamp
Significance		

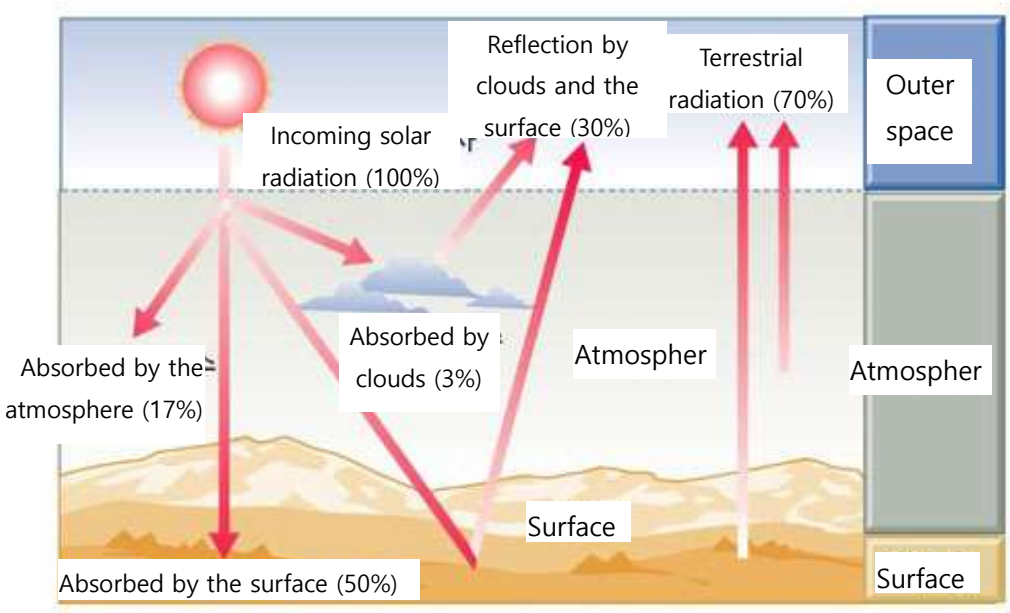
4. Explain the differences in temperature changes between the white and black aluminum cups and provide the reason.

Extension Activity

1. Based on the experimental results, explain why the Earth's average temperature remains constant over a long period.

2. Predict the results if the black aluminum cup's distance from the lamp was varied and describe the expected temperature changes.

3. The following diagram represents the Earth's heat budget..



Earth's radiation balance

Identify all correct statements from the options provided..

< Options>

A. The amount of solar radiative energy absorbed by the Earth is 70%.
B. The amount of solar radiative energy reflected by the Earth's atmosphere and surface is 30%.
C. The amount of Earth's radiative energy emitted into space is 50%.

4. Predict how temperature distribution by latitude would differ if the Earth's axial tilt did not exist


Report
(For Students)
Report
(For Teachers)