NASA Image, The Pale Blue Dot, imaged by Voyager. Earth from 6 billion km.

In the picture above, the spacecraft Voyager I has gone past the orbit of Pluto and is well into the Kuiper belt, a region of space sparsely populated by dwarf planets and other rocky objects. The Earth is just visible in the sunbeam because it has an albedo, that is the surface reflects some of the radiation from the Sun. The rest is absorbed and over thousands of years the Earth reaches an equilibrium temperature where the radiation absorbed during the day equals the radiation emitted during the night. If the radiation absorbed is changed, for example by a changing albedo, then the equilibrium will be disturbed and the Earth will try to reach a new equilibrium temperature. Climate change models seek to determine what that new equilibrium temperature will be when radiation absorption patterns are changed, for whatever reason.

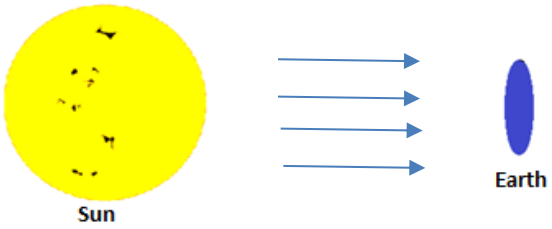
1. Context of the activity:

- Light is reflected differently from different surfaces or colours. In this activity, we measure the percentage of reflected light from sheets of paper with colours similar to those that dominate the surface of our planet, taking as a standard the shiny side of a sheet of aluminum (good reflector).

- If the Earth were a disc ($area = \pi R_E^2$), the solar radiation incident perpendicular to the atmosphere for all wavelengths, is about **1370** W/m^2. This value is called the solar constant, and was measured by satellites placed above the atmosphere (at a point where the Sun is directly overhead).

- Some of the incoming solar radiation is reflected by the atmosphere, clouds and the Earth's surface, constituting the Earth's **ALBEDO**.

- The ***albedo*** of a planet is the % of incident radiation reflected by the planet.



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2. Learning Outcomes:

- Are able to use a light sensor to measure the amount of illumination.
- Are able to determine the percentage reflectance for different colours.
- Are able to estimate the Earth's albedo from the results obtained.
- Know that albedo affects global warming.
- Are able to estimate, in what dimension different surfaces in urban areas are affecting the Albedo effect.
- Are able to make a direct relation of use up / consumption of soil and change of Albedo.

3. Experiment notes and instructions:

1. Position the light sensor **5** *cm* above the sheet (see fig **1**). The existing light in a classroom will be sufficient for this activity.

   Note: If using the Vernier light sensor, select the range 0-600 lux.

2. Set up DataQuest Mode for Selected Events

   Enter the name "*colour*" and enable the average over 10 *s*

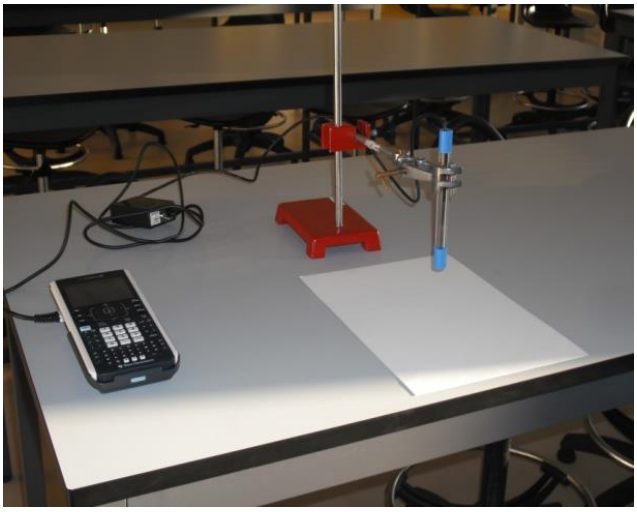

Fig 1

3. Start collecting data using the foil first and remembering that a sample is averaged over 10 seconds.
4. Repeat the same process for all sheets.

   4a. Extension: Repeat the same process with different soil surfaces at your location, e.g. concrete, lawn, asphalt, raw earth, gravel path, …

5. To do the calculations, open a new Lists & Spreadsheet application and enter the data obtained in DataQuest.

4. Results

Colour	Aluminum	White	Green	Blue	Sand colour	Black
Reflection value (Lux)						

4a. Results extension

Colour	Concrete	Lawn	Asphalt	Raw Earth	Gravel Path	…
Reflection value (Lux)						

5. Questions

1. Since the earth is roughly a sphere, and not a disc, determine the average value of the incoming solar radiation over the entire Earth at the upper surface of the atmosphere.

2. Calculate the percentage of light reflectivity of each of the colours, and fill in the table.

Colour	Aluminum	White	Green	Blue	Sand colour	Black
% of reflectivity	**100%**					

3. What type of surface will give a planet a high reflectivity? Explain.

4. Does planet Earth have a high reflectivity? Explain.

5. The distribution of surface area of earth is approximately: water-70%, deserts - 9%, forests and plantations - 14%, ice and snow - 7% and Asphalt - 0.05%. Based on this information and with the results obtained, make an estimate of the albedo of the Earth. *(Do the calculations in a Lists & Spreadsheet application)*

6. Find out what the current value for the Earth's albedo is and compare with the value obtained in this activity (suggestion - determine the relative error)

7. Based on the results, determine the energy absorbed (in W/m2) by the earth's surface.

8. How is the so-called "global warming" affected by the albedo of our planet?

Extension questions (on the natural soil surfaces; results 4a)

- What can be stated with the help of these measurements?
- Which types of surfaces dominate in your city?
- How many hectares of the areas with the least Albedo effect have been lost in your region during the last 20 years?
- What direct influences do have the different surfaces on the local climate?