FYI A Planet's Temperature

A planet's temperature is an important characteristic related to many factors, such as how much electromagnetic radiation reaches the planet from the sun, how much of that electromagnetic radiation is reflected by the planet and how much is absorbed, and if/how the absorbed energy is trapped and distributed.

Temperature, heat, and electromagnetic radiation are related but different concepts.

- **Temperature** is a measure of the average energy of the particles (atoms and/or molecules) in objects or systems. This energy is in the form of the motions of those particles. In an object with higher temperature—a hotter object—the particles move extremely fast. In an object with a lower temperature—a colder object—the particles move more slowly. The temperatures need to be close to absolute zero, which is as cold as it gets, in order for us to directly observe the motions.
- **Heat** is a form of energy directly related to the internal energy of an object or system—to the motion of the atoms and molecules that make up the object or system. (An **atom** is a building block for all matter. It is the smallest unit of an element, such as hydrogen (H) or helium (He), that retains the properties of that element. A **molecule** is the smallest particle of a substance, such as water (H_2O), that retains all the properties of the substance. A molecule is composed of two or more atoms.). As an object or system receives heat, its temperature rises. Similarly, as an object or system loses heat, its temperature decreases.
- **Electromagnetic radiation** is a form of energy that propagates through space at the speed of light. **Visible light**, which we refer to simply as "light," is the form of electromagnetic radiation that we see with our eyes.

When electromagnetic radiation from the sun reaches a planet (or moon), some of the energy from the sun is absorbed by the planet. This absorbed energy becomes part of the planet's energy and helps determine the temperature of the planet. The more energy a planet absorbs from the sun, the higher that planet's temperature.

The amount of energy available for absorption is not the same for each planet, however. The amount of electromagnetic radiation reaching a planet decreases rapidly as distance from the sun increases. As a result, the amount of energy available for absorption is much lower for planets and moons farther from the sun. This means that, all else being equal, the farther a planet is from the sun, the lower that planet's surface temperature.

In fact, "all else" is not equal. Not all planets are equally able to absorb and trap electromagnetic radiation from the sun. Other factors, such as a planet's albedo and a planet's atmosphere (if any), also influence a planet's temperature. A planet's albedo determines how much of the electromagnetic radiation reaching the planet is actually absorbed. **Albedo** is a measure of the reflectivity of a planet. More specifically, it is the fraction or percentage of incoming radiation that is reflected by the atmosphere and/or the surface of a planet. The higher the albedo, the more radiation is reflected. For example,

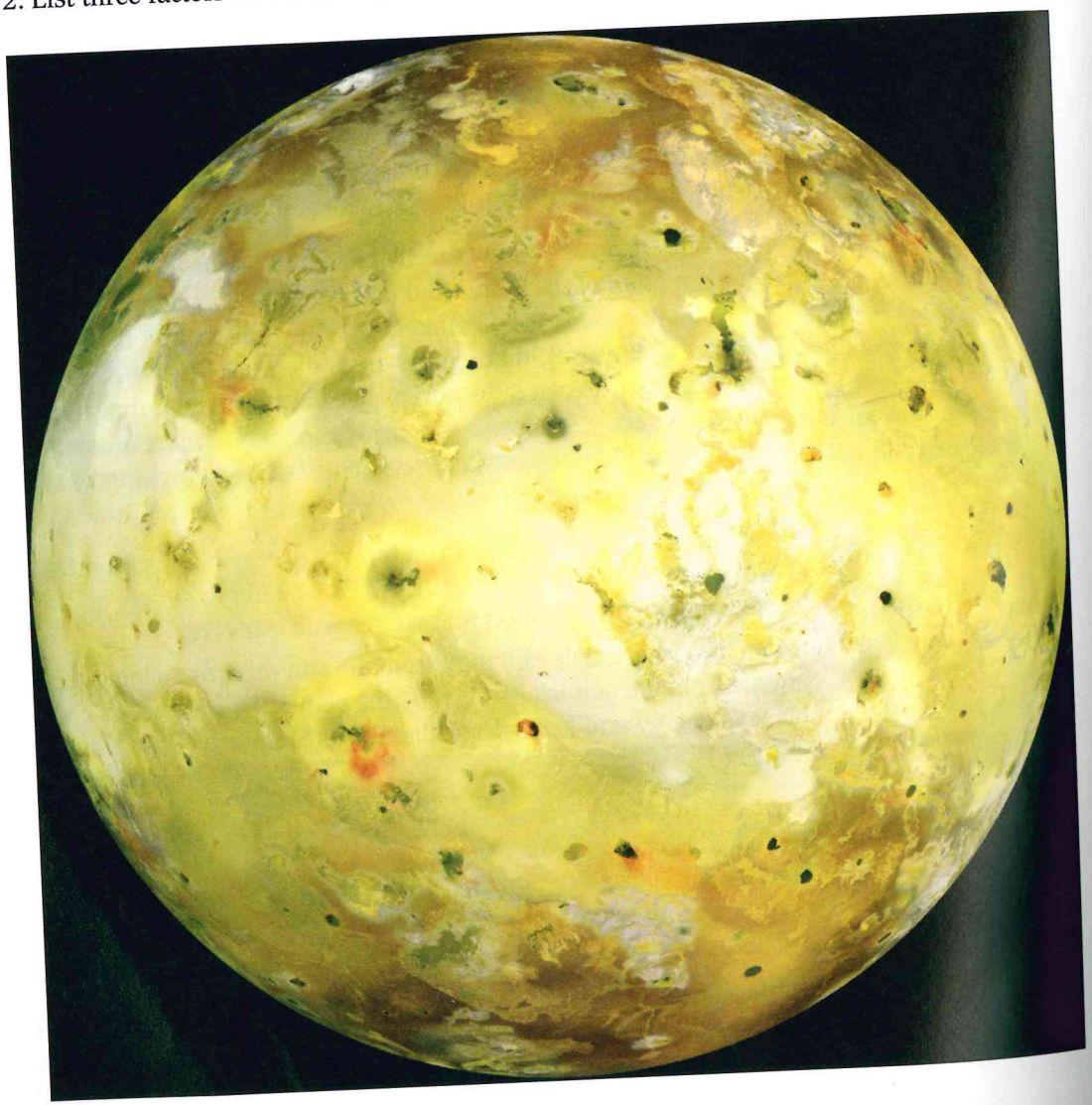
ice, which is highly reflective, has an albedo about 0.8, or 80%. Earth, with its oceans and clouds, has an albedo of 0.37, while the moon has an albedo of only 0.11.

In addition, not all planets are equally able to hold on to the energy they absorb from the sun's electromagnetic radiation. An atmosphere plays a major role in how much heat a planet can retain, the range of temperatures experienced by a planet, and the distribution of temperatures across a planet. (See FYI: *The Importance of an Atmosphere.*) We talk about a planet's average temperature, minimum temperature, and maximum temperature.

Finally, planets and moons do have other sources of energy that can contribute to their temperatures. For example, there are internal sources of heat, such as volcanism.

Checking In

1. How are heat and temperature different?
2. List three factors that affect a planet's temperature.



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