Exploring the Optimal Environmental Conditions for Life

Living Space

Temperature on Earth and on the ISS

Action Project
Backgrounder

Temperature on Earth

We experience temperature every day. When we move around our environment, we may feel hot, warm, cool or cold. When we talk about how hot or cold something is, we are talking about its temperature. In science, temperature is a measurement of the movement of particles that make up all matter.

Temperature is measured using a device called a thermometer. The thermometers you have probably seen have a red liquid (coloured alcohol) inside a thin tube. As the temperature rises, the liquid moves up the tube. We read a thermometer by looking at the number line beside the tube.

There are several units of measurement for temperature. In Canada, and in many places around the world, people use the metric unit of measurement which is called **Celsius**. The short form of Celsius is °C. The Celsius scale sets the freezing point of water at 0°C and the boiling point of water at 100°C.

People feel temperature differently. A room may feel warm to one person and cool to another. Sometime a room may feel too hot or too cold for everyone, which can be a problem! When people spend time in a hot place, they begin to feel tired and thirsty. The danger level for high temperature is when body temperature rises above 40°C. At this temperature people can experience **hyperthermia**. Hyperthermia can give you a headache as well as make you feel dizzy or faint. Hot environments can also affect people's mental well-being. When hot, people can get moody and aggressive and have a hard time concentrating. This can make learning a challenge.

Did you know?
The average normal body temperature is around 37°C.

People also tend to feel uncomfortable in cold environments. When people are in cold environments, they may find that their cheeks turn red, their noses run and they shiver. The danger level for low temperature is when the body temperature drops below 35°C. At this temperature, people can experience **hypothermia**, which is the opposite of hyperthermia. Hypothermia can make people's legs and arms feel numb, and can affect heart rate and breathing.

When we are cold, our immune system also does not work as well. This means that when people are cold, they tend to get more colds and the flu as well as infections in the sinuses and lungs. This explains why so many people get sick in the winter.

So, what is the optimal or 'best' range for temperature in a classroom? It depends on the season. In the spring, summer and fall, the optimal temperature for an indoor environment is 24.5°C with an acceptable range of 23°C - 26°C. In the winter, the optimal temperature for an indoor environment is 22°C with an acceptable range of 20°C - 23.5°C.

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Temperature on the International Space Station

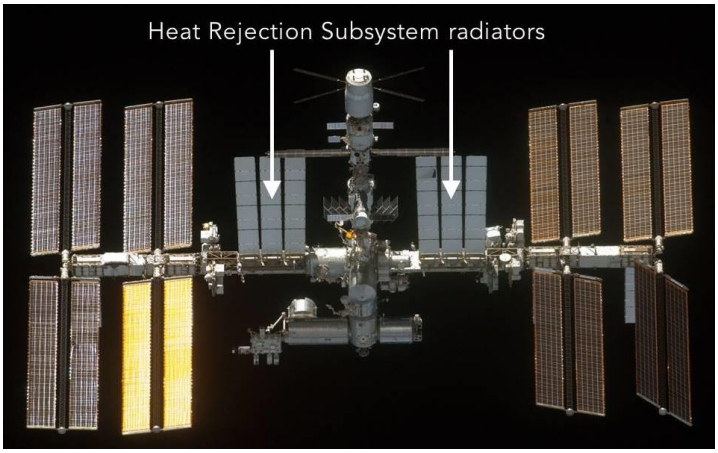
On Earth, temperatures can vary a lot, from 50°C and higher in the hottest deserts to -50°C and lower in the Arctic regions. Earth's atmosphere helps to spread heat around. It usually gets cooler at night or in the shade, but not much cooler. The temperature on the side of the International Space Station (ISS) facing the Sun can reach 121°C, while the side facing away from the Sun can go as low as -157°C. This is a difference of almost 300°C! People cannot live in temperatures that high or low, so engineers designing the ISS had to figure out how to keep the inside of the space station at a comfortable temperature for astronauts and equipment.

The first way that heat is controlled inside the ISS is through the use of **insulation**. Most of the ISS is coated with blankets of Multi-Layer Insulation (MLI), which are made up layers of Mylar and Kapton. These lightweight materials are also used to make emergency blankets here on Earth. These blankets help to keep heat inside the ISS, keep outside heat from entering the ISS, and protect astronauts inside the ISS from solar radiation.

Inside the ISS, there are a lot of electronic devices that generate heat. The astronauts themselves also generate heat. A system called the Active Thermal Control System (ATCS) keeps the temperature inside the ISS comfortable for the astronauts. The ATCS has three subsystems: one for heat collection, one for heat transportation, and one for heat rejection.

Heat collection happens through several **heat exchangers** around the ISS. These keep the temperature at around 24°C, allowing astronauts to work comfortably in t-shirts.

Heat transportation is done using closed loops of pipes filled with water. The heat exchangers heat up the water in the pipes, which then transport the heat to another set of closed loops of pipes filled with ammonia, which freezes at a much lower temperature (-77°C) than water.



The Heat Rejection Subsystem radiators on the International Space Station. (Photo by NASA)

The pipes filled with ammonia transport the heat outside of the ISS to the **Heat Rejection Subsystem** (HRS) radiators. These radiate (give off) excess heat into space. The HRS radiators are the two big sets of light-coloured panels that can be seen on the outside of the ISS near the crew modules.

Another important part of controlling the temperature in the ISS is moving air inside the station. The ATCS must work with the Environmental Control and Life Support System to make sure that warm air is flowing throughout the ISS. This prevents cold spots in the station, which could lead to condensation, corrosion, or even fungi growing in the ISS.