Living Space

Light on Earth and on the ISS

Action Project
Backgrounder

Light on Earth

Sometimes a day is bright and cheery, and other times it is dark and gloomy. How bright or dark a place is has to do with light. When we talk about how "bright" light is, we could be talking about how much light a light source gives off, how intense the light source appears, or how well the light source lights up objects at a distance. Let's look at these one at a time.

1. Lumen

The total amount of visible light coming from a light source is called its **luminous flux**. The unit of measurement is the **lumen (lm)**. The higher then number of lumens, the brighter the light source (see the table on the right).

Brightness →	450 lumens	800 lumens	1600 lumens
Incandescent	40 W	60 W	100 W
Compact Fluorescent	10 W	13 W	23 W
LED	5 W	10 W	20 W

2. Candelas

The intensity of a light source is called its **luminous intensity**. The unit of measurement is the **candela (cd)**. Candelas are a useful measurement when you want to compare beams of light, such as flashlights, spot lights and laser points. The number of candelas also tells you have far away you can be from a light source while still being able to see it. 1 candela is roughly equal to the light from a single birthday candle.

3. Lux

The amount of light falling on a surface per unit area is called **illuminance**. This is one of the most commonly used measurements of light. The unit of measurement for this is **lux (lx) 1 lux = 1 lm/m^2**. Lux is measured using a device called a **Lux meter**. Imagine you were sitting outside readying a book. On a bright day, the pages would be easy to read (and maybe a bit too bright even), that is because the illuminance is very high (large lux). When the clouds come out, the book will get harder to read because the illuminance is not as high. At sunset, you might not be able to read the book at all because the illuminance is low (small lux).

	Lux
Full daylight	10 000
Cloudy day	1 000
Dark stormy day	100
After sunset	10
Full moon	< 1

The brightness of light on surfaces around us can affect how we fell physically as well as mentally. If lux levels are too high, people can strain their eyes and get headaches. An overly bright room can also make it difficult to concentrate, and for some people, they may feel wound up. It is even possible to damage to eyes if light sources and lux is too high. If lux levels are too low, again people can strain their eyes and get headaches. They may even get sleepy since light stops the production of melatonin, a hormone that makes people sleepy. If a room is very dark, it is possible for people to bump into objects and feel afraid.

People who design indoor lighting try to find a light level (lux) that works best for the things people do in those spaces. For example, theatres and stairwells are usually fairly dim (200 lx); kitchens, libraries and grocery stores are brighter still (500 lx), and operating rooms are very bright (1 000 lx). People who design lighting also need to consider other things such as safety, maintenance and cost.

So, what is the optimal or 'best' range for light in a classroom? The best range is between 250 - 500 lx. 300 lx is best in areas where students work most, and 500 lx in areas that teachers use most.

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Exploring the Optimal Environmental Conditions for Life

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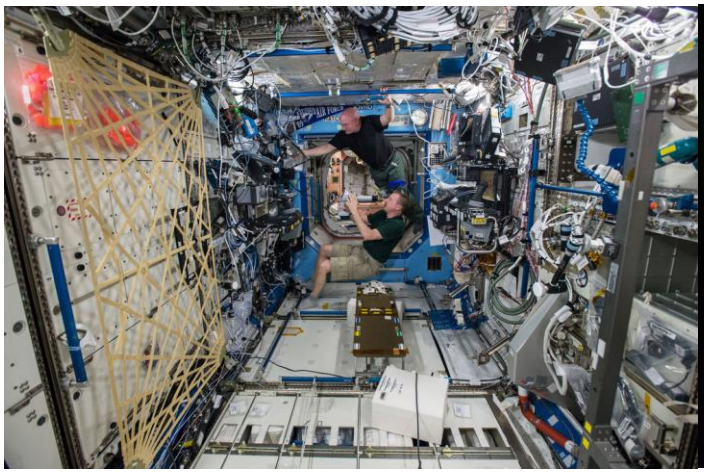
Light on the International Space Station

One of the many things that is different about living on board the International Space Station (ISS) is that astronauts get to see 16 sunrises and sunsets each day! Because the ISS orbits the Earth every 90 minutes, astronauts on board don't have the same sense of day and night that we do on Earth, which rotates once every 24 hours. This can be a problem for astronauts' **circadian rhythms**. The circadian rhythm is our body's natural clock, which controls our sleeping and eating patterns. Our circadian rhythm is connected to the light-dark cycle on Earth, so if people don't get those light and dark cues from their environment it can have bad health effects.

The ISS uses its indoor lighting system to simulate a 24-hour day-night cycle. The clocks on the ISS are set to **Coordinated Universal Time** (UTC). Astronauts have 15 ½ hours of simulated daylight, when the lights in the station are at full brightness, and 8 ½ hours of sleep time, when the lights are dimmed (the lights can't be turned completely off, in case of an emergency). Despite this, most astronauts only sleep about 6 hours a day, and sleep problems are common amongst astronauts in space. Problems with their circadian rhythms from being in space have a lot to do with astronauts' sleep problems.

When the ISS was first assembled in space, the lighting system used long fluorescent light tubes called General Luminaire Assemblies for its lighting. These lights give off a particular colour of light (sky blue) that wakes up our brains and makes us feel more alert. Looking at blue light before bedtime makes it harder for people to calm down and get to sleep, so the lights on the ISS were contributing the sleep problems that astronauts were having. In 2016, the ISS began getting new LED lights, called Solid-State Light Assemblies. These lights have three different settings that help astronauts' circadian rhythms by changing light brightness and colour during the astronauts' day. The regular setting provides good light for astronauts to see during everyday activities. Before bedtime, the lights switch to a lower intensity that has less blue light, and there is also a setting with more blue light that can help astronauts when they need to concentrate and be more alert.



Above: Lighting inside the Destiny Laboratory Module on board the ISS during astronauts' work time. (Photo by NASA)

Above: Lighting inside the Destiny Laboratory Module on board the ISS during astronauts' sleep time. (Photo by NASA)

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