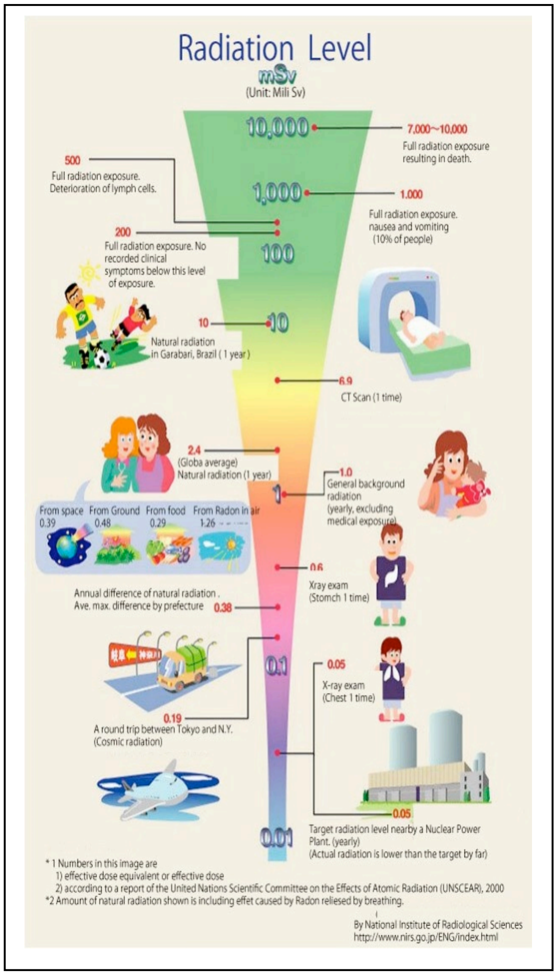

The Van Allen belts are also called ‘radiation belts’ because they are filled with very high energy electrons and protons. Although they would be totally invisible if you looked at them, the particles would penetrate your spacecraft, spacesuits and skin and cause radiation sickness or even death.

Since they were discovered in 1958, scientists have sent many spacecraft into this region of space to study its origins and radiation. The current Van Allen Probes spacecraft are the first spacecraft to intentionally operate where the belts are the most intense.

Although scientists have many precise ways to measure radiation levels, for humans and spacecraft, the Sievert (Sv) and the Gray (Gy) are the two most common. Gray is the amount of energy deposited in the material, while Sievert is the amount of energy and damage this radiation does to organic tissue.
1 Gy = 1 Sv multiplied by the damage it does.

<u>For x-rays and gamma-rays</u>, 1 Gy = 1.0 Sv,

<u>For electrons, 1 Gy = 1.0 Sv</u>

<u>For protons</u>, 1 Gy = 2.0 Sv

Problem 1 – A human living on the surface of Earth receives a total dose of 4 milliSv each year (365 days) from the natural environment, food, and other sources for which there is little control. What is the radiation dose rate in A) microSv/day? B) microSv/hour?

Problem 2 - The radiation dose rate on the International Space Station is 1 milliSv/day. How many days worth of natural background radiation does this dose rate equal on the ground?

Problem 3 – In the Van Allen belts, the average radiation dose rate for a satellite is about 50 Gray per year. If a human astronaut had the same shielding as a satellite, and required 1 hour to travel through the Van Allen belts, what would be their total dose at the end of the trip if 1 Gray = 1 Sievert?

Problem 4 – Satellites are eventually damaged by the radiation effects they accumulate over their lifetimes. A satellite that accumulates 1000 Grays of radiation is usually at the end of its reliable lifespan. How long would such a satellite last in the Van Allen belts if its annual dose rate is 50 Gray per year for a lightly-shielded satellite?

Problem 1 – A human living on the surface of Earth receives a total dose of 4 milliSv each year (365 days) from the natural environment, food, and other sources for which there is little control. What is the radiation dose rate in A) microSv/day? B) microSv/hour?

Answer: A) 4 milli Sv / 365 days = 0.010 milli Sv/day or **10 microSv/day**.
B) 10 microSv/day x (1 day/24 hrs) = **0.4 microSv/hr**.

Problem 2 - The radiation dose rate on the International Space Station is 1 milliSv/day. How many days worth of natural background radiation does this dose rate equal on the ground?

Answer: 1 day on the ground equals 10 microSv or 0.010 milliSv. So every day on the ISS equals about **100 days on the ground**!

Problem 3 – In the Van Allen belts, the average radiation dose for a satellite is about 50 Gray per year. If a human astronaut had the same shielding as a satellite, and required 1 hour to travel through the Van Allen belts, what would be their total dose at the end of the trip if 1 Gray = 1 Sievert?

Answer: 50 Gy x (1/365 days) x (1 day/24 hrs) x (1 Sv/1 Gy) = 0.006 Sv/hour.

For 1 hour exposure in the spacecraft, this equals a total dose of **6 milliSv**.

Note, the average background radiation on the surface of Earth is about 4 milliSv in 1 year, so the astronaut in the Van Allen belts would accumulate a full year's normal dose in less than 1 hour! Additional shielding will reduce this considerably!

Problem 4 – Satellites are eventually damaged by the radiation effects they accumulate over their lifetimes. A satellite that accumulates 1000 Grays (100 kilorads) of radiation is usually at the end of its reliable lifespan. How long would such a satellite last in the Van Allen belts if its annual dose is 50 Grays per year for a lightly-shielded satellite?

Answer: T = 1000 Gy/50 Gy = **20 years**.