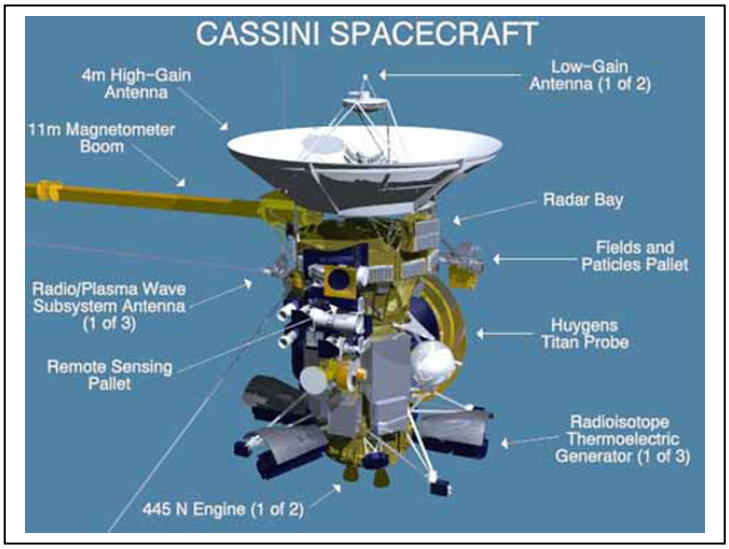

The Cassini mission is so far away from the sun that solar panels do not get enough sunlight to create solar electricity. At Saturn, the sun is nearly 90 times fainter than near Earth.

To produce electricity, the Cassini mission uses three RTG units. Each unit produces 296 watts of electricity from the decay of the element plutonium-238.

Problem 1 – The formula K = 273+(F-32)/1.8 is used to convert a temperature from degrees Fahrenheit to kelvins. Kelvins are commonly used by scientists and engineers to measure heat energy. For the RTGs onboard the Cassini spacecraft orbiting Saturn, the inside temperature is 2200 F and the outside temperature is -460 F. What is the temperature difference in kelvins?

Problem 2 - Each Cassini RTG uses plutonium-238 to generate the heat it needs to create electricity. One gram of plutonium produces about 0.57 watts of heat energy, but only 6.7% of this heat energy can be converted to electricity. How many kilograms of decaying plutonium do you need to provide the 296 watts from one Cassini RTG unit?

Problem 3 - The thermal 'heat' energy is produced by fast-moving neutrons from the decay of plutonium. An atom of plutonium-238 has 144 neutrons and 94 protons and decays into the element lead-206 which has 82 protons and 124 neutrons. How many protons does plutonium have if the number of neutrons in plutonium is 20 more than in lead?

Problem 1 – The formula K = 273+(F-32)/1.8 is used to convert a temperature from degrees Fahrenheit to kelvins, which are commonly used by scientists and engineers to measure heat energy. For the RTGs onboard the Cassini spacecraft orbiting Saturn, the inside temperature is 2200 F and the outside temperature is -460 F. What is the temperature difference in kelvins?

Answer: 2200 F = 1477 kelvins and -460 F = 0 kelvins so temperature difference is **1477 kelvins**.

Problem 2 - Each Cassini RTG uses plutonium-238 to generate the heat it needs to create the electricity. One gram of plutonium produces about 0.57 watts of heat energy, but only 6.7% of this heat energy can be converted to electricity. How many kilograms of decaying plutonium do you need to provide the 296 watts from one Cassini RTG unit?

Answer: T = thermal power, E = electric power, then E = 0.067T. Since you need E = 296 watts, you must have T = 296/0.067 = 4418 thermal watts of heat. Since 1 gram of plutonium produces 0.57 thermal watt, M = 4418 watts / 0.57 watts/1gm = 7750 grams or **7.75 kilograms**.

Problem 3 - The thermal 'heat' energy is produced by fast-moving neutrons from the decay of plutonium. The sum of the neutrons and protons in Pu-238 is 238, which decays into the element lead which has 82 protons and a total of 206 protons and neutrons. How many protons does plutonium have if the number of neutrons in plutonium is 20 more than in lead?

Answer:

We have: Np + Pp = 238 and 206 = Nl + 82
so Nl=206-82 = 124 neutrons in a lead atom

Then Nl +20 = Np so Np = 124+20 = 144 neutrons in plutonium

so Pp = 238-144 = **94 protons in plutonium**.