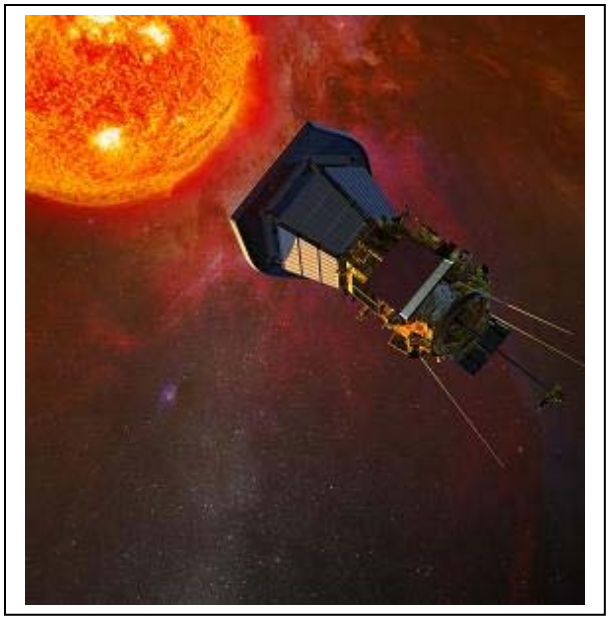

The Solar Probe Plus mission will be launched in 2018 for a rendezvous with the sun in 2024. To lose enough energy to reach the sun, the spacecraft will make seven fly-bys of Venus.

As the spacecraft approaches the sun, its heat shield must withstand temperatures exceeding 2500 F and blasts of intense radiation.

The 480 kg spacecraft, costing $740 million, will approach the sun to a distance of 6 million km. Protected by the heat shield will be five instruments that will peak over the edge of the heat shield and measure the particles and radiation fields in the outer solar corona.

A simple formula that predicts the temperature, in Kelvins, of a surface exposed to solar radiation is given by

$$T = 396\frac{(1-A)^{\frac{1}{4}}}{\sqrt{R}}$$

where R is the distance to the solar surface in Astronomical Units, and A is the fraction of the incoming radiation that is reflected by the surface. Because only the amount of absorbed sunlight determines how hot a body becomes, the final temperature depends on the quantity (1 – A) rather than A alone. (Note 1 Astronomical Unit is the distance of Earth from the center of the sun; 147 million kilometers).

Problem 1 – An astronaut's white spacesuit reflects 80% of the incoming radiation at Earth's orbit (1 Astronomical Unit). From the formula, about what is the temperature of the surface of the spacesuit?

Problem 2 - The Solar Probe Plus spacecraft will use a heat shield facing the sun with a reflectivity of about A = 0.60. What will be the temperature of the heat shield, called the Thermal Protection System or TPS, at the distance of 5.9 million km (0.040 AU), A) In Kelvins? B) In degrees Centigrade? C) In degrees Fahrenheit?

Problem 3 – Suppose that the TPS consisted of a highly-reflective mirrored coating with a reflectivity of 99%. What would be the temperature in Kelvins, of the back of the heat shield when the Solar Probe is closest to the sun at a distance of 0.04 AU?

Problem 1 – An astronaut's white spacesuit reflects 80% of the incoming radiation at Earth's orbit (1 Astronomical Unit). From the formula, about what is the temperature of the surface of the spacesuit?

Answer: $T = 396\frac{(1-0.8)^{\frac{1}{4}}}{\sqrt{1AU}}$ so **T = 265 Kelvin**.

Problem 2 - The Solar Probe Plus spacecraft will use a heat shield facing the sun with a reflectivity of about A = 0.60. What will be the temperature of the heat shield, called the Thermal Protection System or TPS, at the distance of 5.9 million km (0.040 AU), A) In Kelvins? B) In degrees Centigrade? C) In degrees Fahrenheit?

Answer: A) **T = 1600 K**.
B) Tc = Tk – 273 so **Tc = 1,300 C**
C) Tf = 9/5 (Tc) + 32 so **Tf = 2,400 F**.

Problem 3 – Suppose that the TPS consisted of a highly-reflective mirrored coating with a reflectivity of 99%. What would be the temperature in Kelvins, of the back of the heat shield when the Solar Probe is closest to the sun at a distance of 0.04 AU?

Answer: A = 0.99 then

$T = 396\frac{(1-0.99)^{\frac{1}{4}}}{\sqrt{0.04AU}}$ so Tk = **630 Kelvins**.

For more mission details, visit:

http://solarprobe.jhuapl.edu/

http://www.nasa.gov/topics/solarsystem/sunearthsystem/main/solarprobeplus.html