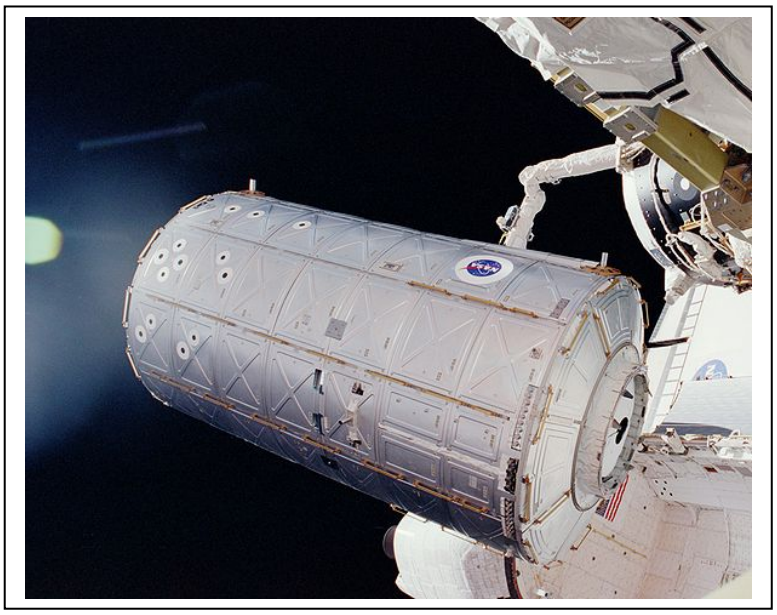
The Interior Volume of the *Destiny* Laboratory Module



The *Destiny* Laboratory module is the US-built module used for Earth science studies. It is also equipped with storage points for dozens of experiment modules that can be brought up from Earth or returned when the experiments are completed. Made of aluminum, Destiny is 8.5 meters long and has a diameter of 4.2 meters. The walls are about 10 cm thick and consist of an inner and outer shell of aluminum (density= 2.7 grams per cubic centimeter) about 0.3 cm thick. In between the two walls is polyurethane to improve radiation shielding of the astronauts inside.

Problem 1 – From the dimensions of the outer cylindrical shell, what is the volume of the Destiny laboratory to the nearest cubic meter?

Problem 2 - From the information of the wall thickness, what is the volume of the inside 'pressurized' cylinder?

Problem 3 - Suppose that the surface density of the outer wall is 2.7 kilograms per square meter. What is the total mass of the outer wall of the Destiny module including the two circular end-plates to the nearest kilogram?

Answer Key

Problem 1 – From the dimensions of the outer cylindrical shell, what is the volume of the Destiny laboratory to the nearest cubic meter?

$V = \pi r^2 h$, h = 8.5 meters, r = 2.1 meters so V = **118 cubic meters**.

Problem 2 - From the information of the wall thickness, what is the volume of the inside 'pressurized' cylinder?

The walls are 12 cm thick or 0.12 meters, so the inside radius is 2.1-0.1 = 2.0 meters. The length is 8.5 – 0.1 – 0.1 = 8.3 meters.

$V = 3.141 \times 2^2 \times 8.3 =$ **104 cubic meters**.

Problem 3 - Suppose that the surface density of the outer wall is 2.7 kilograms per square meter. What is the total mass of the outer wall of the Destiny module including the two circular end-plates?

Endplates: The end plates each have an outer radius of 2.1 meters and an area of $\pi (2.1)^2$ = 13.8 meters^2 for a total area of 27.6 meters^2. Their total mass is then 2.7 kg/m^2 x 27.6 m^2 = 74.5 kilograms.

Shell: The shell length is 8.5 meters and the radius is 2.1 meters so the area of this cylinder is $A = 2\pi rh = 2 \times 3.141 \times 2.1 \times 8.5 = 112.1$ meters^2. The mass is then 2.7 kg/m^2 x 112.1 meters^2 = 302.7 kilograms.

The total mass is then 302.7 + 74.5 = **377 kilograms**.