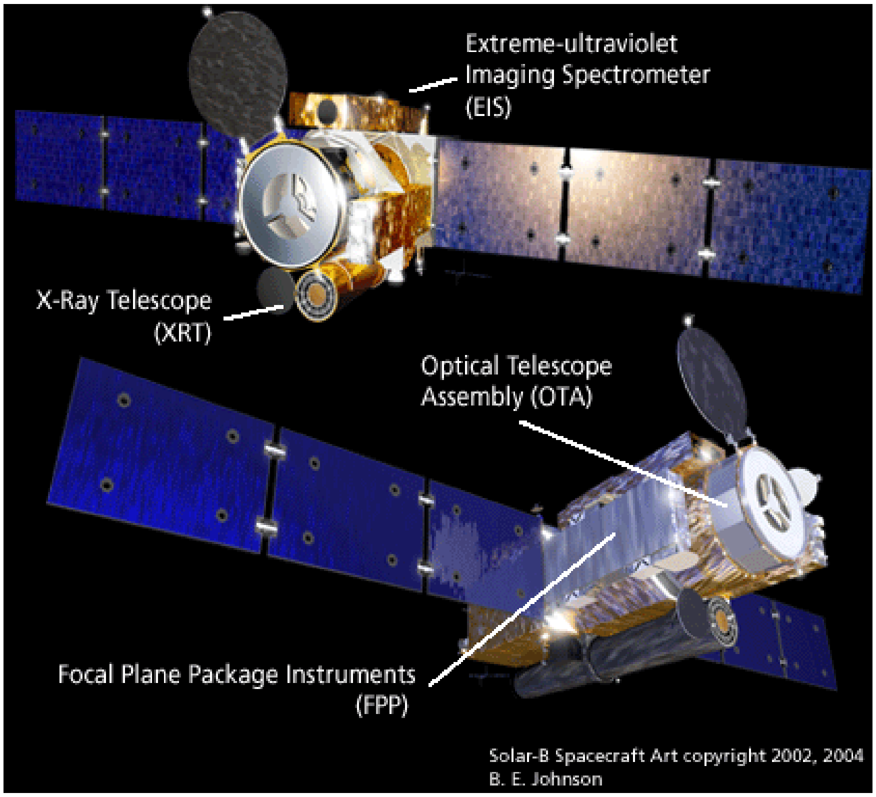
Hinode Satellite Power



The Hinode satellite weighs approximately 700 kg (dry) and carries 170 kg of gas for its steering thrusters, which help to maintain the satellite in a polar, sun-synchronous orbit for up to two years. The satellite has two solar panels (blue) that produce all of the spacecraft's power. The panels are 4 meters long and 1 meter wide, and are covered on both sides by solar cells.

Problem 1 - What is the total area of the solar panels covered by solar cells in square centimeters?

Problem 2 - If a solar cell produces 0.03 watts of power for each square centimeter of area, what is the total power produced by the solar panels when facing the sun? Can the satellite supply enough power to operate the experiments which require 1,150 watts?

Problem 3 - Suppose engineers decided to cover the surface of the cylindrical satellite body with solar cells instead. If the satellite is 4 meters long and a diameter of 1 meter, how much power could it produce if only half of the area was in sunlight at a time? Can the satellite supply enough power to keep the experiments running, which require 1,150 watts?

Answer Key:

Problem 1 - What is the total area of the solar panels covered by solar cells in square centimeters?

Answer: The surface area of a single panel is 4 meters x 1 meter = 4 square meter per side. There are two sides, so the total area of one panel is 8 square meters. There are two solar panels, so the total surface area covered by solar cells is 16 square meters. Converting this to square centimeters:

$$16 \text{ square meters} \times (10{,}000\ \text{cm}^2/\text{m}^2) = 160{,}000\ \text{cm}^2$$

Problem 2 - If a solar cell produces 0.03 watts of power for each square centimeter of area, what is the total power produced by the solar panels when facing the sun? Can the satellite supply enough power to operate the experiments which require 1,150 watts?

Answer: Only half of the solar cells can be fully illuminated at a time, so the total exposed area is 80,000 cm^2. The power produced is then:

$$\text{Power} = 80{,}000\ \text{cm}^2 \times 0.03\ \text{watts/cm}^2 = 2{,}400\ \text{watts.}$$

Yes, the satellite solar panels can keep the experiments running, with 2400-1150 = 1,250 watts to spare!

Problem 3 - Suppose engineers decided to cover the surface of the cylindrical satellite body with solar cells instead. If the satellite is 4 meters long and a diameter of 1 meter, how much power could it produce if only half of the area was in sunlight at a time? Can the satellite supply enough power to keep the experiments running, which require 1,150 watts?

Answer - Surface area of a cylinder = Area of 2 circular end caps + area of side of cylinder

$$= 2\pi R^2 + 2\pi R h$$

$S = 2 \times (3.14)\ (0.5 \text{ meters})^2 + 2 \times (3.14)\ (0.5 \text{ meters})\ (4 \text{ meters})$
= 1.57 square meters + 12.56 square meters
= 14.13 square meters.

Only half of the solar cells can be illuminated, so the usable area is 7.06 square meters or 70,600 square centimeters. The power produced is 70600 x 0.03 = 2,100 watts.

Yes..the satellite can keep the experiments running with this solar cell configuration.