Satellite Surface Areas

The NASA Imager for Magnetosphere-to-Aurora Global Exploration (IMAGE) satellite was launched on March 25, 2000. The instruments and other electrical systems inside the satellite are powered by solar cells on the satellite's outer surface. In this problem you will calculate the surface area of the satellite, and how much electrical power can be collected by the satellite. (Hints - http://image.gsfc.nasa.gov/poetry/workbook/page14.html)

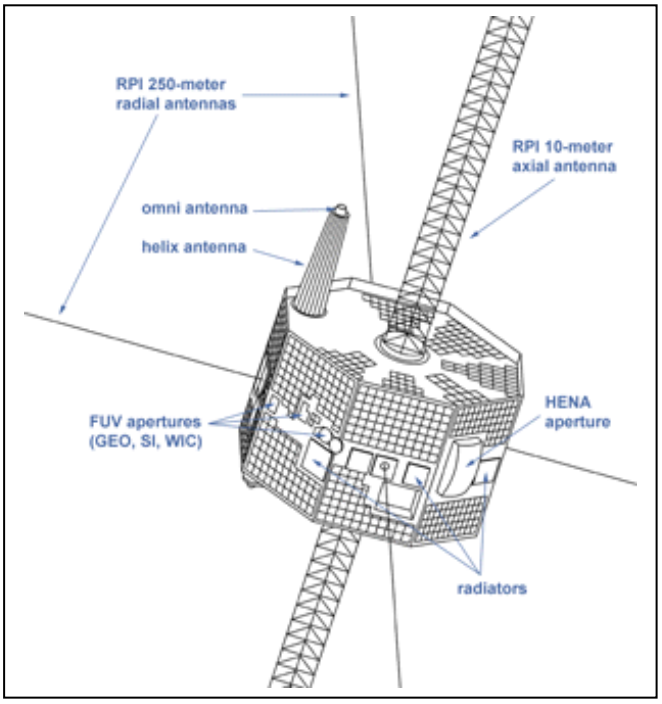
Question 1:

The shape of the satellite is an octagonal cylinder with a diameter of 237 centimeters. Each face has a width of 90 centimeters, and a height of 136 centimeters.

A) Calculate the surface area of the 8 faces in square centimeters.

B) Calculate the surface area of each of the two octagonal faces (top and bottom) in square centimeters.

C) Calculate the total surface area.



Question 2. Solar cells produce 0.0017 watts of electrical power per square centimeter from sunlight falling on their surfaces. What is the maximum power that can be produced by the satellite if only half of the solar cells that cover the satellite's surface actually face the sun at any given moment?

Answer Key

Question 1: The shape of the satellite is an octagonal cylinder. The satellite has a diameter of 237 centimeters (radius =118.5 cm) and is 136 centimeters tall. Calculate the surface area of the 8 faces in square centimeters. Calculate the surface area of each of the two octagonal faces (top and bottom) in square centimeters from a scaled drawing. Encourage students to use any reasonable method.

A) Area of 8 side rectangles with dimensions 90 cm x 136 cm:

8 x (90 cm) x (136 cm) = 97,920 square centimeters.

B) Area of top and bottom:
Each octagonal face consists of 8 isosceles triangles with a base of 90 cm and two equal sides of 118.5 cm. The height, h, of each triangle can be found from the Pythagorean Theorem as $h^2 = (118.5^2 - 45^2)$ or h = 109.6 cm. Students can also solve for h by making a scaled drawing of the triangle. The total area is then:

2 sides x 8 triangles x 1/2 (90) (109.6) = 157,824 square centimeters
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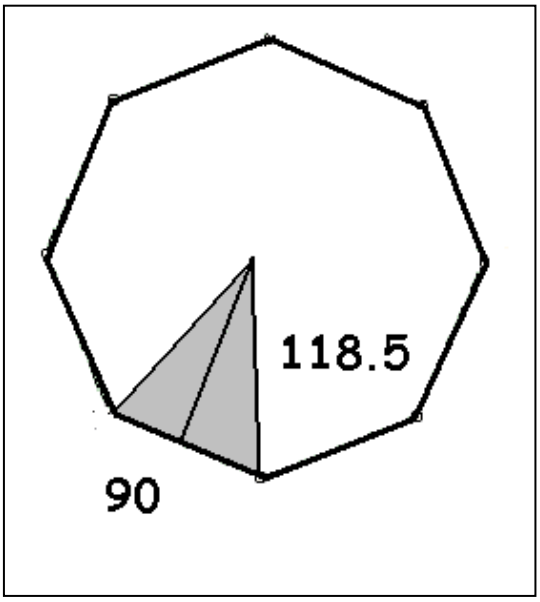

C) Total satellite surface area:

97,920 + 157,824 = 255,744 square centimeters.

Question 2. The solar cells produce 0.0017 watts of electrical power per square centimeter. What is the maximum power that can be produced by the satellite if only half of the solar cells face the sun at any given moment?

Only half of the satellite's surface area faces the sun at any one time, so the maximum possible wattage is

(0.5) x (255744 cm^2) x (0.0017 watts/cm^2) = 217 watts