Satellites use electricity to run their various systems and experiments. Since the dawn of the Space Age, engineers have used solar cells to generate this energy from sunlight.

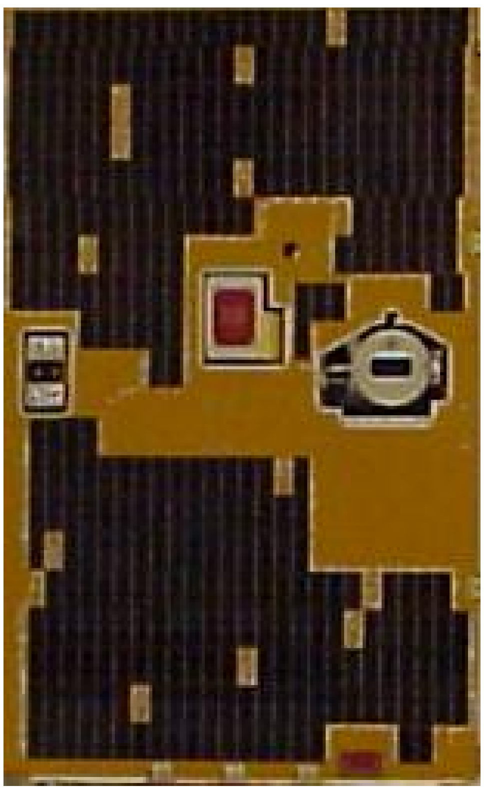
In this exercise, you will calculate how much power the IMAGE satellite can generate from one of its 8 hexagonal faces, allowing for the areas lost by instrument windows and other blank areas on the satellite. **Note: The solar cells used by the IMAGE satellite can generate 0.03 watts per square centimeter of area**.

Question 1: What is the usable area of the satellite's face shown below?

Question 2: What electrical power can be generated by the panel?

Question 3: If there are 8 similar panels on the satellite, what is the approximate total power that can be generated if all faces are fully illuminated, and have about the same number of solar cells?

IMAGE satellite Face 1



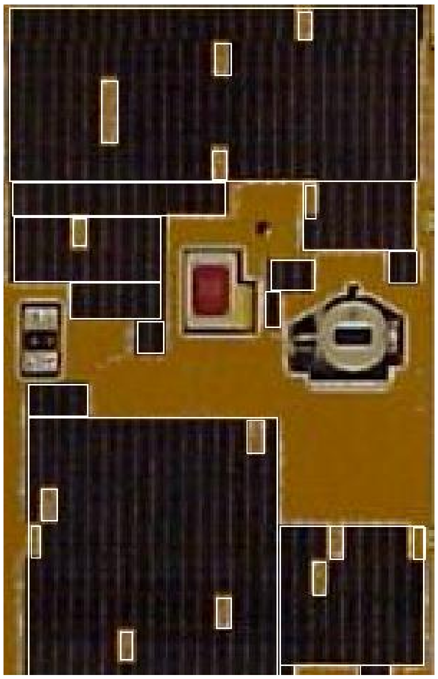
The panel above is 136 centimeters long and 90 centimeters wide. The solar cells that generate the electricity are shown in black. The brown-colored areas do not generate electricity.

Come up with a plan to determine the sizes of the black areas from the given information and image, then answer the three questions above after performing the required calculations.

Goal: Students will calculate the area of a satellite solar panel and estimate the total electrical power that can be generated. Students will use the images and dimensions provided to create a scaled drawing of each satellite face, and from this determine the scaled dimensions of the dark solar cell areas.

Note: If you want to make a full-sized model of the satellite visit the *IMAGE Satellite Scaled Model* page at

http://image.gsfc.nasa.gov/poetry/workbook/page14.html



A

B,C
D,E,F
G,H
I
J

K,L

As a benchmark: The maximum possible area of the panel is 136 cm x 90 cm = 12,240 sq cm. The maximum power is therefore (0.03 watts/sq cm) x 12,240 sq cm = 367 watts if the panel is fully illuminated.

The scale factor of the students image is 137 cm (actual) / 10.2 cm (picture) or **13.4**

Suggested Method: Determine the black area by breaking the panel into rectangles as indicated by the letters from left to right. Subtract from each rectangle the area of the non-black regions. There are 15 small rectangles within the boxed black regions. Each have the same size = 0.3cmx0.5cm (image). Note, perform all are a calculations in 'image' units, then convert final area answer to actual units by multiplying by (13.4)^2.

ID	W	L	A	ID	W	L	A	ID	W	L	A
A	6.0	3.5	21.0	**E**	0.7	0.5	0.4	**I**	0.4	0.5	0.2
B	0.5	3.2	1.6	**F**	0.5	0.5	0.3	**J**	0.9	0.5	0.5
C	1.0	1.7	1.7	**G**	1.4	0.5	0.7	**K**	3.7	4.0	14.8
D	1.0	2.3	2.3	**H**	0.2	0.5	0.1	**L**	1.9	2.0	3.8

W, L = image width and height in cm

A = image area in sq.cm.

Question 1: What is the usable area of the satellite's face? **Answer**: Add A-L areas to get 47.4 sq cm, then subtract the areas of the 15 non-celled rectangles (15 x 0.15 = 2.3) and get 47.4 – 2.3 = 45.1 square cm in image units. Convert to actual area by multiplying by 13.4 x 13.4 = 179.6. The total area of the solar cells is then 45.1 x 179.6 = 8100 sq. cm. Note, the maximum panel area is 12,240 sq. cm, so (8100/12240)x100% = 66% of the panel is covered by solar cells.

Question 2: What electrical power can be generated by the panel? **Answer**: 0.03 W/sq.cm x 8100 sq. cm = 243 watts.

Question 3: If there are 8 similar panels on the satellite, what is the approximate total power that can be generated if 4 faces are fully illuminated at a given time, and have about the same number of solar cells? **Answer:** 4 x (243 W) = 972 Watts.