



Most satellites that 'take pictures' of the sun, moon, earth and distant stars use a camera (called an imaging system) based on a Charge-Coupled Device (CCD) chip. These chips, like the one shown to the left, are similar to the ones used inside the common digital camera and consist of millions of individual sensors called 'pixels' in a square format.

CCD cameras are described according to the number of pixels they contain in multiples of one million pixels (1 megapixel). They are also described by their format in rows (M) and columns (N) as containing $M \times N$ pixels. The total number of pixels is usually rounded to the nearest power of 2 as is the row and column format.

For example, a CCD with a format of 1024×1024 pixels has a total of 1,048,576 pixels. In the digital camera industry, this is called 1 megapixel. A 4 megapixel CCD has a format of 2048×2048 pixels or 4,194,304 pixels.

Problem 1 - A digital camera created a 1024×2048 pixel image. What was the format of this image and how many megapixels did it contain?

Problem 2 - A new digital camera produces square images containing 16 megapixels. What is the likely format for the image, and the actual number of pixels in the image?

Problem 3 - The CCD and camera optics are designed so that, from an orbiting satellite, the picture will have a resolution of 1 meter per pixel. What are the dimensions of the total area that can be recorded in square 4 megapixel image in kilometers?

Problem 1 - A digital camera created a 1024x2048 pixel image. What was the format of this image and how many megapixels did it contain?

Answer: There were **1024 rows and 2048 columns** for a total of $1024 \times 2048 = 2,097,152$ pixels or **2 megapixels**.

Problem 2 - A new digital camera produces square images containing 16 megapixels. What is the likely format for the image, and the actual number of pixels in the image?

Answer; For a square image, one side will have a length of $m = n = (16 \text{ million})^{1/2}$ so $m=n=4,000$ pixels. Since m and n are specified as powers of 2, the format is **4096 x 4096**. The actual total number of pixels is $4096 \times 4096 = 16,777,216$ pixels.

Problem 3 - The CCD and camera optics are designed so that, from an orbiting satellite, the picture will have a resolution of 1 meter per pixel. What are the dimensions of the total area that can be recorded in a 4 megapixel image?

Answer: The format of the camera image is $m=n=(4 \text{ million})^{1/2} = 2,000$. The nearest power of 2 is $2^{11} = 2048$, so the actual format is 2048 pixels x 2048 pixels. At 1 meter/pixel, the image covers about **2.0 kilometers x 2.0 kilometers**.