The 15 instruments on NASA's latest solar observatory will usher in a new era of solar observation by providing scientists with HD-quality viewing of the solar surface in nearly a dozen different wavelength bands.

One of the biggest challenges is how to handle all the data that the satellite will return to Earth 24/7/365! It is no wonder that the design and construction of this data handling network has taken nearly 10 years to put together! To make sense of the rest of this story, here are some units and prefixes you need to recall (1 byte = 8 bits):

Kilo = 1 thousand
Mega = 1 million
Giga = 1 billion
Tera = 1 trillion
Peta = 1,000 trillion
Exa = 1 million trillion

Problem 1 - In 1982 an IBM PC desktop computer came equipped with a 25 megabyte hard drive (HD) and cost $6,000. In 2010, a $500 desktop comes equipped with a 2.5 gigabyte hard drive. By what factor do current hard drives have more storage space than older models?

Problem 2 - A 2.5 gigabyte hard drive is used to store music from iTunes. If one typical 4-minute, uncompressed, MPEG-4 song occupies 8 megbytes, about A) How many uncompressed songs can be stored on the HD? B) How many hours of music can be stored on the HD? (Note: music is actually stored in a compressed format so typically several thousand songs can be stored on a large HD)

Problem 3 - How long will it take to download 2 gigabytes of music from the iTunes store A) Using an old-style 1980's telephone modem with a bit rate of 56,000 bits/sec? B)With a modern fiber-optic cable with a bit rate of 16 megabits/sec?

Problem 4 - The SDO satellite's AIA cameras will generate 67 megabits/sec of data as they take 4096x4096-pixel images every 3/4 of a second. The other two instruments, the HMI and the EVE, will generate 62 megabits/sec of data. The satellite itself will also generate 20 megabits/sec of 'housekeeping' information to report on the health of the satellite. If a single DVD can store 5 gigabytes of information, how many DVDs-worth of data will be generated by the SDO: A) Each day? B) Each year?

Problem 5 - How many petabytes of data will SDO generate during its planned 5-year mission?

Problem 6 - It has been estimated that the total amount of audio, image and video information generated by all humans during the last million years through 2009 is about 50 exabytes including all spoken words (5 exabytes). How many DVDs does this equal?

Space Math   http://spacemath.gsfc.nasa.gov

Problem 1 - In 1982 an IBM PC desktop computer came equipped with a 25 megabyte hard drive (HD) and cost $6,000. In 2010, a $500 desktop comes equipped with a 2.5 gigabyte hard drive. By what factor do current hard drives have more storage space than older models? Answer: Take the ratio of the modern HD to the one in 1982 to get 2.5 billion / 25 million = 2,500,000,000/25,000,000 = 2,500/25 = **100 times.**

Problem 2 - A 2.5 gigabyte hard drive is used to store music from iTunes. If one typical 4-minute MPEG-4 song occupies 8 megbytes, about A) how many songs can be stored on the HD? B) How many hours of music can be stored on the HD?
Answer: A) Number of songs = 2.5 gigabytes/8 megabytes = 2,500 megabytes/8 megabytes = 312 B) Time = 312 songs x 4 minutes/song = 1,248 minutes = **20.8 hours.**

Problem 3 - How long will it take to download 2 gigabytes of music from the iTunes store A) Using an old-style 1980's telephone modem with a bit rate of 56,000 bits/sec? B)With a modern fiber-optic cable with a bit rate of 16 megabits/sec?
Answer; A) 2 gigabytes x 8 bits/1 byte = 16 gibabits. Then 16,000,000,000 bits x (1 second/56,000 bits) = 285,714 seconds or **79.4 hours**.   B) 16,000,000,000 bits x (1 second/16,000,000 bits) = 1,000 seconds or about **17 minutes.**

Problem 4 - The SDO satellite's AIA cameras will generate 67 megabits/sec of data as they take 4096x4096-pixel images every 3/4 of a second. The other two instruments, the HMI and the EVE, will generate 62 megabits/sec of data. The satellite itself will also generate 20 megabits/sec of 'housekeeping' information to report on the health of the satellite. If a single DVD can store 5 gigabytes of information, how many DVDs-worth of data will be generated by the SDO each A) Day? B) Year? Answer: Adding up the data rates for the three instruments plus the satellite housekeeping we get 67+63+20 = 150 megabits/sec. A) In one day this is 150 megabits/sec x (86,400 sec/1day) = 12.96 terabites or since 1 byte = 8 bits we have 1.6 terabytes. This equals 1,600 gigabytes x (1 DVD/8 gigabytes) = **200 DVDs each day**. B) In one year this equals 365 days x 1.6 terabytes/day = 584 terabytes per year or 365 days/1 year x 200 DVDs/1 year = **73,000 DVDs/year.**

Problem 5 - How many petabytes of data will SDO generate during its planned 5-year mission? Answer: In 5 years it will generate 5 years x 584 terabytes/year = 2,920 terabytes. Since 1 petabyte = 1,000 terabytes, this becomes **2.9 petabytes**.

Problem 6 - It has been estimated that the total amount of audio, image and video information generated by all humans during the last million years through 2009 is about 50 exabytes including all spoken words (5 exabytes). How many DVDs does this equal? Answer: 1 exabyte = 1,000 petabytes = 1,000,000 terabytes = 1,000,000,000 gigabytes. So 50 exabytes equals 50 billion gigabytes. One DVD stores 5 gigabytes, so the total human information 'stream' would occupy 50 billion / 5 billon = **10 billion DVDs.**