

## 014 Space and Scientific Notation

Scientific notation is an important way to represent very big, and very small, numbers. Here is a sample of astronomical problems that will test your skill in using this number representation.

Problem 1: The sun produces  $3.9 \times 10^{33}$  ergs per second of radiant energy. How much energy does it produce in one year ( $3.1 \times 10^7$  seconds)?

Problem 2: One gram of matter converted into energy yields  $3.0 \times 10^{20}$  ergs of energy. How many tons of matter in the sun is annihilated every second to produce its luminosity of  $3.9 \times 10^{33}$  ergs per second? (One metric ton = 1 Mega grams)

Problem 3: The mass of the sun is  $1.98 \times 10^{33}$  grams. If a single proton has a mass of  $1.6 \times 10^{-24}$  grams, how many protons are in the sun?

Problem 4: The approximate volume of the visible universe (A sphere with a radius of about 14 Giga light years) is  $1.1 \times 10^{31}$  cubic light-years. If a light-year equals  $9.2 \times 10^{17}$  centimeters, how many cubic centimeters does the visible universe occupy?

Problem 5: A coronal mass ejection from the sun travels  $1.5 \times 10^{13}$  centimeters in 17 hours. What is its speed in kilometers per second?

Problem 6: The NASA data archive at the Goddard Space Flight Center contains 25 terabytes of data from over 1000 science missions and investigations. (1 terabyte =  $10^{15}$  bytes). How many CD-ROMs does this equal if the capacity of a CD-ROM is about  $6 \times 10^8$  bytes? How long would it take, in years, to transfer this data by a dial-up modem operating at 56,000 bits/second? (Note: one byte = 8 bits).

Problem 7: Pluto is located at a distance of  $5.9 \times 10^{14}$  centimeters from Earth. At the speed of light ( $2.99 \times 10^{10}$  cm/sec) how long does it take a light signal (or radio message) to travel to Pluto and return?

Problem 8: The planet HD209458b, now known as Osiris, was discovered by astronomers in 1999 and is at a distance of 150 light-years (1 light-year =  $9.2 \times 10^{12}$  kilometers). If an interstellar probe were sent to investigate this world up close, traveling at a maximum speed of 700 km/sec (about 10 times faster than our fastest spacecraft: Helios-1), how long would it take to reach Osiris?