



**PART II**

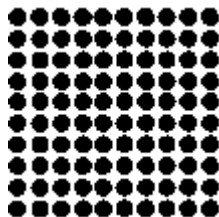
How big is a googol?

To start, here are 10 dots (covering about 1-inch):

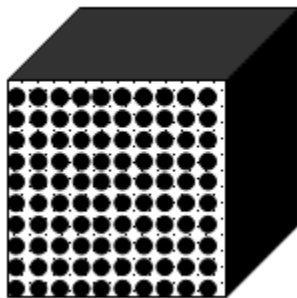


4. Express this number (10) in scientific notation:

If we make a square 10 dots on a side, we have 100 dots:



If we fill a 10 x 10 x 10 cube with dots, we have 1000 dots, something like this:



5. Express each of these numbers in scientific notation:

100:

1,000:

If we made this cube 10 times larger *on each side* (10 inches), we'd have 1,000,000 dots inside;  
 10 times larger than that *on each side* (100 inches = 8.3 feet) we'd have 1,000,000,000 dots;  
 10 times larger than that *on each side* (1000 inches = 83 feet) we'd have 1,000,000,000,000 dots.

6. Express these numbers in scientific notation. What *words* are used for these large numbers?

1,000,000:

1,000,000,000:

1,000,000,000,000:

*Words* for big numbers, while meaningful, are awkward. For example, you cannot do mathematical manipulations with words; try multiplying the words *billion* and *trillion*! In any case, the numbers soon become large, difficult to imagine, and there's no simple word for them.

7. Express a googol in scientific notation.

We'll now look at some astronomical numbers. Use whatever reference sources you need (including the Internet). Be sure the units of the numbers are consistent.

We can discuss the amount of matter in a variety of ways. One is in terms of mass—the number of kilograms, say. In chemistry, one might discuss the number of *moles*. Or, the amount of matter might be discussed in terms of the number of atoms. In the discussion to come, you will begin with kilograms or moles and then make a calculation to obtain the number of atoms, which you'll then compare to a googol.

8. Approximately how much matter is there in Earth?

9. Approximately how much matter is there in the Sun?
10. How do they compare?
11. What do you think is the importance of that comparison?
12. What is the approximate number of stars in a typical (average) galaxy?
13. What is the approximate number of galaxies in the visible universe?
14. Now, finally, what is the number of atoms in the visible universe?
15. How does this number compare with a googol?

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