

## ASTRONOMY 1210: SUPPLEMENT I

### A. POWERS OF TEN

Because of the large *range* of scales involved in astronomy, we will need to make extensive use of the standard scientific **powers of ten notation**.

In this convenient and compact notation, large (or small) numbers are expressed as a regular decimal number multiplied by ten raised to an integer positive (or negative) power.

For example, the speed of light is twenty-nine billion nine hundred million centimeters per second or:  $c = 29,900,000,000$  cm/sec. It would be very awkward to have to write out such a large number for computations. But in powers of ten notation, this becomes:

$$c = 2.99 \times 10^{10} \text{ cm/sec}$$

...much more tractable.

The exponent of ten in this notation is the number of times 10 must be multiplied by itself:

$$10 = 10^1 \quad 1,000 = 10 \times 10 \times 10 = 10^3 \quad 1,000,000 = 1000 \times 1000 = 10^6 \text{ etc.}$$

Negative exponents indicate values smaller than 1 and represent the number of times that  $\frac{1}{10}$  must be multiplied by itself:

$$0.1 = \frac{1}{10} = 10^{-1} \quad 0.001 = 1/1000 = \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = 10^{-3} \text{ etc}$$

Thus, in powers of ten notation,

$$35,000 = 3.5 \times 10^4 \quad 0.00035 = 3.5 \times 10^{-4}.$$

Note that:

$$\text{one thousand} = 10^3, \quad \text{one million} = 10^6, \quad \text{one billion} = 10^9$$

and that the following prefixes (usually applied to units of length, time, energy, or mass) indicate particular powers of ten:

$$\begin{array}{lll} \mathbf{milli} = 10^{-3} & \mathbf{micro} = 10^{-6} & \mathbf{nano} = 10^{-9} \\ \mathbf{kilo} = 10^3 & \mathbf{mega} = 10^6 & \mathbf{giga} = 10^9 \end{array}$$

## B. SPECIAL SYMBOLS

Astronomy is an “order of magnitude” science. That is, we often cannot measure quantities of interest to better than a factor of ten in accuracy. For this reason, the “approximate” symbol ( $\approx$  or  $\sim$ ) is used more often than the “equals sign”:

$x \approx 20$  means “x is approximately equal to 20”.

Other mathematical symbols we will occasionally use as shorthand include:

- $<$  “is less than”
- $>$  “is greater than”
- wrt* “with respect to”
- $\Rightarrow$  “implies”
- $\uparrow$  “increases”
- $\downarrow$  “decreases”
- $\exists$  “there is”
- @ “at”

Examples:

$L \uparrow \Rightarrow T \downarrow$  means “if L increases then T decreases”

@  $1200^\circ$ ,  $x > y$  means “at 1200 degrees, x is greater than y”.

Some astronomical symbols:

- $\odot$  stands for the Sun
- $\oplus$  stands for the Earth

Commonly used symbols for other quantities:

- $n$  for neutron
- $p$  for proton
- $e$  or  $e^-$  for electron
- $c$  for speed of light
- $\lambda$  for wavelength of electromagnetic wave
- $\nu$  for frequency of electromagnetic wave