ASTRONOMY MATH GUIDE

2016 January

You learned all the math you need for ASTR 1013 and ASTR 1023 in high school. However, if your math is rusty, you can review this handout, visit the Mathematics Learning Success Center on the fifth floor of the Edmon Low Library (744-5818), and *google* specific topics.

A couple questions on every astronomy test will involve some of the math below. Mastery of it will pay you dividends at OSU and for the rest of your life!

Astronomical Magnitude Scale (ASTR 1023 only)

The magnitude scale uses a range of small numbers to rank stars and other astronomical objects from the very brightest to the very dimmest. It is explained in the textbook, and will be covered in lecture.

Sample test question: "If Stars A and B have magnitudes of 3 and 1, respectively, then how many times brighter is Star B than Star A?"

Law of 72

If something (*e.g.*, the money in your savings account) is growing at a steady annual percentage rate (*APR*), then an easy-to-use, very good approximation for the number of years required for that something to double (t_{double}) is

$t_{double} = 72 / APR.$

Example: A $200 sum that is earning 3% interest annually in your bank account will grow to $400 in 24 years (= 72 / 3).

Simplification of Compound Fractions

If a/b and c/d are two fractions, it is handy to know that their ratio, which can be written as $\frac{\frac{a}{b}}{\frac{c}{d}}$ or $\frac{a/b}{c/d}$, also equals $\left(\frac{a}{b}\right)\times\left(\frac{d}{c}\right)$. *Example*: $\frac{1/2}{3/4} = \left(\frac{1}{2}\right)\times\left(\frac{4}{3}\right) = \frac{4}{6} = \frac{2}{3}$.

In other words, it equals the top fraction times the reciprocal of the bottom fraction!

Percentages

Know how to calculate with paper and pencil the answers to questions like these: (1) What percentage of 130 is 23? (2) What number is 78% of 240? (3) Express 46% as a decimal (0.46) and also as a fraction (46/100).

Scientific Notation (better called Federal Notation?)

Know how to calculate with paper and pencil the answers to questions like these: (1) Express 7,800,000 and 0.0045 in scientific notation. (2) Express 5.4×10^3 and 7.6×10^{-5} in their longhand forms. (3) Multiply and divide numbers in scientific notation.

Angles

Angles are measured in degrees (°) and subdivisions called arcminutes (') and arcseconds ("). An example is 23° 50' 30", where 1' = 1/60° and 1" = 1/3600°. Thus, it is also true that 1° = 60' and 1' = 60". Converting this angle into pure degrees is straightforward: 50' is 50/60 of 1°, and 30" is 30/3600 of 1°, so

$23° 50' 30" = 23° + 50/60° + 30/3600° = 23.8417°.$

Time

Time is measured in hours, minutes, and seconds (not to be confused with the angles called arcminutes and arcseconds). In astronomy, times, time intervals, and right ascension coordinates are frequently written this way: $14^h\ 25^m\ 17^s$.

When adding or subtracting times, recall that 1 hour = 60 minutes and 1 minute = 60 seconds. You can then see that the interval between $14^h\ 25^m\ 17^s$ and $16^h\ 20^m\ 10^s$ is

$$16^h\ 20^m\ 10^s - 14^h\ 25^m\ 17^s = 16^h\ 19^m\ 70^s - 14^h\ 25^m\ 17^s$$

$$= 15^h\ 79^m\ 70^s - 14^h\ 25^m\ 17^s = 1^h\ 54^m\ 53^s.$$

A Helpful Picture for Altazimuth (Horizon) Coordinates

Altitude and azimuth are angles that describe the direction of a star relative to an observer on Earth's surface. These coordinates are described in Voyager Project #2. A star's azimuth is the number of degrees you turn to the right to face a star (starting from north. When you are facing the star, its altitude is the the angle between your horizon and the star. A star exactly overhead has an altitude of 90°.

This drawing shows that a star's altitude and azimuth depends on your location on Earth. Of course, they also depend on the time (because Earth rotates)!