**Homework #3**
**Due in class Wednesday, February 8**

*Answer parts 1 and 2 on a separate sheet of paper. You do NOT need to print this to hand it with your answers.*

## Part 1. Definitions

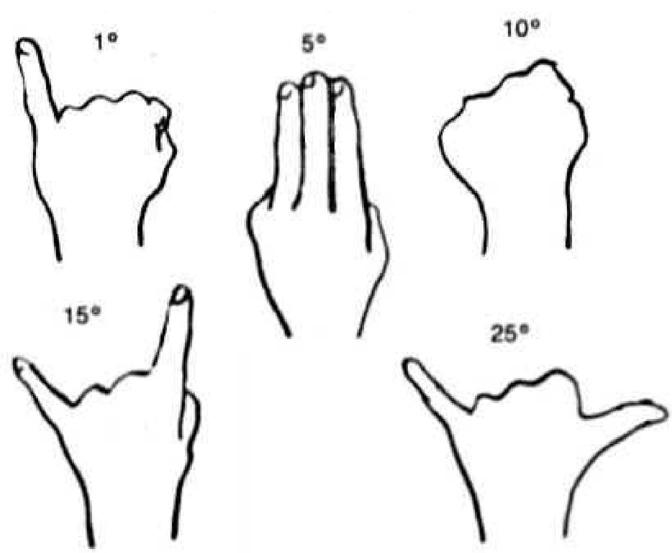
For each of the terms below, write two sentences. The first sentence should be a definition in your own words, and the second should be an explanation of how this concept is significant in Astronomy.

a) Differential Rotation
b) Isotope
c) Nuclear Fusion
d) Convection
e) Solar Wind

## Part 2. Observing

(a) Using the astrolabe that you made in class (and your planisphere to find it), measure the height of the north star. Record it below.

(b) Using the "fist and finger method" outlined in the celestial motions lab (summarized below) record the height of the north star again. State the total and how you arrived at it (ex: two fists + 1 finger = 21 degrees)




(c) How close are your two measurements? Which do you trust more and why? Write a paragraph outlining your answer.

## Part 3. Math Skill #2: Powers of Ten

*In science, powers of ten are an important tool for understanding the scale of a number, or its rough size. They are particularly powerful when comparing two quantities, or trying to figure out how much bigger one thing is than another. This can be very important in astronomy, where numbers vary in magnitude from the size of atoms (about $10^{-10}$ meters) to the size of the observable universe (about $10^{26}$ meters). Comparing those powers of ten, for example, tells you that the atom is $10^{36}$, or 1,000,000,000,000,000,000,000,000,000,000,000,000 times smaller than the universe as a whole.*

*This skill is also useful, however, in life. For example, you often hear politicians talking about state budgets, government bailouts and the federal deficit in terms of thousands, millions, billions, and trillions of dollars. Understanding what these words mean in terms of powers of ten is a useful tool for understanding how much money you're really talking about, rather than just thinking of them all as really big numbers, which is what we tend to do.*

*A power of ten is really exactly what it sounds like – the number 10 raised to some power (or "exponent"). The goal of a power of ten is really just to tell you roughly how big something is in terms of how many zeroes there would be if you were to round the number to it's nearest multiple of ten.*

*In other words, ignoring everything else, is the number you're talking about closer to 10 ($10^1$) or 100 ($10\times10$ or $10^2$)? Is it closer to 10,000 ($10\times10\times10\times10$ or $10^4$) or 100,000 ($10^5$)? 10 billion ($10^{10}$) or 100 billion ($10^{11}$)?*

*Here are several things to note about powers of ten:*

(1) *We are only talking about so-called "round" powers of ten here, so there are no numbers besides ones or zeroes to worry about. This means that we are indeed rounding, or approximating, our answers in many cases, but that's ok in that we are using powers of ten as a tool to understand the* ***rough*** *size of a number*

(2) *The "power" in the power of ten, is equivalent to the number of zeroes when you write the number out completely, so $10^6$ is 1 with 6 zeroes after it, or 1,000,000 (one million!).*

(3) *The "power" in the power of ten could also be thought of as the number of tens you need to multiply together to get the number. To use $10^6$ again, this means that 1 million is the same thing as 6 tens multiplied together, or $10\times10\times10\times10\times10\times10=1,000,000=10^6$*

(4) *This can also extend to negative powers, where a negative power of ten represents dividing the number 1 by that many 10s, rather than multiplying. For example $10^{-1}$ is $1\div10$ and $10^{-2}$ is $1\div10\div10$, or $1\div100$.*

**Exercise 1: Rounding**

For each number listed below, write it as a power of 10 (as in $10^X$), write it out completely with all its zeroes and write out the word that we commonly use for this number. Two examples are given below for your reference.

| | | | | | |
|---|---|---|---|---|---|
| 9,988,012 | ≈ | 10,000,000 | = | $10^7$ | = "ten million" |
| 0.0000000004567 | ≈ | 0.0000000001 | = | $10^{-10}$ | = "one ten-billionth" |

Note that the highlighted symbol above is a "squiggly" equals sign which means "approximately equal to". Using this symbol instead of a regular equals sign means that you're rounding, or approximating, the answer. This distinction is very important!

| | | | | | |
|---|---|---|---|---|---|
| 1,234 | ≈ | | = | | = |
| 26.1 | ≈ | | = | | = |
| 0.783 | ≈ | | = | | = |
| 89.098732 | ≈ | | = | | = |
| 0.003456 | ≈ | | = | | = |
| 89,483,217 | ≈ | | = | | = |
| 670,000 | ≈ | | = | | = |
| 0.000002 | ≈ | | = | | = |

**Exercise 2: Comparing Powers of Ten**

By comparing the difference in the exponents of two powers of ten, you can easily tell how many times bigger one is than the other. This saves you the trouble of having to write both numbers out and count zeroes. For each of the pairs of powers of ten listed, write a statement (of three sentences) in the format of the examples below where the words/numbers that you should alter are underlined.

**Example 1: $10^9$ vs. $10^6$**
$10^{\underline{9}}$ (1,000,000,000 or <u>one billion</u>) and $10^{\underline{6}}$ (1,000,000 or <u>one million</u>) are different by <u>three</u> powers of 10, or $10^{\underline{3}}$.

$10^{\underline{3}}$ = <u>1,000</u> = <u>one thousand</u>, so the powers of ten are telling you that <u>one billio</u>n is <u>one thousand</u> times bigger than <u>one million</u>.

To state this another way, <u>one billion</u> is the same as <u> one thousand millions</u>.

**Example 2: $10^{-2}$ vs $10^2$**
$10^{\underline{-2}}$ (<u>0.01 or</u> <u>one hundredth</u>) and $10^{\underline{2}}$ (<u>100 or one hundred</u>) are different by <u>four</u> powers of 10, or $10^{\underline{4}}$.

$10^{\underline{4}}$ = <u>10,000</u> = <u>ten thousand</u>, so the powers of ten are telling you that <u>one hundred</u> is <u>ten thousand</u> times bigger than <u>one hundredth</u>.

To state this another way, <u>one hundred</u> is the same as <u> ten thousand hundredths</u>.

1. $10^{12}$ vs. $10^9$

2. $10^{-1}$ vs $10^{-3}$

3. $10^1$ vs $10^5$