AST 101LB SOLAR SYSTEM LAB

ANGULAR MEASUREMENT AND YOU

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NAME ___________________________

Section _____________ (the day lab meets)

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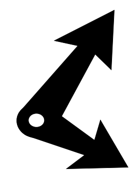
I. INTRODUCTION

This lab is to begin your preparation for future night sky observing of the moon. The use of angles arises naturally in this situation. When you look at the sky you only see the directions to celestial objects and their apparent sizes. Both entail angles.



Angles are formed by intersecting lines; they are the difference in direction of two intersecting lines.

When you look at two different stars, you are looking along two lines of sight, right? They come together (intersect) at you. This intersection is called the vertex. The angle is formed by the difference in direction between the two lines of sight.

Apparent sizes are also expressed in angles. Do you see where the angle is? It is formed by the difference in direction of the two lines of sight from you to the opposite sides of the object.

Today, I want you to measure the apparent sizes of your fist and thumb when viewed at arm's length. The end phrase is critical–apparent sizes depend inversely upon the distance from the observer; that is, the greater the distance, then the smaller the apparent size. For example, move an object three times farther away and it will look one-third the size.

The apparent size also depends upon the actual size, and this is a direct relation. For example, suppose you have a round balloon at some distance from you and then you blow up the balloon to a four times larger actual size. How many times larger does the expanded balloon now appear to you? The apparent size also increases (varies directly) with the increase of the actual size--four times, of course.

Now put these two functional dependencies together--that apparent size varies directly with actual size and inversely with distance, and you get the following equation for apparent size:

$$\textbf{apparent size} = \frac{\textbf{actual size}}{\textbf{distance}}$$

To prepare you for observing the direction (altitude and azimuth) of the moon in the sky (the Moon Observing Lab, to be handed out), we are going to have you use your fist and your thumb as "rulers" to measure the relavent angles.

All you do is measure their widths (actual size) and their distance from your eyes when your hand is held at arm's length. We will use this distance in the calculations that determine apparent size. Next, fill in the blanks below.

II. MEASUREMENTS

A. ARM'S LENGTH (distance)

USE A METER STICK, AND MEASURE THREE TIMES TO THE NEAREST MILLIMETER (mm), LOWERING YOUR ARM AND METER STICK BETWEEN EACH MEASURE.

(Scientists never measure a unknown quantity just once, if they can help it. The average of a number of measures, usually more than three, actually, is more accurate.) Don't be concerned for now with the "Entry numbers" that follow the measurement and calculations.

measurement 1 ________ mm Entry 1a.

measurement 2 ________ mm Entry 1b.

measurement 3 ________ mm Entry 1c.

average _________ (to nearest mm) Entry 1d.

We will use the symbol "D" to refer to this distance.

B. THUMB WIDTH (actual size)

USE A METRIC RULER TO MEASURE THE WIDTH OF YOUR THUMB (HALFWAY UP THUMBNAIL), AGAIN TO THE NEAREST MILLIMETER.

measurement 1 ________ mm Entry 2a.

measurement 2 ________ mm Entry 2b.

measurement 3 ________ mm Entry 2c.

average _________ (to nearest mm) Entry 2d.

We will use the symbol "d_t" to refer to this distance.

C. FIST WIDTH

USE A METRIC RULER TO MEASURE THE WIDTH OF YOUR FIST (FROM INDEX FINGER KNUCKLE TO LITTLE FINGER KNUCKLE), AGAIN TO THE NEAREST MILLIMETER.

measurement 1 ________ mm Entry 3a.

measurement 2 ________ mm Entry 3b.

measurement 3 ________ mm Entry 3c.

average _________ (to nearest mm) Entry 3d.

We will use the symbol "d_f" to refer to this distance.

III. ANGLE CALCULATIONS

A. THE APPARENT (ANGULAR) SIZE OF YOUR THUMB AT ARM'S LENGTH

What do you think you do to get your thumb's apparent size? Right! (You did think, didn't you?) You just divide your thumb's actual size, d_t, by your arm's length, D, so:

d_t/D = _______ (express result to 4 digit accuracy) Entry 4 (thumb's apparent size, in radians)
(no units--units cancel in ratios)

B. THE APPARENT (ANGULAR) SIZE OF YOUR FIST

Well, what do you think?

d_f/D = _______ (express result to 4 digit accuracy) Entry 5. (fist's apparent size, in radians)

"Isn't that special?" you're thinking. What kind of numbers are these? They aren't degrees. They are radians. You have just learned (perhaps) a new way of expressing angles. This simple way of expressing angles is used a lot in science and engineering—-it is simply the ratio of the arc length to the distance from the vertex. But we are used to expressing angles in degrees. So as a final step, you need to convert the radian determinations of your fist and thumb widths to degrees. Use this equation to convert your angles from radians to degrees:

$$\text{angle in degrees} = \text{angle in radians} \times 180 \div 3.14159$$

EXPRESS YOUR RESULTS TO THE NEAREST HALF-DEGREE (means X.5 or X.0 degrees)*.

Your thumb's apparent size = _________ degrees Entry 6.

Your fist's apparent size = _________ degrees Entry 7.

*For example, if your thumb value in degrees calculates to 1.859, it rounds up to 2.0. If it were to calculate to 1.659, it would round down to 1.5 degrees. Do you see the break point values are at X.25 and X.75?