Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ St. #\_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**IN. SS.1 How accurate will I be in estimating different**

**kinds of measurements?**

In scientific measurement, the degree of precision required varies. Usually very precise

measurements are necessary but it is still helpful to be able to make estimates. The degree of accuracy in estimating varies considerably with the individual and the extent of his/her experience. The first time a person attempts to make an estimate, his/her accuracy is probably much less than it would be the tenth time.

How accurate will you be in estimating different kinds of measurements? In this investigation you will find out by making several estimates, comparing them to the precise measurements and then calculating your percent accuracy. In the process you will also gain experience in using some of the equipment and measuring tools that we will be using throughout the year in this class. ***Percent accuracy is calculated in two steps using the following formulas:***

**Step 1:** units off x 100 = % error

correct units

**Step 2:** 100% ­­— % error = % accuracy

**MATERIALS**

Metric ruler, graduated cylinder, dropper, test-tube rack, 5 test tubes, a tube of “Unknown”, stirring rod, methylene blue dye, dial-a-gram balance, nickel, sand, weighing cup, clock with second hand.

**PROCEDURE**

Set up a data table as follows:

COLUMNS: Dimension, Estimate, Correct units, Units off, % error, % accuracy, Calculations. *NOTE: The “Calculations” column is where you will “show your work” for any value you enter on the table that you determined mathematically (that is, that you did NOT measure directly, rather you found it by performing a calculation).*

ROWS:5 blank rows beneath the column headings.

**A. ESTIMATING LENGTH**

1. On your lab paper (below your data table) draw a line freehand that you think is 10 cm long. Do not look at a ruler as you do this (however it may help to know that 30.5 cm is approximately 12 inches). Label this line “ESTIMATE”. Now, using the ruler, draw a line right below your estimate that you measure to be exactly 10 cm long. Label this line “CORRECT”. Enter the value 10 cm in the “correct units” column on your data table.

2. Measure your “estimated” line and enter this value under “estimate” on your data table. Determine how many cm off your line was from the “correct” and enter this in the “units off” column.

3. Using the formulas given, calculate your % accuracy and record it on your data table. Be sure to “show your work” in the “Calculations” column.

**B. ESTIMATING VOLUME**

4. Find the 5 ml level on the graduated cylinder. Estimate the number of drops of water that it would take to fill the graduated cylinder to this level. Record this estimate on your data table.

5. Now use your dropper to determine how many drops it actually takes to fill it to the 5 ml mark. This is your “correct units”. Record this, then determine units off and percent accuracy as you did in Part A.

**C. ESTIMATING CONCENTRATIONS**

*“Concentration” of a substance means how much of that substance is in a solution compared to how much water. Concentration can be expressed in different ways but in this exercise it will be expressed in percent. You will attempt to estimate the concentration of methylene blue dye in an “UNKNOWN”. Then you will determine it’s actual concentration by making a series of dilutions and comparing them to the unknown.* ***(Concentration is already expressed in percent, so you will calculate % accuracy differently for this part of the procedure. Follow step 9 carefully!)***

1. Set up the 5 empty test tubes in your test tube rack and label them A, B, C, D, and E

2. In test tube A put 10 ml of 100 % methylene blue solution. In test tube E put 10 ml of water (since this test tube has no methylene blue its concentration of methylene blue is 0%).

3. Compare the color of the “UNKNOWN” test tube to the 100% solution and the 0% solution. What % methylene blue do you think is in the unknown? Record this under “Estimate” on your data table. **Be sure to do this BEFORE you go on to step 4!**

4. Now place 5 ml of water each into test tubes B, C and D.

5. Measure out 5 ml of the 100% solution from test tube A and add it to the water in test tube B. Gently stir. (Concentration of methylene blue in test tube B = \_\_\_\_\_\_\_%)

6. Measure out 5 ml of the solution in B and add it to the water in test tube C. Stir. (Concentration of methylene blue in C = \_\_\_\_\_\_\_\_\_%)

7. Measure out 5 ml of the solution in C and add it to the water in test tube D. Stir. (Concentration of methylene blue in D = \_\_\_\_\_\_\_\_\_%)

8. Now compare the color of the unknown to the solutions in test tubes A, B, C, D, and E. The concentration in the tube that best matches the unknown is the “Correct” concentration. Record this concentration on your data table.

9. Since concentration is already expressed as percent, the “units off” IS the “percent error”.

*Thus to calculate “% accuracy” in this case simply determine the “units off” and subtract it from 100%. Record.*

**D. ESTIMATING WEIGHT**

*In this part of the investigation you will try to guess the amount of sand it would take to equal the weight of a nickel. In doing this section be sure to carefully follow all of the guidelines in Reference Sheet 6.*

1. Hold the nickel to get an idea of its weight. Now carefully spoon sand into the paper weighing cup until you think the amount of sand weighs the same as the nickel. *BE CAREFUL NOT TO GET ANY SAND ON THE BALANCE!*

2. Following the steps in Reference Sheet 6, find the weight of the sand. (*Careful! What do you need to do to take into account the weight of the cup??*) The weight of the sand is your estimate. Record on your data table.

3. Now weigh the nickel. This is the “Correct” weight. Record.

4 Using the formulas in the introduction, calculate and record your percent accuracy.

**E. ESTIMATING TIME**

*In this section you will try to estimate how long 30 seconds is without looking at a clock. You and your lab partner will take turns being estimator and timer.*

1. Have your lab partner watch a clock with a second hand. Have your partner tell you when to start, then, when you think 30 seconds have passed, you say “Stop”.

2. The number of seconds that passed before you said “Stop” is your estimate. 30 seconds is the “correct” time you were trying to determine. Record these numbers and determine your percent accuracy as in parts A, B and D.

3. Repeat, switching roles with your partner.

**F. AVERAGE PERCENT ACCURACY**

1. Calculate the average of the five % accuracies you obtained for steps A through E. Record this figure on your data table.

2. Record your average on the whiteboard as directed by the instructor.

**DISCUSSION QUESTIONS**

1. Prepare a table similar to the one below on which you will enter the numbers of students in your class who had percent accuracies in each range.

|  |  |
| --- | --- |
| **Average % Accuracy** | **Number of Students**  NOTE: This is NOT the data table required on your prelab. This is for use AFTER completion of the procedures. |
| 100-96 |  |
| 95-91 |  |
| 90-86 |  |
| etc. | etc. |

1. Plot the information from your table on a graph (**use graph paper**) similar to the example below. (Remember to follow all guidelines in Reference Sheet 7!)
   1. Draw a “best fit” line (in this case it will be a curve).
   2. Place an “X” on the “best fit” curve to indicate your own average % accuracy.

etc.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 4 |  |  |  |  |  |
| **Number of students**  3 |  |  |  |  |  |
| 2 |  |  |  |  |  |
| 1 |  |  |  |  |  |
|  |  |  |  |  |  |

96-100 91-95 86-90 81-85 76-80 71-75 🡪 etc.

**Average % accuracies**

3. In which area of estimating were you the most accurate? Do you think your accuracy was more a matter of luck or experience? Explain.

4. Write a paragraph describing what you have learned by doing this investigation and how it will help you in the future in science.