LESSON PLAN
SIGNIFICANT FIGURES AND ACCURACY OF MEASUREMENTS

STANDARD(S) & INDICATOR(S):
HS.N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

OBJECTIVE(S): Students will be able to:
Define accuracy and precision, and differentiate between the two terms
Apply the concepts of accuracy and precision to a given situation
Apply the concept of significant figures to measurement and mathematics operations

PART I.
Part I shows the connection between significant figures and accuracy of measurements (value and mass).

MATERIALS:
Calculator, pencil, paper, handout

BACKGROUND INFORMATION:
When a scientist makes a measurement, he/she needs to know that it is reliable. There are two ways he/she can check his/her work:
Precision – Repetition of a measurement
Accuracy – exactness of a measurement

A measurement is rarely meaningful by itself. More commonly, measurements are combined by adding, subtracting, multiplying or dividing them to produce the values of mass, volume, or temperature needed in a scientific investigation. The certain digits and the striated digit of a measurement are together called the significant digits of the measurement.

CLASSROOM ACTIVITY DESCRIPTION (LABORATORY/EXERCISES/PROBLEMS) including detailed procedures:
Discussions about accuracy and significant digits
Calculate the number of significant digits in numbers
Round numbers to proper significant digits

SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:
What is the difference between accuracy and precision?
What are significant digits?
How can you calculate the density of an object?

HOMEWORK ACTIVITY/EXERCISES/PROBLEMS:
Prentice Hall: Chemistry – Connections to Our Changing World (textbook written by LeMay, Bali, Robblee and Brower)
Page 52, Problems 35-40
Homework-Ditto (Handouts)

PARAMETERS TO EVALUATE STUDENT WORK PRODUCTS:
Students present the answers and their calculations on the board
Students have an open discussion in class, and will later break up into smaller groups to further the discussion

REFERENCES:
Prentice Hall: Chemistry – Connections to Our Changing World (textbook written by LeMay, Bali, Robblee and Brower)

SIGNIFICANT FIGURES

Name _____

A measurement can only be as accurate and precise as the instrument that produced it. A scientist must be able to express the accuracy of a number, not just its numerical value. We can determine the accuracy of a number by the number of significant figures it contains.

1) All digits 1-9 inclusive are significant.
   Example: 129 has 3 significant figures.
2) Zeros between significant digits are always significant.
   Example: 5,007 has 4 significant figures.
3) Trailing zeros in a number are significant only if the number contains a decimal point.
   Example: 100.0 has 4 significant figures.
   100 has 1 significant figure.
4) Zeros in the beginning of a number whose only function is to place the decimal point are not significant.
   Example: 0.0025 has 2 significant figures.
5) Zeros following a decimal significant figure are significant.
   Example: 0.000470 has 3 significant figures.
   0.47000 has 5 significant figures.

Determine the number of significant figures in the following numbers.

1. 0.02 _____
2. 0.020 _____
3. 501 _____
4. 501.0 _____
5. 5,000 _____
6. 5,000. _____
7. 6,051.00 _____
8. 0.0005 _____
9. 0.1020 _____
10. 10,001 _____

Determine the location of the last significant place value by placing a bar over the digit. (Example: 1.70$\bar{0}$)

1. 8040 _____
2. 0.0300 _____
3. 699.5 _____
4. 2.000×10^2 _____
5. 0.90100 _____
6. 90,100 _____
7. 4.7×10^{-8} _____
8. 10,800,000. _____
9. 3.01×10^{21} _____
10. 0.000410 _____

CALCULATIONS USING SIGNIFICANT FIGURES

Name _____

When multiplying and dividing, limit and round to the least number of significant figur any of the factors.

Example 1: 23.0 cm x 432 cm x 19 cm = 188,784 cm^3

The answer is expressed as 190,000 cm^3 since 19 cm has only two significant figures.

When adding and subtracting, limit and round your answer to the least number of dec places in any of the numbers that make up your answer.

Example 2: 123.25 mL + 46.0 mL + 86.257 mL = 255.507 mL

The answer is expressed as 255.5 mL since 46.0 mL has only one decimal place.

Perform the following operations expressing the answer in the correct number of signific figures.

1. 1.35 m x 2.467 m = _____
2. 1.035 m^2 ÷ 42 m = _____
3. 12.01 mL + 35.2 mL + 6 mL = _____
4. 55.46 g − 28.9 g = _____
5. .021 cm x 3.2 cm x 100.1 cm = _____
6. 0.15 cm + 1.15 cm + 2.051 cm = _____
7. 150 L^3 ÷ 4 L = _____
8. 505 kg − 450.25 kg = _____
9. 1.252 mm x 0.115 mm x 0.012 mm = _____
10. 1.278 x 10^3 m^2 ÷ 1.4267 x 10^2 m = _____

PART II.

MODULE TOPIC:
Part II shows how accuracy of measurements relates to one another and to significant figures.

MATERIALS:
Calculator, pencil, paper, handout, pennies, balance, water, cylinder

BACKGROUND INFORMATION:
When a scientist makes a measurement, he/she needs to know that it is reliable. There are two ways he/she can check his/her work:
Precision – Repetition of a measurement
Accuracy – exactness of a measurement

A measurement is rarely meaningful by itself. More commonly, measurements are combined by adding, subtracting, multiplying or dividing them to produce the values of mass, volume, or temperature needed in a scientific investigation. The certain digits and the striated digit of a measurement are together called the significant digits of the measurement.

Prior to 1982, pennies were made of copper. In 1982, it was determined to use a mixture of other metals (cheaper) for the creation of pennies.
Find the density of the two kinds of coins, to three significant figures. Be careful not to mix up the two kinds, which are kept separately in marked containers.

CLASSROOM ACTIVITY DESCRIPTION (LABORATORY/EXERCISES/PROBLEMS) including detailed procedures:
Discussions about accuracy and significant digits
Working with groups to determine proper number of pennies needed in order to have solutions with 3 significant figures

SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:
What is the difference between the two densities?
Some of the coins are old and worn. How will that affect the density you found?
Some of the coins have acquired a patina, that is, they have reacted with the surrounding air and/or water vapor (moisture in the air). How will that affect the density? Explain how you came to your conclusion.

HOMEWORK ACTIVITY/EXERCISES/PROBLEMS:
Lab report (following the Rules of Writing a Lab Report)

PARAMETERS TO EVALUATE STUDENT WORK PRODUCTS:
Students find and report the density of objects in 3 significant digits by adjusting the number of pennies so that the mass and volume (which are used to find density) will give density in 3 significant figures.

REFERENCES:

Prentice Hall: Chemistry – Connections to Our Changing World (textbook written by LeMay, Bali, Robblee and Brower)

This material is based upon work supported by the National Science Foundation under Grant Nos. EEC-0908889

Supporting Program: Center for Pre-College Programs, at the New Jersey Institute of Technology

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Name_____

Lab #2 – Lab

There is no lab outline for this lab, so you and your partner need to keep a thorough record of your procedure and your observations for your lab report. Make sure you both have a record of the data so that you will not get stuck if either of you get ill or lose the data.

Lab:

Work in pairs.

Prior to 1982 pennies were made of copper. In 1982, it was determined to use a mixture of other metals (cheaper) for the making of pennies.

Find the density of the two kinds of coins, to three significant figures. Be careful not to mix up the two kinds, which are kept separately in marked containers.

Questions (to be answered on the lab report):

a) What is the difference between the two densities?
b) Some of the coins are old and worn. How will that affect the density you found (i.e., will it make it higher or lower than the correct value)? Explain how you came to your conclusion.
c) Some of the coins have acquired a patina, that is, they have reacted with the surrounding air and/or water vapor (moisture in the air). How will that affect the density? Again, explain how you came to your conclusion.

Name:

Lab Report Analysis

Lab Report Components	Comments	Points
Title		5/5
Objective		10/10
Materials		5/5
Procedure		10/10
Data		25/25
Observation		10/10
Calculation		10/10
Conclusion		15/15
Participation		10/10