Decimals, Fractions, Percentages and Significant Figures for Statistics

"Baseball is ninety percent mental and the other half is physical."
- Yogi Berra

In statistics, we frequently use ratios in fraction, decimal or even percentage form. For example, the likelihood of an event is defined as the ratio of positive outcomes to total possible outcomes. Statisticians may use any of the forms to indicate a likelihood so it is very helpful to be able to convert between them. Obviously, Yogi didn't quite understand how to mix fractions and percentages. We also need to be able to do arithmetic with all of them. Below you will find demonstrations showing how to convert between different forms of a number and how to add, subtract, multiply and divide fractions. At the end, there are numerous exercises.

CONVERSIONS

A. Changing a Mixed Number to an Improper Fraction

Mixed number – $4\dfrac{2}{3}$ (contains a whole number and a fraction)

Improper fraction - $\dfrac{14}{3}$ (numerator is larger than denominator)

Step 1 – Multiply the denominator and the whole number
Step 2 – Add this answer to the numerator; this becomes the new numerator
Step 3 – Carry the original denominator over

Example #1: $3\dfrac{1}{8}$ $=$ $3 \times 8 + 1 = 25$

$$\dfrac{25}{8}$$

Example #2: $4\dfrac{4}{9}$ $=$ $4 \times 9 + 4 = 40$

$$\dfrac{40}{9}$$

B. Changing an Improper Fraction to a Mixed Number

Step 1 – Divide the numerator by the denominator
Step 2 – The answer from step 1 becomes the whole number
Step 3 – The remainder becomes the new numerator
Step 4 – The original denominator carries over

Example #1: $\dfrac{47}{5} = 47 \div 5$ or $5\overline{)47} = 5\overline{)\overset{9}{47}} = 9\dfrac{2}{5}$
$$\underline{45}$$
$$2$$

Example #2: $\dfrac{9}{2} = 2\overline{)9} = 2\overline{)\overset{4}{9}} = 4\dfrac{1}{2}$
$$\underline{8}$$
$$1$$

C. Reducing Fractions

Step 1 – Find a number that will divide into both the numerator and the denominator
Step 2 – Divide numerator and denominator by this number

Example #1: $\dfrac{10}{15} = \dfrac{2}{3}$ (because both 10 and 15 are divisible by 5)

Example #2: $\dfrac{4}{8} = \dfrac{1}{2}$ (because both 4 and 8 are divisible by 4)

D. Raising Fractions to Higher Terms When a New Denominator is Known

Step 1 – Divide the new denominator by the old denominator
Step 2 – Multiply the numerator by the answer from step 1 to find the new numerator
*Note: If the original number is a mixed number, convert it to an improper fraction before raising to higher terms (see Example #2)

Example #1: $\dfrac{2}{3} = \dfrac{}{12}$ becomes $\dfrac{2}{3} = \dfrac{8}{12}$ because $12 \div 3 = 4$
and $2 \times 4 = 8$

Example #2: $2\dfrac{1}{5} = \dfrac{}{20}$ becomes $\dfrac{11}{5} = \dfrac{}{20}$ becomes $\dfrac{11}{5} = \dfrac{44}{20}$

because $20 \div 5 = 4$ and $11 \times 4 = 44$

E. Converting fractions to decimals

Step 1 - Divide the numerator (the top number) by the denominator (the bottom number) of the fraction.

Example: $\dfrac{5}{8}$

$$
\begin{array}{r}
.625 \\
8\overline{)5.000} \\
\underline{48} \\
20 \\
\underline{16} \\
40 \\
\underline{40} \\
0
\end{array}
$$

← Add as many zeros as needed.

F. Converting decimals to fractions

Step 1 - Determine the place value of the last number in the decimal; this becomes the denominator.
Step 2 – Make the decimal number your numerator.
Step 3 - Reduce your answer.

Example: .625 - the 5 is in the thousandths column, therefore,

$$.625 = \frac{625}{1000} = \text{reduces to} \ \frac{5}{8}$$

(Hint: Your denominator will have the same number of zeros as there are decimal digits in the decimal number you started with - .625 has three decimal digits so the denominator will have three zeros before reductions.)

G. Multiplying Simple Fractions

Step 1 – Multiply the numerators
Step 2 – Multiply the denominators
Step 3 – Reduce the answer to lowest terms

Example: $\dfrac{1}{7} \times \dfrac{4}{6} = \dfrac{4}{42}$ which reduces to $\dfrac{2}{21}$

H. Multiplying Mixed Numbers

Step 1 – Convert the mixed numbers to improper fractions first
Step 2 – Multiply the numerators
Step 3 – Multiply the denominators
Step 4 – Reduce the answer to lowest terms

Example: $2\dfrac{1}{3} \times 1\dfrac{1}{2} = \dfrac{7}{3} \times \dfrac{3}{2} = \dfrac{21}{6}$ which then reduces to $3\dfrac{1}{2}$

*Note – When opposing numerators and denominators are divisible by a common number, you may reduce the numerator and denominator before multiplying.   In the above example, after converting the mixed numbers to improper fractions, you will see that the 3 in the numerator and the opposing 3 in the denominator could have been reduced by dividing both numbers by 3, resulting in the following reduced fraction:

$$\frac{7}{1\cancel{3}} \times \frac{\cancel{3}1}{2} = \frac{7}{2} = 3\frac{1}{2}$$

I. Dividing Simple Fractions

Step 1 – Change division sign to multiplication
Step 2 – Change the fraction following the multiplication sign to its
  reciprocal (flip the fraction around so the old denominator is the
  new numerator and the old numerator is the new denominator)
Step 3 - Multiply the numerators
Step 4 – Multiply the denominators
Step 5 – Change the answer to lowest terms

Example: $\dfrac{1}{8} \div \dfrac{2}{3} =$ becomes $\dfrac{1}{8} \times \dfrac{3}{2}$ which when solved is $\dfrac{3}{16}$

J. Dividing Mixed Numbers

Step 1 – Convert the mixed number or numbers to improper fraction
Step 2 – Change the division sign to multiplication
Step 3 – Change the fraction following the multiplication sign to its
  reciprocal (flip the fraction around so the old denominator is the
  new numerator and the old numerator is the new denominator)
Step 4 - Multiply the numerators
Step 5 – Multiply the denominators
Step 6 – Change the answer to lowest terms

Example: $3\dfrac{3}{4} \div 2\dfrac{5}{6} =$ becomes $\dfrac{15}{4} \div \dfrac{17}{6}$ becomes $\dfrac{15}{4} \times \dfrac{6}{17} =$

which when solved is $\dfrac{15}{24} \times \dfrac{\cancel{6}3}{17} = \dfrac{45}{34}$ which simplifies to $1\dfrac{11}{34}$

K. Adding and Subtracting Fractions

Step 1 – Find a common denominator (a number that both denominators will go into)
Step 2 – Raise each fraction to higher terms as needed
Step 3 – Add or subtract the numerators only as shown
Step 4 – Carry denominator over
Step 5 – Change the answer to lowest terms

Example #1: $\dfrac{1}{2} + \dfrac{7}{8} =$ Common denominator is 8 because both 2 and

8 will go into 8

$$\dfrac{1}{2} = \dfrac{4}{8}$$
$$+\dfrac{7}{8} = \dfrac{7}{8}$$

$$\dfrac{11}{8} \quad \text{which simplifies to} \quad 1\dfrac{3}{8}$$

Example #2: $4\dfrac{3}{5} - \dfrac{1}{4} =$ Common denominator is 20 because both 4

and 5 will go into 20

$$4\dfrac{3}{5} = 4\dfrac{12}{20}$$
$$-\dfrac{1}{4} = \dfrac{5}{20}$$

$$4\dfrac{7}{20}$$

Example #3:

$$2\frac{1}{8} \quad = \quad 2\frac{1}{8} \quad = \quad 1\cancel{2}\ \frac{1}{8}+\frac{8}{8} \quad = \quad 1\frac{9}{8}$$

$$-\ 1\frac{1}{4} \quad = \quad 1\frac{2}{8} \quad = \qquad 1\frac{2}{8} \qquad = \quad 1\frac{2}{8}$$

$$\frac{7}{8}\ \ **$$

Note – In this problem you must borrow from the whole number to adjust your fraction so that you can subtract. However, you may do this problem another way. Simply change the mixed number to improper form before finding the common denominator to prevent having to borrow.

$$2\frac{1}{8} \quad = \quad \frac{17}{8} \quad = \quad \frac{17}{8}$$

$$-\ 1\frac{1}{4} \quad = \quad \frac{5}{4} \quad = \quad \frac{10}{8}$$

$$\frac{7}{8}$$

FRACTIONS
PRACTICE SHEET

A. Write as an improper fraction.

1. $1\frac{1}{8}$

2. $4\frac{1}{5}$

3. $1\frac{2}{3}$

4. $2\frac{3}{16}$

5. $2\frac{5}{7}$

6. $2\frac{1}{16}$

7. $1\frac{5}{8}$

8. $3\frac{4}{5}$

9. $7\frac{1}{4}$

10. $5\frac{2}{3}$

11. $3\frac{5}{6}$

12. $6\frac{1}{2}$

B. Write as a mixed number.

1. $\frac{10}{4}$

2. $\frac{19}{2}$

3. $\frac{25}{3}$

4. $\frac{9}{8}$

5. $\frac{25}{16}$

6. $\frac{35}{4}$

7. $\frac{7}{3}$

8. $\frac{21}{8}$

9. $\frac{4}{2}$

10. $\frac{12}{7}$

11. $\frac{17}{4}$

12. $\frac{48}{9}$

C. Write in lowest terms.

1. $\frac{6}{32}$

2. $\frac{21}{35}$

3. $\frac{18}{24}$

4. $\frac{12}{15}$

5. $\frac{5}{30}$

6. $\frac{9}{27}$

7. $\frac{14}{49}$

8. $\frac{8}{32}$

5. $1\frac{12}{21}$

10. $2\frac{16}{20}$

11. $5\frac{8}{14}$

12. $3\frac{10}{25}$

D. Find the missing numerator by raising the fraction to higher terms.

1. $\dfrac{3}{4} = \dfrac{?}{12}$ 2. $\dfrac{7}{16} = \dfrac{?}{64}$ 3. $\dfrac{5}{8} = \dfrac{?}{48}$ 4. $\dfrac{5}{9} = \dfrac{?}{72}$

5. $5\dfrac{2}{3} = \dfrac{?}{12}$ 6. $1\dfrac{4}{5} = \dfrac{?}{10}$ 7. $1\dfrac{1}{4} = \dfrac{?}{12}$ 8. $2\dfrac{3}{5} = \dfrac{?}{10}$

E. Convert the following fractions into decimals.

1. $\dfrac{2}{3}$ 2. $\dfrac{1}{8}$ 3. $\dfrac{4}{5}$ 4. $\dfrac{5}{6}$ 5. $\dfrac{7}{16}$ 6. $\dfrac{9}{16}$

F. Convert the following decimals to fractions.

1. .225   2. .375   3. .0175   4. .95   5. .5   6. .45

G. Multiply.

1. $\dfrac{1}{9} \times \dfrac{1}{2} =$ 2. $\dfrac{7}{10} \times \dfrac{2}{5} =$ 3. $\dfrac{3}{8} \times \dfrac{2}{7} =$ 4. $\dfrac{1}{2} \times \dfrac{3}{16} =$

5. $\dfrac{3}{4} \times \dfrac{2}{3} =$ 6. $\dfrac{7}{16} \times \dfrac{4}{3} =$ 7. $\dfrac{15}{64} \times \dfrac{1}{12} =$ 8. $\dfrac{2}{9} \times \dfrac{5}{9} =$

9. $\dfrac{3}{4} \times 10 =$ 10. $1\dfrac{1}{2} \times \dfrac{5}{6} =$ 11. $\dfrac{3}{16} \times \dfrac{5}{12} =$ 12. $14 \times \dfrac{3}{8} =$

13. $\dfrac{1}{2} \times 1\dfrac{1}{3} =$ 14. $3\dfrac{1}{16} \times \dfrac{1}{5} =$ 15. $18 \times 1\dfrac{1}{2} =$ 16. $16 \times 2\dfrac{1}{8} =$

17. $6\dfrac{3}{8} \times 1\dfrac{3}{5} =$ 18. $2\dfrac{2}{3} \times 4\dfrac{3}{8} =$ 19. $4\dfrac{4}{9} \times 4\dfrac{2}{4} =$ 20. $3\dfrac{1}{8} \times 2\dfrac{2}{5} =$

H. Divide as shown.

1. $\dfrac{1}{2} \div \dfrac{1}{4} =$

2. $\dfrac{2}{5} \div \dfrac{1}{2} =$

3. $\dfrac{8}{3} \div \dfrac{2}{3} =$

4. $\dfrac{2}{9} \div \dfrac{1}{3} =$

5. $4 \div \dfrac{1}{8} =$

6. $8 \div \dfrac{4}{5} =$

7. $9 \div \dfrac{3}{4} =$

8. $\dfrac{6}{5} \div \dfrac{4}{5} =$

9. $\dfrac{4}{11} \div \dfrac{1}{11} =$

10. $\dfrac{2}{7} \div \dfrac{5}{9} =$

11. $\dfrac{2}{3} \div 4 =$

12. $14 \div \dfrac{7}{8} =$

13. $15 \div \dfrac{5}{6} =$

14. $8 \div \dfrac{3}{4} =$

15. $1\dfrac{1}{4} \div 1\dfrac{1}{2} =$

16. $3\dfrac{1}{2} \div 5 =$

17. $6\dfrac{1}{4} \div 2\dfrac{1}{2}$

18. $5\dfrac{1}{3} \div 2\dfrac{2}{3} =$

19. $2\dfrac{3}{4} \div 1\dfrac{1}{8} =$

20. $3\dfrac{1}{5} \div 1\dfrac{5}{7} =$

I. Add or subtract as shown.

1. $\dfrac{3}{8} + \dfrac{7}{8} =$

2. $\dfrac{2}{3} + \dfrac{3}{4} =$

3. $\dfrac{3}{32} + \dfrac{1}{8} =$

4. $\dfrac{3}{5} + \dfrac{5}{6} =$

5. $\dfrac{5}{8} + \dfrac{1}{10} =$

6. $\dfrac{3}{8} + 1\dfrac{1}{4} =$

7. $\dfrac{1}{4} + \dfrac{1}{5} =$

8. $2\dfrac{1}{8} + 1\dfrac{1}{4} =$

9. $1\dfrac{5}{8} + \dfrac{13}{16} =$

10. $2\dfrac{2}{3} + \dfrac{4}{9} =$

11. $\dfrac{9}{10} - \dfrac{3}{16} =$

12. $\dfrac{7}{8} - \dfrac{1}{2} =$

13. $\dfrac{11}{16} - \dfrac{1}{4} =$

14. $\dfrac{5}{6} - \dfrac{1}{5} =$

15. $\dfrac{7}{8} - \dfrac{3}{10} =$

16. $1\dfrac{1}{2} - \dfrac{3}{32} =$

17. $5\dfrac{5}{6} - 2\dfrac{3}{9} =$

18. $3\dfrac{2}{3} - 1\dfrac{7}{8} =$

19. $2\dfrac{1}{4} - \dfrac{5}{6} =$

20. $4\dfrac{5}{6} - 1\dfrac{1}{2} =$

J. Solve the word problems below using fractions.

1. The Cooper family decided to hike to Hillside Lake, approximately $8\frac{5}{8}$ miles away. After an hour the lake was still $5\frac{1}{3}$ miles away. How far did the group hike so far?

2. While riding her bike, Susan burns 450 calories every ½ hour. Based on this rate, how many calories will Susan burn if she rides the bike for 1¾?

3. Last Friday Tony worked for 7½ hours. Express this time as a fraction of the day.

4. When an oil tank is $\frac{7}{12}$ full, it contains 5¼ gallons. How many gallons does it hold when full?

5. How many pieces of $10\frac{5}{16}$ inch bar can be cut from a stock 20 foot bar?

6. Byron purchased a box of candy at the store. On his way home he ate ¼ of the candy in the box. At dinner with friends later that night he served ½ of what was left. If there are 6 chocolates now left in the box, how many did the box contain to start with?

7. Seth earns $560 per week. He has $\frac{1}{5}$ of his income withheld for federal taxes, $\frac{1}{15}$ of his income withheld for state taxes, and $\frac{1}{25}$ of his income withheld for medical coverage. How much income is left each week after those deductions?

8. A bolt extends through ¾" thick plywood, a washer that is ⅛" thick, and a nut that is $\frac{3}{16}$" thick. The bolt should be ⅝" longer than the sum of the thickness of the plywood, washer and nut. What is the minimum length of the bolt?

9. A recipe for French toast that serves 6 calls for ¾ cup granulated sugar, 1 cup of evaporated milk, ⅓ teaspoon of vanilla, and 12 thick slices of French bread. How much of each ingredient is needed to serve only three?

10. Boll's Electrical has a washing machine on sale for ⅓ off the regular price of $429. What is the sale price of the washing machine?

11. For a family party, Tanisha made $\frac{2}{5}$ of the desserts. If a total of 40 desserts were brought to the party, how many did Tanisha supply?

12. The price of computers has fallen by $\frac{2}{5}$. If the price of a computer was originally $10,275, by how much has the price fallen?

Percentages

By the time we are out of high school, most of us have lots of experience talking about percentages. For instance, most people know that 2 out of 4 soccer wins is a rate of 50%. Three students getting As out of 12 is 25%. Etc. But do you know enough about percentages to understand statistical arguments? Is a percentage the same thing as a fraction or a proportion? Should we take the difference between two percentages or their ratio? In their ratio, which percentage goes in the numerator and which goes in the denominator? Does it matter? What do we mean by something being statistically significant at the 5% level? What is a 95% confidence interval?

The basics

What is a percentage?

A percentage is a part of a whole. It can take on values between 0 (none of the whole) and 100 (all of the whole). The whole is called the base. The base must ALWAYS be reported whenever a percentage is determined.

Example: There are 20 students in a classroom, 12 of whom are males and 8 of whom are females. The percentage of males is 12 "out of" 20, or 60%. The percentage of females is 8 "out of" 20, or 40%. (20 is the base.)

X% means X/100. Notice that a percentage can be converted quickly into a fraction: 25% = 25/100 = ¼. 350% = 350/100 = 7/2.

How does a percentage differ from a fraction and a proportion?

Fractions and proportions are also parts of wholes, but both take on values between 0 (none of the whole) and 1 (all of the whole), rather than between 0 and 100. To convert from a fraction or a proportion to a percentage you multiply by 100 and add a % sign. To convert from a percentage to a proportion you delete the % sign and divide by 100. That can in turn be converted to a fraction. For example, 1/4 multiplied by 100 is 25%. .25 multiplied by 100 is also 25%. 25% divided by 100 is .25, which can be expressed as a fraction in a variety of ways, such as 25/100 or, in "lowest terms", 1/4.

Percentages have to add to 100.

That is, if the percentages are all taken on the same base for the same variable, if only one "response" is permitted, and if there are no missing data. For a group of people consisting of both males and females, the % male plus the % female must be equal to 100. In the above example 40% + 60% = 100%. If the variable consists of more than two categories, the total might not add to 100 because of rounding. As a hypothetical example, consider what might happen if the variable is something like Religious Affiliation and you have percentages reported to the nearest tenth for a group of 153 people of 17 different religions. It would be unlikely that those percentages would add exactly to 100.

What is a rate?

A rate is a special kind of ratio – and therefore a percentage – in which the numerator and denominator have different units. Miles/Hours for instance will give speed = rate of change of distance travelled. An interest rate of 10% on a loan, for example, means that there are 0.1 dollars owed on every dollar borrowed = 10/100 = 0.1.

Birth rates and death rates are of particular concern in the analysis of population growth or decline. In order to avoid small numbers, they are usually reported "per thousand" rather than "per hundred" (which is what a simple percent is). For example, if in the year 2010 there were to be six million births in the United States "out of" a population of 300 million, the ("crude") birth rate would be 6/300, or 2%, or 20 per thousand. If there were to be three million deaths in that same year, the (also "crude") death rate would be 3/300, or 1%, or 10 per thousand.

One of the most interesting rates is the "response rate" for surveys. It is the percentage of people who agree to participate in a survey. For some surveys, especially those that deal with sensitive matters such as religious beliefs and sexual behavior, the response rate is discouragingly low (and often not even reported), so that the results must be taken with more than the usual grain of salt.

Some rates are phrased in even different terms, e.g., parts per 100,000 or parts per million (the latter often used to express the concentration of a particular pollutant).

Percent change

Percent change is defined to be the ratio of the amount of change divided by the original amount. So a salary increase of $3000 on an annual salary of $60,000 is a 3000/60000 x 100 = 5% increase.

Whenever there are missing data (see above) the base changes. But when you're specifically interested in percent change the base also does not stay the same, and strange things can happen. Consider the example in Darrell Huff's delightful book, How to lie with statistics (1954), of a man whose salary was $100 per week and who had to take a 50% pay cut to $50 per week because of difficult economic times. [(100-50)/100 = .50 or 50%.] Times suddenly improved and the person was subsequently given a 50% raise. Was his salary back to the original $100? No. The base has shifted from 100 to 50. $50 plus 50% of $50 is $75, not $100.   There are several other examples in the research literature and on the internet regarding the problem of % decrease followed by % increase, as well as % increase followed by % decrease, % decrease followed by another % decrease, and % increase followed by another % increase.

Converting between decimals and fractions

To change a decimal to a fraction: use the place value of the last digit

$$0.85 = \frac{85}{100} \overset{\div 5}{\underset{\div 5}{=}} \frac{17}{20}$$

For example

hundredths

On a calculator press: $85 \; a\frac{b}{c} \; 100 =$

To change a fraction to a decimal: divide the top by the bottom

For example $\qquad \frac{4}{5} = 4 \div 5 = 0.8$

Converting between percentages and fractions or decimals

To write a % as a fraction or decimal: divide by 100

For example $64\% = 64 \div 100 = 0.64$

or $\qquad 64\% = \frac{64}{100} = \frac{16}{25}$

On a calculator press: $64 \; a\frac{b}{c} \; 100 =$

To write a decimal or fraction as a %: multiply by 100

For example $\quad 0.125 \qquad\qquad = 0.125 \times 100 = 12.5\%$

$$\frac{2}{5} \qquad\qquad = \frac{2}{5} \times 100 \quad (\text{i.e. } \frac{2}{5} \text{ of } 100\%) = 40\%$$

or $\qquad \frac{2}{5} \qquad\qquad = 2 \div 5 \times 100 = 40\%$

On a calculator press: $2 \; a\frac{b}{c} \; 5 \times 100 = 40\%$

Examples

1 **Write these decimals as fractions:**

0.3 =   0.5 =   0.6 =   0.02 =

0.05 =   0.25 =   0.36 =   0.125 =

2 **Write these fractions as decimals:**

$\frac{7}{10}$ = $\frac{1}{5}$ = $\frac{2}{5}$ = $\frac{3}{4}$ =

$\frac{7}{8}$ = $\frac{2}{3}$ = $\frac{9}{20}$ = $\frac{7}{25}$ =

3 **Write these percentages as decimals:**

3% =   30% =   25% =   80% =

8% =   12% =   67% =   17.5% =

4 Write these percentages as fractions:

20% =   75% =   5% =   30% =

40% =   15% =   24% =   35% =

5 Write these decimals as percentages:

0.25 =   0.5 =   0.7 =   0.07 =

0.45 =   0.09 =   0.4 =   0.375 =

6 Write these fractions as percentages:

$\frac{1}{10}$ = $\frac{1}{5}$ = $\frac{9}{10}$ = $\frac{3}{4}$ =

$\frac{4}{5}$ = $\frac{17}{20}$ = $\frac{1}{3}$ = $\frac{2}{3}$ =

Significant Figure Rules

There are three rules on determining how many significant figures are in a number:

1. Non-zero digits are always significant.
2. Any zeros between two significant digits are significant.
3. A final zero or trailing zeros in the decimal portion <u>ONLY</u> are significant.

Rule 1: Non-zero digits are always significant.

If you measure something and the device you use (ruler, thermometer, triple-beam balance, etc.) returns a number to you. Hence a number like 26.38 would have four significant figures and 7.94 would have three. The problem comes with numbers like 0.00980 or 28.09.

Rule 2: Any zeros between two significant digits are significant.

Suppose you had a number like 406. By the first rule, the 4 and the 6 are significant. However, to make a measurement decision on the 4 (in the hundred's place) and the 6 (in the unit's place), you HAD to have made a decision on the ten's place. The measurement scale for this number would have hundreds and tens marked with an estimation made in the

unit's place. Like this:
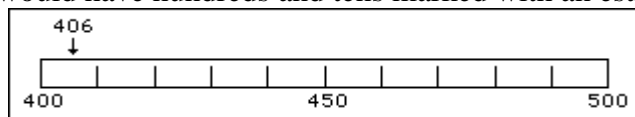
Rule 3: A final zero or trailing zeros in the decimal portion <u>ONLY</u> are significant.

Here are two examples of this rule with the zeros this rule affects in boldface: 0.005**00,** 0.0304**0**

Here are two more examples where the significant zeros are in boldface: 2.3**0** x 10^{-5}, 4.5**00** x 10^{12}

What Zeros are Not Discussed Above

<u>Zero Type #1</u>: Space holding zeros on numbers less than one.

Here are the first two numbers from just above with the digits that are NOT significant in boldface: 0.**00**500, 0.**0**3040. These zeros serve only as space holders.

<u>Zero Type #2</u>: the zero to the left of the decimal point on numbers less than one.

When a number like 0.00500 is written, the very first zero (to the left of the decimal point) is put there by convention. Its sole function is to communicate unambiguously that the decimal point is a deciaml point. If the number were written like this, .00500, there is a

possibility that the decimal point might be mistaken for a period. Many students omit that zero. They should not.

Zero Type #3: trailing zeros in a whole number.

200 is considered to have only ONE significant figure while 25,000 has two.

This is based on the way each number is written. When whole number are written as above, the zeros, BY DEFINITION, did not require a measurement decision, thus they are not significant.

However, it is entirely possible that 200 really does have two or three significnt figures. If it does, it will be written in a different manner than 200.

Typically, scientific notation is used for this purpose. If 200 has two significant figures, then 2.0×10^2 is used. If it has three, then 2.00×10^2 is used. If it had four, then 200.0 is sufficient. See rule #2 above.

Zero Type #4: leading zeros in a whole number.

00250 has two significant figures. 005.00×10^{-4} has three.