

## Step by Step: Significant Figures

### III. Rules for Rounding with Significant Figures

#### a) Addition/Subtraction

The answer is rounded to the **decimal place of the least accurate digit** in the problem.

Ex. 1) The more digits after the decimal, the more accurate. We want to round it to the least accurate, so the least number of digits after the decimal place. The first number below has the least number of digits after the decimal place (tenths place, 1 number after the decimal), so the final answer is rounded to tenths place (1 number after the decimal place).

429.3 tenths \*tenths is least accurate

37.45 hundredths

+ 1.93 hundredths

468.68 round it to tenths

468.7 = **4.687 X10<sup>2</sup>** When it is rounded to tenths, then put the number into exponential notation, but do not round off any more digits. (Do not round it twice!)

Ex. 2) The more digits after the decimal, the more accurate. We want to round it to the least accurate, so the least number of digits after the decimal place. The second and third number below have the least number of digits after the decimal place (hundredths place, 2 numbers after the decimal), so the final answer is rounded to hundredths place (2 numbers after the decimal place).

0.049 thousandths

1.20 hundredths \*hundredths is least accurate

+3.02 hundredths

4.269 round to hundredths

4.27 = **4.27 X10<sup>0</sup>** When it is rounded to hundredths, then put the number into exponential notation, but do not round off any more digits. (Do not round it twice!)

Ex. 3) The more digits after the decimal, the more accurate. We want to round it to the least accurate, so the least number of digits after the decimal place. The second number below has the least number of digits after the decimal place (0 numbers after the decimal, ones place), so the final answer is rounded to ones place (0 numbers after the decimal place).

Ex. 3)  $1.956 \times 10^2 - 2.3 \times 10^1$  **\*\*1<sup>st</sup> take the numbers out of exponential notation.**

195.6 tenths

-23. ones \*ones is least accurate

172.6 round to ones

173 = **1.73 X10<sup>2</sup>** When it is rounded to ones place, then put the number into exponential notation, but do not round off any more digits. (Do not round it twice!)

## b) Multiplication/Division

The answer should have the same number of significant figures as the term with the **least number of significant figures** in the problem.

Ex. 1) For multiplication & division we are not looking at decimal place; we are looking at the number of significant figures. The “X10” part just tells us where the decimal goes. Ignore this and just look at the number part. The first number, the “4.2” has 2 significant figures vs. the “2.43” has 3 significant figures. We want the least number of significant figures, which is 2. So round the answer to 2 significant figures.

$$\begin{aligned} \text{Ex. 1) } 4.2 \times 10^4 \times 2.43 \times 10^2 &= (4.2 \times 10^4) \times (2.43 \times 10^2) = 10206000 = 1.0206 \times 10^7 \\ 1^{\text{st}} \text{ number has 2 sig fig, } 2^{\text{nd}} \text{ number has 3 sig fig, 2 is least} & \qquad \qquad \qquad = \mathbf{1.0 \times 10^7} \end{aligned}$$

Ex. 2) For multiplication & division we are not looking at decimal place; we are looking at the number of significant figures. The “X10” part just tells us where the decimal goes. Ignore this and just look at the number part. The first number, the “4.9” has 2 significant figures vs. the other numbers that have 3 significant figures. We want the least number of significant figures, which is 2. So round the answer to 2 significant figures.

$$\begin{aligned} \text{Ex. 2) } 4.9 \times 10^{-2} \times 3.11 \times 10^2 / 3.97 \times 10^3 &= (4.9 \times 10^{-2}) (3.11 \times 10^2) / (3.97 \times 10^3) = \\ 0.003838539 &= 3.838539 \times 10^{-3} = \mathbf{3.8 \times 10^{-3}} \\ 1^{\text{st}} \text{ number has 2 sig fig, } 2^{\text{nd}} \text{ number has 3 sig fig, } 3^{\text{rd}} \text{ number has 3 sig fig, 2 is least} & \end{aligned}$$

Ex. 3) For multiplication & division we are not looking at decimal place; we are looking at the number of significant figures. The “X10” part just tells us where the decimal goes. Ignore this and just look at the number part. The second and third numbers have 3 significant figures vs. the first number has 4 significant figures. We want the least number of significant figures, which is 3. So round the answer to 3 significant figures.

$$\begin{aligned} \text{Ex. 3) } 3.729 \times 10^2 \times 2.36 \times 10^2 / 4.56 \times 10^2 &= (3.729 \times 10^2) (2.36 \times 10^2) / (4.56 \times 10^2) = \\ 192.9921053 &= \mathbf{1.93 \times 10^2} \\ 1^{\text{st}} \text{ number has 4 sig fig, } 2^{\text{nd}} \text{ number has 3 sig fig, } 3^{\text{rd}} \text{ number has 3 sig fig, 3 is least} & \end{aligned}$$

#### IV. Combined Operations

Steps:

- 1) Work out the problem on the calculator.
- 2) Then go back and find what the numbers should be rounded to.
- 3) Round off the original answer.

First, work out the problem on the calculator. **This answer 79.2986 will be the answer we round off at the end.**

$$\text{Ex. 1) } (4.23 + 5.6) (3.13 + 4.937) = (9.83) (8.067) = 79.2986$$

Now we figure out what the numbers should have been rounded to. When adding & subtracting we look at the decimal place. We want the least accurate, which will have the **fewest numbers after the decimal**. The first sum should have been rounded to one place after the decimal, tenths (the least accurate). The second sum should have been rounded to two places after the decimal place, hundredths (the least accurate).

$$\begin{array}{r} 4.23 \\ +5.6 \quad \leftarrow \text{tenths least accurate} \\ \hline 9.8 \quad \text{rounded to tenths} \end{array} \qquad \begin{array}{r} 3.13 \quad \leftarrow \text{hundredths least accurate} \\ +4.937 \\ \hline 8.07 \quad \text{rounded to hundredths} \end{array}$$

Now when the numbers are multiplied we are looking at the number of significant figures. We want the least number of significant figures. The first sum should have been rounded to 9.8, which has 2 significant figures, while the second sum should have been rounded to 8.07, which has 3 significant figures. 2 significant figures is least, so our original answer of 79.2986 should be rounded to 2 significant figures. (Do not re-multiply  $9.8 \times 8.07$ , because this answer may be off due to rounding along the way!)

$$\begin{array}{c} (9.8) (8.07) = 79 = 7.9 \times 10^1 \text{ rounded to 2 sig fig} \\ \uparrow \\ 2 \text{ sig fig is the least amount} \end{array}$$

First, work out the problem on the calculator. **This answer 8.7441517 will be the answer we round off at the end.**

$$\text{Ex. 2) } \frac{(1.53 + 2.961 + 37.0)}{(42.3 - 29.345 - 8.21)} = \frac{41.491}{4.745} = 8.7441517$$

Now we figure out what the numbers should have been rounded to. When adding & subtracting we look at the decimal place. We want the least accurate, which will have the **fewest numbers after the decimal**. The first sum should have been rounded to one place after the decimal, tenths (the least accurate). The second sum should have been rounded to one place after the decimal place, tenths (the least accurate).

$$\begin{array}{r} 1.53 \\ +2.961 \\ +\underline{37.0} \quad \leftarrow \text{tenths least accurate} \\ \hline 41.5 \quad \text{rounded to tenths} \end{array} \qquad \begin{array}{r} 42.3 \quad \leftarrow \text{tenths least accurate} \\ -29.345 \\ -\underline{8.21} \\ \hline 4.7 \quad \text{rounded to tenths} \end{array}$$

Now when the numbers are divided we are looking at the number of significant figures. We want the least number of significant figures. The first sum should have been rounded to 41.5, which has 3 significant figures, while the second sum should have been rounded to 4.7, which has 2 significant figures. 2 significant figures is least, so our original answer of 8.7441517 should be rounded to 2 significant figures. (Do not re-divide 41.5 / 4.7, because this answer may be off due to rounding along the way!)

$$(41.5) / (4.7) = \mathbf{8.7} = \mathbf{8.7 \times 10^0} \quad \text{rounded to 2 sig fig}$$

↑  
2 sig fig is the least amount