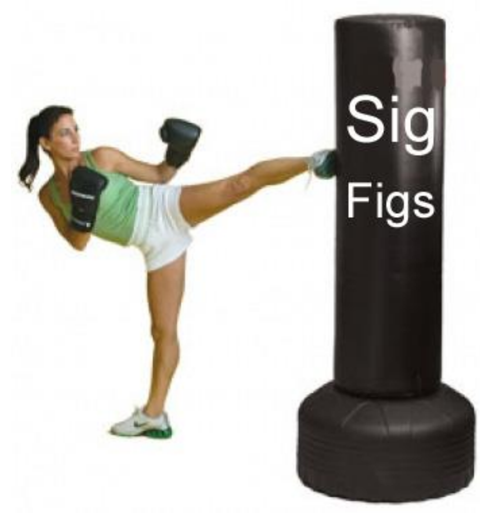
Review of Significant Figures



"If "significant figures" was a person, I would punch him."

--an LHA student

1. The rules for identifying significant digits when writing or interpreting numbers are as follows:

- All non-zero digits are considered significant. For example, 91 has two significant figures (9 and 1), while 123.45 has five significant figures (1, 2, 3, 4 and 5).

  Examples:

- Zeros appearing anywhere between two non-zero digits are significant. Example: 101.12 has five significant figures: 1, 0, 1, 1 and 2.

  Examples:

- Leading zeros are not significant. For example, 0.00052 has two significant figures: 5 and 2.

  Examples:

- Trailing zeros in a number containing a decimal point are significant. For example, 12.2300 has six significant figures: 1, 2, 2, 3, 0 and 0. The number 0.000122300 still has only six significant figures (the zeros before the 1 are not significant). In addition, 120.00 has five significant figures. This convention clarifies the precision of such numbers; for example, if a result accurate to four decimal places is given as 12.23 then it might be understood that only two decimal places of accuracy are available. Stating the result as 12.2300 makes clear that it is accurate to four decimal places.

- Examples:

a) How many significant figures are in 12.0050 cm?___________

b) In 0.000030 cm_____________

c) In 120 $\pm 1 seonc$______________

d) In my lifetime I have kissed my wife about 20 000 times____________

e) 0.00 kg______________

f) 50 600 calories may be 3, 4, or 5 significant figures depending on the context

The potential ambiguity in the last rule can be avoided by the use of standard exponential, or "scientific," notation. For example, depending on whether the number of significant figures is 3, 4, or 5, we would write 50 600 calories as:

5.06×10^4 calories has ____ significant figures
5.060×10^4 calories has ____ significant figures
5.0600×10^4 calories has ____ significant figures

2. <u>Significant Digits in Multiplication, Division, Trig. functions, etc.</u>

In a calculation involving multiplication, division, trigonometric functions, etc., the number of significant digits in an answer should equal the least number of significant digits in any one of the numbers being multiplied, divided etc.

a) Express with the correct sig figs:

$$V = \frac{1.00\ mole(8.31\frac{L\,kPa}{K\,mole})(273.15K)}{101.3kPa}$$

b) Now as you convert the above answer to ml and use 1000 ml/L, you will **<u>not</u>** change the number of sig figs of the previous answer. Explain.

3. **Squeech chooses 1.00797 g/mole as the mola**r mass of H.
Bellissima uses 1.0 g/mole.

If 12.0 grams of H is to be converted into moles, Squeech and Bellissima will not express their answers the same way.

a) Carry out both calculations, and express each one with the correct number of significant figures.

b) Who is doing a better job and why?

4. **Significant Digits in Addition and Subtraction**

When quantities are being added or subtracted, the number of *decimal places* (not significant digits) in the answer should be the same as the least number of decimal places in any of the numbers being added or subtracted.

a) $x + y + z = ?$, where $x = 48.1$, $y = 77$, and $z = 65.789$

b) $m - n - p = ?$, where $m = 25.6$, $n = 21.1$, and $p = 2.43$

5. **Significant Figures and Experimental Error**

When a difference between two measurements is used in a calculation, the number of significant figures limiting the answer is based on the difference and not on the original measurements.

Example: Suppose an iron nail reacted with $CuSO_4$ to produce copper and $FeSO_4$:

$$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$$

Experiment 1: Before the reaction, the nails weighed 7.07 ± 0.01 grams. Afterwards, they weighed 6.99 ± 0.01 g.

Experiment 2: Before the reaction, the nails weighed 8.07 ± 0.01 grams. Afterwards, they weighed 8.03 ± 0.01 g.

a) In each case calculate the amount of copper produced.
b) Also find the experimental error associated with the difference in each case.
c) Relate the number of significant figures to the % error.

Exercises

Siginificant Figures Exercise

1. What is the correct number of significant figures in the following measurements?

   a. 2.0004 cm
   b. 300. cm(there is a deliberate point after the last zero)
   c. 300 m
   d. There are about 6 billion people on earth.
   e. 1.9900 ml
   f. 2.00×10^4 kg
   g. 0.00403 g

2. The mass of an empty can is 61 ± 1 grams. Then 30 ± 1 grams of water are added to the can. What is the lowest possible total mass for the can and water? The highest?

3. A student observed that the temperature of 100.0 ml of water with a known density of 1.0 g/ml increased from 10.5 ^oC to 22.8 ^oC. Express the amount of heat absorbed by the water in kJ with the correct number of significant figures. Use c = 4.19 J/(g^{o}C).

4. A gas sample contains 1000.233 moles of He and 0.35 moles of H_2. What is the total number of moles of gas in the sample, expressed with the correct number of sig- figs?

5. H_2 with a molar mass of 2(1.00797) g/mole consumes 8.0 grams of sodium, according to the following reaction:

   $$2\,Na_{(s)} + H_{2(g)} \rightarrow 2\,NaH_{(s)}$$

   How many grams of sodium hydride, NaH will be produced? Express with the correct number of significant figures.

6. In a lab, measurements for the height of a tube ranged from 5.5 cm to 6.8 cm. The least accurate concentrations of the solutions used was 0.0010 M. Assuming that the value for K(an equilibrium constant) should have been expressed with just as many significant figures as in the above numbers, how should Peter have expressed the average of the following 4 values for K?

   96.37754
   87.05914
   126.1661
   230.3015

7. Given:

   $$2\,NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2\,H_2O$$

   0.010 moles of NaOH were in a beaker. Johnny only added enough acid to neutralize part of the base because from the pH measurement he realized that there were still 0.008 moles left over. How many grams of sodium sulfate did he produce? Express with sig figs.