Significant Figures

Nature of Measurement

Measurement - quantitative observation consisting of 2 parts

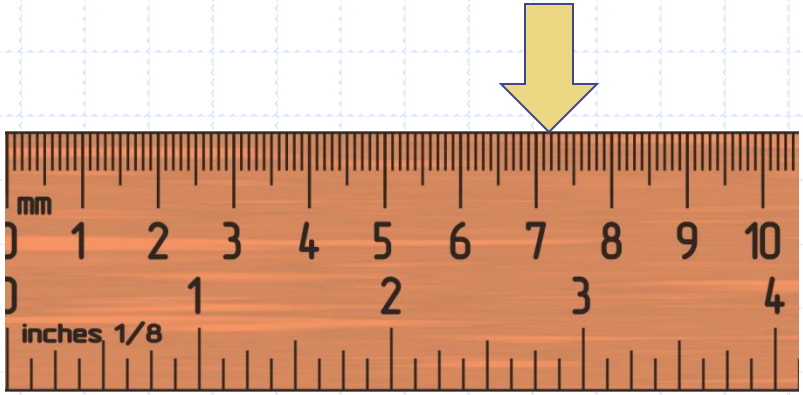
Part 1 - number
Part 2 - scale (unit)

Examples:

20 grams
6.63×10^{-34} Joule seconds

Significant Figures

- **All of the known digits + 1 estimated digit**



Uncertainty of Measurement

- The last digit on any physical measurement is always an approximation.
- Significant figures are the number of digits that can be accurately measured and the first uncertain digit.

Rule #1

- All non-zero numbers are significant

- 3.89 = 3 significant figures

- 938.3 = 4 significant figures

Rule #2

- Sandwich rule: all zero's between non-zero or significant numbers are significant

a.) 202 = 3 ___ significant figures

Rule #2

b.) 67000045 = 8 significant figures

c.) 150098 = 6 significant figures

Rule #3

- leading zeros are never significant

Rule #3 Leading zeros are NEVER significant

- 0.91 = 2 significant figures
- 0.0089 = 2 significant figures

Rule #4

- **Trailing zeros are only significant if there is a decimal place in the number**

- 202.00 = 5 significant figures

Practice the zero rules:

- 10.0098 = 6 sig digs
- 9800 = 2 sig digs
- 0.009800 = 4 sig digs

Sig Fig Practice #1

How many significant figures in each of the following?

1.0070 m → 5 sig figs

17.10 kg → 4 sig figs

100,890 L → 5 sig figs

3.29×10^3 s → 3 sig figs

0.0054 cm → 2 sig figs

3,200,000 → 2 sig figs

Rule #5

- Numbers obtained through counting or are defined have unlimited significant figures
  - 24 people in the class
  - 60 minutes = 1 hour
- both have unlimited

Significant Figures in Calculations

- An answer cannot be more precise than the least precise measurement in the calculation

Rounding

- Look at the digit to the right of the one you need to round.
  - If is is < 5 – leave it alone
  - If it is ≥ 5 – round up

- 56.312 m = _____ (4 sig. figs.)
- 56.31 m

Rounding

- 0.001775 m = _____ (2 sig. figs.)
- 0.0018 m

- 8792 m = _____ (2 sig. figs.)
- 8800 m

Addition and Subtraction

- Answers should be rounded to the same number of ***decimal places*** as the least (lowest) number of decimal places in the calculation

Using significant figures when adding and subtracting

892.542	←	3
20.629	←	3
0.18	←	2
+ 4.20	←	2
917.551		

The least amount of significant figures to the right of the decimal in the numbers is 2; therefore, the answer should only have 2 significant figures to the right of the decimal.

917.55

Examples

- 12.52 m + 349.0 m =
- 361.52 m = **361.5 m**

- 74.626 m - 28.34 m =
- 46.286 m = **46.29 m**

Sig Fig Practice #2

Calculation	Calculator says:	Answer
3.24 m + 7.0 m	10.24 m	10.2 m
100.0 g - 23.73 g	76.27 g	76.3 g
0.02 cm + 2.371 cm	2.391 cm	2.39 cm
713.1 L - 3.872 L	709.228 L	709.2 L
1818.2 lb + 3.37 lb	1821.57 lb	1821.6 lb
2.030 mL - 1.870 mL	0.16 mL	0.160 mL

Multiplication and Division

- The answer should be rounded to the same number of ***significant figures*** as the least number of significant figures in the calculation

Examples

- 7.55 m x 0.34 m =
- 2.567 m^2 = **2.6 m^2**

- 2.10 m x 0.70 m =
- 1.47 m^2 = **1.5 m^2**

Examples

- 2.4526 m / 8.4 m =
- 0.2922 = **0.29 m^2**

- 0.365 m / 0.0200 m =
- 18.25 = **18.3 m^2**

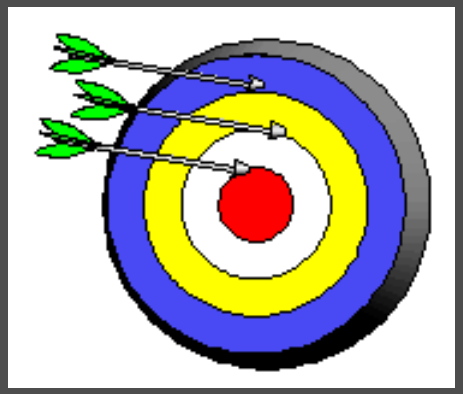
Sig Fig Practice #3

Calculation	Calculator says:	Answer
3.24 m x 7.0 m	22.68 m^2	23 m^2
100.0 g ÷ 23.7 cm^3	4.219409283 g/cm^3	4.22 g/cm^3
0.02 cm x 2.371 cm	0.04742 cm^2	0.05 cm^2
710 m ÷ 3.0 s	236.6666667 m/s	240 m/s
1818.2 lb x 3.23 ft	5872.786 lb·ft	5870 lb·ft
1.030 g ÷ 2.87 mL	2.9561 g/mL	2.96 g/mL

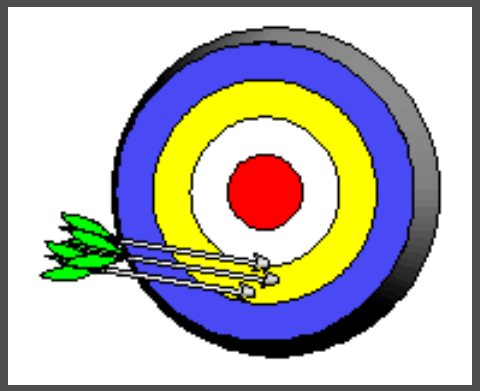
Precision and Accuracy

Accuracy refers to the agreement of a particular value with the true value.

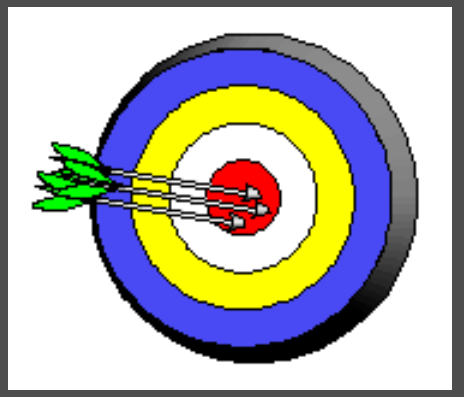
Precision refers to the degree of agreement among several measurements made in the same manner.



Neither accurate nor precise



Precise but not accurate



Precise AND accurate