SIGNIFICANT FIGURES

The following rules will be used to determine the number of significant figures in a measured or calculated number.

1. All nonzero digits are always significant.

examples: 1.23 (3 s.f.) ; 1567 (4 s.f.)

2. Zeros between nonzero digits are always significant.

examples: .17009 (5 s.f.) ; 6.008 (4 s.f.) ; 3405 (4 s.f.)

3. Leading zeros (zeros to the left of the first nonzero digit) are never significant.

examples: .00987 (3 s.f.) ; 0.00001234 (4 s.f.)

4. Trailing zeros (zeros to the right of the last nonzero digit) in a number **with a decimal point** will always be counted as significant

examples: 345.980 (6 s.f.) ; .12300 (5 s.f.) ; 0.000**9800** (4 s.f.)

5.1 Trailing zeros in a number **without a decimal point** generally will not be significant.

examples: 2000 (1 s.f.) ; 101200 (4 s.f.)

5.2 If one or more of the trailing zeroes are significant, then it is best to convert the number to scientific notation and include only the significant zeroes. **Remember, every digit included in a number written in scientific notation is considered to be significant.**

Consider the following possibilities for the number 109000

a) None of the trailing zeroes are significant (3 s.f.).
109000 written with 3 s.f. = 1.09×10^5

b) Only the first trailing zero is significant (4 s.f.).
109000 written with 4 s.f. = 1.090×10^5

c) The first two trailing zeroes are significant (5 s.f.).
109000 written with 5 s.f. = 1.0900×10^5

d) All three trailing zeroes are significant (6 s.f.).

109000 written with 6 s.f.= 109000. (notice the decimal point) or using scientific notation it would be 1.09000×10^5

Practice with Significant Figures
(version = 2003)

I. Counting significant figures.

1. State the number of significant figures in each of the following numbers and give the rule you used in each case.

Number	significant figures	Based on Rule #
345.56	5 s.f.	1
4500	2 s.f.	5.1
239.1300	7 s.f.	4
.00004976	4 s.f.	3
1.200×10^{-12}	4 s.f.	5.2
25.0086	6 s.f.	2

2. Your turn ! Note: I do not expect you to remember the rule number, it is much more important that you have the rules for counting significant figures memorized so you will know which rule to apply when counting significant figures.

Number	Significant figures	State the Rule
1000000		
1000000.		
1200.003		
.0012300		
1457		
.00045321		
1457.		
1.00200		

II. Rounding off calculated results.

3. Round off each of the following numbers to 4 significant figures.

a) .12346 = .1235 decider number (6) greater than 5
b) 12343 = 12350 or 1.235×10^4 decider number (3) less than 5

Do you see why 12350 is correct and 12350. or 1235 are not? In the first case 12350. is 5 s.f.(rule 4). In the second case the number 1235 would change the magnitude of the original number. That is, the original number is about twelve thousand and 1235 is about twelve hundred. The original magnitude of the number must be retained.

c) 1.00345 = 1.003 decider number (45) less than 50
d) 1.00350 = 1.004 decider number (50) equals 50; even remains even
e) 1.00850 = 1.008 decider number (50) equals 50; odd raised to even
f) 1.00851 = 1.009 decider number (51) greater than 50;
f) .000023445 = .00002344 decider number (45) less than 50
$= 2.344 \times 10^{-5}$
g) 25300821= 2.530×10^7 decider number (0821) less than 5000
h) 199999 = 2.000×10^5 decider number (99) greater than 50

4. Your turn. Round off the following to 5 significant figures.

a) 1.00345 = _____

b) .0023087610 = _____

c) 12300000 = _____

d) 56.340502 = _____

e) 9.2003498 = _____

f) 39999999 = _____

III. Determining the number of significant figures in the result of a calculation.

5. Rule 1 — The result of a multiplication or division should contain the same number of significant figures as was present in the number with the fewest significant figures.

2.0044(5 s.f.) x 12.54 (4 s.f.) = 25.135176 = 25.14(4 s.f.)

$$\frac{.00342(3\text{ s.f.}) \times 1.230(4\text{ s.f.})}{56.781(5\text{ s.f.})} = .000074085 = .0000741(3\text{ s.f.})$$

6. Rule 2 ---- The result of an addition or subtraction should contain the same number of **decimal places (d.p.)** as the number with the fewest **decimal places**.

3.123 (3 d.p.) + 123.23(2 d.p.) = 126.353 = 126.35 (2 d.p.)

456.1(1 d.p.) - 476.25 (2 d.p.) = - 20.15 = - 20.2 (1 d.p.)

7. Notice how the number of significant figures and decimal places change in the following calculation as the different rules come into play.

$$\frac{\textbf{3.123 (3 d.p.) + 123.23(2 d.p.)}}{\textbf{456.1(1 d.p.) - 476.25 (2 d.p.)}} = \frac{\textbf{126.353}}{\textbf{- 20.15}} = \frac{\textbf{126.35 (2 d.p. , 5 s.f)}}{\textbf{- 20.2 (1 d.p. , 3 s.f.)}} = \textbf{- 6.25495 = - 6.25 (3 s.f.)}$$

8. Your turn.

$$\frac{.002345}{137.49} \times (5.234 + 123) = \underline{\qquad}$$

$$\frac{23.023 \times 18.000 \times .00087638}{3.870 \times 10^{-4}} = \underline{\qquad}$$

$$\frac{88.312 - 81.1}{88.312 + 81.1} = \underline{\qquad}$$