Name:______________________
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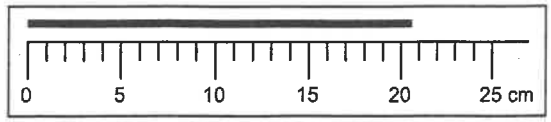
SIGNIFICANT DIGITS



The length of the line is approx. 20.7 cm. The 2 and 0 are certain, the 7 is uncertain. All three digits are significant.

Summary: associated with every measurement made is some degree of uncertainty. For instance, you might measure the length of the dark line shown in the diagram as 20.7 cm. The digits 2 and 0 are certain - there is no doubt that the length is "20 point something" cm. The 7 is uncertain - it might be a little less or a little more. The number of 'significant digits' indicates the certainty of our measurement. There are three significant digits in this case (20.7). Thus, significant digits in a measurement or calculation consist of all those digits that are certain, plus one uncertain digit. Although your calculator may give you an answer to eight decimal places or more, you should not include all of these digits in your answer.

Rules For Determining The Number Of Significant Digits

If you have trouble determining the number of significant digits, follow these steps.

1. All digits from 1 to 9 (non-zero digits) are considered to be significant.

Example	Number of significant digits
1.23 g	3

2. Zeros between non-zero digits are always significant

1.03 g	3

3. Zeros to the left of non zero digits, serve only to locate the decimal point; they are not significant.

0.00123 g	3; zeros to the left of the 1 simply locate the decimal point. To avoid confusion you can write numbers in scientific notation. I.e. $0.00123 = 1.23 \times 10^{-3}$

4. Any zero printed to the right of a non-zero digit is significant if it is also to the right of the decimal point.

2.0 g and 0.020 g	2 for both; all zeros that are right of both a non-zero digit and the decimal point are significant.

5. Any zero printed to the right of a non-zero digit may or may not be significant if there is no decimal point indicated. For example, if someone tells you that a mountain is 3600 m high they are probably certain of the 3, and uncertain of the 6. In other words, there are likely 2 significant digits. However 3600 m may also have 3 significant digits (if the measurement was taken to the nearest 10 m) or 4 significant digits if the measurement was taken to the nearest 1 m).

100 g	1, 2, or 3; in numbers that do not contain a decimal point, "trailing" zeros may or may not be significant. To eliminate possible confusion, one practice is to underline the last significant digit. Thus, $1\underline{0}0$ has two significant digits, whereas $10\underline{0}$ has three. Ideally, we write the number in scientific notation: for example 1.0×10^{-2} has two significant digits and 1.00×10^{-2} has three significant digits. Notice that for numbers written in scientific notation, all digits are significant.

6. Any number that is counted instead of measured has an infinite number of significant digits.

3 test tubes	Infinite; exact numbers, for example, the number of meters in a kilometer or numbers obtained by counting (4 people, 5 beakers), are said to have an infinite number of significant digits.

A) How many significant digits do the following measured quantities have?

i) 2.83 cm	iii) 14.0 g	v) 0.02 mL	vii) 2.350×10^{-2} L	ix) 3 fingers
ii) 36.77 mm	iv) 0.0033 kg	vi) 0.2410 km	viii) 1.00009 L	x) 0.0056040 g

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B) i) 83.25 – 0.1075 ii) 4.02 + 0.001 iii) 0.2983 + 1.52

C) i) 7.255 ÷ 81.334 ii) 1.142 x 0.002 iii) 31.22 x 9.8

D) Solve the following (do one step at a time, according to BEDMAS): i) 6.12 x 3.734 + 16.1 ÷ 2.3
ii) 0.0030 + 0.02 iii) $1.70 \times 10^{3} + 1.34 \times 10^{5}$ iv) (33.4 + 112.7 + 0.032)/(6.487)

E) Convert these measurements: i) 1.0 cm = ______ m, ii) 0.0390 kg = ______ g, iii) 1.7 m = _____ mm

Guidelines for Significant Digits, Manipulation of Data, and Rounding in the Mathematics and Sciences

Significant Digits

1. For all non-logarithmic values, regardless of decimal position, any of the digits 1 to 9 is a significant digit; 0 may be significant. For example:

   123 0.123 0.00230 2.30×10^3
   all have 3 significant digits

2. Leading zeros are not significant. For example:

   0.12 and 0.012 each have two significant digits

3. Trailing zeros to the right of the decimal are significant. For example:

   0.123 00 and 20.000 each have five significant digits

4. Zeros to the right of a whole number are considered to be ambiguous. **The Student Evaluation Branch considers all trailing zeros to be significant**. For example:

   200 has one significant digit

5. For logarithmic values, such as pH, any digit to the left of the decimal is **not significant**. For example:

   a pH of 1.23 has two significant digits
   a pH of 7 has no significant digits

Manipulation of Data

1. When adding or subtracting measured quantities, the calculated answer should be rounded to the same degree of precision as that of the least precise number used in the computation **if this is the only operation**. For example:

   12.3 (least precise)
   0.12
   12.34
   24.76

   The answer should be rounded to 24.8.

2. When multiplying or dividing measured quantities, the calculated answer should be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits **if this is the only operation**. For example:

   $(1.23)(54.321) = 66.81483$

   The answer should be rounded to 66.8.

3. When a series of calculations is performed, each interim value should not be rounded before carrying out the next calculation. The final answer should then be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits. For example:

   In determining the value of $(1.23)(4.321)/(3.45 - 3.21)$, three calculations are required:

   a. $3.45 - 3.21 = 0.24$

   b. $(1.23)(4.321) = 5.31483$

   c. $5.31483/0.24 = 22.145125$

   [Not $5.31/0.24 = 22.125$]

   The value should be rounded to 22.

Rounding

1. When the first digit to be dropped is less than or equal to 4, the last digit retained should not be changed. For example:

   1.2345 rounded to three digits is 1.23

2. When the first digit to be dropped is greater than or equal to 5, the last digit retained should be increased by one. For example:

   12.25 rounded to three digits is 12.3