ACCURACY AND PRECISION

Objective: Identify and explain sources of errors and uncertainty in distance, time, and speed measurements and express results in a form that indicates the limit of accuracy.

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- What is Accuracy?
  - How close a measurement is to the actual value.
  - Accuracy= Correct
- What is Precision?
  - How close measurements are to each other.
  - Precision = Repeatable

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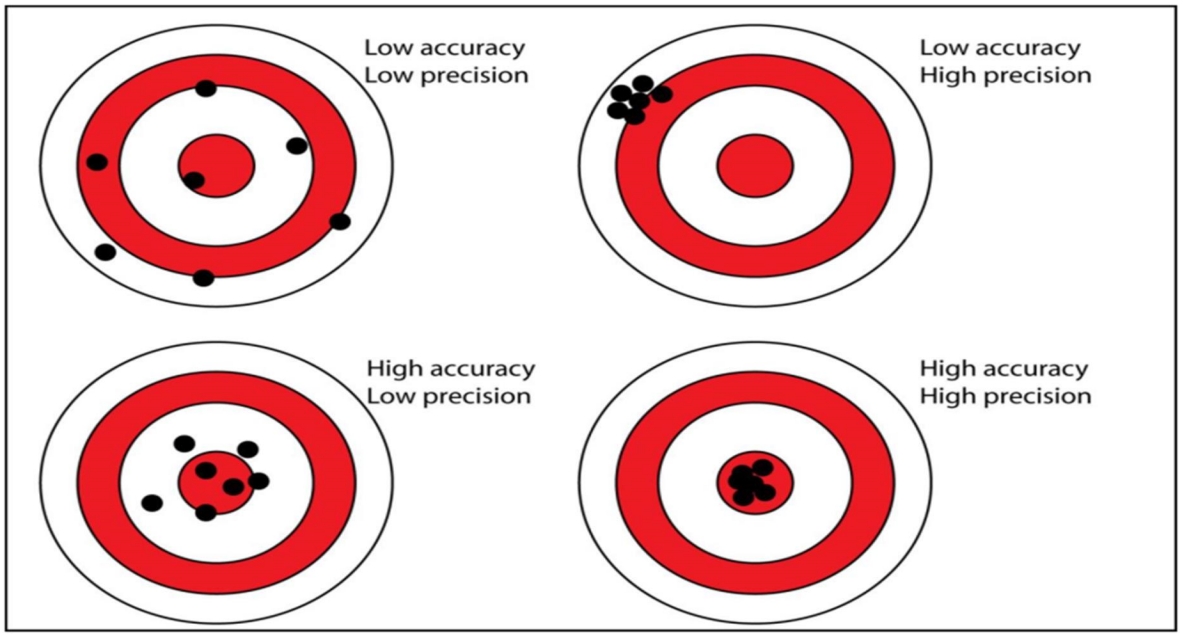

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The Rule of Certainty

- Tells us how precise a measurement is by telling us how many digits are important or 'significant'.
- We record all digits that are certain (measured) plus one uncertain (estimated) digit.

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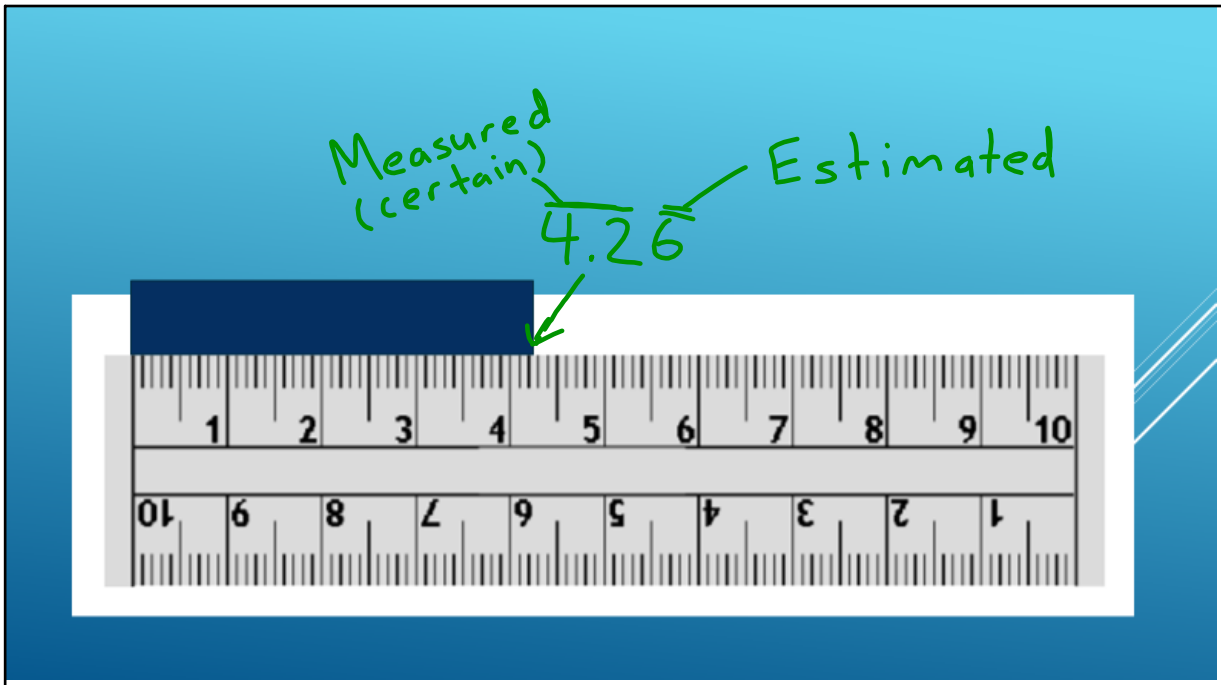

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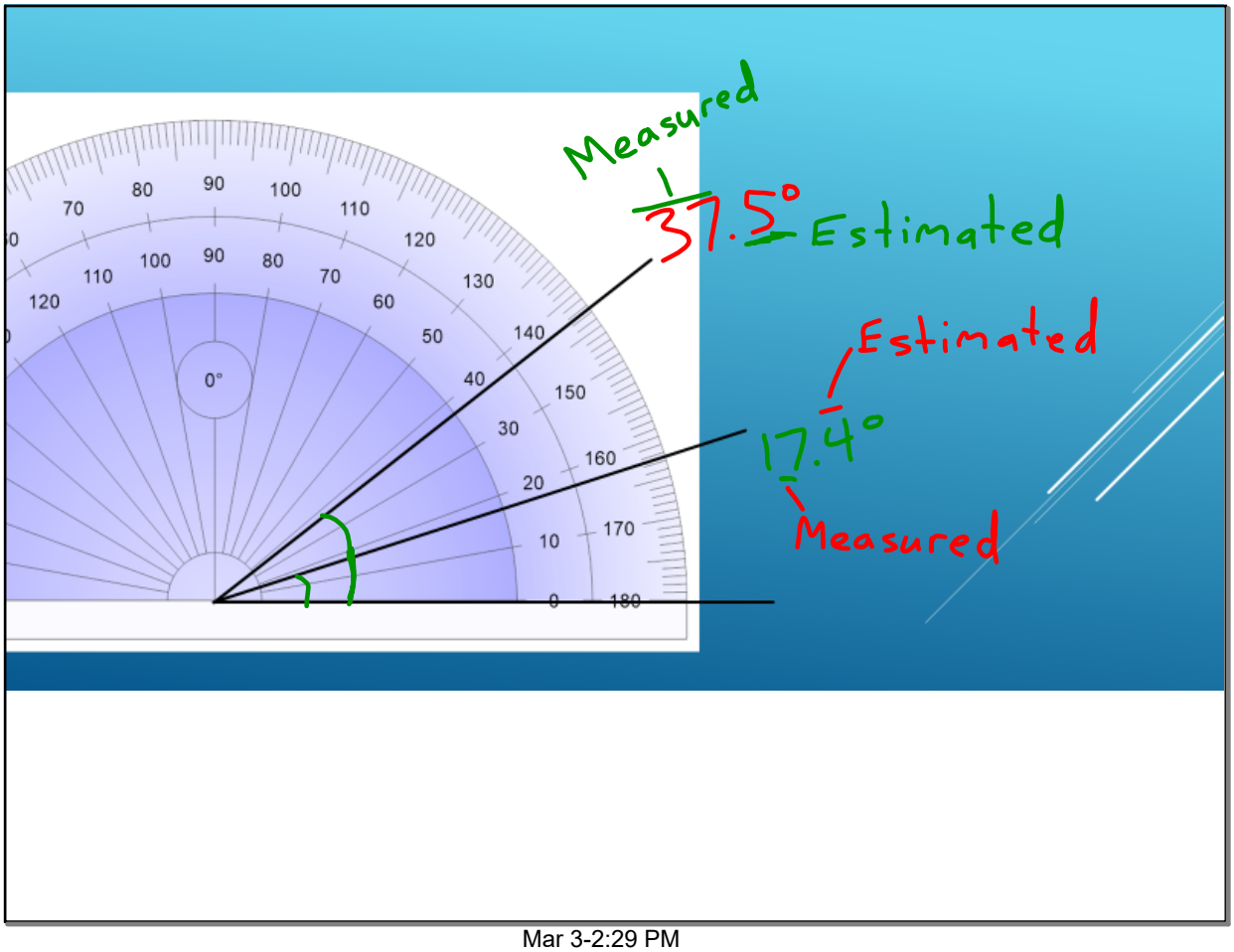

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Significant Digits

1. All non-zero digits (1-9) ARE significant.

ex. 27 has 2 significant digits
277 has 3 significant digits
2779 has 4 significant digits

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Significant Digits

2. Zeros between non-zero digits ARE significant

ex. 2034 has 4 significant digits
3.0005 has 5 significant digits

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Significant Digits

3. Any zeros to the left of the first non-zero digit are NOT significant (called leading zeroes)

ex. 0.005 has 1 significant digits
0.036 has 2 significant digits

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Significant Digits

4. Any zeros at the end of a number that contains a decimal point ARE significant

ex. *3.0 has 2 significant digits*
0.0250 has 3 significant digits
800. has 3 significant digits
800.0 has 4 significant digits

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Significant Digits

5. Zeroes at the end of a whole number that does not contain a decimal point are NOT significant

ex. *800 has 1 significant digit*
102 000 has 3 significant digits

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When written in scientific notation, all numbers are Significant!

2.4×10^{3} 2 SD

2.40×10^{5} 3 SD

2.4000×10^{-20} 5 SD

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Counted Value	Defined Value
4 Dogs	1000m/km
10 CDs	10mm/cm
3 Days	1h/60min

The type of items in the above table are not considered when determining the number of significant digits in your answers.

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102 cm

- **Practice:** SD
- 1) 1.02 Km = 3 significant digits
- 2) 0.32 cm = 2 significant digits
- 3) 3600 kg = 2 significant digits
- 4) 20.060 L = 5 significant digits
- 5) 0.0030 g = 2 significant digits

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Set A: Determine the number of significant digits in each number.

1. 2605.40 — 6 SD
2. 10,733 — 5 SD
3. 0.00420 — 3 SD
4. 990. — 3 SD
5. 325 — 3 SD
6. 0.0004 — 1 SD
7. 3000.0 — 5 SD
8. 9.0 — 2 SD
9. 2.36 — 3 SD
10. 7 — 1 SD
11. 7.00 — 3 SD
12. 52,000 — 2 SD
13. 8000 — 1 SD
14. 325.00 — 5 SD

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Rounding

Determine how many significant figures are needed and locate the last significant figure. Use standard rounding rules:

next digit to the right is 0-4: stays the same

next digit to the right is 5-9: round up

Examples:

1.08 — 1.0768 rounded to 3 sig. dig.

0.003 — 0.0034 rounded to 1 sig. dig.

5000. — 5000.0 rounded to 4 sig. dig.

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Set B: Round to the number of significant digits indicated.

1. 5.67498 to 1 sig. dig. 6
2. 0.04102 to 3 sig. dig. 0.0410
3. 2.998 to 2 sig. dig. 3.0
4. 26, 384 to 2 sig. dig. 26000
5. 37.446 to 3 sig. dig. 37.4
6. 49.0385 to 3 sig. dig. 49.0
7. 0.00794 to 1 sig. dig. 0.008
8. 0.006008 to 3 sig. dig. 0.00600
9. 825,066 to 1 sig. dig. 800000
10. 30.0026 to 4 sig. dig. 30.00

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Multiplication/Division

First complete the calculation, and then round to the same number of significant digits as the least precise number.

Examples:

$2.56 \times 4.1 = 10.496 \rightarrow 10.$ (3, 2)

$0.00475 \times 9.320 = 0.0443$ (3, 4)

$1.02 \div 6.78 = 0.150$ (3, 3)

$140 \div 0.00501 = 28000$ (2, 3)

$7 \times 14 \times 12.2 = 100$ (1, 2, 3)

$4.0 \div 2.1 \div 0.798 = 2.4$ (2, 2, 3)

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Set C: Multiply or divide as indicated. Round the final answer to the appropriate number of significant digits.

1. 27.3 x 4.5 120
2. 4.68 x 400 2000
3. 323 x 0.0002 0.06
4. 4008 ÷ 2.763 1451
5. 69 ÷ 7.0 9.9
6. 4000 ÷ 23 200
7. 30.0 x 25.00 750.
8. 4.1 x 6.22 x 5.478 140
9. 32 ÷ 5 6
10. 4008 ÷ 3.0 1300
11. 0.009 ÷ 7 0.001
12. 6.14 x 30.5 x 500. 93600
13. 30,000 ÷ 3.004 10000
14. 7.0000 x 0.003 0.02

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- Adding/Subtracting
- First complete the calculation, and then round to the same number of decimal places as the number with the least number of decimal places.

Examples:

1.1 +1.11 + 1.111 → 3.321 → 3.3

1.111
1.11
1.1

4.56 - 10.1 + 62.00003 → 56.5

145.24 + 5.623 - 4. → 147

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Set D: Add or subtract as indicated. Round to the appropriate number of decimal places.

1. 5.72 + 2 8
2. 500 – 79.4 421
3. 0.006 + 0.04 0.05
4. 84.3 – 0.009 84.3
5. 66.3 + 27.008 93.3
6. 67.45 – 12.2 55.3
7. 13.708 – 4 10
8. 76.62 + 23.245 −40.1 59.8
9. 64 – 3.88 60
10. 5.05 + 6.2 + 3.89 15.1
11. 75.0006 – 3.42 −8 64
12. 4005.2 + 0.6659 4005.9
13. 20,623.1 – 839.54 + 11.8 19795.4
14. 0.00516 + 0.003 0.008

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Attachments

Unit Conversion Significant Figures Crash Course Chemistry 2.mp4