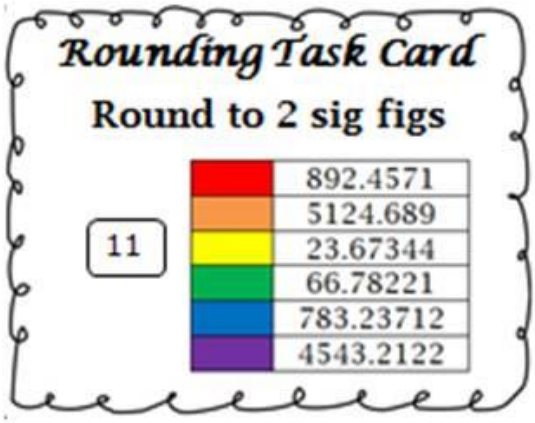
Chemistry 9-12

Significant Figures

Guided Inquiry with Manipulatives

By Shari Kendrick



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Significant Figures Lesson
Teacher Notes

How I use this lesson in my classroom:

- I usually put all of the needed handouts and card sets in plastic boxes located on a bookshelf near the door. For this lesson, the boxes would contain the handout. I like to keep the puzzles and task cards in boxes at the front of the room. The "Task Card Answer Sheet" is provided with the lesson.

- Students pick up the boxes when they enter the classroom. I usually let students work with up to three other students or they may work alone. More structured collaborative groups could also be set up and would work well.

- Students start at the beginning of the lesson and work their way through the lesson. I move between individuals and groups answering questions, asking higher order questions, and verbally assessing.

- The bullet symbols in the lesson serve as visual action cues to the student.
  - Indicates that the student needs to do something: get out cards, sort something, etc.
  - Indicates that the student needs to make an observation.
  - ? Indicates that the student needs to answer a question.

Teacher Preparation:

- ***The Handout*:** I usually print several copies of the handout and laminate them.

- ***The Puzzles:*** There are six different versions of the puzzle. Each version is a different color.

- ***The Task Cards:*** There are two sets of task cards: Rounding Task Cards and Calculation Task Cards. The Rounding Task Cards should be placed or hidden around the room for the students to find. Each of the Rounding Task Cards has six different questions associated with different colors. I usually have the student answer the question next to the same color as their puzzle color. There are six different versions of the Calculation Task Cards. Each version is a different color. I like to attach each set together with a metal ring.

- ***The "Task Card Answer Sheet"***: Students record their answers to the puzzle and task cards on the "Task Card Answer Sheet". Students should record the name of the puzzle or task card set and the color of the cards on their "Task Card Answer Sheet". I usually have the students turn in the answer sheet for a grade. I give students the "Task Card Answer Sheet" along with the lesson.

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- ***The Study Sheet:*** I usually provide the study sheet along with the lesson, but it could also be given out after the lesson or before a quiz.

- ***Scientific Notation:*** This lesson presumes that the student understands scientific notation. Since most calculators will convert numbers back and forth between standard and scientific notation, I usually only discuss this topic briefly prior to the lesson.

- ***Modifications:*** This lesson has several kinesthetic and visual components. Student and teacher interactions during the lesson also ensure a strong verbal component. Because of this, it works well "as is" for on level, special education, and most 504 students. I usually modify as needed by varying the level of my questioning when interacting with students. This lesson could also be used as an introductory activity for more advanced students.

Learning Objectives (Bloom's Revised Taxonomy):

- *Remembering*

  Identify the number of significant figures in a measurement.

- *Understanding*

  Explain the difference between rounding to the right of a decimal and rounding to the left of a decimal.

- *Applying*

  Contrast how to round the answer to a multiplication or division calculation with how to round the answer to an addition or subtraction calculation.

- *Analyzing*

  Perform simple calculations and round the answers to the correct number of digits.

- *Evaluating*

  Discuss why it is important to properly round the answers to calculations involving measurements.

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Significant Figures

By the end of this lesson, I will be able to:

- ✓ Identify the number of significant figures in a measurement.
- ✓ Explain the difference between rounding to the right of a decimal and rounding to the left of a decimal.
- ✓ Contrast how to round the answer to a multiplication or division calculation with how to round the answer to an addition or subtraction calculation.
- ✓ Perform simple calculations and round the answers to the correct number of digits.

✋ *Ask your teacher for the handout that accompanies this lesson. You will also need a copy of a paper titled "Task Card Answer Sheet".*

Part 1: Counting Significant Figures

👁 *Look at the handout titled "Significant Figures".*

This handout shows six groups of measurements. For each group, the number of significant figures is indicated.

👁 Analyze the data on the handout to determine when zero and nonzero digits are counted as significant figures.

? When are nonzero digits counted as significant figures?

? When are zero digits counted as significant figures? (Hint! There are <u>two</u> answers to this question.)

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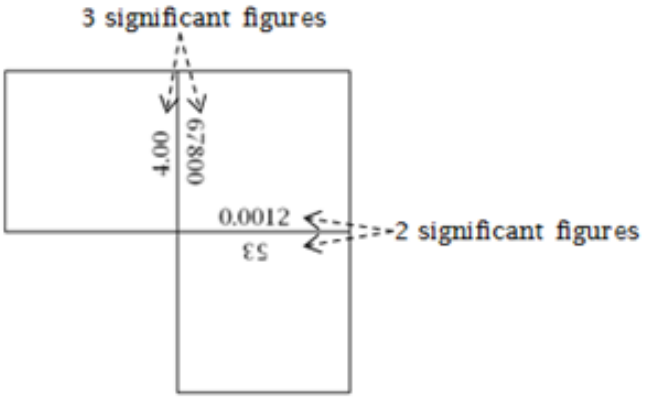
? When are zero digits NOT counted as significant figures? (Hint! There are <u>two</u> answers to this question.)

Ask your teacher for an envelope containing a "Significant Figure Puzzle" and get out the "Task Card Answer Sheet".

The puzzle has twelve square cards with numbers written on the sides of the squares.

Assemble the cards in a 3 x 4 grid so that the numbers that are touching one another have the same number of significant figures.



? Record your card arrangement on the "Task Card Answer Sheet" by copying the cards onto the grid. Be sure to also record the color of the cards.

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Part 2: Rounding Numbers

Compare the two groups of numbers below.

Both groups show numbers that have been rounded to a certain number of significant figures.

Group 1
Rounding to the right of the decimal point:

Round to 4 sig fig: 4.67391 ⟶ 4.674
Round to 3 sig fig: 4.67391 ⟶ 4.67
Round to 2 sig fig: 4.67391 ⟶ 4.7

Group 2
Rounding to the left of the decimal point:

Change to scientific notation!

Round to 4 sig fig: 56486.54 ⟶ 5.648654×10^4 ⟶ 5.649×10^4
Round to 3 sig fig: 56486.54 ⟶ 5.648654×10^4 ⟶ 5.65×10^4
Round to 2 sig fig: 56486.54 ⟶ 5.648654×10^4 ⟶ 5.6×10^4

? Describe how to round a number when the number of significant figures needed ends to the right of the decimal point.

? Describe how to round a number when the number of significant figures needed ends to the left of the decimal point.

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Return to your "Task Card Answer Sheet".

Your teacher has hidden Rounding Task Cards around the room. Each task card has six colors next to six questions. Each question asks you to round a number to a certain number of significant figures.

Find each task card and answer the question next the color that was on your "Significant Figure Puzzle" in Part 1.

? Record your answers on your "Task Card Answer Sheet".

Part 3: Calculations

Compare the following rules for rounding the answers to calculations .

The answers to calculations involving measurements must be rounded so that they reflect the smallest degree of precision used in the measurement.

Rule 1
Multiplication and Division

Round answer to the smallest number of significant figures used in the calculation.

Ex. 4.32 x 7.301 = 31.54032
3sf 4sf 7sf

Lowest # of sig. fig. used

Round answer to : 31.5
3sf

*sf = significant figures

Rule 2
Addition and Subtraction

Round answer to the smallest number of decimal places used in the calculation.

Ex. 3.678 + 2.12 = 5.789
3dp 2 dp 3dp

Lowest # of dec. places. used

Round answer to : 5.79
2dp

*dp = decimal places

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? What is the main rounding difference between the two rules?

Ask your teacher for a set of "Calculation Task Cards" and get out the "Task Card Answer Sheet".

? Perform the calculations on the Calculation Task Cards. Use the rules from above to round each answer to the correct number of digits. **Record your answers on your "Task Card Answer Sheet".**

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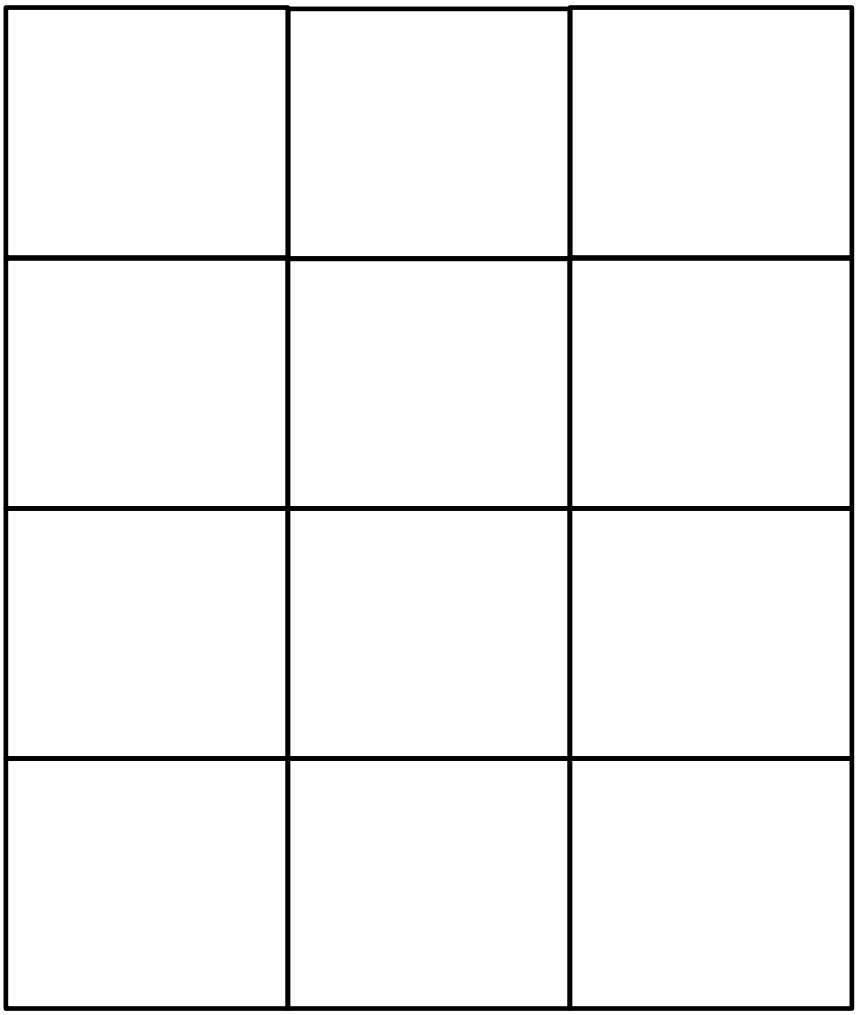
Task Card Answer Sheet

Page 1

Significant Figures Puzzle

Color_____



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Task Card Answer Sheet

Page 2

Rounding Task Cards

Color_____

1	2	3	4
5	6	7	8
9	10	11	12

Calculation Task Cards

Color_____

1	2	3	4
5	6	7	8

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Significant Figures
Study Sheet

Identifying Significant Figures

Significant	NOT Significant
All nonzero numbers (1, 2, 3, 4, 5, 6, 7, 8, 9) 0's in between digits (3201) Trailing 0's <u>with</u> a decimal (45.300)	Leading 0's (0.00023) Trailing 0's <u>without</u> a decimal (743000)

Rounding

To the <u>right</u> of the decimal

Round to 3 sig figs: 67.3735

↓

Remove unneeded digits.

67.3735 = 67.3

↓

Round up if necessary.

67.3 = 67.4

To the <u>left</u> of the decimal

Round to 2 sig figs: 83452

↓

Change to scientific notation.

83452 = 8.3452×10^4

↓

Remove unneeded digits.

$8.3452 \times 10^4 = 8.3 \times 10^4$

↓

Round up if necessary.

Not necessary

Calculations

Rule 1
Multiplication and Division

Round answer to the smallest number of <u>significant figures</u> used in the calculation.

Ex. 4.32 x 7.301 = 31.54032
3sf 4sf 7sf

Lowest # of sig. fig. used

Round answer to : 31.5
3sf

*sf = significant figures

Rule 2
Addition and Subtraction

Round answer to the smallest number of <u>decimal places</u> used in the calculation.

Ex. 3.<u>678</u> + 2.<u>12</u> = 5.<u>789</u>
3dp 2 dp 3dp

Lowest # of dec. places. used

Round answer to : 5.<u>79</u>
2dp

*dp = decimal places

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Significant Figures

1 Significant Figure

4
400
4.
0.0044
4×10^3

2 Significant Figures

45
450
4.5
0.00045
4.5×10^3

3 Significant Figures

453
45300
4.53
0.00453
4.53×10^3
403

4 Significant Figures

4537
453700
4.537
0.004537
4.537×10^3
4007

5 Significant Figures

45372
4537200
4.5372
0.0045372
4.5372×10^3
40002

6 Significant Figures

453726
45372600
4.53726
0.00453726
4.53726×10^3
400006

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0.007 5	4.1 4000 0.005681	280 4041
10000000 97310 1.234	550 5.670 0.00007 2.11×10^5	0.0053 300 0.0852143
80.00 10000 456	0.00478 2 0.09361 8.2201	590021 2.003×10^3 0.00476
101 39100	70072 42 3.00×10^3	1010 0.0023

0.005 3	3.2 0.009442 2000	280 7051
70000000 86210	760 0.00009 3.370	0.0026 700
6.412 70.00	3.33×10^5 0.00942	0.0641296 690077
612 10000	9201 0.05219 5	0.00945 1.003×10^3
701 48200	50012 21 5.00×10^3	8020 0.0067

0.008 2	7.4 0.003961 9006	740 2064
90000000 73210 4.254	830 0.00003 6.260 4.21×10^{5}	0.0064 006 0.0256143
80.00 70000 259	0.00478 0.03261 9 2.2301	590021 7.003×10^{3} 0.00796
101 52100	70072 93 4.00×10^{3}	1010 0.0098

6	7000	0.003281
0.002	2.4	3021
80000008	640	0.0023
88310	2.170	0.00002
9.434	7.85×10^{5}	200
40.00	0.00395	610076
50000	7	0.03651
762	5.1301	6.003×10^{3}
106	10082	4020
67100	72	0.0012
901	8.00×10^{3}	0.00523
		0.0152853
		310

401	30032	9060
54300	13	0.0056
20.00	0.00654	430021
70000	0.04321	3.009×10^{3}
974	6.3801	0.00546
20000000	230	0.0043
62310	0.00003	700
8.573	5.41×10^{5}	0.0931143
8	0008	7054
0.008	6.2	840

4.00×10^{3}

6.270

0.0004987

0.003 6	7.6 4000 0.0026967	560 9041
30000000 69810 9.539	610 5.670 0.00003 9.64×10^{5}	0.0084 100 0.0742963
50.00 90000 912	0.00632 4 0.08261 9.6501	790023 4.003×10^{3} 0.00643
308 72100	20032 62 5.00×10^{3}	5080 0.0031

Significant Figures in Calculations - Answers

By the end of this lesson, I will be able to:

- ✓ Identify the number of significant figures in a measurement.
- ✓ Explain the difference between rounding to the right of a decimal and rounding to the left of a decimal.
- ✓ Contrast how to round the answer to a multiplication or division calculation with how to round the answer to an addition or subtraction calculation.
- ✓ Perform simple calculations and round the answers to the correct number of digits.

✋ *Ask your teacher for the handout that accompanies this lesson. You will also need a copy of a paper titled "Task Card Answer Sheet".*

Part 1: Counting Significant Figures

👁 *Look at the handout titled "Significant Figures".*

This handout shows five groups of measurements. For each group, the number of significant figures is indicated.

👁 Analyze the data on the handout to determine when zero and nonzero digits are counted as significant figures.

? When are nonzero digits counted as significant figures?

> Nonzero digits are always counted as significant figures.

? When are zero digits counted as significant figures? (Hint! There are <u>two</u> answers to this question.)

> Zero digits are counted as significant figures when they are in between other digits AND when they are trailing zeroes **<u>in a decimal</u>**.

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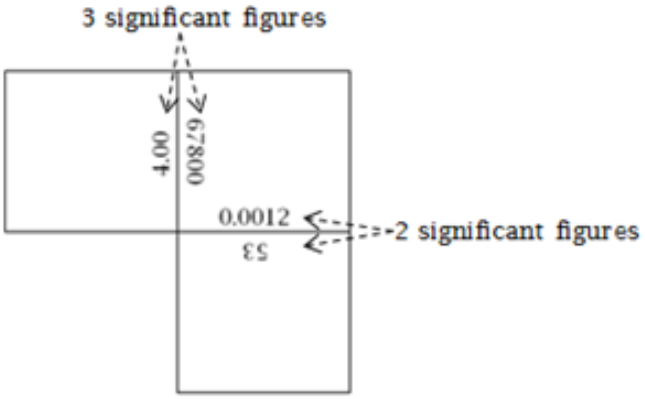
? When are zero digits NOT counted as significant figures? (Hint! There are <u>two</u> answers to this question.)

Zero digits are note counted as significant figures when they are leading zeroes AND when they are trailing zeroes **<u>in a nondecimal</u>**.

Ask your teacher for an envelope containing a "Significant Figure Puzzle" and get out the "Task Card Answer Sheet".

The puzzle has twelve square cards with numbers written on the sides of the squares.

Assemble the cards in a 3 x 4 grid so that the numbers that are touching one another have the same number of significant figures.



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Round to 3 sig fig: $4.67391 \longrightarrow 4.67$
Round to 2 sig fig: $4.67391 \longrightarrow 4.7$

Group 2
Rounding to the left of the decimal point:

Change to scientific notation!

Round to 4 sig fig: $56486.54 \longrightarrow 5.648654 \times 10^4 \longrightarrow 5.649 \times 10^4$
Round to 3 sig fig: $56486.54 \longrightarrow 5.648654 \times 10^4 \longrightarrow 5.65 \times 10^4$
Round to 2 sig fig: $56486.54 \longrightarrow 5.648654 \times 10^4 \longrightarrow 5.6 \times 10^4$

? Describe how to round a number when the number of significant figures needed ends to the right of the decimal point.

Remove digits from the right of the number. Round the last digit up if the last digit removed is greater than or equal to five.

? Describe how to round a number when the number of significant figures needed ends to the left of the decimal point.

Change the number to scientific notation. Remove digits from the right of the number. Round the last digit up if the last digit removed is greater than or equal to five.

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✋ *Return to your "Task Card Answer Sheet".*

Your teacher has hidden Rounding Task Cards around the room. Each task card has six colors next to six questions. Each question asks you to round a number to a certain number of significant figures.

✋ Find each task card and answer the question next the color that was on your "Significant Figure Puzzle" in Part 1.

? Record your answers on your "Task Card Answer Sheet".

Part 3: Calculations

👁 *Compare the following rules for rounding the answers to calculations .*

The answers to calculations involving measurements must be rounded so that they reflect the smallest degree of precision used in the measurement.

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Round answer to the smallest number of decimal places used in the calculation.

Ex. 3.678 + 2.12 = 5.789
3dp 2 dp 3dp

Lowest # of dec. places. used

Round answer to : 5.79
2dp

*dp = decimal places

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? What is the main rounding difference between the two rules?

In multiplication and division, the answer should be rounded to the lowest number of significant figures used. In addition and subtraction, the answer should be rounded to the lowest number of decimal places used.

Ask your teacher for a set of "Calculation Task Cards" and get out the "Task Card Answer Sheet".

? Perform the calculations on the Calculation Task Cards. Use the rules from above to round each answer to the correct number of digits. **Record your answers on your "Task Card Answer Sheet".**

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Task Card Answers

Puzzle Answers

See the arrangement of the cards before cutting.

Rounding Answers

Card	Red	Orange	Yellow	Green	Blue	Violet
1	3.460	9.071	23.61	496.4	92.74	561.9
2	4.3×10^4	8.9×10^2	7.2×10^3	9.7×10^5	6.9×10^4	1.5×10^4
3	6.9×10^3	3.2×10^4	6.9×10^7	2.7×10^2	9.3×10^8	4.2×10^5
4	2.85	9.12	1.38	8.57	4.08	5.23
5	8×10^3 (8000)	10×10^4 (1.0×10^5) (100000)	2×10^5 (200000)	9×10^4 (90000)	6×10^3 (6000)	4×10^4 (40000)
6	7.92×10^5	4.79×10^3	2.46×10^4	8.77×10^2	6.53×10^7	3.92×10^8
7	4.3197×10^7	7.0347×10^6	5.3279×10^5	2.8535×10^6	3.7655×10^5	6.8457×10^7
8	5.8	4.5	9.4	3.6	2.8	1.4
9	6.72×10^5	4.33×10^4	2.13×10^4	8.30×10^4	3.97×10^5	5.83×10^4
10	6.128×10^5	8.330×10^2	3.426×10^7	2.483×10^3	4.284×10^9	5.846×10^6
11	8.9×10^2	5.1×10^3	24 (2.4×10^1)	67 (6.7×10^1)	7.8×10^2	4.5×10^3
12	1.644×10^5	9.309×10^6	5.973×10^5	2.873×10^5	4.733×10^6	3.747×10^5

Calculation Answers

Card	Red	Orange	Yellow	Green	Blue	Violet
1	6.1×10^1 (61)	4.7×10^1 (47)	5.4×10^1 (54)	4.1×10^1 (41)	2.6×10^1 (26)	7.1×10^1 (71)
2	14.2	16.2	18.2	13.1	13.2	17.2
3	14.5	19.9	8.01	11.7	18.2	13.9
4	32	25	32	27	54	18
5	4.1×10^3	3.4×10^4	4.4×10^5	1.8×10^4	2.1×10^3	2.2×10^4
6	3.91	3.88	1.37	1.92	3.01	3.23
7	1.64	2.19	2.73	3.50	1.63	1.32
8	5.813	8.629	11.809	14.704	10.840	12.606

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