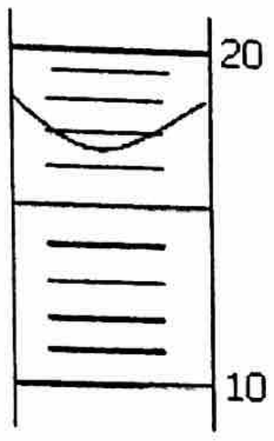
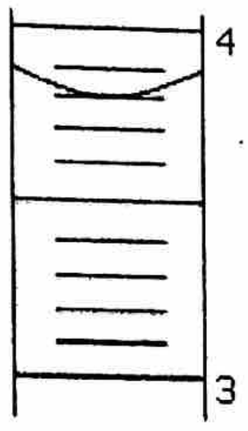
READING MEASURING DEVICES NOTES

Here are a couple of examples of graduated cylinders:



A



B

An important part of Chemistry is measurement. It is very important that you read the measuring devices we use in lab as accurately as possible. Here is how to determine how accurately a measuring device can be read:
Look at the graduation marks on the piece of equipment. (Those are the lines or marks that are not numbered.) Decide what each mark is worth using the numbers given as a guide. You should read the instrument to one more decimal place to the right than the smallest graduation mark. This last number will be an estimate on your part. This will lead us into our next topic in measurement – significant figures. A: Each of the smaller lines represents 1 mL. That means that our reading should be to one place to the right of the decimal point. To me, it looks like the bottom of the curve is about halfway between the 16 and the 17, so I would say that the reading on this graduated cylinder would be 16.5 mL.

B: Each line represents 0.1 mL. That means that our reading should be to two places to the right of the decimal point. The bottom of the curve looks to me like it is exactly on the line that would represent 3.8. My reading, however, needs to be to two places to the right of the decimal. Because it is exactly on the line, my reading will be 3.80 mL.

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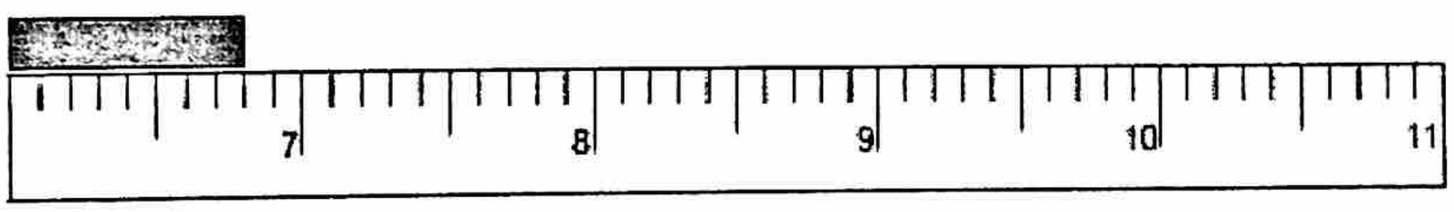
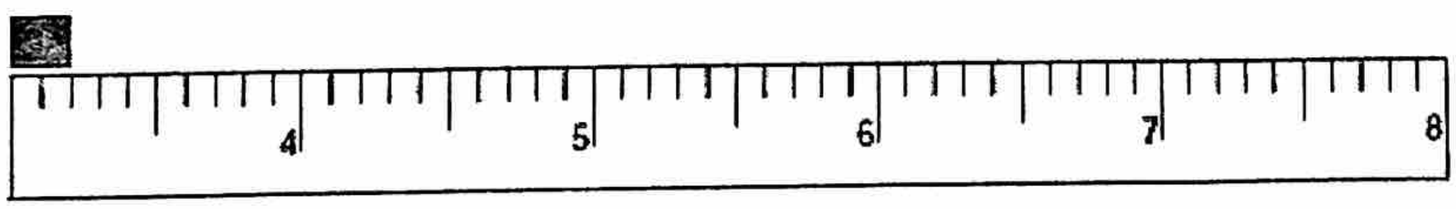
PRACTICE WITH READING MEASURING DEVICES WORKSHEET

Part 1 - What are the readings on these metric rulers? Be sure to include units with your answers.

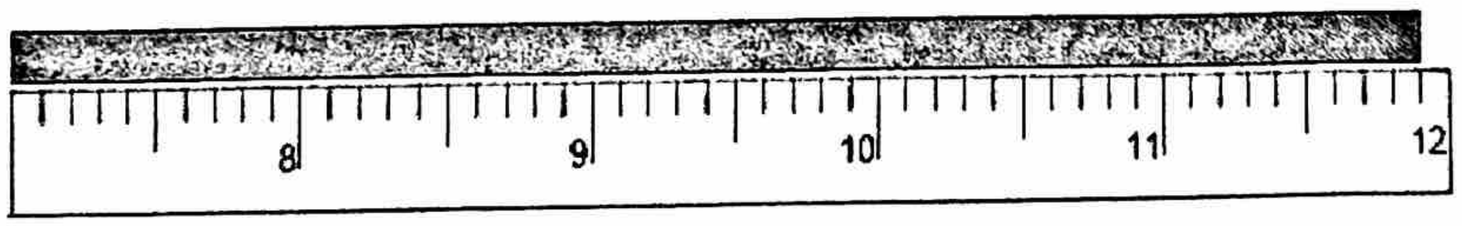
You don't have to have exactly the same answer as me, but you must have the same # of decimal places

1.) 

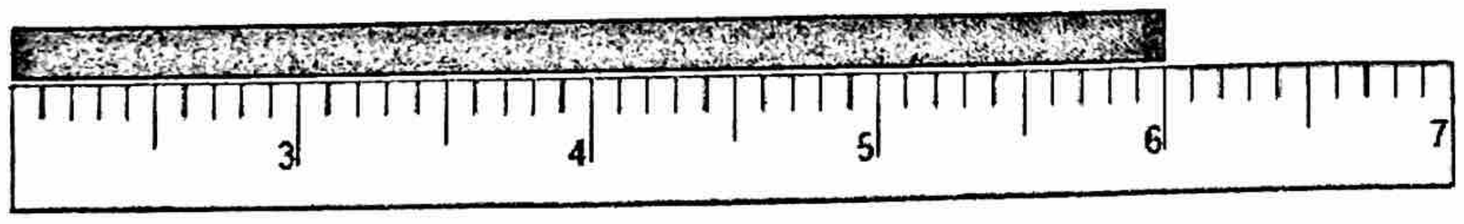
6.80 cm

2.) 

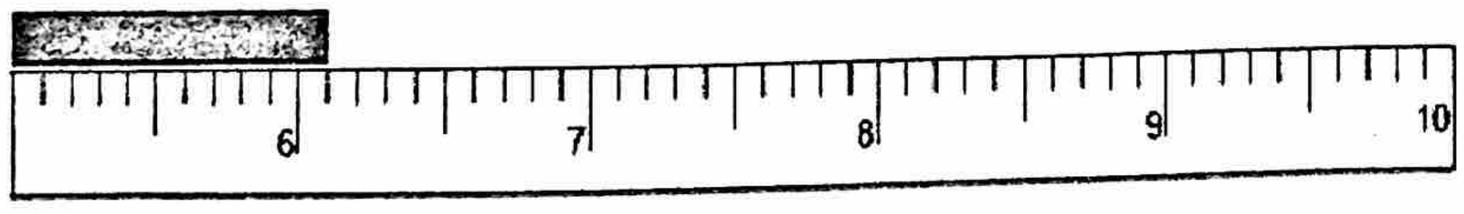
3.20 cm

3.) 

11.90 cm

4.) 

6.00 cm

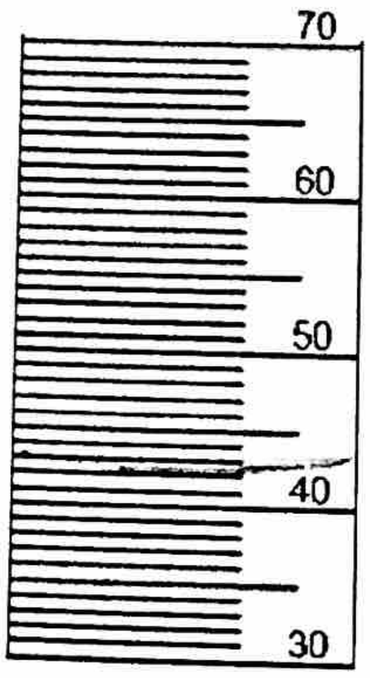
5.) 

6.10 cm

Rulers, graduated cylinders, and thermometers on "Practice With Reading Measuring Devices Worksheet" are from math-aids.com

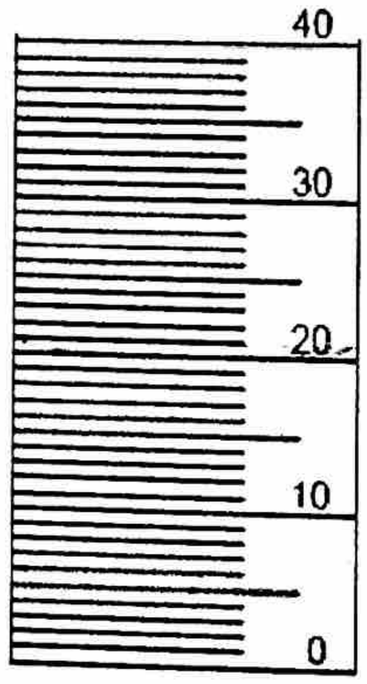
Part 2 – What are the readings on these graduated cylinders? Be sure to include units with your answers.

6.)



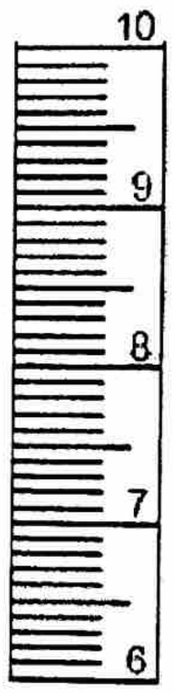
42.5 mL

7.)



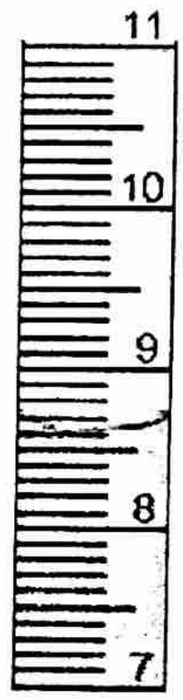
20.0 mL

8.)



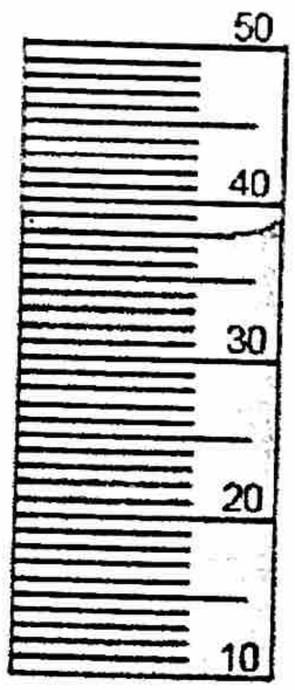
8.00 mL

9.)



8.65 mL

10.)

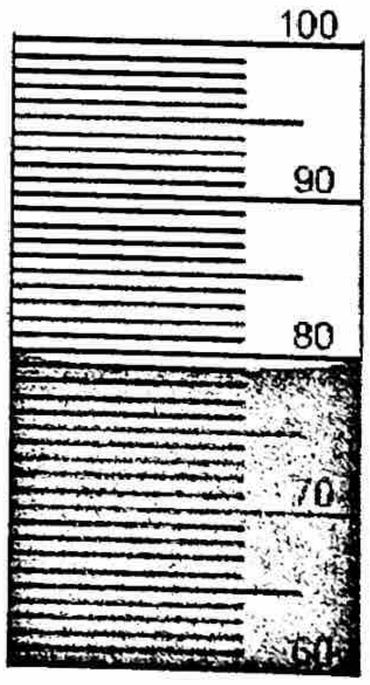


38.0 mL

11.)

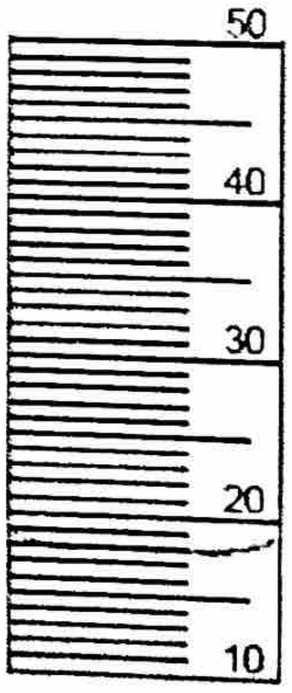
45.9 mL

12.)



79.0 mL

13.)

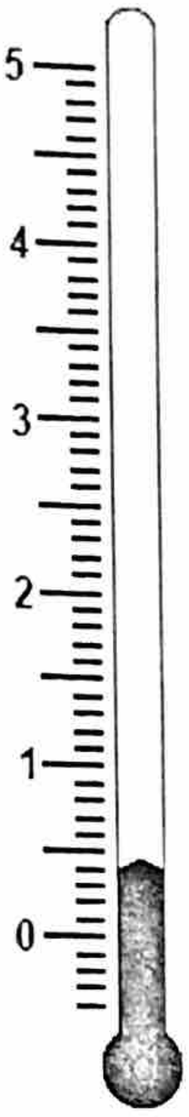


18.0 mL

3

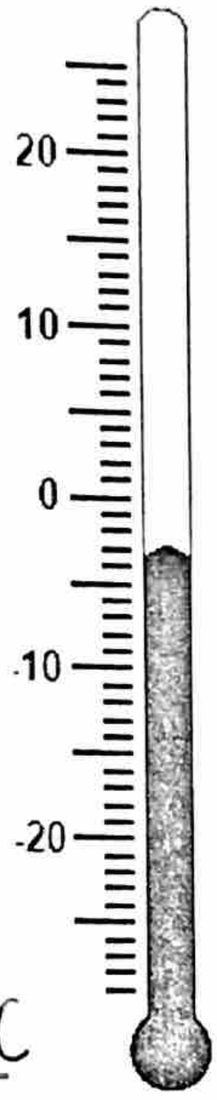
Part 3 – What are the readings on these thermometers? Be sure to include units with your answers.

14.)



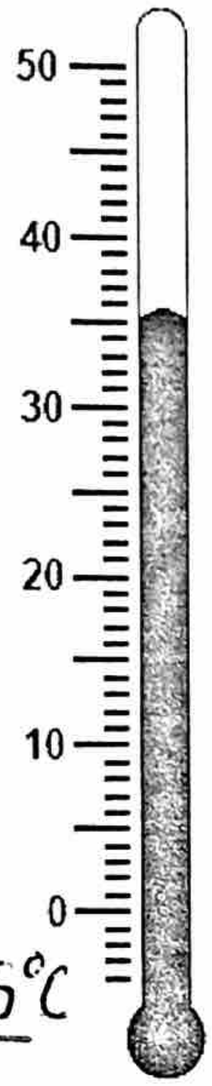
0.40°C

15.)



-0.35°C

16.)



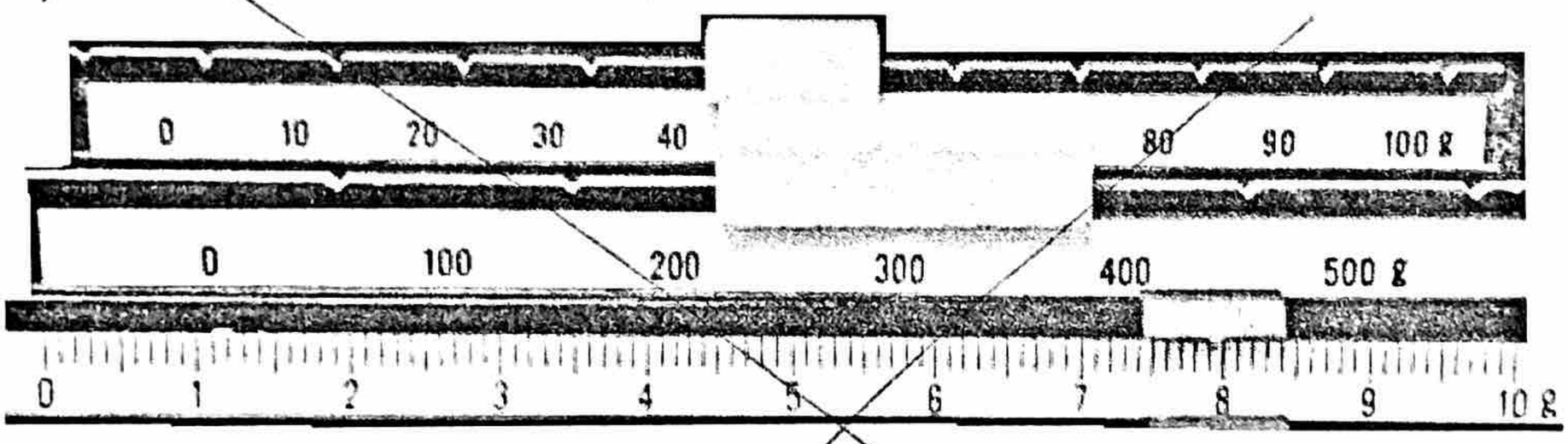
35.0°C

17.)

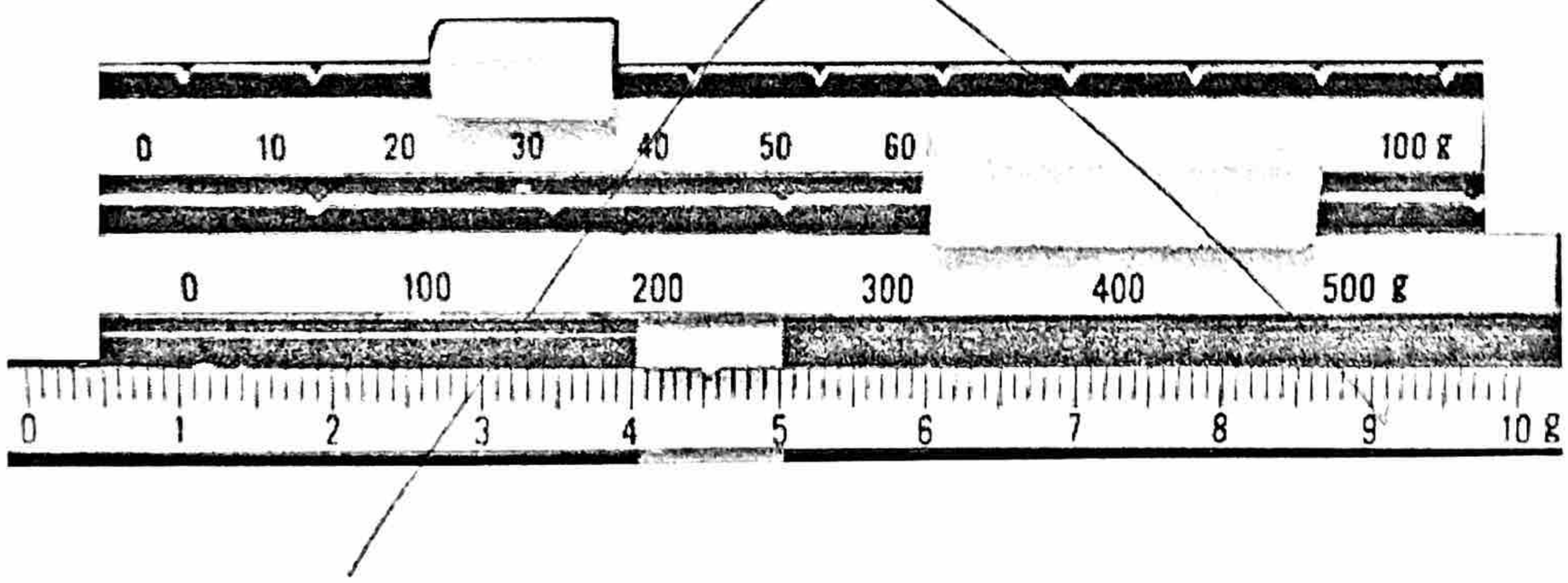
0.27°C

Part 4 – What are the readings on these triple beam balances? Be sure to include units with your answers.

18.)



19.)



Scientific Notation Worksheet

Convert the following numbers into scientific notation:

1) 3,400 3.4×10^{3}

2) 0.000023 2.3×10^{-5}

3) 101,000 1.01×10^{5}

4) 0.010 1.0×10^{-2}

5) 45.01 4.501×10^{1}

6) 1,000,000 1×10^{6}

7) 0.00671 6.71×10^{-3}

8) 4.50 4.50×10^{0}

Convert the following numbers into standard notation:

9) 2.30×10^{4} 23000

10) 1.76×10^{-3} 0.00176

11) 1.901×10^{-7} 0.00000001901

12) 8.65×10^{-1} 0.865

13) 9.11×10^{3} 9110

14) 5.40×10^{1} 54.0

15) 1.76×10^{0} 1.76

16) 7.4×10^{-5} 0.000074

Worksheet #3: Scientific Notation

Name_____

Express these numbers in scientific notation.

1. 0.0023 2.3×10^{-3}
2. 0.258 2.58×10^{-1}
3. 10.236 1.0236×10^{1}
4. 14,000 1.4×10^{4}
5. 0.000036 3.6×10^{-5}
6. 2.52 2.52×10^{0}

Express these numbers in decimal notation. (standard notation)

1. 4.36×10^{2} 436
2. 3.40×10^{-3} 0.00340
3. 2.67×10^{5} 267000
4. 1.45×10^{-2} 0.0145
5. 5.02×10^{4} 50200
6. 1.21×10^{-7} 0.000000121

Use your calculator to solve the following. Be sure to express your answer in scientific notation even if your calculator does not.

1. $(3.0 \times 10^{3}) + (5.0 \times 10^{3})$ 8.0×10^{3}
2. $(6.9 \times 10^{3})(2.455 \times 10^{4})$ 1.7×10^{8}
3. $\dfrac{(4.3 \times 10^{9})(3.1 \times 10^{-3})}{(5.0214 \times 10^{5})}$ 2.7×10^{1}
4. $(4.58 \times 10^{-5}) \div (3.2 \times 10^{-2})$ 1.4×10^{-3}

Significant Figures, Version 2.0, 6/11/08, Blas & Lee

Answer the questions below based on the tables provided. In this document, "SF" stands for ***Significant Figures***.

Group 1

Number	# of SF
7	1
3.2	2
6.54	3
855	3

Critical Thinking Questions

1. Engage in a group discussion that tries to determine what pattern or rules exist between the **Numbers** and **# of SF** listed in Group 1 and write that rule below…

   All numbers are significant

2. How many SF's would be in the following numbers?
   a. 95 2
   b. 7.56 3
   c. 45256 5

Group 2

Number	# of SF
305	3
3005	4
6.05	3
6.005	4
9.05006	6
9.50006	6

3. Engage in a group discussion that tries to determine what pattern or rules exist between the **Numbers** and **# of SF** listed in Group 2 and write that rule below…

   All numbers are significant

4. How many SF's would be in the following numbers?
   a. 35 2
   b. 706 3
   c. 35.06 4
   d. 60.701 5

Group 3

Number	# of SF
30	1
300	1
3000	1

Group 4

Number	# of SF
30.	2
300.	3
3000.	4

Group 5

Number	# of SF
1.0	2
35.0	3
35.00	4
10.0	3
300.00	5

5. Engage in a group discussion that tries to determine what pattern or rules exist between the **Numbers** and **# of SF** listed in Groups 3, 4 & 5 and write that rule below…

   zeros to the right of non-zero numbers (trailing zero's) only count if there is a decimal anywhere in the number

6. How many SF's would be in the following numbers?
   a. 722 — 3
   b. 702.05 — 5
   c. 50 — 1
   d. 50. — 2
   e. 500 — 1
   f. 700 — 1
   g. 7.700 — 4

Group 6

Number	# of SF
0.1	1
0.020	2
0.00213	3
0.0303	3

Group 7

Number	# of SF
1×10^{-1}	1
2.0×10^{-3}	2
2.13×10^{-4}	3
3.03×10^{-2}	3
1.20×10^{-4}	3
2.060×10^{10}	4
2.060×10^{-10}	4

7. Engage in a group discussion that tries to determine what pattern or rules exist between the **Numbers** and **# of SF** listed in Groups 6 & 7 and write that rule below…

   the sigfigs in standard notation should be the same as the sigfigs in scientific notation (just the numbers out in front)

   * zero's the the left of non-zero numbers (leading zeros) are not significant

8. How many SF's would be in the following numbers?
   a. 0.01 — 1
   b. 0.0023 — 2
   c. 23.6×10^{-4} — 3
   d. 23.0×10^{-4} — 3
   e. 1.234×10^{3} — 4

9. Now, condense all of the rules that you've written above into the shortest, most condensed list as possible that still applies to every group listed above. These rules must be grammatically correct.

* All non-zero numbers are significant
* zero's between non-zero numbers (sandwiched zeros) are always significant
* leading zeros are never significant
* trailing zeros are sometimes significant, only significant if there is a decimal place somewhere in the number

Now, go to the board as directed by the instructor and add your rules to the appropriate section. After the class discussion and editing session, write the final SF rules on your note card.

Exercises

Complete the following table:

Number	# if SF	Group above (1-7) that this number would fit into
2.307	4	2
30000.	5	4
5.230	4	5
271.2	34	1
1.750×10^{-3}	4	7
0.01234	4	6
5000	1	3

Exercises

Complete the following table:

Number	# of SF	Do the number of SF match the example to the left (circle Yes or No)
8.020	3	Yes..(No)
0.23060	5	(Yes)..No
5.670×10^{10}	3	Yes..(No)
5000.00	5	Yes..(No)

Problems

1. If you were to weigh a handful of 14 marbles and the entire lot weighed 17.3 g, what would each marble weigh? As a group, decide how many decimal places you should report in your answer.
   Answer 1.24 g 17.3/14 = 1.2357g

least # of sig figs from the data

2. Discuss as a group and explain why you decided on that number of decimal places? Use grammatically correct sentences.

The balance gave us two certain digits, and one estimated digit, so our final answer has to reflect the correct amount of sig figs.

3. Do you think that there should be a standard number of decimal places reported in answers to problems? How would this benefit/harm science as a whole? Discuss this as a group and explain. Use grammatically correct sentences.

No, it should be based on how good your measuring tool is.

Significant Figures Worksheet

1. Indicate how many significant figures there are in each of the following measured values.

246.32	5	1.008	4	700000	1
107.854	6	0.00340	3	350.670	6
100.3	4	14.600	5	1.0000	5
0.678	3	0.0001	1	320001	6

2. Calculate the answers to the appropriate number of significant figures.

$$\begin{array}{r} 32.567 \\ 135.0 \\ +\ 1.4567 \\ \hline 169.0237 \end{array} \rightarrow 169.0$$

$$\begin{array}{r} 246.24 \\ 238.278 \\ +\ 98.3 \\ \hline 582.818 \end{array} \rightarrow 582.8$$

$$\begin{array}{r} 658.0 \\ 23.5478 \\ +\ 1345.29 \\ \hline 2026.8378 \end{array} \rightarrow 2026.8$$

3. Calculate the answers to the appropriate number of significant figures.

a) 23.7 x 3.8 = 90.06 → 90.

b) 45.76 x 0.25 = 11.44 → 11

c) 81.04 g x0.010 = 0.8104 → 0.81

d) 6.47 x 64.5 = 417.315 → 417

e) 43.678 x 64.1 = 2799.7598 → 2.80×10^3

f) 1.678 / 0.42 = 3.995 → 4.0

g) 28.367 / 3.74 = 7.5848 → 7.58

h) 4278 / 1.006 = 4252.49 → 4252

4. (12.01 - 11.59) /36.1 =

→ 0.42 / 36.1 = 0.012

5. Calculate the density of an object that has a mass of 23.0 g and the volume is found by water displacement. The water level starts at 5.05 mL and after the object is put it, has a water level of ~~11.3mL~~. 11.30 mL

Volume = 11.30mL - 5.05mL = 6.25mL

$$D = \frac{m}{V} = \frac{23.0\,g}{6.25\,mL} = 3.68\,g/mL$$