Exercise 01.5

Significant Digits & Measurement

Name: _____

Date: _____ Per: _____

Identifying Significant Digits

1. Significant digits apply to measurements and thus should always be accompanied by the measurement's unit. *(For simplicity, units are not included in the following examples.)*
2. Digits other than zero are always significant – thus **123.45** contains five significant digits.
3. Zeros between non-zero digits are always significant – thus **1002.05** contains six significant digits.
4. Leading zeros (zeros to the left of the first non-zero) are never significant. These zeros are place holders to put digits in the right decimal places – thus **0.00123** has three significant digits (e.g., **0.00123 grams** = **1.23 milligrams**; since **1.23** has three significant digits, **0.00123** must also have three significant digits).
5. Trailing zeros (zeros following the last non-zero) are significant when the measurement contains a decimal point – thus **921000** contains three significant digits, **921000.** has six significant digits, and **0.012300** and **25.000** both contain five significant digits. These zeros indicate to what decimal place the measurement was made.

DIRECTIONS: Assume each of the following is a measurement in grams. Give the number of significant digits in each of the following measurements.

1.	1278.50	—	7.	8.002	—	13.	43.050	—
2.	120000	—	8.	823.012	—	14.	0.147	—
3.	90027.00	—	9.	0.005789	—	15.	6271.91	—
4.	0.0053567	—	10.	2.60	—	16.	6	—
5.	670	—	11.	542000.	—	17.	3.47	—
6.	0.00730	—	12.	2653008.0	—	18.	387465	—

Rounding Answers in Science

Rounding should only take place for the final answer. After determining the appropriate place to round an answer:

- If the digit following the rounding position is less than 5, truncate the number at the rounding position.
- If the digit following the rounding position is greater than 5, round the final digit up.
- If the digit following the rounding position is exactly 5 (or 5000…), round the final digit to the closest even digit.

DIRECTIONS: Round the following numbers to three significant digits.

19.	1225000	—	22.	0.0008769	—	25.	43.659	—
20.	5.457	—	23.	4.53619	—	26.	876493	—
21.	1.263×10^{-3}	—	24.	1.005×10^{-5}	—	27.	0.00012550	—

Significant Figures in Calculations

In all calculations, the answer must be governed by the least significant figure used.

ADDITION AND SUBTRACTION: The answer should be rounded to contain the same number of decimal places as the measurement with the *least number of decimal places*. In other words, *an answer can be only as precise as the number with the least precision*.

Thus: **11.31 + 33.264 + 4.1 = 48.674** **Rounded to 48.7**

MULTIPLICATION AND DIVISION: The answer should be rounded to contain the same number of significant digits as found in the measure with the *fewest significant digits*.

Thus: **5.282 x 3.42 = 18.06444** **Rounded to 18.1**

DIRECTIONS: Perform the following operations giving the proper number of significant figures in the answer.

28.	23.4 × 14	=	33.	0.2 ÷ 0.0005	=
29.	7.895 + 3.4	=	34.	$3.5 \times 10^{3} \div 2.75$	=
30.	0.0945 × 1.47	=	35.	$8.25 \times 10^{12} \times 2.11 \times 10^{-17}$	=
31.	0.005 – 0.0007	=	36.	67.89 × 23.6 / 42.8	=
32.	7.895 / 34	=	37.	0.0012 + 1.3 + 0.0184	=

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Significant Figures in Calculations

LOGARITHMS & ANTILOGRITHMS (Exponentiation): When finding the logarithm of a number, the mantissa (the number to the right of the decimal point in the logarithm) should have the same number of significant digits as there are in the number whose logarithm is being found.

Thus: **$\log(5.250\times10^{4}) = 4.720159$ Rounded to 4.7202 & $\log(5.2\times10^{4}) = 4.716003$ Rounded to 4.72**

When finding the antilogarithm of a number, the number should have the same number of significant digits as the mantissa of the number's logarithm.

Thus: **$\text{antilog}(7.250\times10^{-2}) = 1.181680$ Rounded to 1.18 & $\text{antilog}(1.3) = 19.952623$ Rounded to 20**

DIRECTIONS: Perform the following operations giving the proper number of significant figures in the answer.

38. $\log(0.365)$ = _____
39. $\text{antilog}(-5.615)$ = _____
40. $\log(12000)$ = _____
41. $\text{antilog}(4.3\times10^{-4})$ = _____
42. $\log(12.85\times10^{-9})$ = _____
43. $\text{antilog}(4.0)$ = _____
44. $\log(0.00100)$ = _____
45. $\text{antilog}(-6.500)$ = _____
46. $\log(1.0100\times10^{9})$ = _____
47. $\text{antilog}(-0.000010)$ = _____

Significant Figures in Multi-Step Calculations

Multi-step calculations that involve different types of operations require tracking of significant digits from one step to another until the final answer is derived. The normal order of operations should be used.

- At each step, consider the appropriate rounding position for that type of operation.
- Underline the rounding position and keep one additional unrounded decimal place. *Do NOT round after each step.*
- Round at the end according to the final operation and the underlined uncertain digits.

Example: Solve the following for x: $x = ((9.751 + 0.0136)/49.2) - (4.739\times10^{-3})$

$x = (9.76\underline{4}6/49.2) - (4.739\times10^{-3})$ *Addition: Round to least precise decimal place.*
$x = (0.19\underline{8}4) - (4.739\times10^{-3})$ *Division: Round to match fewest sig figs.*
$x = 0.19\underline{3}6$ *Subtraction: Round to least precise decimal place.*
$x = 0.194$ *Final answer.*

DIRECTIONS: Perform the following operations giving the proper number of significant figures in the answer.

48. $(4\times972) + (76.4\times29.3) - (12\times7)$ = _____

49. $\dfrac{(72.67 - 72.632)\times(4.2694)}{(9.7204 + 0.01)}$ = _____

50. $\dfrac{10000000\times0.0003845\times4.55}{4.331\times10^{-6}}$ = _____

51. $\dfrac{(5.21\times10^{-2}) + (1.381\times10^{2})}{\text{antilog}(-0.00010)}$ = _____

52. $\dfrac{9.5 + 4.1 + 2.8 + 3.175}{4}$ = _____
(average ∴ 4 is exact number)

53. $(8.71\times0.0301)/0.056$ = _____

54. $\dfrac{4.1\times10^{-3} - (6.9\times10^{-2})}{(7.2\times10^{-6}) + (8.943\times10^{4})}$ = _____

55. $\dfrac{1.45(40.0 + 273) + \log(1.010\times10^{9})}{(9.04 + 10.0100)}$ = _____

56. $\dfrac{(42.47 - 2.690)\bullet\log(3.110\times10^{2})}{(12.30 - 2.804)\times(4.2001)}$ = _____

57. $\dfrac{8.925 - 8.905}{8.925}\times100$ _____
(% error ∴ 100 is exact number)

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58. The beakers shown below have different precisions.

Beaker 1 Beaker 2 Beaker 3

a. Label the amount of water in each of the three beakers to the correct number of significant figures.

Beaker 1: _____ Beaker 2: _____ Beaker 3: _____

b. Is it possible for each of the beakers to contain the exact same amount of water? If no, why not? If yes, did you report the same volumes in part a.? Explain.

_____

_____

_____

c. Suppose you pour the water from these three beakers into one container. What should be the volume in the container reported to the correct number of significant figures?

_____

59. Use the following EXACT conversion factors to perform the stated calculations: (Show all work with units)

1 mile = 1609 meters	40 rods=1 furlong	8 furlongs = 1 mile

The Kentucky Derby race is 1.25 miles. How long is the race in rods, furlongs, meters, and kilometers?

_____ rods
_____ furlongs
_____ meters
_____ kilometers

60. For a pharmacist dispensing pills or capsules, it is often easier to weigh the medication to be dispensed than to count the individual pills. If a single antibiotic capsule weighs 650 mg and a pharmacist weighs out 15.6 g of capsules, how many capsules have been dispensed? Show all work with units.

61. A 25.00 g sample of a solid is placed in a graduated cylinder and the cylinder is filled to the 50.0 mL mark with benzene. The mass of benzene and solid together is 58.80 g. Assuming that the solid is insoluble in benzene and the density of benzene is 0.880 g/cm^3, calculate the density of the solid. Show all work with units.

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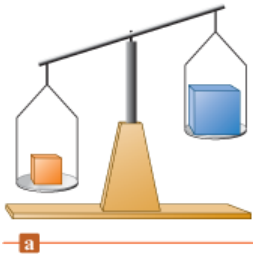
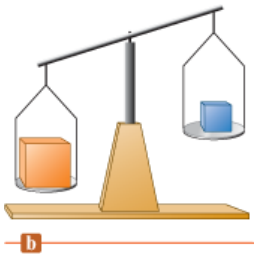
62. Draw a picture showing the markings (graduations) on glassware that would allow you to make each of the following volume measurements of water.

128.7 mL	18 mL	23.45 mL

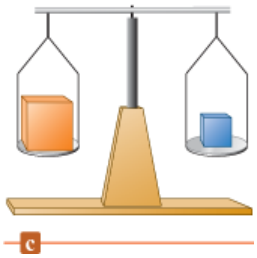
63. For each of the following decide which block is denser: the left block, the right block, or it cannot be determined. Explain your answers.



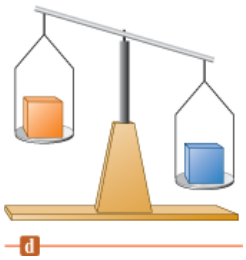
a. _____



b. _____



c. _____



d. _____