

This is ACA # 3, our third ACA of the Fall semester. It is OK to use your textbook, but if you can answer the questions without it that is OK too.

I recommend you print out this page and bring it to class. [Click here](#) to show a set of five ACA3 student responses, randomly selected from all of the student responses thus far, in a new window.

John, here are your responses to the ACA and the Expert's response.

1. Indicate the number of significant figures in each of the following measurements,

a) 1.020 mLs *7% 3 sig. figs*  
*91% 4 sig. figs*

4

4 sig figs...rules say a zero is significant when it is between two nonzero digits; rules say a zero is significant when a nonzero digit is to its left AND a decimal point is present.

b) 0.01020 gms *2% 3 sig figs*  
*90% 4 sig figs*  
*6% 5 sig figs*  
*1% 6 sig figs*

4

4 sig figs...rules says a zero is NOT significant if there is no nonzero digit to its left. 0.01020 gms the numbers in black are not significant.

c) 5.0060 x 10<sup>2</sup> km *2.6% 3 sig figs*  
*9% 4 sig figs*  
*84% 5 sig figs*  
*1.3% 6 sig figs*  
*1.3% 7 sig figs*

5

5 sig figs...for the number 5.0060 see the above rules. All of the zeros are significant. Note the 10<sup>2</sup> is not used to count sig figs as it is a power that positions the decimal point.

d) 1600 people were estimated to have attended the meeting

*86% 2 sig. figs*  
*12% 4 sig figs*

2

2 sig figs the two zeros are not significant in this number. In this case the absence of the decimal point causes a dilemma...significant or not significant. In this course such zeros are not significant.

2. Complete the following calculations and report the answer to the correct number of significant figures,

a)  $0.0821 * 273.15 = 22.4$

$22.4 (0.0821 * 273.15 = 22.425615)$

96% correct math & ~~2 sig fig~~  
 88% " " &  $\pm 1$  sig. fig  
 77% " " & 3 sig. figs

Indicate how many significant figures are in your answer in Q2a 3

Sig fig rules for multiplication and division say the number of sig figs in the answer can be no more than the measurement with the least number of significant figures. In this case 0.0821 has 3 sig figs and 273.15 has 5 sig figs. So the answer is limited to 3 sig figs.

b)  $23.45 - 20.023 = 3.43$

$3.43$  (calculation  $23.45 - 20.023 = 3.427$ )

92% correct math &  $\pm 1$  sig. fig  
 71% correct math & correct sig. figs/digits

Indicate how many significant figures are in your answer in Q2b 3 significant figures

Sig fig rules for addition and subtraction say the result can have no more digits to the right of the decimal than the measurement with the least number of digits to the right of the decimal. In this case 23.45 has 2 digits to the right of the decimal...20.023 has 3 digits to the right of the decimal. The answer can only have 2 digits to the right of the decimal. 3.427 must be rounded to 2 digits to the right of the decimal. Since the digit to be dropped is greater than 5 the correct answer is 3.43 and there are 3 significant figures in the result.

c)  $1/313 - 1/97 = -7.11e-3$  (this one is challenging! Note the 1 in both numerators is an exact number.)

25% correct math & sig. figs 50% correct math.

$0.003194882 - 0.0103092784 = -0.0071143902$  or  $-7 \times 10^{-3}$  Challenging problem!

Indicate how many significant figures are in your answer in Q2c 3 significant figures

We must systematically apply both division and subtraction significant figure rules in this calculation. First  $1/313$  is 0.003194882. In this case (division) the result can only have 3 sig figs. The 1 in the numerator is an exact number and does not limit the number of significant digits, so 313 has 3 sig figs. Second,  $1/97$  is 0.0103092784. In this case (division) the result can only have 2 sig figs. Now we do the subtraction,  $0.003194882 - 0.0103092784 = -0.0071143902$ . In this case (subtraction) our answer can have no more digits to the right of the decimal than the value with the least number of digits to the right of the decimal. Since 0.003194882 must be reported with three sig figs that generates 5 digits to the right of the decimal. The number 0.0103092784 can only have 2 sig figs so it has 3

digits to the right of the decimal. So our answer can only have 3 digits to the right of the decimal. So looking at 0.0071143902 we must round at the 4th digit. Since that digit is a '1' we drop it and all numbers to its right. The answer is then -0.007 and there is 1 significant figures in the result.

d)  $1.823 \times 10^{-4} + 9.18 \times 10^{-2} = 9.20 \times 10^{-2}$

$0.01823 \times 10^{-2} + 9.18 \times 10^{-2} = 9.19823 \times 10^{-2}$  or  $9.20 \times 10^{-2}$  this is another challenging problem!

*100% correct math & sig. figs*

Indicate how many significant figures are in your answer in Q2d 3 significant figures

To solve this problem both numbers must be expressed so the power of 10 is the same. In this case the best way to do that is to express  $1.823 \times 10^{-4}$  as  $0.01823 \times 10^{-2}$  and then do the addition. By express both number with the same power of 10 we can compare numbers of digits to the right of the decimal properly. So  $0.01823 \times 10^{-2}$  has 5 digits to the right of the decimal, while  $9.18 \times 10^{-2}$  has 2 digits to the right of the decimal. So our answer can only have 2 digits to the right of the decimal.  $0.01823 \times 10^{-2} + 9.18 \times 10^{-2} = 9.19823 \times 10^{-2}$  Reporting the answer to 2 digits to the right, and remembering to round the answer is  $9.20 \times 10^{-2}$  and there are 3 significant figures in the result.

3) Fun with conversions....watch your significant figures!

a) How many centimeters in 3.00 feet?

91.4 cm

*94% ± 1 sig. fig*

$3.00 \text{ feet (12 inches/1 foot) (2.54 cm/1 inch) = 91.4 cm}$

Indicate how many significant figures are in your answer in Q3a 3 significant figures

3 significant digits in the answer to Q3a. Since all of the operations are multiplication and division, and every conversion is an exact number, the result can have no more or less significant digits than the initial measurement.

b) How many  $\text{ft}^2$  in  $126 \text{ in}^2$ ?

.875  $\text{ft}^2$

*61%  
26% ~ 10.5*

$$126 \text{ in}^2 (1 \text{ foot}/12 \text{ inches})^2 = 0.875 \text{ ft}^2$$

Indicate how many significant figures are in your answer in Q3b 3 significant figures

3 significant digits in the answer to Q3b. Since all of the operations are multiplication and division, and every conversion is an exact number, the result can have no more or less significant digits than the initial measurement.

c) Diamond (a form of elemental carbon) has a density of  $3.513 \text{ g cm}^{-3}$ . What is the density of diamond in pounds  $\text{foot}^{-3}$ ?

219.1 pounds  $\text{foot}^{-3}$

53%

14% CNA or blank

3% 0.2361

2% 0.007745

2% 0.000254

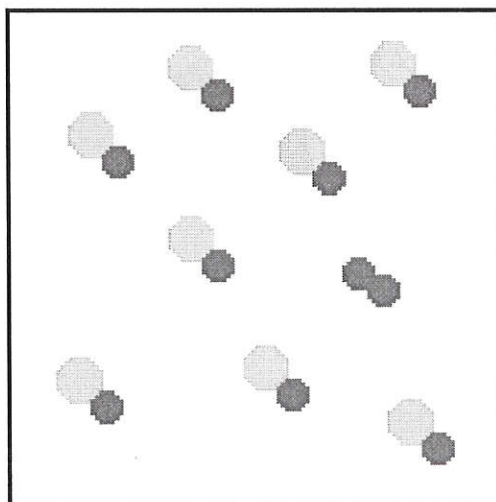
2% 0.0001241

$$3.513 \text{ g cm}^{-3} (1 \text{ pound}/454 \text{ g}) (2.54 \text{ cm}/1 \text{ inch})^3 (12 \text{ inches}/1 \text{ foot})^3 = 219.1 \text{ pounds foot}^{-3}$$

Indicate how many significant figures are in your answer in Q3c 4 significant figures

4 significant digits in the answer to Q3c. Since all of the operations are multiplication and division, and every conversion is an exact number, the result can have no more or less significant digits than the initial measurement.

4. In the space provided describe the contents of the container as best you can.



homogeneous mixture of a compound (gray/green) and an element (diatomic gray/gray molecule) in the gas phase

The contents of the container is a homogeneous mixture of a compound (green/gray

diatomic molecule) and an element (gray/gray diatomic element) in the gas phase.

**5. Is there anything about the questions that you feel you do not understand? List your concerns/questions.**

nothing

**6.. If there is one question you would like to have answered in lecture, what would that question be?**

nothing

**This ACA focused on four areas: significant figures, rounding to the correct number of significant figures, reporting the result of a mathematical operation to the correct number of significant digits and performing conversions and reporting the result of the conversion to the correct number of significant digits.**

**Here is how well the Expert thinks you have done:**

**Identifying the correct number of significant figures:** You have identified the correct number of significant figures in Question 1a, you have identified the correct number of significant figures in Question 1b, you have identified the correct number of significant figures in Question 1c, and you have identified the correct number of significant figures in Question 1d.

**Reporting the result of a mathematical operation to the correct number of significant digits:** You have the correct product for Question 2a, and you have identified the correct number of significant figures in Question 2a. You have the correct difference for Question 2b, and you have identified the correct number of significant figures in Question 2b. You have the correct difference for Question 2c, and you have the wrong number of significant figures in Question 2c. You have the correct difference for Question 2d, and you have identified the correct number of significant figures in Question 2d. Be sure to check the Expert's Response on each part that you rounded incorrectly to see the rounding rule you are having difficulty with.

**Performing conversions and reporting the result of the conversion to the correct number of significant digits:** You have the correct value for the conversion of centimeters to feet in Question 3a and you have the correct number of significant figures in Question 3a. You have the correct value for the conversion of square feet to square centimeters in Question 3b and you have the correct number of significant figures in Question 3b. You have the correct value for the density conversion in Question 3c and you have the correct number of significant figures in Question 3c.