

CHEMISTRY 31 EXAM 1  
March 6, 2017

NAME \_\_\_\_\_

LAB SECTION # \_\_\_\_\_

**Some Useful Equations and Constants:**

Propagation of uncertainty:

Addition/subtraction:

$$y = a + b \text{ or } y = a - b$$

$$S_y = \sqrt{S_a^2 + S_b^2}$$

multiplication/division:

$$y = a \cdot b \text{ or } y = a / b$$

$$\frac{S_y}{y} = \sqrt{\left(\frac{S_a}{a}\right)^2 + \left(\frac{S_b}{b}\right)^2}$$

Exponents:

$$y = a^n$$

$$\frac{S_y}{y} = n \frac{S_a}{a}$$

Note: n = constant  
with no uncertainty

Statistics:

Standard deviation:

$$S = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$\text{Case 3 t-test: } t_{calc} = \frac{|\bar{d}|\sqrt{n}}{S_d}$$

$$\text{Grubbs Test: } G_{calculated} = \frac{|x_{suspect} - \bar{x}|}{S}$$

F-Test:

$$F_{calc} = S_1^2/S_2^2 \text{ (where } S_1 > S_2)$$

Thermodynamics:

$$\Delta G = \Delta G^\circ + RT \ln Q \quad \Delta G^\circ = -RT \ln K \text{ (at equilibrium)} \quad R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}, 0^\circ\text{C} = 273.15 \text{ K}$$

$$\text{The quadratic equation for } ax^2 + bx + c = 0 \text{ is } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

**A. Multiple Choice/Fill in the Blank Section.** Only one correct answer for multiple choice questions. (4 points for each question)

1. Which of the following units is an SI base unit?

- a) centimeter      b) minute      c) atmosphere      d) mole

2. An Mg standard is 0.996% by mass. How many grams of solution are needed to deliver 2.00 g of Mg?

- a) 0.0199 g      b) 1.99 g      c) 2.01 g      d) 201 g

3. The number of significant figures in the sum of 13.11 + 0.9 is:

- a) 1      b) 2      c) 3      d) 4

4. In a weight loss show, a contestant measures her weight every day for one week. One day the weight was 4 lbs more than any other day's reading, and the contestant wants to discard that one measurement. In order to discard that measurement, she should use a/an:

- a) F-test      b) Grubbs test      c) Case 1 t-test      d) Case 3 t-test



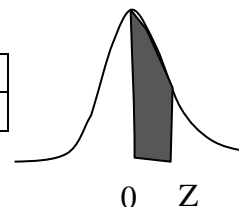
2. A chemist wants to find the mass and absolute uncertainty in mass of a metal alloy cube. It has a side of length  $1.81 \pm 0.07$  cm and a density of  $2.9 \pm 0.2$  g/cm<sup>3</sup>. Be sure to give the answer with the correct number of significant figures. The volume of a cube of length  $\ell = \ell^3$ . (14 pts)

Bonus Question. The uncertainty from which measurement contributed more to the uncertainty in the alloy mass. You must show with a calculation to get credit. (3 pts)

3. A water treatment plant just installed a water fluoridation unit. It wants to make sure that the fluoride concentration exceeds 2.00 ppm less than 1 percent of the time. It takes 20 samples and finds the mean and standard deviation in the fluoride concentration are 1.18 ppm and 0.27 ppm, respectively. Assuming that the measured mean and standard deviation are equivalent to the population mean and standard deviation, calculate the percent of samples that would give a value over 2.00 ppm. (10 pts)

Z Table

Z	1	1.5	2	2.5	3	3.5
Area (0 to Z)	0.341	0.433	0.477	0.493	0.499	0.4998



Area given in table corresponds to part of Gaussian curve shown to right

4. Arsenic is measured by repeated analysis of a well water sample. The following values are recorded: 23.1, 20.2, 19.7, and 22.3 ppb (parts per billion by weight). (12 pts)

Using the table below, determine:

a) the 95% confidence interval (mean  $\pm$  uncertainty) from the good data. Give with correct number of significant figures.

t tables

Degrees of freedom	2	3	4	5
t-value (at 95% level)	4.30	3.18	2.776	2.571

b) If the well water sample was split with part of it being analyzed 3 times by an independent laboratory, what test should be used to determine if there is a significant difference in the mean values?

5. A scientist is using an instrument to measure the alcohol content in beer. Standards ranging from 2.0% to 8.0 % alcohol are used for calibration giving: response =  $m \cdot \text{concentration} + b$  where  $m = 0.45 \text{ mV/\% alc}$  and  $b = -0.23 \text{ mV}$ . A sample of home brewed beer gives a reading of 2.84 mV. Calculate the % alcohol in the beer. (6 pts)

6. Given that the  $K_{sp}$  for  $\text{CaF}_2$  is  $3.2 \times 10^{-11}$ , determine the maximum concentration of  $\text{F}^-$  (in M) that could be added in the presence of  $1.0 \times 10^{-3} \text{ M Ca}^{2+}$  (without precipitation of  $\text{CaF}_2$ ). (10 pts)