CHEM 201 Self Quiz – 1 (Experimental Errors/Statistical Analysis)
Answer Key

1. A - How many significant figures in each?

a) 3.200×10^{9}

Answer: 4

b) $2.33 \times 6.085 \times 2.1 = 29.773905 = 2.9773905*10^{1} = 3.0*10^{1}$ or 30

Answer: 2

c) 780,000,000

Answer: 2

d) $(4.52 \times 10^{-4}) \div (3.980 \times 10^{-6}) = 1.135678392*10^{2} = 1.14*10^{2}$

Answer: 3

1. B - Give the correct answer with the correct number of significant figures.

a) log 23.0 = **1.361**

b) log $(1.2 \times 10^{6})^{3}$ = **18.23**

2. What are the types of errors (and their characteristics) in a chemical analysis?

Systematic: consistent, possible to eliminate

Random: uncontrollable, can not be eliminated

4. The statistical test best suited for testing the validity of a model used to fit a data set is:
a) The paired-t test.
b) The F test.
c) The Q test
d) A combination of the paired-t and F tests.
e) No response is correct.

Answer: The paired-t test.

5. Why is it desirable in the method of standard addition to add a small volume of a concentrated solution rather than a large volume of dilute standard?

Answer: If sample analysis is affected by matrix effect then addition of the large volume of the standard changes the concentration of the matrix.

6. The following data were obtained from the replicate analysis of a calcite sample: percent CaO = 55.95, 56.00, 56.04, 56.08, and 56.23. The last value appears anomalous. Should this result be retained or rejected?

gap = 0.15
spread = 0.28
n = 5

$$Q_{calc} = \frac{gap}{spread} = \frac{0.15}{0.28} = 0.54$$
$$Q_{table} = 0.64$$
$$Q_{table} > Q_{calc}$$

Point should be retained

7. The following data were obtained in the spectrophotometric determination of iron. Determine the linear least squares line.

[Fe], ppm	Absorbance
1.0	0.240
2.0	0.460
3.0	0.662
4.0	0.876

n = 4

$$\sum x_i = 1 + 2 + 3 + 4 = 10$$
$$\sum (x_i)^2 = (1)^2 + (2)^2 + (3)^2 + (4)^2 = 30$$
$$\sum (y_i)^2 = 0.240 + 0.460 + 0.662 + 0.876 = 2.238$$
$$\sum (x_i y_i) = (0.240 * 1) + (0.460 * 2) + (0.662 * 3) + (0.876 * 4) = 6.650$$

$$D = \begin{vmatrix} 30 & 10 \\ 10 & 4 \end{vmatrix} = 20$$

$$m = \begin{vmatrix} 6.650 & 10 \\ 2.238 & 4 \end{vmatrix} \div 20 = 0.211$$

$$b = \begin{vmatrix} 30 & 6.650 \\ 10 & 2.238 \end{vmatrix} \div 20 = 0.042$$

$$y = 0.211x + 0.042$$

8. The results obtained by two analysts for the phosphorus content of water samples are as follows: Using the appropriate test, compare a) the standard deviations and b) the mean values of the two sets of data.

Analyst 1 – 49.32, 49.41, 49.66, 49.45

$$\overline{x_1} = 49.46$$
$$s_1 = 0.144$$
$$n_1 = N_1 - 1 = 4 - 1 = 3$$

Analyst 2 – 49.09, 49.08, 49.25, 49.13, 49.10, 49.19

$\overline{x_2} = 49.14$
$s_2 = 0.067$
$n_2 = N_2 - 1 = 6 - 1 = 5$

$$F_{calc} = \frac{(s_1)^2}{(s_2)^2} = 4.62$$

$$F_{tab} = 5.41$$

$F_{tab} > F_{calc}$

With the 95% confidence data between two labs are not different.

$$s_{pooled} = \sqrt{\frac{(0.144)^2 \cdot 3 + (0.067)^2 \cdot 5}{3+5}} = 0.1$$

$$t_{calc} = \frac{|\overline{x_1} - \overline{x_2}|}{s_{pooled}} \cdot \sqrt{\frac{N_1 \cdot N_2}{N_1 + N_2}} = \frac{|49.46 - 49.14|}{0.1}\sqrt{\frac{6 \cdot 4}{6+4}} = 4.96$$

$t_{calc} > t_{tabul}$

With the 95% confidence data between two labs are different.

9. The following results were obtained during the testing of the validity of a method by analyzing a sample that contains 21.20 % Ca (true value, μ): mean= 21.24%, s=0.12, N=10. Is there a significant difference between the mean and μ at the 90% and 99% confidence interval?

$t_{90\%}^{tab} = 1.833$
$t_{99\%}^{tab} = 3.25$

$$t_{calc} = \frac{(\mu - \overline{x})}{s}\sqrt{n} = \frac{|21.20 - 21.24|}{0.12}\sqrt{10} = 1.05$$

In both cases t_{calc} is less than t_{tabul}: no significant difference between true value and mean value.