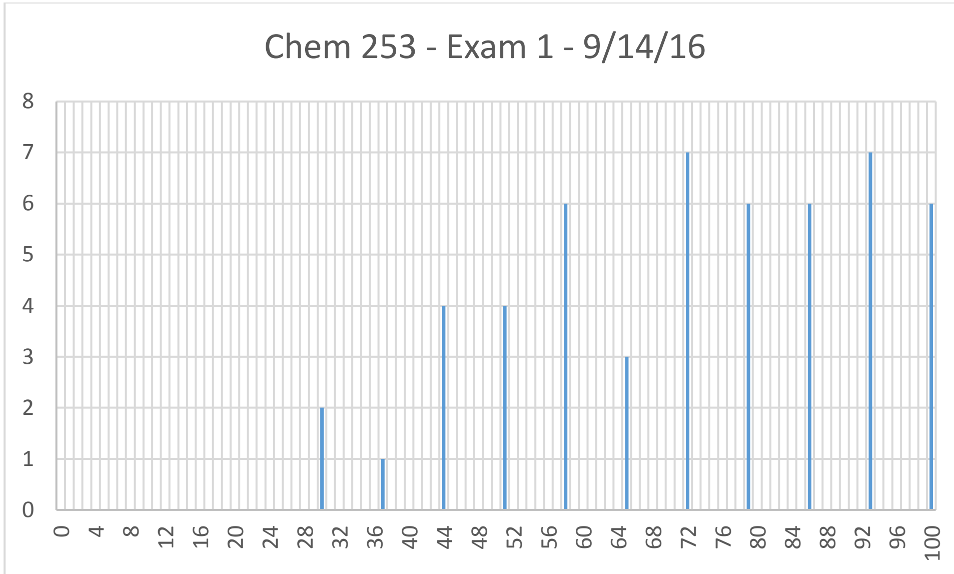
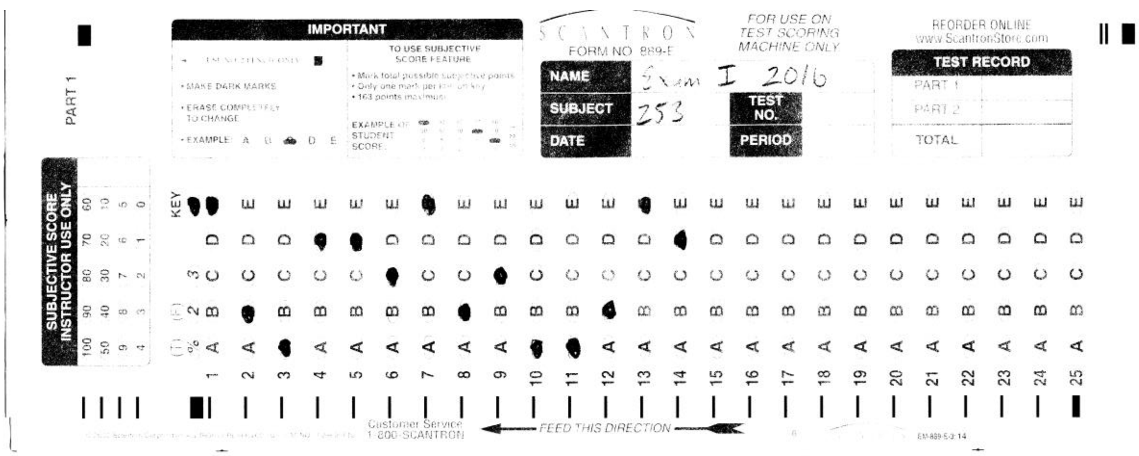


Frequency

Grade

Average = 72, Median = 72, s = 20



Exam 1 – Chem 253 – September 14, 201615 Questions, 7 points each for question 1-14
2 points for answering question 15 correctly

DO NOT OPEN THIS EXAM UNTIL YOU ARE INSTRUCTED TO DO SO

- Please print your name on the scantron
  - Last Name, First Name
  - That's all that's needed
- Sit in every other seat as instructed
- Books & Bags in the front of the room.
- No text entry calculators.
- Use the exams as scratch paper.
- Keep the exams when you are done.
- Turn in the scantrons.

$$\bar{x} = \frac{\sum_i x_i}{n} \qquad s = \sqrt{\frac{\sum_i \left(x_i - \bar{x}\right)^2}{n-1}} \qquad \mu = \bar{x} \pm \frac{t\sigma}{\sqrt{n}}$$

$$y = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}} \qquad z = \frac{x-\mu}{s} \qquad F = \frac{s_1^2}{s_2^2}$$

$$t_{calculated} = \frac{\left|\bar{x}_1 - \bar{x}_2\right|}{s_{pooled}}\sqrt{\frac{n_1 n_2}{n_1 + n_2}} \qquad s_{pooled} = \sqrt{\frac{s_1^2(n_1 - 1) + s_2^2(n_2 - 1)}{n_1 + n_2 - 2}} \qquad d.f = n_1 + n_2 - 2$$

$$t_{calculated} = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \qquad d.f. = \left(\frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2} \right)^2}{\frac{(s_1^2/n_1)^2}{n_1 - 1} + \frac{(s_2^2/n_2)^2}{n_2 - 1}} \right)$$

Table 4-1 **Ordinate and area for the normal (Gaussian) error curve,** $y = \frac{1}{\sqrt{2\pi}} e^{-z^2/2}$

$\lvert z \rvert$[a]	y	Area[b]	$\lvert z \rvert$	y	Area	$\lvert z \rvert$	y	Area
0.0	0.398 9	0.000 0	1.4	0.149 7	0.419 2	2.8	0.007 9	0.497 4
0.1	0.397 0	0.039 8	1.5	0.129 5	0.433 2	2.9	0.006 0	0.498 1
0.2	0.391 0	0.079 3	1.6	0.110 9	0.445 2	3.0	0.004 4	0.498 650
0.3	0.381 4	0.117 9	1.7	0.094 1	0.455 4	3.1	0.003 3	0.499 032
0.4	0.368 3	0.155 4	1.8	0.079 0	0.464 1	3.2	0.002 4	0.499 313
0.5	0.352 1	0.191 5	1.9	0.065 6	0.471 3	3.3	0.001 7	0.499 517
0.6	0.333 2	0.225 8	2.0	0.054 0	0.477 3	3.4	0.001 2	0.499 663
0.7	0.312 3	0.258 0	2.1	0.044 0	0.482 1	3.5	0.000 9	0.499 767
0.8	0.289 7	0.288 1	2.2	0.035 5	0.486 1	3.6	0.000 6	0.499 841
0.9	0.266 1	0.315 9	2.3	0.028 3	0.489 3	3.7	0.000 4	0.499 904
1.0	0.242 0	0.341 3	2.4	0.022 4	0.491 8	3.8	0.000 3	0.499 928
1.1	0.217 9	0.364 3	2.5	0.017 5	0.493 8	3.9	0.000 2	0.499 952
1.2	0.194 2	0.384 9	2.6	0.013 6	0.495 3	4.0	0.000 1	0.499 968
1.3	0.171 4	0.403 2	2.7	0.010 4	0.496 5			

a. $z = (x - \mu)/\sigma$.

b. The area refers to the area between $z = 0$ and $z =$ the value in the table. Thus the area from $z = 0$ to $z = 1.4$ is 0.419 2. The area from $z = -0.7$ to $z = 0$ is the same as from $z = 0$ to $z = 0.7$. The area from $z = -0.5$ to $z = +0.3$ is (0.191 5 + 0.117 9) = 0.309 4. The total area between $z = -\infty$ and $z = +\infty$ is unity.

TABLE 4-5 Critical values of G for rejection of outlier

Number of observations	G (95% confidence)
4	1.463
5	1.672
6	1.822
7	1.938
8	2.032
9	2.110
10	2.176
11	2.234
12	2.285
15	2.409
20	2.557

$G_{calculated}$ = |questionable value − mean|/s. If $G_{calculated} > G_{table}$, the value in question can be rejected with 95% confidence. Values in this table are for a one-tailed test, as recommended by ASTM.

*SOURCE: ASTM E 178-02 Standard Practice for Dealing with Outlying Observations, http://webstore.ansi.org; F. E. Grubbs and G. Beck, Technometrics **1972**, 14, 847.*

Table 4-2 Values of Student's *t*

Degrees of freedom	Confidence level (%) 50	90	95	98	99	99.5	99.9
1	1.000	6.314	12.706	31.821	63.657	127.32	636.619
2	0.816	2.920	4.303	6.965	9.925	14.089	31.598
3	0.765	2.353	3.182	4.541	5.841	7.453	12.924
4	0.741	2.132	2.776	3.747	4.604	5.598	8.610
5	0.727	2.015	2.571	3.365	4.032	4.773	6.869
6	0.718	1.943	2.447	3.143	3.707	4.317	5.959
7	0.711	1.895	2.365	2.998	3.500	4.029	5.408
8	0.706	1.860	2.306	2.896	3.355	3.832	5.041
9	0.703	1.833	2.262	2.821	3.250	3.690	4.781
10	0.700	1.812	2.228	2.764	3.169	3.581	4.587
15	0.691	1.753	2.131	2.602	2.947	3.252	4.073
20	0.687	1.725	2.086	2.528	2.845	3.153	3.850
25	0.684	1.708	2.060	2.485	2.787	3.078	3.725
30	0.683	1.697	2.042	2.457	2.750	3.030	3.646
40	0.681	1.684	2.021	2.423	2.704	2.971	3.551
60	0.679	1.671	2.000	2.390	2.660	2.915	3.460
120	0.677	1.658	1.980	2.358	2.617	2.860	3.373
∞	0.674	1.645	1.960	2.326	2.576	2.807	3.291

NOTE: In calculating confidence intervals, σ may be substituted for s in Equation 4-6 if you have a great deal of experience with a particular method and have therefore determined its "true" population standard deviation. If σ is used instead of s, the value of t to use in Equation 4-6 comes from the bottom row of Table 4-2.

Table 4-5 Critical values of $F = s_1^2/s_2^2$ at 95% confidence level

Degrees of freedom for s_2	Degrees of freedom for s_1: 2	3	4	5	6	7	8	9	10	12	15	20	30	∞
2	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.5	19.5
3	9.55	9.28	9.12	9.01	8.94	8.89	8.84	8.81	8.79	8.74	8.70	8.66	8.62	8.53
4	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.75	5.63
5	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.50	4.36
6	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.81	3.67
7	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.58	3.51	3.44	3.38	3.23
8	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.08	2.93
9	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.86	2.71
10	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.84	2.77	2.70	2.54
11	3.98	3.59	3.36	3.20	3.10	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.57	2.40
12	3.88	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.47	2.30
13	3.81	3.41	3.18	3.02	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.38	2.21
14	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.31	2.13
15	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.25	2.07
16	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.19	2.01
17	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.15	1.96
18	3.56	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.11	1.92
19	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.07	1.88
20	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.04	1.84
30	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.84	1.62
∞	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.46	1.00

1] Concentrated perchloric acid has a molarity of 11.7 M and a mass percentage of 70.5%. What is its density? MW $HClO_4$ is 100.46 g/mol.[1]

2] What is the concentration in ppm of a 3.5×10^{-4} M solution of KCl (MW = 74.5513 g/mol)?[2]

3] A solution has a density of 1.16 g/mL. What is the molarity of 6.12 molal of that solution? The solute has a molar mass of 100.0.[3]

4] A solution has $[H^+] = 4.667 \times 10^{-5}$ M. What is the pH of that solution?[4]

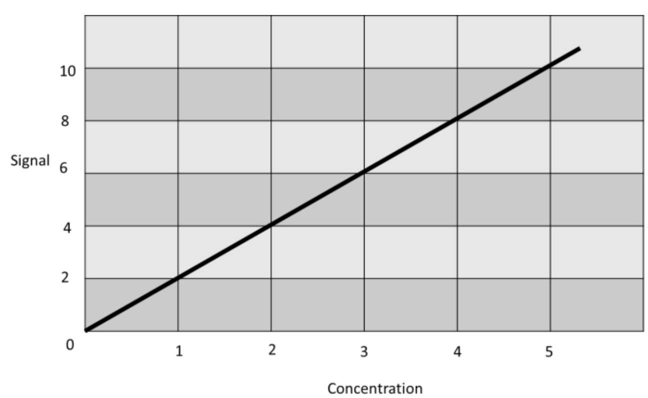
5] Standard Deviation is a measure of[5]

a) accuracy
b) how close the mean is to the true result
c) the mean relative to the true result
d) precision
e) precision and accuracy

6] Two sets of measurements were made by different technicians. The first has a mean of 55.6 ppm with a standard deviation of 7.3 ppm over 7 measurements. The second had $\bar{x}$ = 62.1 ppm with s = 8.5 ppm over 6 measurements. Are the two standard deviations significantly different from each other? [6]

7] A final quantity, D is calculated by the ratio of D = H/G. If H was measured 6 times with a mean of 987.2 grams and a standard deviation of 11.9 grams and G had $\bar{x}$ = 554.2 liters with a standard deviation of 32.7 liters over 10 measurements. What is the absolute uncertainty of D? [7]

8] Calculate the limit of detection of Method A given the calibration curve below. Also note that the curve has 9 data points each replicated 5 times. The data point at the lowest concentration has a standard deviation of 0.12 signal units.[8]



9] Replicate runs of an analysis gave 5 values of 1.77, 1.45, 1.91, 1.85 and 1.82. Can any of these values be discarded with 95% statistical confidence? [9]

10] Replicate runs of an analysis gave 5 values of 9.88, 8.92, 9.62, 9.33 and 9.27. What is the 95% confidence interval of this set of data? [10]

11] When is it appropriate to calculate s_{pooled} for two sets of data?

a) When the 2 standard deviations are statistically the same[11]

b) When t-calculated > t-test
c) When the 2 standard deviations are statistically different
d) When F-calculated = F-table
e) When the 2 standard deviations are not equal

12] Two different methods of Fe analysis were compared to an NIST standard containing 6.50% Fe by mass. The results follow: [12]

Method 1	%Fe	6.33% ± 0.23%
Method 2	%Fe	6.55% ± 0.45%

Which of the following statements is true?

a) Method 1 is less precise and less accurate
b) Method 1 is more precise and less accurate
c) Method 2 is less precise and less accurate
d) Method 2 is more precise and less accurate
e) Method 2 is more precise and more accurate

13] Trace analysis were conducted on a sample 25 times. The average concentration was found to be 10.0 ppb with a standard deviation of 5.0 ppb. What is the chance that a single analysis will yield a result that is twice this average? [13]

14] An analysis for lead in groundwater was conducted. What is the correct terms for the lead and the water? [14]

a) Lead is the sample and the groundwater is the analyte
b) Both the lead groundwater are the analytes
c) Both the lead groundwater are the samples
d) Lead is the matrix and the groundwater is the analyte
e) Lead is the analyte and the groundwater is the matrix

---

[1] (11.7 mol/L) (100.46 g/mol) (L/1000 mL) (100g soln/ 70.5 g acid) = 1.67 g/mL

[2] (3.5e-4 mol/L) (74.5513 g/mol) (L soln/1000 g) 10^6 = 26 ppm

[3] Assume 1 kg of solvent

In 1 kg of solvent
1 kg solv. (6.12 mol/kg solv.) (100.0 g/mol) = 612 solute
612 g solute + 1000 g solv. = 1612 g solution
Vol solution = 1612 g (mL/1.16g) (1 L/1000 mL) = 1.390 L
Molarity = 6.12 mol / 1.390 L = 4.40 M

[4] pH = -log[H^+] = -log (4.667×10^{-5}) = 4.3309<u>6</u> = 4.3310

[5] d) precision

[6] Use F-test s_1 = 8.5 and s_2 = 7.3   F = $8.5^2/7.3^2$ = 1.35579 df_1 = 6-1 = 5 df_2 = 7-1 = 6

F-table 4.39   F < F-table so std. dev. Are not statistically different.

[7] $$\sigma(\%) = \sqrt{\sigma(\%)_1^2 + \sigma(\%)_2^2 + \sigma(\%)_3^2 + \ldots\ldots}$$

$s_1(\%)$ = 11.9/987.2 * 100 = 1.21% $s_2(\%)$ = 32.7/554.2 *100 = 5.90%
$s_t(\%)$ = $(1.21^2 + 5.90^2)^{1/2}$ = 6.02%   D = 987.2 g/ 554.2 L = 1.781 g/L

6.02 % of 1.781 g/L = 0.107 g/L

[8] LOD = 3s/m = 3(0.12 signal units)/ 2 signal/conc = 0.18 conc. units

[9] 1.77, 1.45, 1.91, 1.85 and 1.82   mean = 1.76   s = 0.181   1.45?

Use Grubbs Test   G = 1.76 – 1.45 / 0.181 = 1.713   G-Table for n = 5 is 1.672

G > G-table, 1.45 can be discarded.

[10] 9.88, 8.92, 9.62, 9.33 and 9.27   mean = 9.404   s = 0.3643   d.f. = 4   t = 2.776

$$\mu = \bar{x} \pm \frac{t\sigma}{\sqrt{n}}$$ = $\bar{x} \pm 2.776(0.36)/5^{1/2}$ = 0.4469 = 0.45

[11] a) When the 2 standard deviations are statistically the same

[12] B) Method 1 is more precise and less accurate

[13] $$z = \frac{x - \mu}{s}$$ = 20-10/5 = 2   look up 2 on z-table.

Area = 0.4773   Area above 2 = 0.5000 – 0.4773 = 0.0227 or 2.27%

[14] d) Lead is the analyte and the groundwater is the matrix