Chemistry| 2015-2016 Assessment Report

1. Please give a brief overview of the assessment data you collected this year.

   The following Rubric was used to score the students. The student scores are below. Chemistry 323/321 Student Learning Assessment Rubric:

Score	Performed appropriate numerical analysis	Understands spectroscopy	Knowledge of Quantum mechanics	Knowledge of molecular structure	Knowledge of Thermodynamics
0 (Unsatisfactory)	No numerical analysis computed	No mention of the peak shape relation to energy	No understanding	Student unable to calculate a bond length	Student did not correctly apply Boltzmann analysis to peak intensity
1 (Developing)	Conducted a basic linear approach to peak separation	Some mention of the peak shape	Some understanding	Student calculated a bond length but the value was wrong or unphysical	Student attempted Boltzmann analysis but the value was wrong or unphysical
2 (Average)	Applied a quadratic fit equation to peak spacing	Understand the branches of the vibrational transition is related to rovibrational	Understands quantized energy levels	Student was able to correctly calculate the bond length	Student correctly applied analysis but did not do a properly optimized fit
3 (Exemplary)	Applied a cubic fit equation to peak spacing	Understand the branches and non-constant spacing of levels	Understands quantization of both rotation and vibrational levels appearing in spectrum	Student was able to calculate the bond length for the ground state and the next vibrational state	Student correctly applied analysis and conduct a least fit to determine the proper scale factor

Student ID	Performed appropriate numerical analysis	Understands spectroscopy	Knowledge of Quantum mechanics	Knowledge of molecular structure	Knowledge of Thermodynamics	Score
1	3	2	2	3	2	12
2	$_2$A	2	2	$_1$B	2	9
3	3	1	2	$_1$B	2	9
4	3	$_3$C	3	3	2	14
5	3	3	3	3	2	14
6	3	3	2	2	1	11
7	3	3	3	0	0	9
8	$_2$D	0	3	$_1$E	1	7
9	3	2	2	3	3	13
10	3	0	1	1	1	1
11	3	3	1	1	1	9
12	3	3	3	3	0	12
13	NC	NC	NC	NC	NC	NC
14	3	0	2	2	3	10
AVERAGES	2.85	1.83	2.23	1.85	1.54	

Comments:
A – Only analyzed data with a quadratic
B – Didn't get the correct bond length (forgot to square root r2)
C – Mentioned the selection rules between rotational levels
D – Baseline could have been better
E – Bond length off by an order of magnitude
NC – Not completed/Handed in

2. How will you use what you've learned from the data that was collected?

Analysis of Table:

The students are above average in numerical analysis. We did many labs that required some form of nonlinear least squares fitting to determine accurate numerical parameters. This is one of the main overall objectives I have for the lab and it appears students are proficient in perform nonlinear least square fits and plotting the results.

Understanding spectroscopy was slight below average. In most of the lab reports the students didn't spend much, if any, time describing the shape of the vibrational mode and how it relates to the underlying energy levels. Unfortunately, I think they "took it for granted" that the reader understands this, which I've tried to stress, is not a good assumption on lab reports.

The students are above average in quantum mechanics understanding. One of the central ideas in quantum mechanics is that of discrete energy levels and transitions between said levels. We covered ro-vibrational levels in both lecture and lab and the idea of quantized energy levels seems to be well understood.

Knowledge of molecular structure was the lowest average. There were two students who forgot to square root their values to get the correct bond length. These students would have calculated the correct length if they would have just performed the square root. I decided to give these a score of 1 (developing), because, while a minor error (there calculations were accurate) – the student should always have units in mind and a bond length on the order of 10^{-20} m should have caught their attention. The other student had a factor of ten error which is usually more to do with using their calculator or MAPLE than an actual understanding of the problem. Ultimately, students could have easily checked their answer with literature values.

The Boltzmann analysis was below average most likely because this is where students were given very little guidance. In addition to the Boltzmann population the intensity is also dependent on the transition dipole moment and frequency. Some students didn't attempt it. Of the ones that did, they had a decent fit but usually didn't apply a scalable factor to the results to maximize the fit.

Changes to pursue:

I think it must be emphasized that students need to consider the validity of their answers. Emphasizing the use of units (which they usually do) might help in catching mistakes. Also the checking of results in literature journals must also be stressed, many of the techniques used were directly from "journal of Chemical Education" articles.