

## Physical Science Liaison Report prepared by Allan Wilson

### **Results from the 121 Posttest**

After several semesters of collecting data, I am thrilled to be able to report on the results of the assessment that we use at the end of our Chem 121 classes. The data represent results from the fall 2015, spring 2016, and fall 2016 semesters, and include 79 students. Thank you to everyone who participated in our departmental assessment efforts and made these results possible!

The posttest for Chem 121 is the California Chemistry Diagnostic Test, a 44-question multiple choice test. The average number of correct responses is 20.7 out of 44 in our courses, which is slightly below 50%. The particular questions that were relatively easy or difficult did not change much from semester to semester.

Some questions stand out as being well-understood (arbitrarily defined as being answered correctly by more than 70% of our students). There is a straightforward question about calculating a molar mass that gave our students no problems; neither did a question about balancing equations. Students can select the element that possesses a given electron configuration, and they can calculate the subatomic particles in an atom given its symbol, mass, and charge. Given a selection of measurements, students can calculate an average. All of these topics are fundamental learning outcomes for CHEM 121; since this knowledge will be needed continuously in subsequent courses, it is gratifying to see our students doing so well.

Several questions, on the other hand, were very difficult for our students (answered incorrectly by at least 80% of them). There is a question that asks students to choose a generalized balanced equation that describes a pair of before-and-after molecular “pictures”, with the added complication that there is a limiting reactant. This question, perhaps unsurprisingly, was challenging. Students likewise struggled with a question that asked them to select the best description for the bonding present in ammonium chloride. On average, students do not know that atoms get smaller as they lose electrons, and they struggle to accurately describe what would happen to  $T$  if  $P$  and  $V$  are doubled while  $k$  is held constant in the equation  $PV/T = k$ .

In general, it seems that what predicts student success on a question is the difficulty of the question itself, not the difficulty of the topic that question assesses. If the question is straightforward, our students do well, even if the material itself (like electron configurations) is challenging. But they struggle with multistep and “trick” questions. So it is all the more surprising that the very first question on the test is actually the hardest, and it seems quite simple – calculate the number of atoms in half a mole of  $N_2$  gas. Why is this question such a challenge for our students? The explanation is not immediately obvious, and I would welcome your feedback.

**Implications for 121:**

The results of the 121 post-tests should be examined more closely to confirm the tentative conclusions described above, ideally with data from a few more semesters. To this end, I would like to extend another invitation to all faculty to participate in our assessment efforts, particularly for CHEM 121. Considering that we collected data from three semesters, it would be nice to have more than 79 data points. To put this in perspective, a similar analysis that was done for the CHEM 201 courses had data from the same three semesters, and had tests from over 200 students!

But if it is true that our students can answer a variety of easy questions but struggle with harder ones, then several ideas come to mind. For instance, it might be productive for 121 faculty to meet to discuss how these new hours from the reintroduction of Chem 100 are being used. Perhaps someone has found a creative strategy for fostering more sophisticated problem solving techniques. Also, since writing higher level questions is often difficult, faculty could pool test questions so that we are not constantly duplicating others' work.

Are there additional aspects of our Chem 121 courses you think would be fruitful for us to study as we work to give our students the best possible foundation in chemistry? Have the reports generated thus far been interesting? Helpful? Is there something you can suggest that would make this process even more useful to you?