Appendix 1: Sample online homework questions

Three sample homework problems are shown below. The feedback a student would receive for selecting an alternative is shown in italics below that alternative.

1. While working in the lab, you find a bottle of white powder labeled "analgesic compound #5". Since the original investigator neglected to record the identity of the substance, you decide to perform a combustion analysis to identify the compound. You have a 65.7 g sample that when burned produces 182 g CO_2 and 51.7 g H_2O. What is the formula of this compound?

1. $C_{13}H_{18}O$
You used the molecular weight of O_2 in determining the number of moles of oxygen. You should only do that when you are determining the mass or number of moles of O_2, not for oxygen in general. You determine the formula by calculating the moles of carbon (from CO_2), the moles of hydrogen (from H_2O) and the moles of oxygen {mass O = mass of sample -(mass C + mass H)}. Note: Always be careful about rounding off numbers when determining formulas. For example, if you get C(1.16666) you can multiply by 6 to get C(7). Always try multiplying through by a factor of 2 to 6 until you get all of the elements having whole number subscripts. You should read section 5.5 and do homework problems 47, 49 and 85. You can also work through the computer tutorial Chemistry Lessons c.

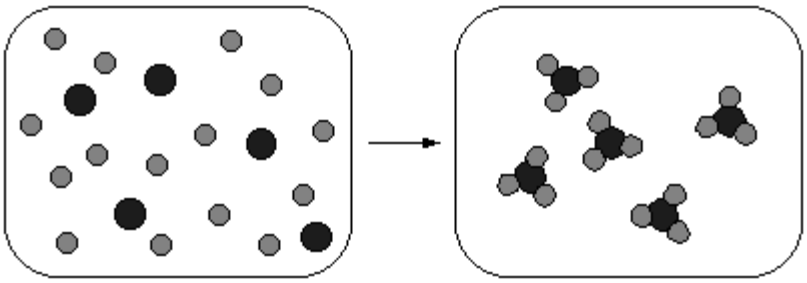
2. C_7H_9O
You should be careful in rounding off molar ratios in determining a molecular formula. You determine the formula by calculating the moles of carbon (from CO_2), the moles of hydrogen (from H_2O) and the moles of oxygen {mass O = mass of sample -(mass C + mass H)}. Note: Always be careful about rounding off numbers when determining formulas. For example, if you get C(1.16666) you can multiply by 6 to get C(7). Always try multiplying through by a factor of 2 to 6 until you get all of the elements having whole number subscripts. You should read section 5.5 and do homework problems 47, 49 and 85. You can also work through the computer tutorial Chemistry Lessons c.

3. $C_{13}H_{18}O_2$
Correct. You determine the formula by calculating the moles of carbon (from CO_2), the moles of hydrogen (from H_2O) and the moles of oxygen {mass O = mass of sample -(mass C + mass H)}. Note: Always be careful about rounding off numbers when determining formulas. For example, if you get C(1.16666) you can multiply by 6 to get C(7). Always try multiplying through by a factor of 2 to 6 until you get all of the elements having whole number subscripts. If you weren't sure you should read section 5.5 and do homework problems 47, 49 and 85. You can also work through the computer tutorial Chemistry Lessons c.

4. $C_3H_4O_8$
You cannot calculate how much oxygen was present in the compound by adding the amounts of oxygen in carbon dioxide and water. Remember that burning involves the combination of the compound and oxygen. You determine the formula by calculating the moles of carbon (from CO_2), the moles of hydrogen (from H_2O) and the moles of oxygen {mass O = mass of sample -(mass C + mass H)}. Note: Always be careful about rounding off numbers when determining formulas. For example, if you get C(1.16666) you can multiply by 6 to get C(7). Always try multiplying through by a factor of 2 to 6 until you get all of the elements having whole number subscripts. You should read section 5.5 and do homework problems 47, 49 and 85. You can also work through the computer tutorial Chemistry Lessons c.

5. $C_{10}H_7O_2$
Remember that there are 2 moles of hydrogen in one mole of water. You determine the formula by calculating the moles of carbon (from CO_2), the moles of hydrogen (from H_2O) and the moles of oxygen {mass O = mass of sample -(mass C + mass H)}. Note: Always be careful about rounding off numbers when determining formulas. For example, if you get C(1.16666) you can multiply by 6 to get C(7). Always try multiplying through by a factor of 2 to 6 until you get all of the elements having whole number subscripts. You should read section 5.5 and do homework problems 47, 49 and 85. You can also work through the computer tutorial Chemistry Lessons c.

2. The following diagram shows a compound reacting to form products. Which equation best describes the stoichiometry of the reaction shown in the diagram?



1. $A + 3B \rightarrow AB_3$
Correct. The expression reflects the molecules in the diagram, balances the number of atoms, and reduces the coefficients to the simplest ratio. If you weren't sure, you should read Section 4.2 and do homework problems 14,16 and 86.

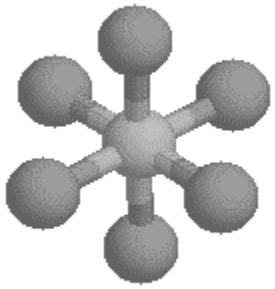
2. $A + B \rightarrow AB_3$
This expression does not have the number of atoms balanced. You need to make sure the expression reflects the molecules in the diagram, balance the number of atoms, and reduce the coefficients to the simplest ratio. You should read Section 4.2 and do homework problems 14,16 and 86.

3. $5A + 5B \rightarrow 5AB$
This expression does not reflect the molecules shown in the diagram. You need to make sure the expression reflects the molecules in the diagram, balance the number of atoms, and reduce the coefficients to the simplest ratio. You should read Section 4.2 and do homework problems 14,16 and 86.

4. $5A + 15B \rightarrow 5AB_3$
This expression reflects what is actually in the diagram, but general expressions should have the coefficients reduced to the simplest ratio. You should read Section 4.2 and do homework problems 14,16 and 86.

There is also a tutorial available in WebCT on balancing equations under Chemical Reactions. CLICK HERE to enter the tutorial.

3. Which of the following molecules/ions have a molecular geometry consistent with the chime structure shown below?



1. ICl_4^-
The molecular geometry is only concerned with the arrangement of the atoms of the molecule and does not include lone pairs. However, the electron-pair geometry must be determined first, because the position of lone pairs will determine the molecular geometry for molecules or ions with lone pairs of electrons around the central atoms. ICl_4^- has an octahedral electron pair geometry, but it has a square planar molecular geometry. You should review section 10.2 and do homework problems 2, 4 and 16.

2. PCl_6^-
Correct. The molecular geometry is only concerned with the arrangement of the atoms of the molecule and does not include lone pairs. However, the electron-pair geometry must be determined first, because the position of lone pairs will determine the molecular geometry for molecules or ions with lone pairs of electrons around the central atoms. PCl_6^- has an octahedral electron pair geometry and an octahedral molecular geometry. If you weren't sure, you should review section 10.2 and do homework problems 2, 4 and 16.

3. SF_6
Correct. The molecular geometry is only concerned with the arrangement of the atoms of the molecule and does not include lone pairs. However, the electron-pair geometry must be determined first, because the position of lone pairs will determine the molecular geometry for molecules or ions with lone pairs of electrons around the central atoms. SF_6 has an octahedral electron pair geometry and an octahedral molecular geometry. If you weren't sure, you should review section 10.2 and do homework problems 2, 4 and 16.

4. $SnCl_5^-$
The molecular geometry is only concerned with the arrangement of the atoms of the molecule and does not include lone pairs. However, the electron-pair geometry must be determined first, because the position of lone pairs will determine the molecular geometry for molecules or ions with lone pairs of electrons around the central atoms. $SnCl_5^-$ has a triangular bipyramidal electron pair geometry and a triangular bipyramidal molecular geometry. You should review section 10.2 and do homework problems 2, 4 and 16.

5. $XeOF_4$
The molecular geometry is only concerned with the arrangement of the atoms of the molecule and does not include lone pairs. However, the electron-pair geometry must be determined first, because the position of lone pairs will determine the molecular geometry for molecules or ions with lone pairs of electrons around the central atoms. $XeOF_4$ has an octahedral electron pair geometry, but it has a square pyramidal molecular geometry. You should review section 10.2 and do homework problems 2, 4 and 16.

Appendix 2: Text of the Pre- and Post-Attitude Surveys Administered Online.

The format of the two surveys was nearly identical, with minor changes in wording to compensate for the different times the surveys were administered. In these cases, the wording of the Post-Attitude Survey is shown in parentheses. Most of the questions (the exception being question 10) were constructed as a Likert scale ranging between 1-5, with 5 indicating a high level of the quality being examined and 1 indicating a low level. On questions 11-18, a sixth option, not applicable, was added in case the subject did not use the class activity being asked about.

1. Please assess your CONFIDENCE levels in the areas below BEFORE you began (AFTER completing) this course. A score of 1 corresponds to low confidence and a score of 5 corresponds to high confidence.

My confidence in my ability to understand key concepts of chemistry is…

1. 1 (low)
2. 2
3. 3
4. 4
5. 5 (high)

2. My confidence in my ability to solve chemistry problems is…

3. My confidence in my ability to understand the chemistry of lab experiments is…

4. My confidence in my ability to perform lab experiments is…

5. My confidence in my ability to visualize key concepts of chemistry is…

6. My confidence in my ability to apply my knowledge of chemistry to the real world is…

7. My confidence in my ability to understand other areas of science is…

8. My confidence in my ability to succeed in this chemistry course is…

9. My confidence in my ability to succeed in a chemistry-related discipline is…

10. What grade do you expect in this course?

1. C
2. BC
3. B
4. AB
5. A
6. other

11. For each activity listed below, please rate its **overall effectiveness** for assisting your learning in *previous math and science courses.* (*this Chemistry 103 course.*)

working on my own

1. 1 (not very effective)
2. 2
3. 3
4. 4
5. 5 (very effective)
6. not applicable

12. talking with the instructor (in class)

13. talking with the instructor (out of class)

14. working with others on group projects

15. talking with friends (out of class)

16. working on open-ended labs

17. working in small groups (in class)

18. working in small groups (out of class)

Appendix 3: Interview Protocol

I. Introduction

The interviewer will introduce him/herself and explain the reason for the interview. He/she will also ask permission to audiotape the interview and will have the student sign a consent form. Ask the student if he/she has any questions before the interview begins.

II. Interview Content

During the course of the interview the following questions should be answered. While it is not necessary for the interviewer to use this script verbatim, he/she should make sure all the topics have been covered.

1. Why are you taking chemistry 103?
2. What were your expectations when you began this course?
3. How has your experience been different from your expectations?
4. What is your preferred learning style?
   (Do you learn best by reading, hearing, doing, etc.?)
5. Which course tools have helped you learn the most?
   (lecture, discussion, lab, homework, tutorials, demos, videos, animations, online quizzes, group work)
6. Which course tools have helped you learn the least?
7. What role does homework play in your learning process?
8. What role have computers played in your learning process?
9. How do you study for this course? Describe a typical week.
10. How do you know when you understood the material?
11. What is your opinion about the feedback that you receive on your homework?
12. If you had been in the other group (odd or even section), how do you think your experience in this course would have been different?
13. What have been your experiences with computer and web-based instruction in other classes?
14. Use the response to 14 to probe more about how the use of videos, animations, etc. on how technology impacts the student's learning.
15. What are most likely to remember from this course?
16. What would be your advice to someone about to take this course?

III. Closing

Thank student for his/her time and how helpful he/she has been to the study. Ask the student if he/she has any questions. Remind the student that he/she can withdraw from the study at any time and point out the contact information.

Table 1: Composite ANOVA tables summarizing the models

Total Points

Source of Variation	**Sum of Squares**	**Degrees of Freedom**	**Mean Squares**	**F statistic**	**P value**
Model 1	194,035	1	194,035	55.9	3.9×10^{-12}
Model 2	39713	1	39,713	12.2	< 0.001
Model 3	415	1	415	0.127	
Model 4	6000	2	3000	0.917	
Residual	526,542	161	3270		
Total	766,705	166			

Exams

Source of Variation	**Sum of Squares**	**Degrees of Freedom**	**Mean Squares**	**F statistic**	**P value**
Model 1	109,537	1	109,537	62.6	2.9×10^{-13}
Model 2	21,659	1	21,659	13.3	< 0.001
Model 3	63	1	63	0.038	
Model 4	1782	2	891	0.540	
Residual	265,409	161	1649		
Total	398,450	166			

Quizzes

Source of Variation	**Sum of Squares**	**Degrees of Freedom**	**Mean Squares**	**F statistic**	**P value**
Model 1	6599	1	6599	45.5	2.42×10^{-10}
Model 2	1097	1	1097	7.89	< 0.01
Model 3	74	1	74	0.529	
Model 4	406	2	203	1.46	
Residual	22,350	161	139		
Total	30,525	166			

Model 1: Fully reduced

$\mu\{\text{response} \mid \text{ACT}\} = \text{ACT}$

Model 2: No homework effect

$\mu\{\text{response} \mid \text{ACT, GALT}\} = \text{ACT} + \text{GALT}$

Model 3: Parallel Lines

$\mu\{\text{response} \mid \text{ACT, GALT, odd}\} = \text{ACT} + \text{GALT} + \text{odd}$

Model 4: Interaction

$\mu\{\text{response} \mid \text{ACT, GALT, odd}\} = \text{ACT} + \text{GALT} + \text{odd} + \text{ACT} \times \text{odd} + \text{GALT} \times \text{odd}$