Teaching Advanced Placement (AP) Chemistry

Week 1 -- Exam Format and Grading

General Format

A Few Starting Questions:

- Can you tell your students what to expect on the day they take the AP chemistry exam?
- When can a calculator be used?
- What choices in questions will the students have?
- What are the strategies that will help students succeed on the exam?

The AP chemistry exam is organized into two parts:
I. Multiple Choice and II. Free Response. For each part...

- how many questions are there?
- how much time is allowed?
- what % of the total score of the exam is earned?
- what is the calculator use policy?
- what extra information is available?
- how is it scored?
- what strategies are useful?

Calculators and Equations

Reading Assignment:
The College Board discusses the format of the AP chemistry exam in their **Course Description**. You can find this in your College Board supplied materials or online at **collegeboard.com**. Read **The Exam** and **Calculators and Equations**.

Starting on the 2011 AP Exams:

A change in the grading of the Multiple Choice portion of ALL AP exams will be announced in August. The multiple choice will be graded on the number of correct answers. There will be no ¼ point deduction for incorrect responses. It is now to the student's advantage to answer every question.

Read these pages and then think back to your **Study List**.
I can...

- ☐ state the type of calculators allowed on the free response portion of the exam and point students to online AP calculator use policies.
- ☐ explain the scoring of the multiple choice exam and advise students about guessing.
- ☐ list the types of extra information given on each portion of the exam (periodic table, formulas and constants, and table of reduction potentials).
- ☐ state on which questions calculators are allowed.

Which items can you check off? Make some quick notes to which you may refer later.

Math and Multiple Choice Questions

Facing the Multiple Choice portion of the exam **without a calculator** is an extra challenge for many students. There are three ways that non-calculator mathematical questions are written.

1. The answer choices can be displayed as **setups**. Students set up the problem themselves and choose the setup that will give the correct answer.

   Example:

   35. A steady current of 10 amperes is passed through an aluminum-production cell for 15 minutes. Which of the following is the correct expression for calculating the number of grams of aluminum produced? (1 faraday = 96,500 coulombs)

   (A) $\frac{(10)(15)(96,500)}{(27)(60)}$ g

   (B) $\frac{(10)(15)(27)}{(60)(96,500)}$ g

   (C) $\frac{(10)(15)(60)(27)}{(96,500)(3)}$ g

   (D) $\frac{(96,500)(27)}{(10)(15)(60)(3)}$ g

   (E) $\frac{(27)(3)}{(96,500)(10)(15)(60)}$ g

2. The problem uses **rounded-off numbers** (i.e. 10. grams rather than 9.7 grams).
3. The answer choices are very different from each other so that even an **approximate** answer to the question allows the student to choose the correct answer.

Two ways to help students develop the **skill and confidence** to do these calculations:

- Model these techniques routinely in class. Each time you go over a mathematical question, take a moment to estimate the answer. Show students techniques such as canceling common factors, rounding off numbers, and doing simple arithmetic in their heads. I know that it has helped me build confidence in these skills as well.
- A second idea is to re-write exam questions and do not allow calculator use. I haven't tried this one yet. There are a few sources of exam questions written in this format.

Reading Assignment:
Look in the **Course Description** at the sample multiple choice questions (#6, 8, 11, 12, 16, and 17). You can find this in your College Board supplied materials or online at **collegeboard.com**.

Read these pages and then think back to your **Study List**.
I can...

- ☐ explain three techniques for formatting mathematical multiple choice questions to enable solving without calculators.
- ☐ help my students prepare to take the multiple choice exam without a calculator.

Scoring and Strategies for Multiple Choice Questions

Students are generally familiar with the **1/4 point penalty** for incorrectly answered questions. This is new beginning with the 2011 AP exams. This is referred to as "right-scoring." It is now to the student's advantage to answer every question. I do not think this change affects the SAT or other exams.

I advise my students to go through the entire multiple choice exam in **three sweeps**.

- First sweep, do all the problems on which they are **confident and can do quickly**.
- Second sweep, do problems that they know they can do, but take **a little more time**.
- If there is time, go back and **ponder** on the more difficult problems as the third sweep.

The AP exam is **designed** to cover more material than any one student can answer.
Students are **supposed** to skip questions. In general,

- a **5** is awarded by earning **66%** of the points. You can skip **one** out of every **three** questions.
- a **4** is awarded by earning **50%** of the points. You can skip **one** out of every **two** questions.
- a **3** is awarded by earning **33%** of the points. You can skip **two** out of every **three** questions.

Even though students find the AP exams very difficult, the idea of only needing 1/3 of the points to pass makes the goal do-able. These point values apply to both the Multiple Choice and Free Response portions of the exam. Some teachers tell me that they give difficult exams all year and score on this rubric (A = 66%, B = 50%, etc.).

Think back to your **Study List**.
I can...

- ☐ explain the scoring of the multiple choice exam and advise students about guessing.
- ☐ state the general % of points needed for a "5", "4", and "3" on the AP exam.

Format of the Free Response Questions - Part A (Calculators Available)

The free response portion of the AP exam consists of **six** questions in 95 minutes. Students have **55 minutes** to solve the first three problems. Calculators are allowed on these first three problems.
Let's look at each question individually.

Question 1 -- Equilibrium
This question is always equilibrium. It could be K_{sp} (solubility equilibrium), K_a (acid-base equilibrium), or a gaseous equilibrium, K_{eq}.

- 2002 K_a, titration, buffers, and molecular structure/acid strength.
- 2003 K_b, weak base, titration, pH, conjugate acids, and indicators.
- 2004 K_{sp}, Le Chatelier's Principle, solubilities, and concentrations in saturated solutions.
- 2005 K_a, pH, buffers, conjugate bases, and strengths of acids.
- 2006 K_{sp}, solubility, Le Chatelier's Principle, and precipitate forming.

This question counts for **20%** of the free response portion of the exam. A **calculator may be used** and students should budget **20 minutes** for this question.

Questions 2 and 3 -- Any of several mathematical topics
These questions typically involve kinetics, stoichiometry, gas laws, thermodynamics, colligative properties, or electrochemistry. They often involve a combination of ideas.

- 2002-2 stoichiometry/E°/ΔG,Nernst Eq.
- 2002-3 combustion/stoichiometry/PV=nRT/Graham's Law/structural isomers.
- 2003-2 PV-nRT/mole fraction/partial pressure/Graham's Law/equations/stoichiometry.
- 2003-3 order of reaction/rate law/specific rate constant/E°/electron transfer.
- 2004-2 stoichiometry/limiting reactant/ΔS°/spontaneity.
- 2004-3 spectrophotometry/concentrations/kinetics/half-life/graphical methods activation energy.
- 2005-2 stoichiometry/chemical analysis/molality/FP depression/functional groups.
- 2005-3 order of reaction/rate law/specific rate constant/graphical analysis of order/catalysts.
- 2006-2 Hess's Law/DS/DG/spontaneity/K_{eq}.
- 2006-3 stoichiometry/chemical analysis/empirical formula/PV=nRT.

These questions count for **20%** of the free response portion of the exam each. A **calculator may be used** and students should budget **15 - 20 minutes** each for these questions. One of these questions may be based on laboratory work.

Format of the Free Response Questions - Part B

After **55 minutes**, calculators are put away. Students may go back and look at questions 1, 2, and 3 without a calculator.

Question 4 -- Predicting Reactions (The format of this section changed in 2007.)
Students view **three** chemical statements and write a *balanced* chemical equation for each. One point is awarded for correctly writing symbols for the reactants and two points are awarded for correctly predicting the products. One point is awarded for the balancing of the equation and the last point is earned by answering a question about the chemical reaction. We will look at this type of question extensively during Week 3.

This question counts for **10%** of the free response portion of the exam. **No calculator** may be used and students should budget **10 minutes** for this question.

Question 5 – Any non-mathematical topic
This question can address any topic in the chemistry curriculum. If question 3 was not a laboratory question, then this question will involve laboratory situations and techniques. Here are the laboratory topics addressed during the past five years.

- 2002 calorimetry, $q=mc\Delta T$, units, describe calculation, error analysis.
- 2003 spectrophotometry, dilution, choose wavelength, concentration vs. absorbance, Beer's law, error analysis, colored solution.
- 2004 precipitates and unknown solutions, formulas of precipitates, identification scheme.
- 2005 glowing splint test for gases, pH of solutions, identify unknown solution using precipitation.
- 2006 identify unknown solids, precipitation, pH, dilution, chemical properties.

This question may involve non-laboratory topics.

- 2002 use bonding ideas to explain atomic radii, 2nd ionization energies, bond energies, and boiling points.
- 2003 use chemical principles to explain acid rain, colligative properties, non-ideal gases, condensation.
- 2004 electrochemistry, cathode, electron flow, E°, identify metal of electrode, overall

reaction, Nernst equation.

- 2005 Lewis structure, bond angle, hybridization, shape, sigma and pi bonds, formal charge.
- 2006 IMF's of organic molecules, solubility, identify bonding, bonds broken during boiling, potential energy graphs, catalysts.

This question counts for **15%** of the free response portion of the exam. Students should budget **15 minutes** for this question.

Question 6 – Any non-mathematical topic

This question can be about any non-mathematical topic. Often, these questions ask students to use their chemical knowledge to explain observed phenomena. Here are topics that appeared in the past five years.

- 2002-7 mechanism, overall equation, catalyst, intermediate, rate law, units, rate determining step.
- 2002-8 sign of entropy, sign of enthalpy, energy diagram, how solid affects equilibrium.
- 2003-7 bond enegy and ΔH, sign of entropy, sign of ΔG, kinetics vs. thermodynamics.
- 2003-8 structural formula of propanone, bond angle, IMF's, isomers, hybridization, sigma and pi bonding.
- 2004-7 use chemical principles to explain phases, melting points, shapes, and solubilities of pairs of substances.
- 2004-8 Lewis structures, shapes, solubility and pH, graph V vs. T, KE, root-mean-square speed, and moles of two gases.
- 2005-7 identify IMF's and BP's, bonding type and MP's, quantum level of valence electrons and 1st ionization energies, isotopes.
- 2005-8 ΔG and ΔS for dissolving, sign of ΔH, electrolysis, half-reactions, anode, DG of electrolysis.
- 2006-7 Lewis structures, hybridization, geometry, bond angles, oxidation number.
- 2006-8 hypothetical element 119, valence shell, metal/nonmetal, atomic radius, ionic charge, rxn with water, carbonate formed.

This question counts for **15%** of the free response portion of the exam. Students should budget **15 minutes** for this question.

A Closer Look at the Predicting Reactions Section

In this portion of the exam, students are presented with statements such as:
"Solutions of silver nitrate and potassium chromate are mixed."

- The student must **translate** the words into chemical symbols (1 point)
- The student must **predict** the products (2 points).
- The equation needs to be **balanced** (1 point).
- A question about the reaction must be answered (1 point).

- Chemicals are written **together** or as **separate ions** depending on the way they primarily exist.
- Spectator ions are not included.
- **Three** statements are presented; the student must answer all three.

We will spend **Week 3** working on these problems. However, since these problems are **unique** to the AP chemistry exam they warrant a couple of examples. Additionally, the format of this section of the AP exam changed in 2007. The chemistry we teach students as we learn to do these problems, however, has not changed… so questions from older exams may still be useful.

Example 1: *"Solutions of silver nitrate and potassium chromate are mixed."*

Molecular Equation: $2AgNO_3 + K_2CrO_4 \rightarrow Ag_2CrO_4 + 2KNO_3$
Ionic Equation: $2Ag^+ + 2NO_3^- + 2K^+ + CrO_4^{2-} \rightarrow Ag_2CrO_4 + 2K^+ + 2NO_3^-$

Final Answer:

Ex 1	$2Ag^+ + CrO_4^{2-} \rightarrow Ag_2CrO_4$

Possible Question: How might a student visually tell the two reactants apart?
Possible Question: How could the product be separated from any unused reactant?
Possible Question: What is the oxidation number of Cr in the chromate ion?

- Notice that no **phases** need to be marked [e.g. (aq) or (s)].
- The student would lose one point if the **spectator ions** were left in the final answer.
- The question might involve observable properties of the chemicals or understanding of the underlying chemistry involved.

Example 2: *"Solid sodium carbonate is added to a solution of acetic acid."*

Molecular Equation: $Na_2CO_3 + 2HC_2H_3O_2 \rightarrow H_2O + CO_2 + 2NaC_2H_3O_2$
Ionic Equation: $Na_2CO_3 + HC_2H_3O_2 \rightarrow H_2O + CO_2 + 2Na^+ + 2C_2H_3O_2^-$

Final Answer:

Ex 2	$Na_2CO_3 + HC_2H_3O_2 \rightarrow H_2O + CO_2 + 2Na^+ + 2C_2H_3O_2^-$

Possible Question: How would a student observe that this reaction is complete?
Possible Question: How does entropy change during this reaction?
Possible Question: If equimolar amounts of the reactants are used, will the pH of the product solution be less than 7, 7, or greater than 7? Justify your answer.

- The reactants are **not written as ions** because one is a **solid** and the other is a **weak acid**.
- Students need to realize that H_2CO_3 **decomposes** into H_2O and CO_2.
- There are **no spectator ions** in this reaction.

Assignment B:

Now is the time for you to do your **assignment**. Use the information from reading the **AP Chemistry Course Description** and these **lecture notes** to create a **handout** that you can give your students describing the AP Chemistry Exam.

Make your handout complete, concise, and creative. Save the handout on your own computer and send me a copy in either **Microsoft Word format** or **Rich Text Format**. Visit the **Assignment Link** just below these Lecture Notes to **submit** your assignment. (5 points) From the main menu, click on **Course Content** and **Week 1 Information and Assignments**.