

**Revised August 2008**

## AP Chemistry Labs

Up until May 2006, laboratory situations were specifically tested in question #5 on the AP exam, could also come up in parts of other free-response questions, and appeared in a few multiple-choice items. In the new exam format for 2007 you should expect a laboratory based situation as part of either question #2, #3, #5 or #6. Remember, question #2 and #3 are the ones where you have a calculator (i.e. would probably involve calculations), but question #5 and #6 would most likely not involve a calculation, and would probably be more like the pre-2007 question #5.

You should carefully note the following text taken from the College Board AP Chemistry course description;

***“It is unlikely that every student will complete all of the 22 laboratory experiments below while enrolled in an AP Chemistry course. Some of these experiments, in whole or in part, may be performed during a student's first course in Chemistry before the student takes the AP Chemistry course.”***

It is worth bearing in mind that you have NOT be exposed to a “first course in chemistry” and, as such, your lab experience is somewhat limited by your special circumstances (AP chemistry as sophomores with only one year of chemistry).

Below is a table of the 22 “Recommended Experiments” as listed in the College Board AP Chemistry course description. In addition to these specific lab situations, general techniques relating to taking measurements, dilution, titration, tests for gases, conductivity, error analysis and a myriad of other techniques are also potential questions, or part questions.

**\*In an attempt to keep the list of free-response examples manageable and relevant, I have restricted the list to include only questions that;**

- (i) **have appeared SINCE 1990, AND**
- (ii) **that actually make reference to a specific experiment/experimental situation or experimental technique.**

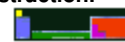
**Those questions that deal with ONLY experimental data, and then ask students to perform calculations *relating* to that experimental data, (as many Section A Free-Response questions do), have deliberately NOT been included. This can be a fine line to determine.**

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Suggested Lab	What's it all about?	Example free-response questions since 1990*
<b>1. Determination of the formula of a compound</b>	For example, taking a mass of magnesium ribbon and heating it in air. The magnesium would combine with the oxygen to form magnesium oxide. The mass after reaction can be determined, and the difference is the mass of oxygen reacted. Then perform a moles/ratio calculation to determine the empirical formula. Another example would be a combustion analysis.	1990, 9
<b>2. Determination of the percentage of water in a hydrate</b>	Heat a hydrated salt to constant mass by driving off water of crystallization and compare moles of water lost to moles of anhydrous salt residue in order to find x in, for example, the formula $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$	2000, 3b, 2008 2a-c
<b>3. Determination of molar mass by vapor density</b>	Determining Molar Mass by vaporizing a volatile liquid. Apply $PV = nRT$ , and $n = \frac{\text{mass}}{\text{Molar Mass}}$	1991, 6
<b>4. Determination of molar mass by freezing-point depression</b>	Add solute to solvent, observe depression in freezing point, then apply; $\Delta T_f = i k_f \left( \frac{\left( \frac{\text{mass of solute}}{\text{Molar Mass of solute}} \right)}{\text{Mass of solvent in kg}} \right)$ Obviously boiling point elevation would be an alternative.	2000, 5
<b>5. Determination of the molar volume of a gas</b>	A gas can either be simply be released from a canister or produced by a reaction and then collected, often over water. Knowing the moles of gas and knowing the volume, it is possible to determine Molar Volume, i.e. the number of L per mole. At s.t.p. the molar volume of any gas is 22.4 L per mole. Look out for calculations that require the subtraction of water vapor pressure from total pressure of gas collected above water.	1995, 3e; 1999, 5
<b>6. Standardization of a solution using a primary standard</b>	Simple titration. Knowing the EXACT molarity of one solution, perform a titration to find the volume of the unknown solution required, and via the ratio of the balanced equation, find the molarity of the unknown.	1998, 5; 2004B, 5; 2006, 5
<b>7. Determination of concentration by acid-base titration, including a weak acid or weak base</b>	Simple titration. Knowing the EXACT molarity of one solution, perform a titration to find the volume of the unknown solution required, and via the ratio of the balanced equation, find the molarity of the unknown. Knowledge of indicators useful. Weak Acid versus weak base could use a pH meter to determine the end point.	1996, 6
<b>8. Determination of concentration by oxidation-reduction titration</b>	REDOX titration. Knowing the EXACT molarity of one solution, perform a titration to find the volume of the unknown solution required, and via the ratio of the balanced REDOX equation, find the molarity of the unknown. Other variations may include the ratio being the unknown.	1993, 3e; 2000, 3c; 2003B, 5, 2007, 5
<b>9. Determination of mass and mole relationship in a chemical reaction</b>	An experiment could be conducted to illustrate limiting reactant or % yield. For example, adding 10 g of Fe to 10 g of $\text{CuSO}_4$ dissolved in water does NOT yield 10 g of products. Reacting ratios and moles need to be considered via balanced chemical equations.	2008B, 3

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Suggested Lab	What's it all about?	Example free-response questions since 1990*
<b>10. Determination of the equilibrium constant for a chemical reaction</b>	By determining the number of moles present in an equilibrium mixture (by titration or other quantitative method like using a spectrophotometer), and knowing the K expression, K can be determined.	<b>2006B, 5</b>
<b>11. Determination of appropriate indicators for various acid-base titrations; pH determination</b>	Know that suitable indicators for acid base titrations must change color in the vertical portion of the titration curve. In the past it has not be necessary to know specific indicators and their colors, rather just select a suitable one form a list.	<b>2000, 8c; 2003, 1e</b>
<b>12. Determination of the rate of a reaction and its order</b>	Measure rate of reaction (time taken for reactants disappear or products appear) and then change one variable to examine the change in rate. Analyze via equations AND graphically. Also consider determination of activation energy via graph a possibility.	<b>2005, 3; 2001, 6, 2004, 3e</b>
<b>13. Determination of enthalpy change associated with a reaction</b>	Mix solutions and measure temperature changes. Temperature goes up, EXOTHERMIC, temperature goes down, ENDOTHERMIC. $q = m c \Delta T$ (q can be shown as $\Delta H$ )	<b>2002, 5, 2003B, 3d</b>
<b>14. Separation and qualitative analysis of cations and anions</b>	Recognizing the presence of certain ions (and perhaps even non-ionic substances as well via negative results) and distinguishing between them via; flame tests, precipitation reactions, colors, chemical tests, solubility etc.	<b>1992, 7; 1995, 5; 1995, 7c; 2001, 5c; 2002B, 5; 2004, 5; 2006, 5, 2008B, 5</b>
<b>15. Synthesis of a coordination compound and its chemical analysis</b>	Making a compound and confirming its chemical composition by performing chemical and physical tests. See the example free-response question for examples of things that may be asked.	<b>2005B, 5</b>
<b>16. Analytical gravimetric determination</b>	An experiment is carried out that yields a solid (often a precipitate) that can be dried and weighed. The mass can be converted to moles in order find out many other things via balanced chemical equations and molar relationships.	<b>1997, 9, 2008 5d-e</b>
<b>17. Colorimetric or spectrophotometric analysis</b>	Beer-Lambert Law. Application of $A = a b c$ .	<b>2003, 5; 2006B, 5</b>



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<p><b>18. Separation by chromatography</b></p>	<p>Physical method used to separate mixtures. Mixture is distributed into two phases; a stationary phase and a mobile phase. The mobile phase moves through the stationary phase carrying the mixture. Each component in the mixture will have a different affinity for the stationary phase. A high affinity for the stationary phase means a component in the mixture will not travel far. Less affinity causes a component to travel further. The differing distances traveled, results in separation. The resulting separated bands are called a chromatogram. <math>R_f</math> values can be determined for each component;</p> $R_f = \frac{\text{Distance traveled by component}}{\text{Distance traveled by solvent}}$ <table border="1" data-bbox="695 730 1084 1209"> <thead> <tr> <th data-bbox="695 730 820 779">Types</th> <th data-bbox="820 730 971 779">Stationary Phase</th> <th data-bbox="971 730 1084 779">Mobile Phase</th> </tr> </thead> <tbody> <tr> <td data-bbox="695 779 820 890"><b>Paper</b></td> <td data-bbox="820 779 971 890">Paper</td> <td data-bbox="971 779 1084 890">Solvent (water, ethanol etc.)</td> </tr> <tr> <td data-bbox="695 890 820 989"><b>Column</b></td> <td data-bbox="820 890 971 989">Alumina or silica gel</td> <td data-bbox="971 890 1084 989">Solvent (water, ethanol etc.)</td> </tr> <tr> <td data-bbox="695 989 820 1087"><b>Thin Layer</b></td> <td data-bbox="820 989 971 1087">Silica gel spread thinly on glass plate</td> <td data-bbox="971 989 1084 1087">Solvent (water, ethanol etc.)</td> </tr> <tr> <td data-bbox="695 1087 820 1209"><b>Gas Liquid</b></td> <td data-bbox="820 1087 971 1209">Liquid</td> <td data-bbox="971 1087 1084 1209">An inert gas carrying the mixture</td> </tr> </tbody> </table>	Types	Stationary Phase	Mobile Phase	<b>Paper</b>	Paper	Solvent (water, ethanol etc.)	<b>Column</b>	Alumina or silica gel	Solvent (water, ethanol etc.)	<b>Thin Layer</b>	Silica gel spread thinly on glass plate	Solvent (water, ethanol etc.)	<b>Gas Liquid</b>	Liquid	An inert gas carrying the mixture	
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<p><b>19. Preparation and properties of buffer solutions</b></p>	<p>Making buffers by one of two methods;                      (1) Either mix a weak acid and one its salts or weak base and one of its salts to create the buffer, or                      (2) Partially neutralize a weak acid with a strong base, or partially neutralize a weak base with a strong acid. In each case the weak component is left in excess, and the salt is produced in situ.                      Subsequent experiments can determine <i>small</i> pH changes when buffers are exposed to acids or bases.</p>	<p><b>1992, 6b &amp; d, 2007B 5c</b></p>															
<p><b>20. Determination of electrochemical series</b></p>	<p>Performing single displacement reactions between metals and solutions. Metals high in the activity series will displace those below them from solution.</p>	<p><b>1994, 5c</b></p>															
<p><b>21. Measurements using electrochemical cells and electroplating</b></p>	<p>Experiments where electricity is passed for a known time. Masses of solids deposited can be determined by weighing electrodes before and after, or volumes of gases can be collected. In calculations apply <math>Q = It</math>, know that <math>1 F \equiv 96500 \text{ c}</math>, and that <math>1 \text{ mol of electrons} \equiv 1 F</math>.</p>	<p><b>2005B, 2; 2003B, 6, 2007, 3</b></p>															
<p><b>22. Synthesis, purification, and analysis of an organic compound</b></p>	<p>Make an organic compound by combining reactants and subsequent purification (filtering, re-crystallization etc.) followed by analysis of the product (e.g. combustion analysis, chemical tests).</p>																