

ABOUT THIS BOOK

This book is intended to help you *review* for the Advanced Placement Chemistry exam. It assumes you have had almost two full years of chemistry instruction and are now preparing to take the AP Chemistry exam. The organization of this review book is based on *Chemistry*, by Raymond Chang (McGraw-Hill). The charts, graphs, and chapter references are taken from the textbook. However, you do not need any particular textbook in order to use this review book to prepare for the AP exam.

We have incorporated a number of features to facilitate your review process. These include:

- *Take Note* boxes include concrete tips on how the subject matter is treated on the AP Chemistry exam.
- *Sample problems* illustrate important concepts frequently tested on the AP Chemistry exam. The step-by-step solutions to the Example problems will allow you to follow the reasoning that leads to the solution. Then you will be able to solve similar problems on your own. Sample quantitative problems are presented in chart form, providing a ‘general strategy’ that you can extrapolate to other problems of the same type. This is followed by the specific solution for the particular example. You should study each example carefully. The problems included in the text as examples represent the fundamental types of problems you will find on the AP exam. Remember, practice makes perfect!
- The chapters of this review book that cover subject matter that is heavily tested on the AP exam, such as Chapter 16 on equilibrium, are more extensive.
- At the end of each chapter there are *multiple choice and comprehension questions with detailed answers* to give you more practice.
- The multiple choice questions at the end of each chapter are designed to be done without a calculator because calculators are not allowed on the Multiple Choice section of the AP exam.
- *Vocabulary words* are bolded and definitions are italicized to enable you to find key concepts and definitions quickly.
- *Two full-scale sample AP exams* with multiple choice questions, free response questions and detailed answers are included at the end of the book. The more problems you practice, the better you will perform on the exam. *Learn from your mistakes as you practice, and you will be less likely to make those mistakes on the actual exam.*

HOW TO USE THIS BOOK

How you use this book depends, in part, on how familiar you are with the chemistry topic being reviewed. As you go through this book, you may take different approaches for different chapters. It is best to start reviewing for the exam earlier rather than later. The

night before the exam is definitely too late; a good night's sleep will do you far more good at that point.

For subject areas with which you feel very comfortable, you might choose to skim the key concepts. The important terms are bolded to help you do this. However, we recommend that you go over the sample problems to make sure that you can *apply* your knowledge. For content areas with which you are less confident, read the summary very carefully and work out all the sample problems. Then do all the multiple choice and comprehension questions at the end of the chapter. You may have to refer back to the textbook for a more comprehensive explanation. This book is meant to help you *review* material to which you have already been exposed, *not* to serve as a stand-alone text.

ABOUT THE AP CHEMISTRY TEST SUBJECT CONTENT

The College Board has defined the AP chemistry course content. You can access their website at www.collegeboard.com/apstudents to get more details.

This review book parallels the 25 chapters in *Chemistry* by Raymond Chang. However, the vast majority of the subject matter tested on the AP exam is presented in 18 chapters of the Chang textbook. These 18 chapters are listed in normal type in the list below. The titles of the chapters that cover material that is tested very little on the AP exam appear in italics.

As you review for the exam, you should focus mainly on the 18 chapters that contain the material that is most heavily tested on the exam. The chapters of this review book vary considerably in length; chapters that cover frequently tested or complex content are longer.

| | |
|-------------------|--|
| Chapter 1 | Chemistry: The Study of Change |
| Chapter 2 | Atoms, Molecules, and Ions |
| Chapter 3 | Mass Relationships in Chemical Reactions |
| Chapter 4 | Reactions in Aqueous Solutions |
| Chapter 5 | Gases |
| Chapter 6 | Thermochemistry |
| Chapter 7 | Quantum Theory and the Electronic Structure of Atoms |
| Chapter 8 | Periodic Relationships Among the Elements |
| Chapter 9 | Chemical Bonding I: Basic Concepts |
| Chapter 10 | Chemical Bonding II: Molecular Geometry and Hybridization of Atomic Orbitals |
| Chapter 11 | Intermolecular Forces and Liquids and Solids |
| Chapter 12 | Physical Properties of Solutions |
| Chapter 13 | Chemical Kinetics |
| Chapter 14 | Chemical Equilibrium |
| Chapter 15 | Acids and Bases |
| Chapter 16 | Acid-Base Equilibria and Solubility Equilibria |
| <i>Chapter 17</i> | <i>Chemistry in the Atmosphere</i> |

| | |
|------------|--|
| Chapter 18 | Entropy, Free Energy, and Equilibrium |
| Chapter 19 | Electrochemistry |
| Chapter 20 | <i>Metallurgy and the Chemistry of Metals</i> |
| Chapter 21 | <i>Nonmetallic Elements and Their Compounds</i> |
| Chapter 22 | <i>Transition Metal Chemistry and Coordination Compounds</i> |
| Chapter 23 | <i>Nuclear Chemistry</i> |
| Chapter 24 | <i>Organic Chemistry</i> |
| Chapter 25 | <i>Synthetic and Natural Organic Polymers</i> |

Table 1 gives you an idea of the relative importance of each content area in the Multiple Choice section of the AP exam. Note that content distribution is different from that in the Free Response section. For example, equilibrium concepts are tested more extensively in the Free Response section than in the Multiple Choice section.

Table 1. Average distribution frequency of content areas in multiple choice section

| Percent of questions | Topic | Chapter(s) in the Chang textbook relating to the topic area |
|----------------------|--|--|
| 1% to 3% | <ul style="list-style-type: none"> • General vocabulary • Precipitation • Nuclear • Organic and complex ions | 1 and throughout textbook 4 23 24 (In this review book, organic naming rules are presented as part of Chapter 2.) |
| 4% to 7% | <ul style="list-style-type: none"> • Gas laws and kinetic molecular theory • Atomic theory • Rates and equilibrium • Oxidation, reduction, and electrochemistry • Thermodynamics • Descriptive chemistry • Laboratory | 5 2 13, 14 4, 19 6, 18 4 and throughout the book Throughout the book |
| 8% to 10% | <ul style="list-style-type: none"> • Mole relationships and stoichiometry problems | 3 and throughout the book |
| 10% to 12% | <ul style="list-style-type: none"> • Acids, bases, and buffers | 15, 16 |
| Over 12% | <ul style="list-style-type: none"> • Bonding, intermolecular forces, and periodic properties • Solutions and phase diagrams | 7, 8, 9, 10 11, 12 |

ABOUT THE AP CHEMISTRY EXAM FORMAT

The AP Chemistry exam is given in two time blocks: Multiple Choice and Free Response. You are given a 10-minute break between the two sections of the exam. The exam description given here is based on the *May 2007 exam*.

Section I. Multiple Choice

The Multiple Choice section is composed of *75 multiple choice questions* to be completed in *90 minutes*. You may *not* use a calculator. The only reference provided to you is a periodic table that contains the element symbols, atomic numbers, atomic masses, and nothing more.

Section II. Free Response

The Free Response section is divided into **Part A** and **Part B** to be completed in *95 minutes*. You may use a calculator for Part A only. There are *four pages of reference material* provided to you: the same periodic table that you had for the Multiple Choice section, plus a list of formulas and the Standard Reduction Potentials Table. *You should be familiar with these pages before you enter the exam* so that if you need to look up something, you'll know exactly where to look. You have only a limited time to complete the exam, so you need to be very efficient about how you use your time.

Part A is generally quantitative. *For Part A, you may use a calculator.* You have 55 minutes to do three problems.

- Question 1 is always an equilibrium problem.
- Question 2 can be in any content area.
- Question 3 can be in any content area.

Note: All quantitative answers must be supported with detailed work in order to receive credit. Be sure you use the proper number of significant figures in your answer. Be sure that your units are in agreement with each other throughout the problem.

Part B is qualitative and *you may not use a calculator.* You have 40 minutes to answer three questions.

- Question 4 asks you to write three balanced net ionic equations. You must write the reactants and predict the products. Equations must be balanced. You will also be asked to answer one question based on each of the three reactions.
- Question 5 can be in any content area.
- Question 6 can be in any content area.

Note: If neither Question 2 nor Question 3 is based on laboratory data and techniques, then Question 5 or 6 will address this topic.

Table 2. Exam format May 2007

| Summary of Exam Format | | |
|-------------------------------|---|-----------------------------------|
| Section I: | Multiple Choice 75 questions Time: 90 minutes | No calculator use allowed. |
| ----- 10-minute break ----- | | |
| Section II: | Free Response | |
| | Part A. Quantitative Questions 1, 2, and 3 Time: 55 minutes. Question 1. Equilibrium problem Question 2. Any topic Question 3. Any topic | Calculator allowed. |
| | Part B. Qualitative Questions 4, 5, and 6 Time: 40 minutes. Question 4. Equations (three reactions) Question 5. Any topic Question 6. Any topic | No calculator use allowed. |

If you are studying old AP exams, you will notice that prior to 2007 the exam format was slightly different. In the old exams, you were given some choice of which problem to solve (Question 2 or 3, Question 7 or 8). You were also given a choice when doing the equations in Question 4 and you were not required to balance the equations. These rules have changed for 2007. Nonetheless, we still strongly recommend that you use old AP exams as part of your review process. They are available on the Web at www.collegeboard.com/apstudents. When you take an old exam, do *all parts of every* problem. If you do this, you will be mimicking the new exam format. If you do every part of the Free Response section of an old exam, you will need to allow yourself more than 95 minutes. We believe 140 minutes would be a realistic amount of time.

ABOUT THE AP GRADING

Multiple Choice Questions. Because a quarter of a point is subtracted from your raw score for each incorrect answer, you should not guess unless you can eliminate some of the choices in the answers. If you have no idea how to answer a question and can eliminate none of the choices, *do not guess the answer* to the question. However, if you can eliminate one or two choices, then guessing from among the remaining answers does make statistical sense.

Free Response Questions. You will be given credit for the parts of the problem done correctly. When answering the quantitative questions, be sure to document your work. Final answers with no work shown are usually assigned *zero* credit.

For example, if 110 g of iron are given in a problem and you convert to moles as part of your solution process, you must show what numbers you used. For example,

$$110. \text{ g Fe} \times \frac{1 \text{ mol Fe}}{55.0 \text{ g Fe}} = 2 \text{ mol Fe}$$

You could condense the above to $\frac{110. \text{ g}}{55.0 \text{ g/mol}} = 2 \text{ mol Fe}$

You may NOT just say 2 mol Fe, with no work shown. You must indicate the division process in some way and give the atomic mass of iron.

Be sure to use the correct number of significant figures (addressed in Chapter 1 of this review book). If you are off by more than one significant figure, a point will be deducted from your score.

When answering an essay question, organize your thoughts *before* you begin writing. When you are no longer sure of what you are saying, stop writing! You can begin answering a question correctly; if you continue writing when you are no longer sure of what you are saying, errors tend to creep into your explanation and then you begin to lose points.

Table 3. Overall grade distribution on the AP chemistry exam

| Grade distribution | |
|--------------------|---|
| Multiple Choice: | 50% of entire exam grade |
| Free Response: | 50% of entire exam grade, broken down as follows: |
| | Question 1 20% |
| | Question 2 20% |
| | Question 3 20% |
| | Question 4 10% |
| | Question 5 15% |
| | Question 6 15% |

HOW TO PREPARE FOR THE AP EXAM

Start reviewing for the exam early! You basically have 18 chapters to review. The AP exams are normally given in the first two weeks of May. *Make a timetable for yourself* and pace out the chapters you need to review. Some chapters will take more time than others. For example, Chapters 14 to 16 deal with equilibrium. This is the most important topic on the AP exam and many students find it challenging. You may want to spend extra time on these chapters. Chapters 1, 2, and 3 are very much a review of first-year high school chemistry and you may be able to zip through them pretty quickly.

You will need to devise a plan to suit your own needs as you begin the review process. *Good planning is important when facing so much content to review.* You should focus on the areas that you find difficult and that also have high representation on the AP exam. Table 4 is one example for a study plan.

Table 4. Sample review calendar

| Date | Main chapter(s) to be reviewed |
|---------------------|--|
| March—week 1 | 1, 2, 3 |
| March—week 2 | 4, 5 |
| March—week 3 | 6, 7, 8 |
| March—week 4 | 9, 10, 11 |
| April—week 1 | 12, 13 |
| April—week 2 | 14, 15 |
| April—week 3 | 16 |
| April—week 4 | 18, 19, and parts of chapter 23 |

TIPS FOR TAKING THE EXAM

Before the exam

- Be familiar with the format of the test.
- Be familiar with the four pages of reference materials (periodic table, Standard Reduction Potentials Table, and list of formulas) that are given to you as part of the Free Response section of the exam.
- Take as many practice AP tests as you have time for.
- Get enough sleep the night before (at least 8 hours).
- Wear comfortable clothing to the exam. Dress in layers so you can adjust to the temperature of the room.
- Bring a snack and water for break time.
- Bring a calculator, pencils, and an eraser to the exam. Do not bring extra stuff like bookbags and jackets.

During the exam

Multiple Choice Questions

- Read the questions carefully.
- There are 75 questions to be completed in 90 minutes, which means you have approximately 75 seconds per question. Do NOT spend too much time on any one question. You can go back to the time-consuming questions after you have gone through the exam once.
- If you can eliminate one or two of the five choices from the answers, making an educated guess from among the remaining choices makes sense. If you have no idea, skip the question. For every wrong answer, a quarter of a point is subtracted from your raw score.

Free Response Questions

- Read the questions carefully. Be sure to answer the *entire* question.
- Stop writing when you begin to be unsure about your facts.
- Watch significant figures.
- In the quantitative questions (Questions 1, 2, and 3), do all the quantitative parts first. After 55 minutes you are required to put your calculators away. You can go back to these questions later in the exam and finish off any unanswered parts such as the qualitative parts of the question. However, you *cannot* use your calculator when you go back.
- When answering Question 4, you can use the Standard Reduction Potentials Table given at the beginning of the exam to obtain an oxidation number of an element if necessary.

COMMON MISTAKES TO AVOID

Multiple Choice Questions

- Time yourself. You have 75 seconds per multiple choice question. If a question is taking an inordinate amount of time, go on with the rest of the exam and then go back if you have time. The difference of a single question is unlikely to affect your score. After 90 minutes, the multiple choice part of the exam is over and you cannot go back to it.
- Read the questions carefully and answer the question asked!
- Do not mix up *increasing trend* (highest value is last in the series) with *decreasing trend* (highest value is first in the series).

Free Response Questions

- Time yourself. You have 55 minutes for the three quantitative problems in Part A. That works out to about 18 minutes per question. After 55 minutes you must put your calculator away. You have 40 minutes to do the three qualitative essays in Part B. That works out to about 13 minutes per question. You can go back to Part A questions during this time but won't have your calculator available.
- Read each question carefully and *answer the question asked*. For example, if the question asks:
 1. *Agree or disagree with a statement. Justify your answer.* In your answer you need to say *I agree or I disagree* and then explain your answer. If you only explain your answer (even if you do so correctly), and never answer the “agree vs. disagree” part of the question, points will be deducted from your answer.
 2. *Increases, decreases, or stays the same. Justify your answer.* In your answer, first state your choice: increases, decreases, or stays the same. Then you must explain your choice. This type of question often occurs with periodic trends and laboratory topics.
- *Read each question carefully. Answer the question asked completely.* Think a minute to compose your answer before beginning to write. For example, if you are asked to distinguish between solid CaCO_3 and solid NaCl , your answer should address *both* chemicals. A complete answer would include what happens with both solids when, for example, $\text{HCl} (aq)$ is added to each. With CaCO_3 , CO_2 gas is produced, but with NaCl no gas is produced. An incomplete answer that addresses only the positive result with CaCO_3 and omits any mention of what happens with NaCl is an incomplete answer. Credit will be deducted.
- Stop writing when you become unsure of what you are saying. When you answer an essay question, put down what you know for sure. Then stop writing. If you keep going, errors tend to enter your answer and you usually begin to lose credit.
- If you are unsure of the charge of an ion, you can use the Standard Reduction Potentials Table as a reference.
- In Part A, make sure that all of your quantitative work is shown.

- Be sure that each of your quantitative answers has the correct number of significant figures.
- Be careful about which R value you use. The value 8.31 J/mol • K is used in most thermodynamics work. But 0.0821 L • atm/mol • K is used with the ideal gas law.
- Be sure that all of your quantitative answers have units.
- Be sure that your units are in agreement when you are doing quantitative work. For example, when using the equation: $\Delta G = \Delta H - T\Delta S$, note that ΔG and ΔH are usually given in kJ/mole and ΔS is given in J/mole. Remember, to convert kJ to J, multiply by 1000.
- Remember to use the Kelvin scale with the gas laws and thermodynamics work.
- Be careful about the vocabulary you choose to use when answering essay questions. For example, do not confuse:

Volume with mass (point mass). Intermolecular forces usually are involved with volume or surface area issues, not mass.

Intramolecular forces (bonds) with intermolecular attractions. When talking about boiling point and melting point, the issue to focus on usually is intermolecular attractions.

Lab measurements with calculations. When asked what measurements need to be made, the initial temperature and final temperature are measurements. ΔT is a calculation, not a measurement. If you give a calculated value when asked for a measurement, you receive zero credit.

