

Applied Practice in

Elements and Periodicity

AP* Chemistry Series **RESOURCE GUIDE**

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APPLIED PRACTICE
Resource Guide
Elements and Periodicity

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A NOTE FOR TEACHERS

The *Applied Practice in AP Chemistry* series was designed for use by teachers as an instructional supplement to major units in the AP Chemistry curriculum. This series was also conceived as a resource for teachers in preparing students for the AP Chemistry Exam. As you teach each unit, your students will have the opportunity to practice and to develop those skills required on the exams.

Each book in the series includes:

- Teaching notes and strategies
- Glossary of terms
- 75 multiple-choice questions replicating Section I of the AP Chemistry Exam
- Multiple-choice answer keys and answer explanations
- 6 free-response questions replicating Section II of the AP Chemistry Exam
- Free-response answer keys and scoring guide

We offer a few suggestions and explanations to help you receive the maximum benefit from our materials:

1. Applied Practice booklets do not purport to duplicate exactly an Advanced Placement Examination. However, questions are modeled on those typically encountered on these exams. Thus, students using these materials will become familiar and comfortable with the format, question types, and terminology of Advanced Placement Examinations.
2. Each Applied Practice booklet focuses on one topic within the AP Chemistry curriculum. These booklets are excellent resources for teachers and their students. Their unique format includes questions designed for use during the initial teaching of the required topics. Other questions are exceptional for the review phase of the course, as students pull the entire year together leading up to the AP Chemistry Exam. The AP exam often will require knowledge in multiple content areas on the same question.
3. You have the option of using the Applied Practice booklets for your own lesson and test preparation or, if you so choose, students may work through an Applied Practice test booklet on their own as they progress through the course. The students can check their own answers with the answer key and read the answer explanations provided in the teacher edition, conferring with the teacher as needed.
4. The order of topics in the Applied Practice booklets has been organized to follow a logical progression that is similar to the sequence in many of the most widely selected AP chemistry textbooks. You will find that they can easily be adapted to whatever sequence you find most productive at your school.

5. The free-response questions in each topic were created to provide practice questions similar to both those given in part A of the AP Chemistry Exam, which allows use of a calculator, and those given in part B, in which no calculator is allowed. In a few cases, the specific content is best assessed with a combination of both types.
6. Due to the emphasis on laboratory experience in the College Board's AP Chemistry program, the Applied Practice booklets in AP Chemistry frequently include laboratory-based questions appropriate to the subtopic addressed. A required laboratory-based question does appear on the AP Chemistry Exam. While most Applied Practice booklets in the AP Chemistry series do contain laboratory-based free-response questions, some topics do not lend themselves to the College Board-recommended laboratory experiments. However, each Applied Practice booklet does contain multiple-choice questions related to both laboratory and descriptive chemistry. Only one of the six free-response questions included on the AP Chemistry Exam is laboratory based.
7. Each booklet includes a glossary of terms that applies to the vocabulary of that particular topic.
8. If the teacher wishes to replicate the conditions under which students will take the actual AP Chemistry Exam, he or she should understand the following about multiple-choice versus free-response questions when using Applied Practice booklets: When answering multiple-choice questions (AP Exam, Section I) students are not allowed the use of a calculator, and the only reference information available to them is a periodic table (with only symbol, mass number, atomic number) and a small table of abbreviations/symbols used in the questions. When answering free-response questions (AP Exam, Section II), much more information is available to the student. In addition to the periodic table, a table of standard reduction potentials in aqueous solutions and a relatively complete list of equations, constants, and abbreviations/symbols are provided.

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GLOSSARY OF TERMS

alkali metal—the elements in the first column on the periodic table, group 1 (although hydrogen is in this group, it is not considered an alkali metal which are particularly reactive metals)

alkaline earth metal—the elements in the second column on the periodic table, group 2

angular momentum quantum number—(*l*) the second of four quantum values which specify particular electrons within an atom's electron cloud. It specifies the set of orbitals of a given shape

aqueous solution—dissolved in water

atomic radius—the size of an atom, measuring from the center of an atom (nucleus) to the outer edge of the electron cloud. However, it is not a precise physical quantity as the cloud does not have a sharp edge. It is typically used in a relative manner to compare different atoms.

cation—a positive ion; an atom or molecule that has lost one or more electrons

chemical properties—a characteristic of a substance that is related to it changing into new substances with new properties

electron affinity—the energy change when an electron is added to a neutral atom in the gaseous state to form a negative ion

electronegativity—the relative ability of an atom in a molecule to attract shared electrons

electronic configuration—(electron configuration) the distribution of electrons into available sublevels (subshells); a shorthand notation showing how many electrons are found in each sublevel in an atom

electropositive—the property of a substance, typically a metal, in which it tends to lose electrons to become positively charged

emission spectrum—the unique set of electromagnetic radiation (photons) that are emitted from an atom that has been heated or exposed to a sufficient voltage; it is a characteristic of each element and can be used to identify elements

excited state—the existence of one or more electrons in an atom or molecule that have absorbed energy and moved to an elevated state

family—(group) the set of elements in a vertical column on the periodic table

Quantum Mechanics

The following answer choices can be used in questions 16-18. Each answer may be used once, more than once, or not at all.

- (A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
- (B) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$
- (C) $1s^2 2s^2 2p^6 3s^2 3p^6$
- (D) $1s^2 2s^2 2p^6 3s^2 3p^5$
- (E) $1s^2 2s^2 2p^6 3s^1$

16. The electronic configuration of an alkaline earth metal

17. The electronic configuration of an atom with two unpaired electrons

18. The electronic configuration of an atom of a halogen

19. Which of the following lists includes only species that are isoelectronic with one another?

- I. Ca^+ , Na^+ , Al^+
- II. Ca^{2+} , Ar , K^+
- III. S^{2-} , Cl^- , P^{3-}

- (A) I only
- (B) II only
- (C) III only
- (D) II and III only
- (E) I, II, and III

20. Which statement is true of electrons within atoms?

- I. They exist in specific, three dimensional areas of space called orbitals that are solutions to the Schrödinger equation.
- II. Each orbital can contain a maximum of $2n^2$ electrons (where n is the principal quantum number).
- III. If two electrons exist in the same orbital, they must have the same spin quantum number.

- (A) I only
- (B) II only
- (C) III only
- (D) I and II only
- (E) I and III only

21. Which of the following is a correct statement about the valence shell electrons in the potassium atom?

- I. They have a principal quantum number $n = 2$.
- II. They have an angular momentum quantum number $l = 0$.
- III. They have magnetic quantum number $m_l = 0$.

- (A) I only
- (B) II only
- (C) III only
- (D) II and III only
- (E) I, II, and III

22. The electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$ could be that of

- I. An “excited” group 1 element
- II. A transition metal element in its ground state
- III. A transition metal ion

- (A) I only
- (B) II only
- (C) III only
- (D) I and II only
- (E) I and III only

1. This question involves a discussion of some periodic properties of the elements.
 - (a) Consider the oxides of the elements of the second period of the periodic table.
 - (i) Write two equations (one to show acidic behavior, one to show basic behavior) that illustrate the acid/base nature of the oxides.
 - (ii) How does the acid/base nature of the oxides vary as a function of position in the second period?
 - (b)
 - (i) Write an equation whose heat of reaction would be the first electron affinity of bromine.
 - (ii) How does the magnitude of first electron affinity vary in group 1 of the periodic table?
 - (iii) When considering both the first AND second electron affinities of oxygen, what are the essential enthalpy (energy) differences between the two processes? Explain.
 - (c) Explain why the first ionization energy of oxygen is found to be less endothermic than predicted by the periodic trend.