

**About the Advanced Placement Program<sup>®</sup> (AP<sup>®</sup>)**

The Advanced Placement Program<sup>®</sup> has enabled millions of students to take college-level courses and earn college credit, advanced placement, or both, while still in high school. AP Exams are given each year in May. Students who earn a qualifying score on an AP Exam are typically eligible, in college, to receive credit, placement into advanced courses, or both. Every aspect of AP course and exam development is the result of collaboration between AP teachers and college faculty. They work together to develop AP courses and exams, set scoring standards, and score the exams. College faculty review every AP teacher's course syllabus.

**AP Chemistry Course Overview**

The AP Chemistry course provides students with a college-level foundation to support future advanced course work in chemistry. Students cultivate their understanding of chemistry through inquiry-based investigations, as they explore topics such as: atomic structure, intermolecular forces and bonding, chemical reactions, kinetics, thermodynamics, and equilibrium.

**LABORATORY REQUIREMENT**

This course requires that 25 percent of the instructional time engages students in lab investigations. This includes a minimum of 16 hands-on labs (at least six of which are inquiry based), and it is recommended that students keep a lab notebook throughout.

**RECOMMENDED PREREQUISITES**

Students should have successfully completed a general high school chemistry course and Algebra II.

**AP Chemistry Course Content**

The key concepts and related content that define the AP Chemistry course and exam are organized around underlying principles called the Big Ideas. They encompass core scientific principles, theories, and processes that cut across traditional boundaries and provide a broad way of thinking about the particulate nature of matter underlying the observations students make about the physical world. The following are Big Ideas:

- The chemical elements are the building blocks of matter, which can be understood in terms of the arrangements of atoms.
- Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
- Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
- Rates of chemical reactions are determined by details of the molecular collisions.
- The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
- Bonds or attractions that can be formed can be broken. These two processes are in constant competition, sensitive to initial conditions and external forces or changes.

**Science Practices**

Students establish lines of evidence and use them to develop and refine testable explanations and predictions of natural phenomena. Focusing on these disciplinary practices enables teachers to use the principles of scientific inquiry to promote a more engaging and rigorous experience for AP Chemistry students. Such practices require that students:

- Use representations and models to communicate scientific phenomena and solve scientific problems;
- Use mathematics appropriately;
- Engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course;
- Plan and implement data collection strategies in relation to a particular scientific question;
- Perform data analysis and evaluation of evidence;
- Work with scientific explanations and theories; and
- Connect and relate knowledge across various scales, concepts, and representations in and across domains.

**Inquiry-Based Investigations**

Twenty-five percent of instructional time is devoted to inquiry-based laboratory investigations. Students ask questions, make observations and predictions, design experiments, analyze data, and construct arguments in a collaborative setting, where they direct and monitor their progress.

## AP Chemistry Exam Structure

### AP CHEMISTRY EXAM: 3 HOURS 15 MINUTES

#### Assessment Overview

Exam questions are based on learning objectives, which combine science practices with specific content. Students learn to

- Solve problems mathematically — including symbolically;
- Design and describe experiments;
- Perform data and error analysis
- Explain, reason, or justify answers; and
- Interpret and develop conceptual models.

Students have a periodic table of the elements and a formula and constants chart to use on the entire exam. In addition, students may use a scientific or graphing calculator on the free-response section.

#### Format of Assessment

**Section I:** Multiple Choice: 60 Questions | 1 Hour, 30 Minutes | 50% of Exam Score

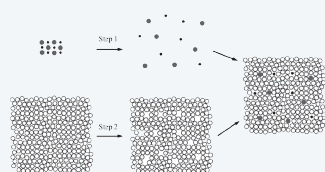
- Discrete items
- Items in sets
- A calculator is not permitted on Section I

**Section II:** Free Response: 7 Questions | 1 Hour, 45 Minutes | 50% of Exam Score

Three long- and four short-answer questions. The seven questions ensure the assessment of the following skills: experimental design, quantitative/qualitative translation, analysis of authentic lab data and observations to identify patterns or explain phenomena, creating or analyzing atomic and molecular views to explain observations, and following a logical/analytical pathway to solve a problem.

## AP CHEMISTRY SAMPLE EXAM QUESTIONS

### Sample Multiple-Choice Question

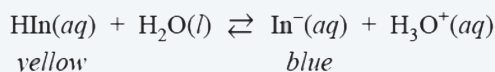


The dissolution of an ionic solute in a polar solvent can be imagined as occurring in three steps, as shown in the figure at left. In step 1, the separation between ions in the solute is greatly increased, just as will occur when the solute dissolves in the polar solvent. In step 2, the polar solvent is expanded to make spaces that the ions will occupy. In the last step, the ions are inserted into the spaces in the polar solvent. Which of the following best describes the enthalpy change,  $\Delta H$ , for each step?

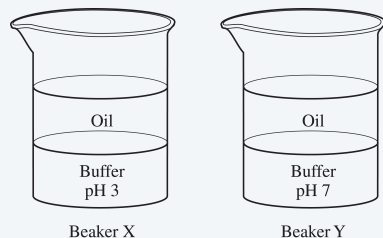
- (A) All three steps are exothermic.
- (B) All three steps are endothermic.
- (C) Steps 1 and 2 are exothermic, and the final step is endothermic.
- (D) Steps 1 and 2 are endothermic, and the final step is exothermic.

Correct Answer: D

### Sample Free-Response Question: Analyzing Lab Data and Observations



The indicator HIn is a weak acid with a  $\text{p}K_a$  value of 5.0. It reacts with water as represented in the equation above. Consider the two beakers below. Each beaker has a layer of colorless oil (a nonpolar solvent) on top of a layer of aqueous buffer solution. In beaker X, the pH of the buffer solution is 3, and in beaker Y, the pH of the buffer solution is 7. A small amount of HIn is placed in both beakers. The mixtures are stirred well, and the oil and water layers are allowed to separate.



- (A) What is the predominant form of HIn in the aqueous buffer in beaker Y, the acid form or the conjugate base form? Explain your reasoning.
- (B) In beaker X, the oil layer is yellow, whereas in beaker Y, the oil layer is colorless. Explain these observations in terms of both acid-base equilibria and interparticle forces.