Applied Practice
in

Gases

AP* Chemistry Series

RESOURCE GUIDE

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APPLIED PRACTICE
Resource Guide
Gases

Teacher Notes and Strategies

Student Practices

Answer Key and Explanations

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 though 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

Avogadro's law—a law stating that with equal conditions of temperature and pressure, equal volumes of gases contain an equal number of molecules

Boyle's law—a law stating that the pressure of an ideal gas at a given temperature varies inversely with its volume; the mathematical expression is PV = constant

Charles' law—a law stating that at constant pressure, the volume of an ideal gas is directly proportional to the absolute (Kelvin) temperature; the mathematical expression is V/T = constant

Daltons' law— a law stating that the sum of the partial pressures of all the gases in a mixture of gases equals the total pressure; the mathematical expression is $P_{total} = P_1 + P_2 + P_3 + ...$

Dumas method—a method for determining of the molar mass of a volatile liquid. The liquid is added to a small flask, the flask is heated and as the sample evaporates, the air is swept out of the container. Then flask is cooled again, and the mass of liquid which condenses is equal to the mass of vapor that filled the flask

effusion—flow of gas through small opening

Erlenmeyer flask— a cone-shaped laboratory piece of glassware with a narrower neck and broader flat bottom; a common piece of laboratory equipment

elastic collisions—collisions between particles on the molecular level where kinetic energy is conserved (no loss in energy due to friction)

Gay-Lussac's law—a law stating that with fixed volume the pressure of an ideal gas is directly proportional to the temperature of the gas; the mathematical expression is P/T = constant

hydrocarbon—compounds composed of carbon and hydrogen

ideal behavior—gases following the ideal gas law, PV=nRT, without needing modification; gases behaving as if they are ideal

ideal gas—the theoretical concept of a hypothetical gas which follows the ideal gas law at all temperatures and pressures; a gas whose particles individually do not take up space and have not mutual attraction

intermolecular forces (IMFs)—forces of attraction and repulsion between molecules

Kelvin temperature—an absolute temperature scale that starts at absolute zero (lowest temperature possible, with no thermal energy)

Basic Gas Laws

The following answer choices can be used in questions 1-3. Each answer may be used once, more than once, or not at all.

(A) Avogadro's law
(B) Boyle's law
(C) Charles' law
(D) Daltons' law
(E) Gay-Lussac's law

1. The gas law that predicts that at constant temperature, the pressure and the volume of a gas are inversely proportional

2. The gas law that predicts that at constant pressure and temperature, the volume and the number of moles of a gas are directly proportional

3. The gas law that predicts that at constant pressure, the volume and the temperature of a gas are directly proportional

4. Assuming that all other conditions are kept constant, which of the following combinations of changes will definitely decrease the pressure of a gas?

   I. Cooling and adding more gas
   II. Increasing the number of moles of gas present and increasing the temperature
   III. Decreasing the temperature and increasing the volume

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

5. A gas is subject to a change in temperature where its volume is reduced to 25% of its original value, and its pressure is increased to 150% of its original value. Which of the following statements is true?

I. The temperature will decrease.
II. The temperature will remain the same.
III. The temperature will be 37.5% of its original value.

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

6. Tripling the Kelvin temperature of a gas in a rigid container and keeping the number of moles of gas the same also causes

I. The density of the gas to triple
II. The pressure of the gas to triple
III. The volume of the gas to triple

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

7. Which of the following properties of a gas are directly proportional to one another?

I. Pressure and volume under conditions of constant temperature
II. Volume and temperature under conditions of constant pressure
III. Pressure and temperature under conditions of constant volume

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

2. In an experiment designed to determine the molar mass of a volatile liquid by the Dumas method, a 15.0 mL sample of the liquid was gently heated using a water bath in order to fill a vessel completely with vapor (the excess vapor was allowed to escape from the vessel). The following data were collected that relate to a 141 mL sample of the vapor.

Mass	0.611 g
Temperature	98.3^{o}C
Pressure	755 mmHg

(a) Assuming ideal behavior, calculate the molar mass of the volatile liquid.

(b) Comment on the effect of each of the following on the calculated molar mass in part (a) when compared to the ACTUAL molar mass. Explain carefully.

(i) The thermometer was incorrectly read as 98.3^{o}C when it actually read 89.3^{o}C.

(ii) At the end of the experiment, some vapor escaped before it was condensed and massed.

(iii) The experiment was repeated, this time using a larger vessel, but still starting with an amount of liquid that was sufficient to fill the container.