CLEP®

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# Chemistry

2012

## Examination Guide



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for the most up-to-date information.

# Introduction

This is the only *official* guide to the 33 College-Level Examination Program® (CLEP®) exams. CLEP exams are administered on computer test centers across the country.

This *Guide* has been written mainly for adults who are making plans to enroll in college, but it contains information of interest to others as well. College-bound high school students, current college students, military personnel, professionals seeking certification and persons of all ages who have learned or wish to learn college-level material outside the college classroom will find the *Guide* helpful as they strive to accomplish their goals.

CLEP is based on the premise that some individuals enrolling in college have already learned part of what is taught in college courses through job training, independent reading and study, noncredit adult courses and advanced high school courses. Often, their jobs and life experiences have enhanced and reinforced their learning. CLEP provides these individuals with the opportunity to demonstrate their mastery of college-level material by taking exams that assess the knowledge and skills taught in college courses.

The first few sections of this study guide explain how CLEP can help you earn credit for the college-level learning you have acquired and provide suggestions for preparing for the exams. The guides to the individual exams include test descriptions, sample questions and tips for preparing to take the exams.

CLEP has also made available an online preparation tool that uses the real computer-based testing (CBT) software to help you prepare to test on this platform. The *CLEP Sampler* contains tutorials to familiarize you with the basic computer skills needed to take the CBT exams. However, if you are already comfortable using a computer, you can bypass those tutorials and go straight to the sections illustrating how to use the testing tools and how to answer the types of questions developed especially for the computer version of each exam. The *Sampler* also shows you what to expect on the day of the test and gives useful test-taking tips and strategies. You can find the *Sampler* at www.collegeboard.org/clepprep.

Use the *Sampler* to get comfortable with the computer-based format of the tests. Then, use this *Guide* to become familiar with the description and content of each exam you're interested in taking. This *Guide* contains sample questions and an answer key for each exam, as well as in-depth information about how to decide which exams to take, how to prepare to take those exams, and how to interpret your scores.

# Preparing to Take CLEP Examinations

Having made the decision to take one or more CLEP exams, most people then want to know how to prepare for them — how much, how long, when, and how should they go about it? The precise answers to these questions vary greatly from individual to individual. However, most candidates find that some type of test preparation is helpful.

Most people who take CLEP exams do so to show that they have already learned the key material taught in a college course. Many of them need only a quick review to assure themselves that they have not forgotten what they once studied, and to fill in some of the gaps in their knowledge of the subject. Others feel that they need a thorough review and spend several weeks studying for an exam. Some people take a CLEP exam as a kind of "final exam" for independent study of a subject. This last group requires significantly more study than do those who only need to review, and they may need some guidance from professors of the subjects they are studying.

The key to how you prepare for CLEP exams often lies in locating those skills and areas of prior learning in which you are strongest and deciding where to focus your energies. Some people may know a great deal about a certain subject area but may not test well. These individuals would probably be just as concerned about strengthening their test-taking skills as they would about studying for a specific test. Many mental and physical skills are required in preparing for a test. It is important not only to review or study for the exams but also to make certain that you are alert, relatively free of anxiety, and aware of how to approach standardized tests. Suggestions about developing test-taking skills and preparing psychologically and physically for a test are given in this chapter. The following section suggests ways of assessing your knowledge of the content of an exam and then reviewing and studying the material.

## Using the Examination Guides

Each exam guide includes an outline of the knowledge and skills covered by the test, sample questions similar to those that appear on the exam, and tips for preparing to take the exam.

You may also choose to contact a college in your area that offers a course with content comparable to that on the CLEP exam you want to take, or read the suggested resources for each exam on www.collegeboard.org/clepprep. If possible, use the textbook and other materials required for that course to help you prepare. To get this information, check the college's catalog for a list of courses offered. Then call the admissions office, explain what subject you're interested in, and ask who in that academic department you can contact for specific information on textbooks and other study resources to use. You might also be able to find the course syllabus, which will list course materials and assignments, online at the college's website. Be sure that the college you're interested in gives credit for the CLEP exam for which you're preparing.

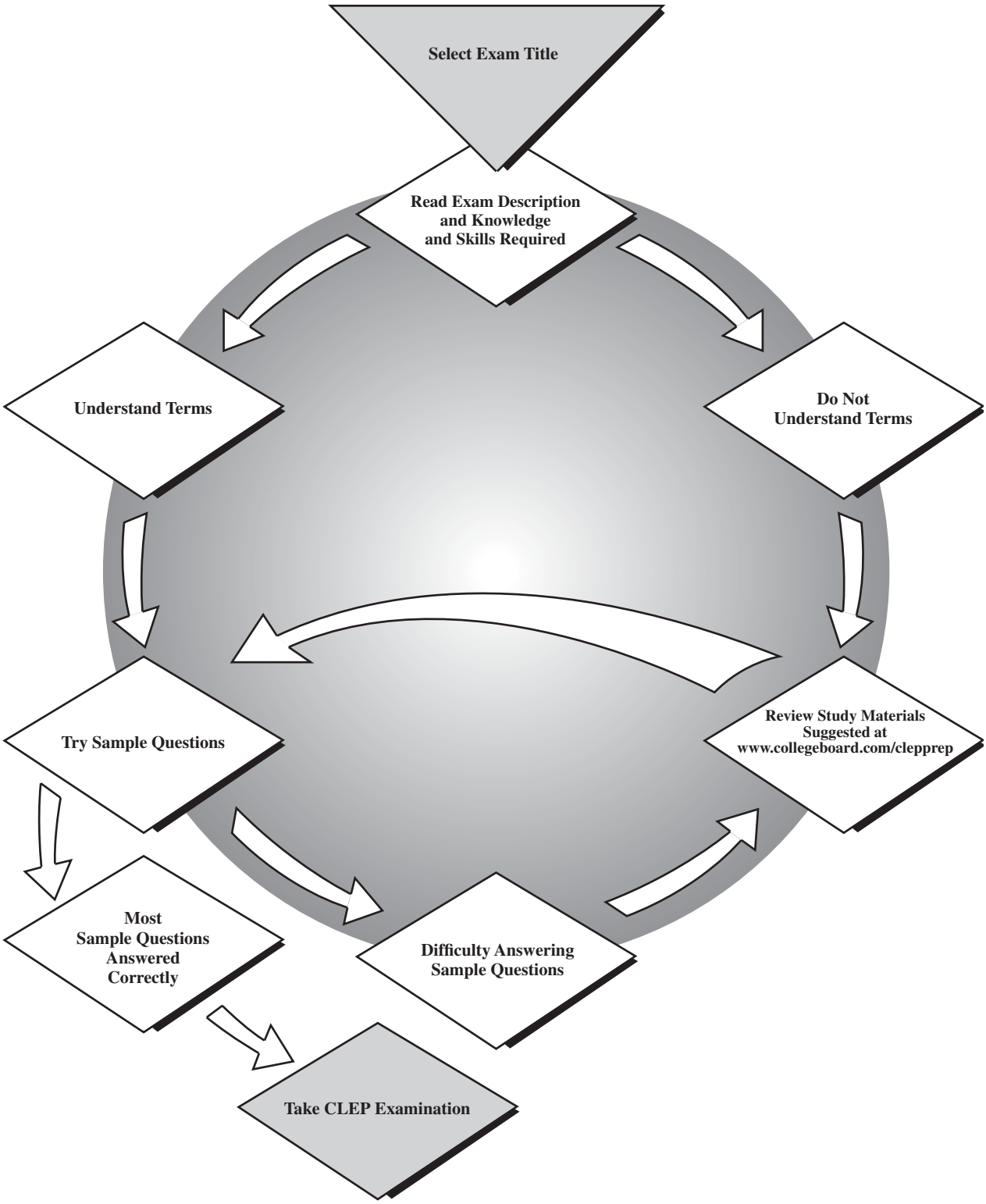
Begin by carefully reading the test description and outline of knowledge and skills required for the exam in the exam guide. As you read through the topics listed, ask yourself how much you know about each one.

Also note the terms, names and symbols that are mentioned, and ask yourself whether you are familiar with them. This will give you a quick overview of how much you know about the subject. If you are familiar with nearly all the material, you will probably need a minimum of review; however, if topics and terms are unfamiliar, you will probably require substantial study to do well on the exam.

If, after reviewing the test description provided in the exam guide, you find that you need extensive review, put off answering the sample questions until you have done some reading in the subject. If you complete them before reviewing the material, you will probably look for the answers as you study, and this will not be a good assessment of your ability at a later date. Do not refer to the sample questions as you prepare for the exam. The sample questions are representative of the types of questions you will find on a CLEP exam, but none of the questions will actually appear on an exam, so concentrating on them without broader study of the subject won't help you.

If you think you are familiar with most of the test material, try to answer the sample questions, checking your responses against the answer key. Use the test-taking strategies described in the next chapter.

# Assessing Your Readiness for a CLEP Examination



## Suggestions for Studying

The following suggestions have been gathered from people who have prepared for CLEP exams or other college-level tests.

**1.** *Use CLEP tutorials.*

Make sure you are familiar with the computer-based format of the CLEP exams. Use the *CLEP Sampler*, which can be downloaded from the CLEP website, to familiarize yourself with CLEP testing software before taking the test. If you are not comfortable using a computer, you can practice the necessary pointing, clicking and scrolling skills by working with the *Sampler.* You'll also be able to practice using the testing tools that will help you navigate throughout the test, and you'll see the types of questions you'll be required to answer.

If you don't have access to a computer, check with the library or test center at the school where you'll be testing. Many CLEP test centers and college libraries will have the *Sampler* installed on computers in public areas, so you'll be able to practice and review before your test date. The tutorials are also part of the testing software, and you'll be able to work through them before you begin your test. Check with the test center to see how much time will be allotted for your testing appointment; then you can determine how much time you might need to spend on the tutorials.

> **Remember, if you want to review *content* covered by each examination, Chapter VII of this *Study Guide* contains a complete exam description — including a content outline, a description of the knowledge and skills required to do well, and sample questions — for each subject. An answer key for each subject is also included. However, the *Study Guide* is not intended to replace a textbook. Additional study may be required.**

**2.** *Define your goals and locate study materials.*

Once you've determined how much preparation you'll need to do, you'll need to define your study goals. Set aside a block of time to review the exam guides provided in this book, and then decide which exam(s) you will take. Using the guidelines for knowledge and skills required, locate suitable resource materials. If a preparation course is offered by an adult school or college in your area, you might find it helpful to enroll. (You should be aware, however, that such courses are not authorized or sponsored by the College Board. The College Board has no responsibility for the content of these courses, nor are they responsible for books on preparing for CLEP exams that have been published by other organizations.) If you know others who have taken CLEP exams, ask them how they prepared.

You may want to get a copy of a syllabus for the college course that is comparable to the CLEP exam(s) you plan to take. You can also ask the appropriate professor at the school you'll be attending, or check his or her website, for a reading list. Use the syllabus, course materials and/or reading list as a guide for selecting textbooks and study materials. You may purchase these or check them out of your local library. Some websites offer course materials and lectures online; these can be an excellent resource. Examples of these include:

- MIT OpenCourseWare (http://ocw.mit.edu),
- Carnegie Mellon's Open Learning Initiative (http://www.cmu.edu/oli/),
- and the National Repository of Online Courses (http://www.montereyinstitute.edu/nroc).

Most of this material is offered for free. Educational websites, like those offered by PBS

(www.pbs.org) or the National Geographic Society (www.nationalgeographic.com), can be helpful as well. You can also find a list of suggested textbooks and online resources for each CLEP exam at www.collegeboard.org/clepprep.

Check with your librarian about locating study aids relevant to the exams you plan to take. These supplementary materials may include videos or DVDs made by education-oriented companies and organizations, language tapes and computer software. And don't forget that what you do with your leisure time can be very educational, whether it's surfing current-events websites, watching a PBS series, reading a financial newsletter, or attending a play.

**3.** *Find a good place to study.*

To determine what kind of place you need for studying, ask yourself the following questions: Do I need a quiet place? Does the telephone distract me? Do objects I see in this place remind me of things I should do? Is it too warm? Is it well lit? Am I too comfortable here? Do I have space to spread out my materials? You may find the library more conducive to studying than your home. If you decide to study at home or in your dorm, you might prevent interruptions by other household members by putting a sign on the door of your study room to indicate when you will be available.

**4.** *Schedule time to study.*

To help you determine where studying best fits into your schedule, try this exercise: Make a list of your daily activities (for example, sleeping, working, eating, attending class, sports or exercise) and estimate how many hours a day you spend on each activity. Now, rate all the activities on your list in order of their importance and evaluate your use of time. Often people are astonished at how an average day appears from this perspective. You may discover that your time can be scheduled in alternative ways. For example, you could remove the least important activities from your day and devote that time to studying or to another important activity.

**5.** *Establish a study routine and a set of goals.*

To study effectively, you should establish specific goals and a schedule for accomplishing them. Some people find it helpful to write out a weekly schedule and cross out each study period when it is completed. Others maintain their concentration better by writing down the time when they expect to complete a study task. Most people find short periods of intense study more productive than long stretches of time. For example, they may follow a regular schedule of several 20- or 30-minute study periods with short breaks between them. Some people like to allow themselves rewards as they complete each study goal. It is not essential that you accomplish every goal exactly within your schedule; the point is to be committed to your task.

**6.** *Learn how to take an active role in studying.*

If you have not done much studying for some time, you may find it difficult to concentrate at first. Try a method of studying, such as the one outlined below and on the next page, that will help you concentrate on and remember what you read.

**a.** First, read the chapter summary and the introduction so you will know what to look for in your reading.

**b.** Next, convert the section or paragraph headlines into questions. For example, if you are reading a section entitled "The Causes of the American Revolution," ask yourself, "What were the causes of the American Revolution?" Compose the answer as you read the paragraph. Reading and answering questions aloud will help you understand and remember the material.

**c.** Take notes on key ideas or concepts as you read. Writing will also help you fix concepts more firmly in your mind. Underlining key ideas or writing notes in your book can be helpful and will be useful for review. Underline only important points. If you underline more than a third of each paragraph, you are probably underlining too much.

**d.** If there are questions or problems at the end of a chapter, answer or solve them on paper as if you were asked to do them for homework. Mathematics textbooks (and some other books) sometimes include answers to some or all of the exercises. If you have such a book, write your answers before looking at the ones given. When problem solving is involved, work enough problems to master the required methods and concepts. If you have difficulty with problems, review any sample problems or explanations in the chapter.

**e.** To retain knowledge, most people have to review the material periodically. If you are preparing for an exam over an extended period of time, review key concepts and notes each week or so. Do not wait for weeks to review the material or you will need to relearn much of it.

## Psychological and Physical Preparation

Most people feel at least some nervousness before taking a test. Adults who are returning to college may not have taken tests in many years, or they may have had little experience with standardized tests. Some younger students, as well, are uncomfortable with testing situations. People who received their education in countries outside the United States may find that many tests given in this country are quite different from the ones they are accustomed to taking.

Not only might candidates find the types of tests and questions unfamiliar, but other aspects of the testing environment may be strange as well. The physical and mental stress that results from meeting this new experience can hinder a candidate's ability to demonstrate his or her true degree of knowledge in the subject area being tested. For this reason, it is important to go to the test center well prepared, both mentally and physically, for taking the test. You may find the following suggestions helpful.

**1.** Familiarize yourself as much as possible with the test and the test situation before the day of the exam. It will be helpful for you to know ahead of time:

**a.** how much time will be allowed for the test and whether there are timed subsections. (This information is included in the examination guides and in the *CLEP Sampler*.)

**b.** what types of questions and directions appear on the exam. (See the examination guides.)

**c.** how your test score will be computed.

**d.** in which building and room the exam will be administered. If you don't know where the building is, get directions ahead of time.

**e.** the time of the test administration. You may wish to confirm this information a day or two before the

exam and find out what time the building and room will be open so that you can plan to arrive early.

**f.** where to park your car and whether you will need a parking permit or, if you will be taking public transportation, which bus or train to take and the location of the nearest stop.

**g.** whether there will be a break between exams (if you will be taking more than one on the same day), and whether there is a place nearby where you can get something to eat or drink.

**2.** Be relaxed and alert while you are taking the exam.

**a.** Get a good night's sleep. Last-minute cramming, particularly late the night before, is usually counterproductive.

**b.** Eat normally. It is usually not wise to skip breakfast or lunch on the day you take the exam or to eat a big meal just before testing.

**c.** Avoid tranquilizers and stimulants. If you follow the other directions in this book, you won't need artificial aids. It's better to be a little tense than to be drowsy, but stimulants such as coffee and cola can make you nervous and interfere with your concentration.

**d.** Don't drink a lot of liquids before taking the exam. Leaving to use the restroom during testing will disturb your concentration and reduce the time you have to complete the exam.

**e.** If you are inclined to be nervous or tense, learn some relaxation exercises and use them to prepare for the exam.

**3.** On the day of the exam, remember to do the following.

**a.** Arrive early enough so that you can find a parking place, locate the test center, and get settled comfortably before testing begins. Allow some extra time in case you are delayed unexpectedly.

**b.** Take the following with you:

- any registration forms or printouts required by the test center. Make sure you have filled out all necessary paperwork in advance of your testing date.
- your driver's license, passport or other government-issued identification that includes your photograph and signature, as well as a secondary form of ID that includes a photo and/or your signature, such as a student ID, military ID, Social Security card or credit card. You will be asked to show this identification to be admitted to the testing area.
- a valid credit card to pay the $77 examination fee. (This fee is subject to change.) Although a credit card is the preferred method of payment, you can also pay by check or money order (payable to the College-Level Examination Program). Your test center may require an additional administration fee. Contact the test center to determine the amount and the method of payment.
- two pencils with good erasers. You may need a pencil for writing an outline or figuring out math problems. Mechanical pencils are prohibited in the testing room.
- your glasses if you need them for reading or seeing the chalkboard or wall clock.

**c.** Leave all books, papers and notes outside the test center. You will not be permitted to use your own scratch paper; it will be provided by the test center.

**d.** Do not take a calculator to the exam. If a calculator is required, it will be built into the testing software and available to you on the computer. The *CLEP Sampler* and the pretest tutorials will show you how to use that feature. For some exams, a sample calculator is available for download via the CLEP website.

**e.** Do not bring a cell phone or other electronic devices into the testing room.

**f.** Be prepared to adjust to an uncomfortable temperature in the testing room. Wear layers of clothing that can be removed if the room is too hot but that will keep you warm if it is too cold.

**4.** When you enter the test room:

**a.** You will be assigned to a computer testing station. If you have special needs, be sure to communicate them to the test center administrator *before* the day you test.

**b.** Read directions carefully and listen to all instructions given by the test administrator. If you don't understand the directions, ask for help before test timing begins. If you must ask a question after testing has begun, raise your hand and a proctor will assist you. The proctor can answer certain kinds of questions but cannot help you with the exam.

**c.** Know your rights as a test-taker. You can expect to be given the full working time allowed for taking the exam and a reasonably quiet and comfortable place in which to work. If a poor testing situation is preventing you from doing your best, ask whether the situation can be remedied. If it can't, ask the test administrator to report the problem on an Electronic Irregularity Report that will be submitted with your test results. You may also wish to immediately write a letter to CLEP, P.O. Box 6656, Princeton, NJ 08541-6656. Describe the exact circumstances as completely as you can. Be sure to include the name of the test center, the test date and the name(s) of the exam(s) you took.

## Arrangements for Students with Disabilities

CLEP is committed to working with test-takers with disabilities. If you have a learning or physical disability that would prevent you from taking a CLEP exam under standard conditions, you may request special accommodations and arrangements to take it on a regularly scheduled test date or at a special administration. Contact a CLEP test center prior to registration about testing accommodations and to ensure the accommodation you are requesting is available. Each test center sets its own guidelines in terms of deadlines for submission of documentation and approval of accommodations. Only students with documented hearing, learning, physical or visual disabilities are eligible to receive testing accommodations. Also, it is important to ensure that you are taking the exam(s) with accommodations that are approved by your score recipient institution.

Testing accommodations that may be provided with appropriate disability documentation include:

- ZoomText (screen magnification)
- Modifiable screen colors
- Scripts for the listening sections of the language exams
- Use of a reader or amanuensis or sign language interpreter
- Extended time
- Untimed rest breaks

# Taking the Examinations

A person may know a great deal about the subject being tested but not be able to demonstrate it on the exam. Knowing how to approach an exam is an important part of the testing process. While a command of test-taking skills cannot substitute for knowledge of the subject matter, it can be a significant factor in successful testing.

Test-taking skills enable a person to use all available information to earn a score that truly reflects his or her ability. There are different strategies for approaching different kinds of exam questions. For example, free-response and multiple-choice questions require very different approaches. Other factors, such as how the exam will be graded, may also influence your approach to the exam and your use of test time. Thus, your preparation for an exam should include finding out all you can about the exam so you can use the most effective test-taking strategies.

## Taking CLEP Exams

1. Listen carefully to any instructions given by the test administrator and read the on-screen instructions before you begin to answer the questions.

2. Keep an eye on the clock and the timing that is built into the testing software. You have the option of turning the clock on or off at any time. As you proceed, make sure that you are not working too slowly. You should have answered at least half the questions in a section when half the time for that section has passed.

3. Before answering a question, read the entire question, including all the answer choices. Instructions usually tell you to select the "best" answer. Sometimes one answer choice is partially correct but another option is better, so it's a good idea to read all the answers even if the first or second choice looks correct to you.

4. Read and consider every question. Questions that look complicated at first glance may not actually be so difficult once you have read them carefully.

5. Do not spend too much time on any one question. If you don't know the answer after you've considered it briefly, go on to the next question. Mark that question using the mark tool at the bottom of the screen, and go back to review the question later, if you have time.

**6.** Watch for the following key words in test questions:

| | | | |
|---|---|---|---|
| all | generally | never | perhaps |
| always | however | none | rarely |
| but | may | not | seldom |
| except | must | often | sometimes |
| every | necessary | only | usually |

When a question or answer option contains words such as ‘‘always,’’ ‘‘every,’’ ‘‘only,’’ ‘‘never’’ and “none,” there can be no exceptions to the answer you choose. Use of words such as ‘‘often,’’ “rarely,” ‘‘sometimes’’ and ‘‘generally’’ indicates that there may be some exceptions to the answer.

**7.** Make educated guesses. There is no penalty for incorrect answers. Therefore, you should guess even if you do not know an answer. If you have some knowledge of the question and are able to eliminate one or more of the answer choices as wrong, your chance of getting the right answer is improved.

**8.** Do not waste your time looking for clues to right answers based on flaws in question wording or patterns in correct answers. CLEP puts a great deal of effort into developing valid, reliable and fair exams. CLEP test development committees are composed of college faculty who are experts in the subjects covered by the exams and are appointed by the College Board to write test questions and to scrutinize each question that is included on a CLEP exam. They make every effort to ensure that the questions are not ambiguous, that they have only one correct answer, and that they cover college-level topics. These committees do not intentionally include ‘‘trick’’ questions. If you think a question is flawed, ask the test administrator to report it, or write immediately to CLEP Test Development, P.O. Box 6600, Princeton, NJ 08541-6600. Include the name of the exam and test center, the exam date, and the number of the exam question. All such inquiries are investigated by test development professionals.

## Answering Essay Questions

The College Composition exam is the only CLEP exam that includes two mandatory essays. Both the multiple-choice section and the essay section of the exam are administered on the computer. You are required to type your essays using a format similar to word processing.

The essays for the College Composition exam will be graded by English professors from a variety of colleges and universities who are trained by CLEP. A process called holistic scoring is used to rate your writing abilities. This process is explained in the examination guide for College Composition, which also includes graded sample essays and essay questions.

Four other CLEP exams have optional essays. Some colleges or universities may require you to take one of these optional essays as part of the American Literature, Analyzing and Interpreting Literature, English Literature or College Composition Modular exam. There is an additional fee of $10 for each of the optional essays, payable to the institution that administers the exam. These essays are administered on paper and are graded by the faculty of the institution that grants the credit. Therefore, you may find it helpful to talk with someone at your college to find out what criteria will be used to determine whether you will get credit. Ask how much emphasis will be placed on your writing ability and your ability to organize your thoughts, as opposed to your knowledge of the subject matter. Find out how much weight will be given to your multiple-choice test score in comparison with your free-response grade in determining whether you will get credit. This will give you an idea of where you should expend the greatest effort in preparing for and taking the exam.

Here are some strategies you will find useful in taking any essay exam:

1. Before you begin to respond, read all the questions carefully and take a few minutes to jot down some ideas or create an outline. Scratch paper will be provided at the test center.
2. If you are given a choice of questions to answer, choose the questions that you think you can answer most clearly and knowledgeably.
3. Determine the order in which you will answer the questions. First, answer those you find the easiest so you can spend any extra time on the questions you find more difficult.
4. When you know which questions you will answer and in what order, determine how much testing time remains and estimate how many minutes you will devote to each question. Unless suggested times are given for the questions, try to allot an equal amount of time for each question.

**5.** Before answering each question, read it again carefully to make sure you are interpreting it correctly. Pay attention to key words, such as those listed below, that often appear in free-response questions. Be sure you know the exact meaning of these words before taking the exam.

| | | | |
|---|---|---|---|
| analyze | demonstrate | enumerate | list |
| apply | derive | explain | outline |
| assess | describe | generalize | prove |
| compare | determine | illustrate | rank |
| contrast | discuss | interpret | show |
| define | distinguish | justify | summarize |

If a question asks you to ‘‘outline,’’ ‘‘define’’ or ‘‘summarize,’’ do not write a detailed explanation; if a question asks you to ‘‘analyze,’’ ‘‘explain,’’ ‘‘illustrate,’’ ‘‘interpret’’ or ‘‘show,’’ you must do more than briefly describe the topic.

# Interpreting Your Scores

CLEP score requirements for awarding credit vary from institution to institution. The College Board, however, recommends that colleges refer to the standards set by the American Council on Education (ACE). All ACE recommendations are the result of careful and periodic review by evaluation teams made up of faculty who are subject-matter experts and technical experts in testing and measurement. To determine whether you are eligible for credit for your CLEP scores, you should refer to the policy of the college you will be attending. The policy will state the score that is required to earn credit at that institution. Many colleges award credit at the score levels recommended by ACE. However, some require scores that are higher or lower than these.

Your exam score will be printed for you at the test center immediately upon completion of the examination, unless you took College Composition. For this exam, you will receive your score three to four weeks after the exam date. Your CLEP exam scores are reported only to you, unless you ask to have them sent elsewhere. If you want your scores sent to a college, employer or certifying agency, you must select this option through the examination software. This service is free only if you select your score recipient at the time you test. A fee will be charged for each score recipient you select at a later date. Your scores are kept on file for 20 years. For a fee, you can request a transcript at a later date.

The pamphlet *What Your CLEP Score Means*, which you will receive with your exam score, gives detailed information about interpreting your scores. A copy of the pamphlet is in the appendix of this *Guide*. A brief explanation appears below.

## How CLEP Scores Are Computed

In order to reach a total score on your exam, two calculations are performed.

First, your "raw score" is calculated. This is the number of questions you answer correctly. Your raw score is increased by one point for each question you answer correctly, and no points are gained or lost when you do not answer a question or answer it incorrectly.

Second, your raw score is converted into a "scaled score" by a statistical process called *equating*. Equating maintains the consistency of standards for test scores over time by adjusting for slight differences in difficulty between test forms. This ensures that your score does not depend on the specific test form you took or how well others did on the same form. Your raw score is converted to a scaled score that ranges from 20, the lowest, to 80, the highest. The final scaled score is the score that appears on your score report.

## How Essays Are Graded

The College Board arranges for college English professors to grade the essays written for the College Composition exam. These carefully selected college faculty consultants teach at two- and four-year institutions nationwide. The faculty consultants receive extensive training and thoroughly review the College Board scoring policies and procedures before grading the essays. Each essay is read and graded

by two professors, the sum of the two grades for each essay is combined with the multiple-choice score, and the result is reported as a scaled score between 20 and 80. Although the format of the two sections is very different, both measure skills required for expository writing. Knowledge of formal grammar, sentence structure and organizational skills are necessary for the multiple-choice section, but the emphasis in the free-response section is on writing skills rather than grammar.

Optional essays for CLEP composition and literature examinations are evaluated and graded by the colleges that require them, rather than by the College Board. If you take an optional essay, it will be sent with a copy of your score report (which includes only the results of your multiple-choice test) to the institution you designate when you take the test.

You may opt not to have your score sent to a college until after you have seen it. In this case, your essay can still be sent to the college of your choice as long as you request a transcript within 18 months after you take the exam. Copies of essays are not held beyond 18 months or after they have been sent to an institution.

# Chemistry

## Description of the Examination

The Chemistry examination covers material that is usually taught in a one-year college course in general chemistry. Understanding of the structure and states of matter, reaction types, equations and stoichiometry, equilibrium, kinetics, thermodynamics, and descriptive and experimental chemistry is required, as is the ability to interpret and apply this material to new and unfamiliar problems. During this examination, an online scientific calculator function and a periodic table are available as part of the testing software.

The examination contains approximately 75 questions to be answered in 90 minutes. Some of these are pretest questions that will not be scored. Any time spent on tutorials and providing personal information is in addition to the actual testing time.

## Knowledge and Skills Required

Questions on the Chemistry examination require candidates to demonstrate one or more of the following abilities.

- **Recall** — remember specific facts; demonstrate straightforward knowledge of information and familiarity with terminology
- **Application** — understand concepts and reformulate information into other equivalent terms; apply knowledge to unfamiliar and/or practical situations; use mathematics to solve chemistry problems
- **Interpretation** — infer and deduce from data available and integrate information to form conclusions; recognize unstated assumptions

The subject matter of the Chemistry examination is drawn from the following topics. The percentages next to the main topics indicate the approximate percentage of exam questions on that topic.

### 20% Structure of Matter

Atomic theory and atomic structure

- Evidence for the atomic theory
- Atomic masses; determination by chemical and physical means
- Atomic number and mass number; isotopes and mass spectroscopy
- Electron energy levels: atomic spectra, quantum numbers, atomic orbitals
- Periodic relationships, including, for example, atomic radii, ionization energies, electron affinities, oxidation states

Chemical bonding

- Binding forces
  - Types: covalent, ionic, metallic, macromolecular (or network), dispersion, hydrogen bonding
  - Relationships to structure and to properties
  - Polarity of bonds, electronegativities
- Geometry of molecules, ions and coordination complexes: structural isomerism, dipole moments of molecules, relation of properties to structure
- Molecular models
  - Valence bond theory; hybridization of orbitals, resonance, sigma and pi bonds
  - Other models, for example, molecular orbital

Nuclear chemistry: nuclear equations, half-lives and radioactivity; chemical applications

## 19% States of Matter

Gases

- Laws of ideal gases; equations of state for an ideal gas
- Kinetic-molecular theory
  - Interpretation of ideal gas laws on the basis of this theory
  - The mole concept; Avogadro's number
  - Dependence of kinetic energy of molecules on temperature: Boltzmann distribution
  - Deviations from ideal gas laws

Liquids and solids

- Liquids and solids from the kinetic-molecular viewpoint
- Phase diagrams of one-component systems
- Changes of state, critical phenomena
- Crystal structure

Solutions

- Types of solutions and factors affecting solubility
- Methods of expressing concentration
- Colligative properties; for example, Raoult's law
- Effect of interionic attraction on colligative properties and solubility

## 12% Reaction Types

Formation and cleavage of covalent bonds

- Acid-base reactions; concepts of Arrhenius, Brønsted-Lowry and Lewis; amphoterism
- Reactions involving coordination complexes

Precipitation reactions

Oxidation-reduction reactions

- Oxidation number
- The role of the electron in oxidation-reduction
- Electrochemistry; electrolytic cells, standard half-cell potentials, prediction of the direction of redox reactions, effect of concentration changes

## 10% Equations and Stoichiometry

Ionic and molecular species present in chemical systems; net-ionic equations

Stoichiometry: mass and volume relations with emphasis on the mole concept

Balancing of equations, including those for redox reactions

## 7% Equilibrium

Concept of dynamic equilibrium, physical and chemical; LeChâtelier's principle; equilibrium constants

Quantitative treatment

- Equilibrium constants for gaseous reactions in terms of both molar concentrations and partial pressure ($K_c$, $K_p$)
- Equilibrium constants for reactions in solutions
  - Constants for acids and bases; pK; pH
  - Solubility-product constants and their application to precipitation and the dissolution of slightly soluble compounds
  - Constants for complex ions
  - Common ion effect; buffers

## 4% Kinetics

Concept of rate of reaction

Order of reaction and rate constant: their determination from experimental data

Effect of temperature change on rates

Energy of activation; the role of catalysts

The relationship between the rate-determining step and a mechanism

**5%** **Thermodynamics**

State functions

First law: heat of formation; heat of reaction; change in enthalpy, Hess's law; heat capacity; heats of vaporization and fusion

Second law: free energy of formation; free energy of reaction; dependence of change in free energy on enthalpy and entropy changes

Relationship of change in free energy to equilibrium constants and electrode potentials

**14%** **Descriptive Chemistry**

The accumulation of certain specific facts of chemistry is essential to enable students to comprehend the development of principles and concepts, to demonstrate applications of principles, to relate fact to theory and properties to structure, and to develop an understanding of systematic nomenclature that facilitates communication. The following areas are normally included on the examination:

- Chemical reactivity and products of chemical reactions
- Relationships in the periodic table: horizontal, vertical and diagonal
- Chemistry of the main groups and transition elements, including typical examples of each
- Organic chemistry, including such topics as functional groups and isomerism (may be treated as a separate unit or as exemplary material in other areas, such as bonding)

**9%** **Experimental Chemistry**

Some questions are based on laboratory experiments widely performed in general chemistry and ask about the equipment used, observations made, calculations performed, and interpretation of the results. The questions are designed to provide a measure of understanding of the basic tools of chemistry and their applications to simple chemical systems.

## Sample Test Questions

The following sample questions do not appear on an actual CLEP examination. They are intended to give potential test-takers an indication of the format and difficulty level of the examination and to provide content for practice and review. Knowing the correct answers to all of the sample questions is not a guarantee of satisfactory performance on the exam.

**Note:** For all questions involving solutions and/or chemical equations, assume that the system is in pure water and at room temperature unless otherwise stated.

### Part A

**Directions:** Each set of lettered choices below refers to the numbered questions or statements immediately following it. Select the one lettered choice that best answers each question or best fits each statement. A choice may be used once, more than once, or not at all in each set.

**Questions 1–3**

(A) F
(B) S
(C) Mg
(D) Ar
(E) Mn

1. Forms monatomic ions with –2 charge in solutions

2. Forms a compound having the formula $KXO_4$

3. Forms oxides that are common air pollutants and that yield acidic solutions in water

**Questions 4–6**

(A) Hydrofluoric acid
(B) Carbon dioxide
(C) Aluminum hydroxide
(D) Ammonia
(E) Hydrogen peroxide

4. Is a good oxidizing agent

5. Is used extensively for the production of fertilizers

6. Has amphoteric properties

**Questions 7–8**

(A) A network solid with covalent bonding
(B) A molecular solid with London (dispersion) forces only
(C) A molecular solid with hydrogen bonding
(D) An ionic solid
(E) A metallic solid

7. Solid ethyl alcohol, $C_2H_5OH$

8. Silicon dioxide, $SiO_2$

**Questions 9–11**

(A) $CO_3^{2-}$
(B) $MnO_4^-$
(C) $NH_4^+$
(D) $Ba^{2+}$
(E) $Al^{3+}$

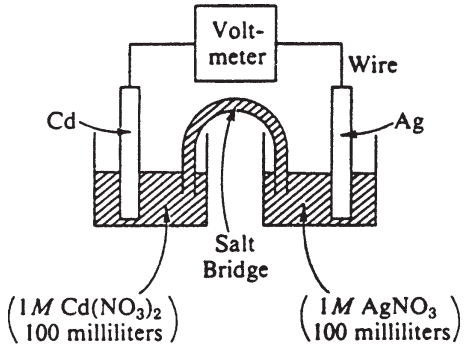
Assume that you have several "unknowns," each consisting of an aqueous solution of a salt that contains one of the ions listed above. Which ion must be present if the following observations are made of that unknown?

9. The solution is colored.

10. An odor can be detected when a sample of the solution is added drop by drop to a warm solution of sodium hydroxide.

11. A precipitate is formed when a dilute solution of $H_2SO_4$ is added to a sample of the solution.

**Questions 12–13**




The spontaneous reaction that occurs when the cell above operates is

$$2\ Ag^+ + Cd(s) \rightarrow 2\ Ag(s) + Cd^{2+}.$$

(A) Voltage increases.
(B) Voltage decreases but remains above zero.
(C) Voltage becomes zero and remains at zero.
(D) No change in voltage occurs.
(E) Direction of voltage change cannot be predicted without additional information.

Which of the above occurs for each of the following circumstances?

12. The silver electrode is made larger.

13. The salt bridge is replaced by a platinum wire.

## Part B

**Directions:** Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case.

14.

| Hydrogen Halide | Normal Boiling Point, °C |
|---|---|
| HF | +19 |
| HCl | –85 |
| HBr | –67 |
| HI | –35 |

The liquefied hydrogen halides have the normal boiling points given above. The relatively high boiling point of HF can be correctly explained by which of the following?

(A) HF gas is more ideal.
(B) HF is the strongest acid.
(C) HF molecules have a smaller dipole moment.
(D) HF is much less soluble in water.
(E) HF molecules tend to form hydrogen bonds.

15. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

Atoms of an element, X, have the electronic configuration shown above. The compound most likely formed with magnesium, Mg, is

(A) MgX
(B) $Mg_2X$
(C) $MgX_2$
(D) $Mg_2X_3$
(E) $Mg_3X_2$

16. The density of an unknown gas is 4.20 grams per liter at 3.00 atmospheres pressure and 127°C. What is the molar mass of this gas? ($R$ = 0.0821 liter·atm/mole·K)

(A) 14.6 g
(B) 46.0 g
(C) 88.0 g
(D) 94.1 g
(E) 138.0 g

**Questions 17–18**

$$H_3AsO_4 + 3\ I^- + 2\ H_3O^+ \rightarrow H_3AsO_3 + I_3^- + 3\ H_2O$$

The oxidation of iodide ions by arsenic acid in acidic aqueous solution occurs according to the balanced equation shown above. The experimental rate law for the reaction at 25°C is

$$\text{Rate} = k\,[H_3AsO_4]\,[I^-]\,[H_3O^+].$$

17. What is the order of the reaction with respect to $I^-$ ?

(A) 1
(B) 2
(C) 3
(D) 5
(E) 6

18. According to the rate law for the reaction, an increase in the concentration of the hydronium ion has what effect on the reaction at 25°C?

(A) The rate of reaction increases.
(B) The rate of reaction decreases.
(C) The value of the equilibrium constant increases.
(D) The value of the equilibrium constant decreases.
(E) Neither the rate nor the value of the equilibrium constant is changed.

19. The critical temperature of a substance is the

(A) temperature at which the vapor pressure of the liquid is equal to the external pressure
(B) temperature at which the vapor pressure of the liquid is equal to 760 mm Hg
(C) temperature at which the solid, liquid, and vapor phases are all in equilibrium
(D) temperature at which the liquid and vapor phases are in equilibrium at 1 atmosphere
(E) lowest temperature above which a substance cannot be liquefied at any applied pressure

20. $Cu(s) + 2\,Ag^+ \rightarrow Cu^{2+} + 2\,Ag(s)$

If the equilibrium constant for the reaction above is $3.7 \times 10^{15}$, which of the following correctly describes the standard voltage, $E°$, and the standard free energy change, $\Delta G°$, for this reaction?

(A) $E°$ is positive and $\Delta G°$ is negative.
(B) $E°$ is negative and $\Delta G°$ is positive.
(C) $E°$ and $\Delta G°$ are both positive.
(D) $E°$ and $\Delta G°$ are both negative.
(E) $E°$ and $\Delta G°$ are both zero.

21. When $^{214}_{84}Po$ decays, the emission consists consecutively of an $\alpha$ particle, then two $\beta$ particles, and finally another $\alpha$ particle. The resulting stable nucleus is

(A) $^{206}_{83}Bi$
(B) $^{210}_{83}Bi$
(C) $^{206}_{82}Pb$
(D) $^{208}_{82}Pb$
(E) $^{210}_{81}Tl$

22. The pH of 0.1 *M* ammonia is approximately

(A) 1
(B) 4
(C) 7
(D) 11
(E) 14

23. $\ldots CrO_2^- + \ldots OH^- \rightarrow$
$\ldots CrO_4^{2-} + \ldots H_2O + \ldots e^-$

When the equation for the half reaction above is balanced, what is the ratio of the coefficients $OH^- : CrO_2^-$?

(A) 1 : 1
(B) 2 : 1
(C) 3 : 1
(D) 4 : 1
(E) 5 : 1

24. $CuO(s) + H_2(g) \leftrightarrows Cu(s) + H_2O(g) \quad \Delta H = -2.0$ kJ

The substances in the equation above are at equilibrium at pressure $P$ and temperature $T$. The equilibrium can be shifted to favor the products by

(A) increasing the pressure by means of a moving piston at constant $T$
(B) increasing the pressure by adding an inert gas such as nitrogen
(C) decreasing the temperature
(D) allowing some gases to escape at constant $P$ and $T$
(E) adding a catalyst

25. The molality of the glucose in a 1.0 *M* glucose solution can be obtained by using which of the following?

(A) Solubility of glucose in water
(B) Degree of dissociation of glucose
(C) Volume of the solution
(D) Temperature of the solution
(E) Density of the solution

26. The geometry of the $SO_3$ molecule is best described as

(A) trigonal planar
(B) trigonal pyramidal
(C) square pyramidal
(D) bent
(E) tetrahedral

27. Which of the following molecules has the shortest bond length?

(A) $N_2$
(B) $O_2$
(C) $Cl_2$
(D) $Br_2$
(E) $I_2$

28. What number of moles of $O_2$ is needed to produce 14.2 grams of $P_4O_{10}$ (molar mass 284 g) from P?

(A) 0.0500 mole
(B) 0.0625 mole
(C) 0.125 mole
(D) 0.250 mole
(E) 0.500 mole

29. If 0.060 faraday is passed through an electrolytic cell containing a solution of $In^{3+}$ ions, the maximum number of moles of In that could be deposited at the cathode is

(A) 0.010 mole
(B) 0.020 mole
(C) 0.030 mole
(D) 0.060 mole
(E) 0.18 mole

30. $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(l)$
$\Delta H^\circ_{rxn} = -889.1$ kJ mol$^{-1}$

$\Delta H_f^\circ\ H_2O(l) = -285.8$ kJ mol$^{-1}$
$\Delta H_f^\circ\ CO_2(g) = -393.3$ kJ mol$^{-1}$

What is the standard heat of formation, $\Delta H_f^\circ$, of methane, $CH_4(g)$, as calculated from the data above?

(A) –210.0 kJ mol$^{-1}$
(B) –107.5 kJ mol$^{-1}$
(C) –75.8 kJ mol$^{-1}$
(D) 75.8 kJ mol$^{-1}$
(E) 210.0 kJ mol$^{-1}$

31. Each of the following can act as both a Brønsted acid and a Brønsted base EXCEPT

(A) $HCO_3^-$
(B) $H_2PO_4^-$
(C) $NH_4^+$
(D) $H_2O$
(E) $HS^-$

32. Two flexible containers for gases are at the same temperature and pressure. One holds 0.50 gram of hydrogen and the other holds 8.0 grams of oxygen. Which of the following statements regarding these gas samples is FALSE?

(A) The volume of the hydrogen container is the same as the volume of the oxygen container.
(B) The number of molecules in the hydrogen container is the same as the number of molecules in the oxygen container.
(C) The density of the hydrogen sample is less than that of the oxygen sample.
(D) The average kinetic energy of the hydrogen molecules is the same as the average kinetic energy of the oxygen molecules.
(E) The average speed of the hydrogen molecules is the same as the average speed of the oxygen molecules.

33. Pi ($\pi$) bonding occurs in each of the following species EXCEPT

(A) $CO_2$
(B) $C_2H_4$
(C) $CN^-$
(D) $C_6H_6$
(E) $CH_4$

34. $3\,Ag(s) + 4\,HNO_3 \rightarrow 3\,AgNO_3 + NO(g) + 2\ H_2O$

The reaction of silver metal and dilute nitric acid proceeds according to the equation above. If 0.10 mole of powdered silver is added to 10. milliliters of 6.0-molar nitric acid, the number of moles of NO gas that can be formed is

(A) 0.015 mole
(B) 0.020 mole
(C) 0.030 mole
(D) 0.045 mole
(E) 0.090 mole

35. Which, if any, of the following species are in the greatest concentration in a 0.100 *M* solution of $H_2SO_4$ in water?

(A) $H_2SO_4$ molecules
(B) $H_3O^+$ ions
(C) $HSO_4^-$ ions
(D) $SO_4^{2-}$ ions
(E) All species are in equilibrium and therefore have the same concentrations.

36. At 20.°C, the vapor pressure of toluene is 22 mm Hg and that of benzene is 75 mm Hg. An ideal solution, equimolar in toluene and benzene, is prepared. At 20.°C, what is the mole fraction of benzene in the vapor in equilibrium with this solution?

(A) 0.23
(B) 0.29
(C) 0.50
(D) 0.77
(E) 0.83

37. Which of the following aqueous solutions has the highest boiling point?

(A) 0.10 *M* potassium sulfate, $K_2SO_4$
(B) 0.10 *M* hydrochloric acid, HCl
(C) 0.10 *M* ammonium nitrate, $NH_4NO_3$
(D) 0.10 *M* magnesium sulfate, $MgSO_4$
(E) 0.20 *M* sucrose, $C_{12}H_{22}O_{11}$

38. When 70 milliliters of 3.0 *M* $Na_2CO_3$ is added to 30 milliliters of 1.0 *M* $NaHCO_3$, the resulting concentration of $Na^+$ is

(A) 2.0 *M*
(B) 2.4 *M*
(C) 4.0 *M*
(D) 4.5 *M*
(E) 7.0 *M*

39. Which of the following species CANNOT function as an oxidizing agent?

(A) $Cr_2O_7^{2-}$
(B) $MnO_4^-$
(C) $NO_3^-$
(D) S
(E) $I^-$

40. A student wishes to prepare 2.00 liters of 0.100 *M* $KIO_3$ (molar mass 214 g). The proper procedure is to weigh out

(A) 42.8 grams of $KIO_3$ and add 2.00 kilograms of $H_2O$
(B) 42.8 grams of $KIO_3$ and add $H_2O$ until the final homogeneous solution has a volume of 2.00 liters
(C) 21.4 grams of $KIO_3$ and add $H_2O$ until the final homogeneous solution has a volume of 2.00 liters
(D) 42.8 grams of $KIO_3$ and add 2.00 liters of $H_2O$
(E) 21.4 grams of $KIO_3$ and add 2.00 liters of $H_2O$

41. A 20.0-milliliter sample of 0.200 *M* $K_2CO_3$ solution is added to 30.0 milliliters of 0.400 *M* $Ba(NO_3)_2$ solution. Barium carbonate precipitates. The concentration of barium ion, $Ba^{2+}$, in solution after reaction is

(A) 0.150 *M*
(B) 0.160 *M*
(C) 0.200 *M*
(D) 0.240 *M*
(E) 0.267 *M*

42. One of the outermost electrons in a strontium atom in the ground state can be described by which of the following sets of four quantum numbers?

(A) 5, 2, 0, $\frac{1}{2}$
(B) 5, 1, 1, $\frac{1}{2}$
(C) 5, 1, 0, $\frac{1}{2}$
(D) 5, 0, 1, $\frac{1}{2}$
(E) 5, 0, 0, $\frac{1}{2}$

43. Which of the following reactions does NOT proceed significantly to the right in aqueous solutions?

(A) $H_3O^+ + OH^- \rightarrow 2\ H_2O$
(B) $HCN + OH^- \rightarrow H_2O + CN^-$
(C) $Cu(H_2O)_4^{2+} + 4\ NH_3 \rightarrow Cu(NH_3)_4^{2+} + 4\ H_2O$
(D) $H_2SO_4 + H_2O \rightarrow H_3O^+ + HSO_4^-$
(E) $H_2O + HSO_4^- \rightarrow H_2SO_4 + OH^-$

44. A compound is heated to produce a gas whose molar mass is to be determined. The gas is collected by displacing water in a water-filled flask inverted in a trough of water. Which of the following is necessary to calculate the molar mass of the gas but does <u>not</u> need to be measured during the experiment?

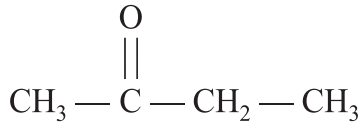
(A) Mass of the compound used in the experiment
(B) Temperature of the water in the trough
(C) Vapor pressure of the water
(D) Barometric pressure
(E) Volume of water displaced from the flask

45. A 27.0 gram sample of an unknown hydrocarbon was burned in excess oxygen to form 88.0 grams of carbon dioxide and 27.0 grams of water. What is a possible molecular formula of the hydrocarbon?

(A) $CH_4$
(B) $C_2H_2$
(C) $C_4H_3$
(D) $C_4H_6$
(E) $C_4H_{10}$

46. If the acid dissociation constant, $K_a$, for an acid HA is $8 \times 10^{-4}$ at 25°C, what percent of the acid is dissociated in a 0.50 *M* solution of HA at 25°C?

(A) 0.08%
(B) 0.2%
(C) 1%
(D) 2%
(E) 4%



47. The organic compound represented above is an example of

(A) an alcohol
(B) an aldehyde
(C) an ether
(D) an organic acid
(E) a ketone

48. Equal numbers of moles of $H_2(g)$, $Ar(g)$, and $N_2(g)$ are placed in a glass vessel at room temperature. If the vessel has a pinhole-sized leak, which of the following will be true regarding the relative values of the partial pressures of the gases remaining in the vessel after some of the gas mixture has effused?

(A) $P_{H_2} < P_{N_2} < P_{Ar}$
(B) $P_{H_2} < P_{Ar} < P_{N_2}$
(C) $P_{N_2} < P_{Ar} < P_{H_2}$
(D) $P_{Ar} < P_{H_2} < P_{N_2}$
(E) $P_{H_2} = P_{Ar} = P_{N_2}$

49. Which of the following is a correct interpretation of the results of Rutherford's experiments in which gold atoms were bombarded with alpha particles?

(A) Atoms have equal numbers of positive and negative charges.
(B) Electrons in atoms are arranged in shells.
(C) Neutrons are at the center of an atom.
(D) Neutrons and protons in atoms have nearly equal mass.
(E) The positive charge of an atom is concentrated in a small region.

50. A 0.1 *M* solution of which of the following ions is orange?

(A) $Fe(H_2O)_4^{2+}$
(B) $Cu(NH_3)_4^{2+}$
(C) $Zn(OH)_4^{2-}$
(D) $Zn(NH_3)_4^{2+}$
(E) $Cr_2O_7^{2-}$

51. In the formation of 1.0 mole of the following crystalline solids from the gaseous ions, the most energy is released by

(A) NaF
(B) $MgF_2$
(C) $MgBr_2$
(D) $AlF_3$
(E) $AlBr_3$

52. If 1 mole of a nonvolatile nonelectrolyte dissolves in 9 moles of water to form an ideal solution, what is the vapor pressure of this solution at 25°C? (The vapor pressure of pure water at 25°C is 23.8 mm Hg.)

(A) 23.8 mm Hg
(B) $\frac{9}{10}$ 23.8 mm Hg
(C) $\frac{10}{9}$ 23.8 mm Hg
(D) $\frac{1}{10}$ 23.8 mm Hg
(E) It cannot be determined from the information given.

53. . . . $MnO_4^-(aq)$ + . . . $NO_2^-(aq)$ + . . . $H_2O(l)$ → . . . $MnO_2(s)$ + . . . $NO_3^-(aq)$ + . . . $OH^-(aq)$

When the redox equation shown above is balanced by using coefficients reduced to lowest whole numbers, the coefficient for $MnO_4^-$ is

(A) 1
(B) 2
(C) 3
(D) 4
(E) 6

54. If a certain solid solute dissolves in water with the evolution of heat, which of the following is most likely to be true?

(A) The temperature of the solution decreases as the solute dissolves.
(B) The resulting solution is ideal.
(C) The solid has a large lattice energy.
(D) The solid has a large heat of fusion.
(E) The solid has a large energy of hydration.

55. A 0.1-molar aqueous solution of which of the following is neutral?

(A) $NaNO_3$
(B) $Na_2CO_3$
(C) $NH_4Br$
(D) KCN
(E) $AlCl_3$

56. Which of the following is a true statement about the halogens?

(A) Fluorine is the weakest oxidizing agent.
(B) Bromine is more electronegative than chlorine.
(C) The halide ions are larger than their respective halogen atoms.
(D) Adding $I_2(s)$ to a solution containing $Br^-(aq)$ will produce $Br_2(l)$.
(E) The first ionization energies increase as the atomic number increases.

$CH_3CHOHCH_2OH$ *X* $CH_3CH_2CH_2CH_3$ *Y* $CH_3CH_2CHOHCH_3$ *Z*

57. Considering the structures of the three compounds, *X, Y,* and *Z,* shown above, the ranking of their solubility in water from least to greatest is which of the following?

(A) $X < Y < Z$
(B) $X < Z < Y$
(C) $Z < Y < X$
(D) $Y < Z < X$
(E) $Y < X < Z$

58. Of the following compounds, which is involved in the environmental problem known as acid rain?

(A) $CO_2$
(B) $CF_2Cl_2$
(C) $SO_2$
(D) $H_2S$
(E) $SiO_2$

$\ldots P_4O_{10} + \ldots Ca(OH)_2 \rightarrow \ldots Ca_3(PO_4)_2 + \ldots H_2O$

59. When the chemical equation above is balanced in terms of lowest whole-number coefficients, the coefficient for $H_2O$ is

(A) 1
(B) 2
(C) 3
(D) 6
(E) 8

60. Which of the following best describes the role of a catalyst in a chemical reaction?

(A) The catalyst lowers the activation energy by changing the mechanism of the reaction.
(B) The catalyst increases the strength of the chemical bonds in the reactant molecules.
(C) The catalyst increases the value of the equilibrium constant.
(D) The catalyst provides kinetic energy to reactant molecules to increase the reaction rate.
(E) The catalyst bonds to the reaction products and drives the equilibrium toward the products.

61. On the basis of trends in the periodic table, an atom of which of the following elements is predicted to have the lowest first ionization energy?

(A) Ar
(B) Cl
(C) K
(D) Rb
(E) I

$$X(g) + Y(g) \rightleftarrows Z(g)$$

62. Which of the following statements is true for the chemical system represented above when the system has reached a state of equilibrium at a constant temperature and pressure?

(A) The forward and reverse reactions have stopped.
(B) The forward and reverse reactions occur at the same rate.
(C) The rate of formation of $Z(g)$ is equal to half the rate of consumption of $X(g)$.
(D) Introducing a catalyst will result in an increased amount of $Z(g)$ at equilibrium.
(E) Introducing more $Y(g)$ to the system will cause more $X(g)$ to form.

63. If a 1.0 *M* solution of HA, a weak acid, has a pH of 2.0, then the value of $K_a$, the acid-dissociation constant, for HA is closest to

(A) $1.0 \times 10^{-4}$
(B) $1.4 \times 10^{-4}$
(C) $1.0 \times 10^{-2}$
(D) $1.4 \times 10^{-2}$
(E) $1.4 \times 10^{-1}$

64. Which of the following elements is <u>never</u> found pure (i.e., chemically uncombined with one or more other elements) in Earth's crust?

(A) S
(B) K
(C) Cu
(D) Pt
(E) Au

65. If an endothermic reaction occurs spontaneously, then it can be correctly inferred that

(A) a catalyst must be present
(B) the reaction occurs at a slow rate
(C) $\Delta G_{rxn} > 0$
(D) $\Delta H_{rxn} < 0$
(E) $\Delta S_{rxn} > 0$

## Study Resources

Most textbooks used in college-level chemistry courses cover the topics in the outline given earlier, but the approaches to certain topics and the emphases given to them may differ. To prepare for the Chemistry exam, it is advisable to study one or more college textbooks, which can be found in most college bookstores. When selecting a textbook, check the table of contents against the knowledge and skills required for this test.

Visit www.collegeboard.org/clepprep for additional chemistry resources. You can also find suggestions for exam preparation in Chapter IV of the *Official Study Guide*. In addition, many college faculty post their course materials on their schools' websites.

## Answer Key

| | | | |
|---|---|---|---|
| 1. | B | 34. | A |
| 2. | E | 35. | B |
| 3. | B | 36. | D |
| 4. | E | 37. | A |
| 5. | D | 38. | D |
| 6. | C | 39. | E |
| 7. | C | 40. | B |
| 8. | A | 41. | B |
| 9. | B | 42. | E |
| 10. | C | 43. | E |
| 11. | D | 44. | C |
| 12. | D | 45. | D |
| 13. | C | 46. | E |
| 14. | E | 47. | E |
| 15. | E | 48. | A |
| 16. | B | 49. | E |
| 17. | A | 50. | E |
| 18. | A | 51. | D |
| 19. | E | 52. | B |
| 20. | A | 53. | B |
| 21. | C | 54. | E |
| 22. | D | 55. | A |
| 23. | D | 56. | C |
| 24. | C | 57. | D |
| 25. | E | 58. | C |
| 26. | A | 59. | D |
| 27. | A | 60. | A |
| 28. | D | 61. | D |
| 29. | B | 62. | B |
| 30. | C | 63. | A |
| 31. | C | 64. | B |
| 32. | E | 65. | E |
| 33. | E | | |

CLEP®

# What Your CLEP® Score Means

In order to reach the total score you see on your score report, two calculations are performed.

First, your "raw score" is calculated. This is the number of questions you answered correctly. Your raw score increases by one point for each question answered correctly, and no points are gained or lost when a question is not answered or is answered incorrectly.

Second, your raw score is converted into a "scaled score" by a statistical process called *equating*. Equating maintains the consistency of standards for test scores over time by adjusting for slight differences in difficulty between test forms. This ensures that your score does not depend on the specific test form you took or how well others did on the same form. Your raw score is converted to a scaled score that ranges from 20, the lowest, to 80, the highest. The final scaled score is the score that appears on your score report.

To see whether you attained a score sufficient to receive college credit, compare your score to the score in the table shown. The scores that appear in this table are the credit-granting scores recommended by the American Council on Education (ACE). **Each college, however, reserves the right to set its own credit-granting policy, which may differ from that of ACE.** If you have not already done so, contact your college as soon as possible to find out the score it requires to grant credit, the number of credit hours granted and the course(s) that can be bypassed with a satisfactory score.

Please note that College-Level Examination Program® (CLEP®) examinations are developed and evaluated independently and are not linked to each other except by the program's common purpose, format and method of reporting results. For this reason, direct comparisons should not be made between CLEP examinations in different subjects. CLEP scores are not comparable to SAT® scores or other test scores.

**Test scores are kept on file for 20 years.** During this period, score reports may be sent to an institution, but only at the request of the candidate. A Transcript Request Form and instructions for having a transcript sent to an institution can be downloaded from the CLEP website (www.collegeboard.org/clep) or obtained by contacting CLEP.

**Candidates may not repeat an examination of the same title within six months of the initial testing date.** If the candidate retakes the examination within the six-month period, the administration will be considered invalid, the score will be canceled and any test fees will be forfeited. DANTES-funded military examinees: Effective December 11, 2010, DANTES will not fund retesting on a previously funded CLEP exam. However, service members may personally fund a retest after waiting six months.

If you have a question about your score report, about a test question or about any other aspect of a CLEP examination that your test center cannot answer, write to CLEP, P.O. Box 6600, Princeton, NJ 08541-6600 or e-mail clep@info.collegeboard.org.

Visit CLEP on the Web: www.collegeboard.org/clep

# 2011-12 CLEP® Credit-Granting Recommendations

| | Computer-Based Testing (CBT) and Paper-and-Pencil Testing | |
|---|---|---|
| | ACE Recommended Score[1] | Semester Hours[1] |
| **Business** | | |
| Financial Accounting | 50 | 3 |
| Information Systems and Computer Applications | 50 | 3 |
| Introductory Business Law | 50 | 3 |
| Principles of Management | 50 | 3 |
| Principles of Marketing | 50 | 3 |
| **Composition and Literature** | | |
| American Literature | 50 | 6 |
| Analyzing and Interpreting Literature | 50 | 6 |
| College Composition | 50 | 6 |
| College Composition Modular | 50 | 3/6[2] |
| English Literature | 50 | 6 |
| Humanities | 50 | 6 |
| **World Languages** | | |
| French Language, Level 1 | 50 | 6 |
| French Language, Level 2 | 59 | 12 |
| German Language, Level 1 | 50 | 6 |
| German Language, Level 2 | 60 | 12 |
| Spanish Language, Level 1 | 50 | 6 |
| Spanish Language, Level 2 | 63 | 12 |
| Level 1 — equivalent to the first two semesters (or six semester hours) of college-level world language course work | | |
| Level 2 — equivalent to the first four semesters (or 12 semester hours) of college-level world language course work | | |
| **History and Social Sciences** | | |
| American Government | 50 | 3 |
| History of the United States I: Early Colonization to 1877 | 50 | 3 |
| History of the United States II: 1865 to Present | 50 | 3 |
| Human Growth and Development | 50 | 3 |
| Introduction to Educational Psychology | 50 | 3 |
| Introductory Psychology | 50 | 3 |
| Introductory Sociology | 50 | 3 |
| Principles of Macroeconomics | 50 | 3 |
| Principles of Microeconomics | 50 | 3 |
| Social Sciences and History | 50 | 6 |
| Western Civilization I: Ancient Near East to 1648 | 50 | 3 |
| Western Civilization II: 1648 to Present | 50 | 3 |
| **Science and Mathematics** | | |
| Biology | 50 | 6 |
| Calculus | 50 | 3 |
| Chemistry | 50 | 6 |
| College Algebra | 50 | 3 |
| College Mathematics | 50 | 6 |
| Natural Sciences | 50 | 6 |
| Precalculus | 50 | 3 |

1. The American Council on Education's College Credit Recommendation Service (ACE CREDIT) has evaluated CLEP processes and procedures for developing, administering and scoring the exams. The scores listed above are equivalent to a grade of C in the corresponding course. The American Council on Education, the major coordinating body for all the nation's higher education institutions, seeks to provide leadership and a unifying voice on key higher education issues and to influence public policy through advocacy, research and program initiatives. For more information, visit the ACE CREDIT website at www.acenet.edu/acecredit.

2. If the college does not require a supplemental essay for the Modular version of the examination, the ACE credit-granting recommendation is three credits. If the college does require a supplemental essay, the credit-granting recommendation is six credits.