CollegeBoard AP

STATISTICS

Course Description

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The College Board: Connecting Students to College Success

The College Board is a not-for-profit membership association whose mission is to connect students to college success and opportunity. Founded in 1900, the association is composed of more than 5,000 schools, colleges, universities, and other educational organizations. Each year, the College Board serves seven million students and their parents, 23,000 high schools, and 3,500 colleges through major programs and services in college admissions, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT®, the PSAT/NMSQT®, and the Advanced Placement Program® (AP®). The College Board is committed to the principles of excellence and equity, and that commitment is embodied in all of its programs, services, activities, and concerns.

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Dear Colleagues:

In 2005, more than 15,000 schools offered high school students the opportunity to take AP® courses, and over 1.2 million students then took the challenging AP Exams. These students felt the power of learning come alive in the classroom, and many earned college credit and placement while still in high school. Behind these students were talented, hardworking teachers who are the heart and soul of the Advanced Placement Program®.

This AP Course Description summarizes the variety of approaches and curricula used in college courses corresponding to the AP course. Teachers have the flexibility to develop their own syllabi and lesson plans, and to bring their individual creativity to the AP classroom. In fact, AP Exams are designed around this flexibility and allow students whose courses vary significantly equal opportunities to demonstrate college-level achievement. Finally, this curricular flexibility is reflected in the AP Course Audit, which identifies elements considered by higher education as essential to a college-level course, providing a consistent standard for disparate AP classes across the world, while not setting forth a mandated AP curriculum.

The College Board is committed to supporting the work of AP teachers. AP workshops and Summer Institutes, held around the globe, provide stimulating professional development for tens of thousands of teachers each year. The College Board Fellows stipends provide funds to support many teachers' attendance at these Institutes. Teachers and administrators can also visit AP Central, the College Board's online home for AP professionals, at apcentral.collegeboard.com. Here, teachers have access to a growing set of resources, information, and tools, from textbook reviews and lesson plans to electronic discussion groups (EDGs) and the most up-to-date exam information. I invite all teachers, particularly those who are new to the AP Program, to take advantage of these resources.

As we look to the future, the College Board's goal is to broaden access to AP classes while maintaining high academic standards. Reaching this goal will require a lot of hard work. We encourage you to connect students to college and opportunity not only by providing them with the challenges and rewards of rigorous academic programs like AP but also by preparing them in the years leading up to AP courses.

Sincerely,

Gaston Caperton
President
The College Board

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Welcome to the AP® Program

The Advanced Placement Program (AP) is a collaborative effort between motivated students; dedicated teachers; and committed high schools, colleges, and universities. Since its inception in 1955, the Program has enabled millions of students to take college-level courses and exams, and to earn college credit or placement, while still in high school.

Most colleges and universities in the United States, as well as colleges and universities in more than 30 other countries, have an AP policy granting incoming students credit, placement, or both on the basis of their AP Exam grades. Many of these institutions grant up to a full year of college credit (sophomore standing) to students who earn a sufficient number of qualifying AP grades.

Each year, an increasing number of parents, students, teachers, high schools, and colleges and universities turn to the AP Program as a model of educational excellence.

More information about the AP Program is available at the back of this Course Description and at AP Central, the College Board's online home for AP professionals (apcentral.collegeboard.com). Students can find more information at the AP student site (www.collegeboard.com/apstudents).

AP Courses

Thirty-eight AP courses in a wide variety of subject areas are available now or are under development. A committee of college faculty and master AP teachers designs each AP course to cover the information, skills, and assignments found in the corresponding college course. See page 2 for a complete list of AP courses and exams.

AP Exams

Each AP course has a corresponding exam that participating schools worldwide administer in May (except for AP Studio Art, which is a portfolio assessment). AP Exams contain multiple-choice questions and a free-response section (either essay or problem solving).

AP Exams are a culminating assessment in all AP courses and are thus an integral part of the Program. As a result, many schools foster the expectation that students who enroll in an AP course will take the corresponding AP Exam. Because the College Board is committed to providing access to AP Exams for homeschooled students and students whose schools do not offer AP courses, it does not require students to take an AP course prior to taking an AP Exam.

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AP Courses and Exams

Art
Art History
Studio Art: 2-D Design
Studio Art: 3-D Design
Studio Art: Drawing

Biology

Calculus
Calculus AB
Calculus BC

Chemistry

Chinese Language and Culture
(First offered 2006-07)

Computer Science
Computer Science A
Computer Science AB

Economics
Macroeconomics
Microeconomics

English
English Language and Composition
English Literature and Composition

Environmental Science

French
French Language
French Literature

German Language

Government and Politics
Comparative Government and Politics
United States Government and Politics

History
European History
United States History
World History

Human Geography

Italian Language and Culture

Japanese Language and Culture
(First offered 2006-07)

Latin
Latin Literature
Latin: Vergil

Music Theory

Physics
Physics B
Physics C: Electricity and Magnetism
Physics C: Mechanics

Psychology

Russian Language and Culture
(First offered: date to be determined)

Spanish
Spanish Language
Spanish Literature

Statistics

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AP Statistics

INTRODUCTION

The Advanced Placement Program offers a course description and exam in statistics to secondary school students who wish to complete studies equivalent to a one-semester, introductory, non-calculus-based, college course in statistics.

Statistics and mathematics educators who serve as members of the AP Statistics Development Committee have prepared the Course Description and exam to reflect the content of a typical introductory college course in statistics. The exam is representative of such a course and therefore is considered appropriate for the measurement of skills and knowledge in the field of introductory statistics.

In colleges and universities, the number of students who take a statistics course is almost as large as the number of students who take a calculus course. A July 2002 article in the *Chronicle of Higher Education* reports that the enrollment in statistics courses from 1990 to 2000 increased by 45 percent—one testament to the growth of statistics in those institutions. An introductory statistics course, similar to the AP Statistics course, is typically required for majors such as social sciences, health sciences, and business. Every semester about 236,000 college and university students enroll in an introductory statistics course offered by a mathematics or statistics department. In addition, a large number of students enroll in an introductory statistics course offered by other departments. Science, engineering, and mathematics majors usually take an upper-level calculus-based course in statistics, for which the AP Statistics course is effective preparation.

THE COURSE

The purpose of the AP course in statistics is to introduce students to the major concepts and tools for collecting, analyzing, and drawing conclusions from data. Students are exposed to four broad conceptual themes:

1. Exploring Data: Describing patterns and departures from patterns
2. Sampling and Experimentation: Planning and conducting a study
3. Anticipating Patterns: Exploring random phenomena using probability and simulation
4. Statistical Inference: Estimating population parameters and testing hypotheses

Students who successfully complete the course and exam may receive credit, advanced placement, or both for a one-semester introductory college statistics course. This does not necessarily imply that the high school course should be one semester long. Each high school needs to determine the length of its AP Statistics course to best serve the needs of its students. Statistics, like some other AP courses, could be effectively studied in a one-semester, a two-trimester, or a one-year course. Most schools, however, offer it as a one-year course.

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Student Selection

The College Board and the Advanced Placement Program encourage teachers, AP Coordinators, and school administrators to make equitable access a guiding principle for their AP programs. The College Board is committed to the principle that all students deserve an opportunity to participate in rigorous and academically challenging courses and programs. All students who are willing to accept the challenge of a rigorous academic curriculum should be considered for admission to AP courses. The Board encourages the elimination of barriers that restrict access to AP courses for students from ethnic, racial, and socioeconomic groups that have been traditionally underrepresented in the AP Program. Schools should make every effort to ensure that their AP classes reflect the diversity of their student population.

The AP Statistics course is an excellent option for any secondary school student who has successfully completed a second-year course in algebra and who possesses sufficient mathematical maturity and quantitative reasoning ability.

Because second-year algebra is the prerequisite course, AP Statistics usually will be taken in either the junior or senior year. The decisions about whether to take AP Statistics and when to take it depend on a student's plans:

- Students planning to take a science course in their senior year will benefit greatly from taking AP Statistics in their junior year.
- For students who would otherwise take no mathematics in their senior year, AP Statistics allows them to continue to develop their quantitative skills.
- Students who wish to leave open the option of taking calculus in college should include precalculus in their high school program and perhaps take AP Statistics concurrently with precalculus.

Students with the appropriate mathematical background are encouraged to take both AP Statistics and AP Calculus in high school.

Students who take the AP Statistics course are strongly encouraged to take the exam.

Teaching the Course

The AP Statistics course lends itself naturally to a mode of teaching that engages students in constructing their own knowledge. For example, students working individually or in small groups can plan and perform data collection and analyses where the teacher serves in the role of a consultant, rather than a director. This approach gives students ample opportunity to think through problems, make decisions, and share questions and conclusions with other students as well as with the teacher.

Important components of the course should include the use of technology, projects and laboratories, cooperative group problem-solving, and writing, as a part of concept-oriented instruction and assessment. This approach to teaching AP Statistics will allow students to build interdisciplinary connections with other subjects and with their world outside school.

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The AP Statistics course depends heavily on the availability of technology suitable for the interactive, investigative aspects of data analysis. Therefore, schools should make every effort to provide students and teachers easy access to computers to facilitate the teaching and learning of statistics.

Providing instructional information and educational opportunities for teachers is an important component of the AP Program. The College Board offers workshops, summer courses, and institutes for teachers in all AP courses. Further information about these and other training opportunities may be obtained at AP Central® (apcentral.collegeboard.com) and from your College Board regional office (contact information is on the inside back cover). The Teachers' Resources section of AP Central offers reviews of textbooks, articles, Web sites, and other teaching resources. The electronic discussion groups (EDGs) accessible through AP Central also provide a moderated forum for exchanging ideas, insights, and practices among members of the AP professional community.

Additionally, the following publications provide some insight into the philosophy of the AP Statistics course.

Cobb, George, "Teaching Statistics: More Data, Less Lecturing." In Steen, Lynn Arthur, ed. 1992. *Heeding the Call for Change: Suggestions for Curricular Action.* Washington, D.C.: Mathematical Association of America. To order MAA publications call 800 331-1622 or go to www.maa.org.

Gordon, Florence and Sheldon, eds. 1992. *Statistics for the Twenty-First Century,* MAA Notes No. 26. Washington, D.C.: Mathematical Association of America.

Moore, Thomas, ed. 2000. *Teaching Statistics: Resources for Undergraduate Instructors,* MAA Notes Vol. 52. Washington, D.C.: Mathematical Association of America.

National Council of Teachers of Mathematics. 2003. *Principles and Standards for School Mathematics,* 3rd. ed. Reston, Va.: National Council of Teachers of Mathematics. www.nctm.org

Course Content Overview

The topics for AP Statistics are divided into four major themes: exploratory analysis (20–30 percent of the exam), planning and conducting a study (10–15 percent of the exam), probability (20–30 percent of the exam), and statistical inference (30–40 percent of the exam).

I. *Exploratory analysis of data makes use of graphical and numerical techniques to study patterns and departures from patterns.* In examining distributions of data, students should be able to detect important characteristics, such as shape, location, variability, and unusual values. From careful observations of patterns in data, students can generate conjectures about relationships among variables. The notion of how one variable may be associated with another permeates almost all of statistics, from simple comparisons of proportions through linear regression. The difference between association and causation must accompany this conceptual development throughout.

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II. *Data must be collected according to a well-developed plan if valid information is to be obtained.* If data are to be collected to provide an answer to a question of interest, a careful plan must be developed. Both the type of analysis that is appropriate and the nature of conclusions that can be drawn from that analysis depend in a critical way on how the data was collected. Collecting data in a reasonable way, through either sampling or experimentation, is an essential step in the data analysis process.

III. *Probability is the tool used for anticipating what the distribution of data should look like under a given model.* Random phenomena are not haphazard: they display an order that emerges only in the long run and is described by a distribution. The mathematical description of variation is central to statistics. The probability required for statistical inference is not primarily axiomatic or combinatorial, but is oriented toward using probability distributions to describe data.

IV. *Statistical inference guides the selection of appropriate models.* Models and data interact in statistical work: models are used to draw conclusions from data, while the data are allowed to criticize and even falsify the model through inferential and diagnostic methods. Inference from data can be thought of as the process of selecting a reasonable model, including a statement in probability language, of how confident one can be about the selection.

TOPIC OUTLINE

Following is an outline of the major topics covered by the AP Statistics Exam. The ordering here is intended to define the scope of the course but not necessarily the sequence. The percentages in parentheses for each content area indicate the coverage for that content area in the exam.

I. Exploring Data: Describing patterns and departures from patterns (20%–30%)

Exploratory analysis of data makes use of graphical and numerical techniques to study patterns and departures from patterns. Emphasis should be placed on interpreting information from graphical and numerical displays and summaries.

A. Constructing and interpreting graphical displays of distributions of univariate data (dotplot, stemplot, histogram, cumulative frequency plot)
   1. Center and spread
   2. Clusters and gaps
   3. Outliers and other unusual features
   4. Shape

B. Summarizing distributions of univariate data
   1. Measuring center: median, mean
   2. Measuring spread: range, interquartile range, standard deviation
   3. Measuring position: quartiles, percentiles, standardized scores (z-scores)
   4. Using boxplots
   5. The effect of changing units on summary measures

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C. Comparing distributions of univariate data (dotplots, back-to-back stemplots, parallel boxplots)
   1. Comparing center and spread: within group, between group variation
   2. Comparing clusters and gaps
   3. Comparing outliers and other unusual features
   4. Comparing shapes
D. Exploring bivariate data
   1. Analyzing patterns in scatterplots
   2. Correlation and linearity
   3. Least-squares regression line
   4. Residual plots, outliers, and influential points
   5. Transformations to achieve linearity: logarithmic and power transformations
E. Exploring categorical data
   1. Frequency tables and bar charts
   2. Marginal and joint frequencies for two-way tables
   3. Conditional relative frequencies and association
   4. Comparing distributions using bar charts

II. Sampling and Experimentation: Planning and conducting a study (10%–15%)

Data must be collected according to a well-developed plan if valid information on a conjecture is to be obtained. This plan includes clarifying the question and deciding upon a method of data collection and analysis.

A. Overview of methods of data collection
   1. Census
   2. Sample survey
   3. Experiment
   4. Observational study
B. Planning and conducting surveys
   1. Characteristics of a well-designed and well-conducted survey
   2. Populations, samples, and random selection
   3. Sources of bias in sampling and surveys
   4. Sampling methods, including simple random sampling, stratified random sampling, and cluster sampling
C. Planning and conducting experiments
   1. Characteristics of a well-designed and well-conducted experiment
   2. Treatments, control groups, experimental units, random assignments, and replication
   3. Sources of bias and confounding, including placebo effect and blinding
   4. Completely randomized design
   5. Randomized block design, including matched pairs design
D. Generalizability of results and types of conclusions that can be drawn from observational studies, experiments, and surveys

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III. Anticipating Patterns: Exploring random phenomena using probability and simulation (20%–30%)

Probability is the tool used for anticipating what the distribution of data should look like under a given model.

A. Probability
   1. Interpreting probability, including long-run relative frequency interpretation
   2. "Law of Large Numbers" concept
   3. Addition rule, multiplication rule, conditional probability, and independence
   4. Discrete random variables and their probability distributions, including binomial and geometric
   5. Simulation of random behavior and probability distributions
   6. Mean (expected value) and standard deviation of a random variable, and linear transformation of a random variable

B. Combining independent random variables
   1. Notion of independence versus dependence
   2. Mean and standard deviation for sums and differences of independent random variables

C. The normal distribution
   1. Properties of the normal distribution
   2. Using tables of the normal distribution
   3. The normal distribution as a model for measurements

D. Sampling distributions
   1. Sampling distribution of a sample proportion
   2. Sampling distribution of a sample mean
   3. Central Limit Theorem
   4. Sampling distribution of a difference between two independent sample proportions
   5. Sampling distribution of a difference between two independent sample means
   6. Simulation of sampling distributions
   7. t-distribution
   8. Chi-square distribution

IV. Statistical Inference: Estimating population parameters and testing hypotheses (30%–40%)

Statistical inference guides the selection of appropriate models.

A. Estimation (point estimators and confidence intervals)
   1. Estimating population parameters and margins of error
   2. Properties of point estimators, including unbiasedness and variability
   3. Logic of confidence intervals, meaning of confidence level and confidence intervals, and properties of confidence intervals
   4. Large sample confidence interval for a proportion
   5. Large sample confidence interval for a difference between two proportions

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6. Confidence interval for a mean
7. Confidence interval for a difference between two means (unpaired and paired)
8. Confidence interval for the slope of a least-squares regression line

B. Tests of significance
1. Logic of significance testing, null and alternative hypotheses; p-values; one- and two-sided tests; concepts of Type I and Type II errors; concept of power
2. Large sample test for a proportion
3. Large sample test for a difference between two proportions
4. Test for a mean
5. Test for a difference between two means (unpaired and paired)
6. Chi-square test for goodness of fit, homogeneity of proportions, and independence (one- and two-way tables)
7. Test for the slope of a least-squares regression line

The Use of Technology

The AP Statistics course adheres to the philosophy and methods of modern data analysis. Although the distinction between graphing calculators and computers is becoming blurred as technology advances, at present the fundamental tool of data analysis is the computer. The computer does more than eliminate the drudgery of hand computation and graphing—it is an essential tool for structured inquiry.

Data analysis is a journey of discovery. It is an iterative process that involves a dialogue between the data and a mathematical model. As more is learned about the data, the model is refined and new questions are formed. The computer aids in this journey in some essential ways. First, it produces graphs that are specifically designed for data analysis. These graphical displays make it easier to observe patterns in data, to identify important subgroups of the data, and to locate any unusual data points. Second, the computer allows the student to fit complex mathematical models to the data and to assess how well the model fits the data by examining the residuals. Finally, the computer is helpful in identifying an observation that has an undue influence on the analysis and in isolating its effects.

In addition to its use in data analysis, the computer facilitates the simulation approach to probability that is emphasized in the AP Statistics course. Probabilities of random events, probability distributions of random variables, and sampling distributions of statistics can be studied conceptually, using simulation. This frees the student and teacher from a narrow approach that depends on a few simple probabilistic models.

Because the computer is central to what statisticians do, it is considered essential for teaching the AP Statistics course. However, it is not yet possible for students to have access to a computer during the AP Statistics Exam. Without a computer and under the conditions of a timed exam, students cannot be asked to perform the amount of computation that is needed for many statistical investigations. Consequently, standard computer output will be provided as necessary and students will be expected to interpret it. (See two examples of computer output in the Multiple-Choice Questions section on pages 20 and 22.)

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A graphing calculator is a useful computational aid, particularly in analyzing small data sets, but should not be considered equivalent to a computer in the teaching of statistics. If a graphing calculator is used in the course, its computational capabilities should include standard statistical univariate and bivariate summaries through linear regression. Its graphical capabilities should include common univariate and bivariate displays such as histograms, boxplots, and scatterplots. Students find calculators where data are entered into a spreadsheet format particularly easy to use. Ideally, students should have access to both computers and calculators for work in and outside the classroom.

Currently, the graphing calculator is the only computational aid that is available to students for use as a tool for data analysis on the AP Exam. Students who utilize graphing calculators on the exam should be aware of the following policy.

> It is not only inappropriate, but unethical, for students who are taking the AP Statistics Exam to have access to any information in their graphing calculators or elsewhere that is not directly related to upgrading the statistical functionality of older graphing calculators to make them comparable to statistical features found on newer models.
>
> During the exam, students are not permitted to have access to any information in their graphing calculators or elsewhere that is not directly related to upgrading the statistical functionality of older graphing calculators to make them comparable to statistical features found on newer models.
>
> Acceptable upgrades include improving the calculator's computational functionalities and/or graphical functionalities for data that students key into the calculator while taking the exam.
>
> Unacceptable enhancements include, but are not limited to, keying or scanning text or response templates into the calculator. Students attempting to augment the capabilities of their graphing calculators in any way other than for the purpose of upgrading features, as described above, will be considered to be cheating on the exam.

Formulas and Tables

Students enrolled in the AP Statistics course should concentrate their time and effort on developing a thorough understanding of the fundamental concepts of statistics. They do not need to memorize formulas.

The following list of formulas and tables will be furnished to students taking the AP Statistics Exam. Teachers are encouraged to familiarize their students with the form and notation of these formulas by making them accessible at the appropriate times during the course.

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I. Descriptive Statistics

$$\bar{x} = \frac{\sum x_i}{n}$$

$$s_x = \sqrt{\frac{1}{n-1}\sum (x_i - \bar{x})^2}$$

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)}}$$

$$\hat{y} = b_0 + b_1 x$$

$$b_1 = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2}$$

$$b_0 = \bar{y} - b_1 \bar{x}$$

$$r = \frac{1}{n-1}\sum \left(\frac{x_i - \bar{x}}{s_x}\right)\left(\frac{y_i - \bar{y}}{s_y}\right)$$

$$b_1 = r\frac{s_y}{s_x}$$

$$s_{b_1} = \frac{\sqrt{\frac{\sum (y_i - \hat{y}_i)^2}{n-2}}}{\sqrt{\sum (x_i - \bar{x})^2}}$$

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II. Probability

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

$$E(X) = \mu_x = \sum x_i p_i$$

$$Var(X) = \sigma_x^2 = \sum (x_i - \mu_x)^2 p_i$$

If X has a binomial distribution with parameters n and p, then:

$$P(X = k) = \binom{n}{k} p^k (1 - p)^{n-k}$$

$$\mu_x = np$$

$$\sigma_x = \sqrt{np(1 - p)}$$

$$\mu_{\hat{p}} = p$$

$$\sigma_{\hat{p}} = \sqrt{\frac{p(1 - p)}{n}}$$

If $\bar{x}$ is the mean of a random sample of size n from an infinite population with mean μ and standard deviation σ, then:

$$\mu_{\bar{x}} = \mu$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

III. Inferential Statistics

Standardized test statistic: $\dfrac{\text{statistic} - \text{parameter}}{\text{standard deviation of statistic}}$

Confidence interval: statistic $\pm$ (critical value) $\bullet$ (standard deviation of statistic)

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Single-Sample

Statistic	Standard Deviation of Statistic
Sample Mean	$\frac{\sigma}{\sqrt{n}}$
Sample Proportion	$\sqrt{\frac{p(1-p)}{n}}$

Two-Sample

Statistic	Standard Deviation of Statistic
Difference of sample means	$\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$ Special case when $\sigma_1 = \sigma_2$ $\sigma\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$
Difference of sample proportions	$\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}$ Special case when $p_1 = p_2$ $\sqrt{p(1-p)}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$

$$\text{Chi-square test statistic} = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

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Table entry for z is the probability lying below z.

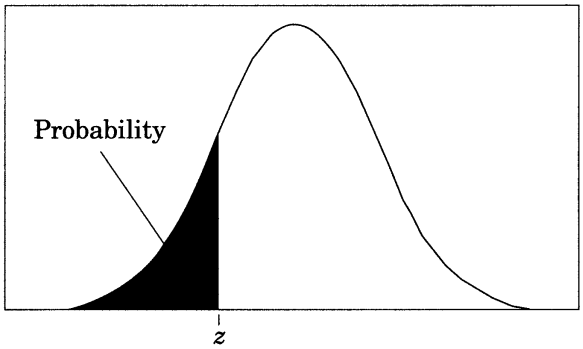

Table A Standard normal probabilities

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
–3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
–3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
–3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
–3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
–3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
–2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
–2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
–2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
–2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
–2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
–2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
–2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
–2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
–2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
–2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
–1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
–1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
–1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
–1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
–1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
–1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
–1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
–1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
–1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
–1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
–0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
–0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
–0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
–0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
–0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
–0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
–0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
–0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
–0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
–0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

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Table entry for z is the probability lying below z.

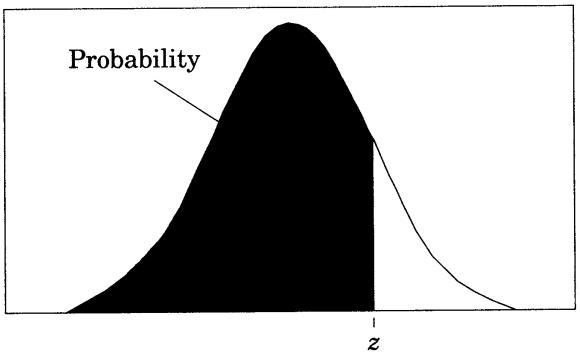

Table A *(Continued)* Standard normal probabilities

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

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Table entry for p and C is the point t^* with probability p lying above it and probability C lying between $-t^*$ and t^*.

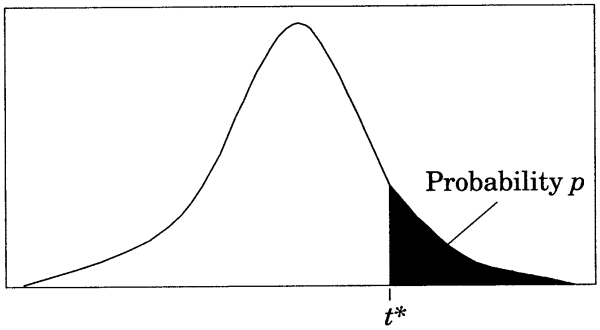

Table B t distribution critical values

	Tail probability p											
df	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
1	1.000	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
2	.816	1.061	1.386	1.886	2.920	4.303	4.849	6.965	9.925	14.09	22.33	31.60
3	.765	.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	.741	.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	.727	.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	.718	.906	1.134	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	.711	.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	.706	.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	.703	.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	.700	.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	.697	.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	.695	.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	.694	.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	.692	.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	.691	.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	.690	.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	.689	.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	.688	.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	.688	.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	.687	.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	.686	.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	.686	.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	.685	.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	.685	.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	.684	.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	.684	.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	.684	.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	.683	.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	.683	.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	.683	.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	.681	.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	.679	.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	.679	.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	.678	.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	.677	.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.390
1000	.675	.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.300
∞	.674	.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.291
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9%
	Confidence level C											

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Table entry for p is the point (χ^2) with probability p lying above it.

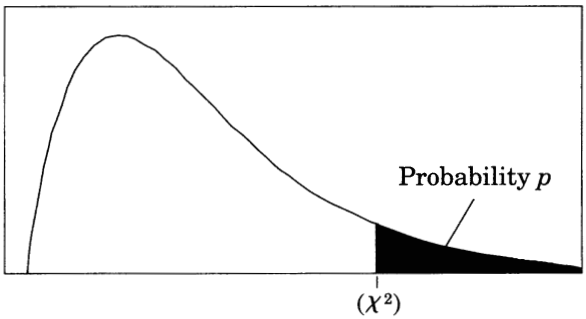

Table C χ^2 critical values

	Tail probability p										
df	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001
1	1.32	1.64	2.07	2.71	3.84	5.02	5.41	6.63	7.88	9.14	10.83
2	2.77	3.22	3.79	4.61	5.99	7.38	7.82	9.21	10.60	11.98	13.82
3	4.11	4.64	5.32	6.25	7.81	9.35	9.84	11.34	12.84	14.32	16.27
4	5.39	5.99	6.74	7.78	9.49	11.14	11.67	13.28	14.86	16.42	18.47
5	6.63	7.29	8.12	9.24	11.07	12.83	13.39	15.09	16.75	18.39	20.51
6	7.84	8.56	9.45	10.64	12.59	14.45	15.03	16.81	18.55	20.25	22.46
7	9.04	9.80	10.75	12.02	14.07	16.01	16.62	18.48	20.28	22.04	24.32
8	10.22	11.03	12.03	13.36	15.51	17.53	18.17	20.09	21.95	23.77	26.12
9	11.39	12.24	13.29	14.68	16.92	19.02	19.68	21.67	23.59	25.46	27.88
10	12.55	13.44	14.53	15.99	18.31	20.48	21.16	23.21	25.19	27.11	29.59
11	13.70	14.63	15.77	17.28	19.68	21.92	22.62	24.72	26.76	28.73	31.26
12	14.85	15.81	16.99	18.55	21.03	23.34	24.05	26.22	28.30	30.32	32.91
13	15.98	16.98	18.20	19.81	22.36	24.74	25.47	27.69	29.82	31.88	34.53
14	17.12	18.15	19.41	21.06	23.68	26.12	26.87	29.14	31.32	33.43	36.12
15	18.25	19.31	20.60	22.31	25.00	27.49	28.26	30.58	32.80	34.95	37.70
16	19.37	20.47	21.79	23.54	26.30	28.85	29.63	32.00	34.27	36.46	39.25
17	20.49	21.61	22.98	24.77	27.59	30.19	31.00	33.41	35.72	37.95	40.79
18	21.60	22.76	24.16	25.99	28.87	31.53	32.35	34.81	37.16	39.42	42.31
19	22.72	23.90	25.33	27.20	30.14	32.85	33.69	36.19	38.58	40.88	43.82
20	23.83	25.04	26.50	28.41	31.41	34.17	35.02	37.57	40.00	42.34	45.31
21	24.93	26.17	27.66	29.62	32.67	35.48	36.34	38.93	41.40	43.78	46.80
22	26.04	27.30	28.82	30.81	33.92	36.78	37.66	40.29	42.80	45.20	48.27
23	27.14	28.43	29.98	32.01	35.17	38.08	38.97	41.64	44.18	46.62	49.73
24	28.24	29.55	31.13	33.20	36.42	39.36	40.27	42.98	45.56	48.03	51.18
25	29.34	30.68	32.28	34.38	37.65	40.65	41.57	44.31	46.93	49.44	52.62
26	30.43	31.79	33.43	35.56	38.89	41.92	42.86	45.64	48.29	50.83	54.05
27	31.53	32.91	34.57	36.74	40.11	43.19	44.14	46.96	49.64	52.22	55.48
28	32.62	34.03	35.71	37.92	41.34	44.46	45.42	48.28	50.99	53.59	56.89
29	33.71	35.14	36.85	39.09	42.56	45.72	46.69	49.59	52.34	54.97	58.30
30	34.80	36.25	37.99	40.26	43.77	46.98	47.96	50.89	53.67	56.33	59.70
40	45.62	47.27	49.24	51.81	55.76	59.34	60.44	63.69	66.77	69.70	73.40
50	56.33	58.16	60.35	63.17	67.50	71.42	72.61	76.15	79.49	82.66	86.66
60	66.98	68.97	71.34	74.40	79.08	83.30	84.58	88.38	91.95	95.34	99.61
80	88.13	90.41	93.11	96.58	101.9	106.6	108.1	112.3	116.3	120.1	124.8
100	109.1	111.7	114.7	118.5	124.3	129.6	131.1	135.8	140.2	144.3	149.4

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THE EXAM

The AP Statistics Exam is three hours long and seeks to determine how well a student has mastered the concepts and techniques of the subject matter of the course. This paper-and-pencil exam consists of (1) a 90-minute multiple-choice section testing proficiency in a wide variety of topics, and (2) a 90-minute free-response section requiring the student to answer open-ended questions and to complete an investigative task involving more extended reasoning. In the determination of the grade for the exam, the two sections will be given equal weight. Each student will be expected to bring a graphing calculator with statistical capabilities to the exam. The expected computational and graphic features for these calculators are described in an earlier section. Minicomputers, pocket organizers, electronic writing pads (e.g., Newton), and calculators with QWERTY (i.e., typewriter) keyboards will not be allowed. Calculator memories will not be cleared. However, calculator memories may be used only for storing programs, not for storing notes. During the exam, students are not permitted to have access to any information in their graphing calculators or elsewhere that is not directly related to upgrading the statistical functionality of older graphing calculators to make them comparable to statistical features found on newer models. Acceptable upgrades include improving the calculator's computational functionalities and/or graphical functionalities for data that students key into the calculator while taking the exam. Unacceptable enhancements include, but are not limited to, keying or scanning text or response templates into the calculator. Students attempting to augment the capabilities of their graphing calculators in any way other than for the purpose of upgrading features as described above will be considered to be cheating on the exam. A student may bring up to two calculators to the exam.

Multiple-Choice Questions

The following are examples of the kinds of multiple-choice questions found on the AP Statistics Exam; the answers to these questions follow question 18. The distribution of topics and the levels of difficulty are illustrative of the composition of the exam; however, this group of questions does not constitute a complete exam, nor does it show the complete range of questions that appear in an exam.

Students often ask whether they should guess on the multiple-choice section. Haphazard or random guessing is unlikely to improve scores, because one-fourth of the number of questions answered incorrectly will be subtracted from the number of questions answered correctly. However, students who have some knowledge of a question and can eliminate one or more answer choices will usually find it advantageous to guess from among the remaining choices.

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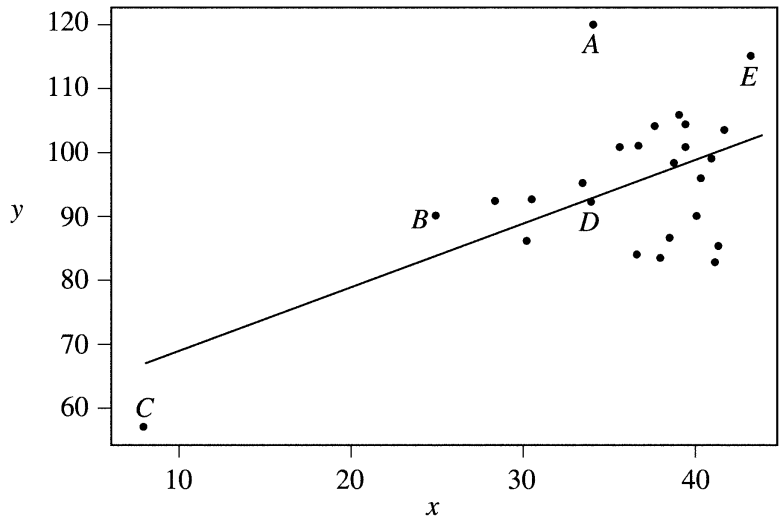

1. In the scatterplot of y versus x shown above, the least squares regression line is superimposed on the plot. Which of the following points has the largest residual?

   (A) A
   (B) B
   (C) C
   (D) D
   (E) E

2. Under which of the following conditions is it preferable to use stratified random sampling rather than simple random sampling?

   (A) The population can be divided into a large number of strata so that each stratum contains only a few individuals.
   (B) The population can be divided into a small number of strata so that each stratum contains a large number of individuals.
   (C) The population can be divided into strata so that the individuals in each stratum are as much alike as possible.
   (D) The population can be divided into strata so that the individuals in each stratum are as different as possible.
   (E) The population can be divided into strata of equal sizes so that each individual in the population still has the same chance of being selected.

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3. All bags entering a research facility are screened. Ninety-seven percent of the bags that contain forbidden material trigger an alarm. Fifteen percent of the bags that do not contain forbidden material also trigger the alarm. If 1 out of every 1,000 bags entering the building contains forbidden material, what is the probability that a bag that triggers the alarm will actually contain forbidden material?

   (A) 0.00097
   (B) 0.00640
   (C) 0.03000
   (D) 0.14550
   (E) 0.97000

4. A candy company claims that 10 percent of its candies are blue. A random sample of 200 of these candies is taken, and 16 are found to be blue. Which of the following tests would be most appropriate for establishing whether the candy company needs to change its claim?

   (A) Matched pairs *t*-test
   (B) One-sample proportion *z*-test
   (C) Two-sample *t*-test
   (D) Two-sample proportion *z*-test
   (E) Chi-square test of association

DESCRIPTIVE STATISTICS

Variable	N	Mean	Median	TrMean	StDev	SE Mean
score	50	1045.7	1024.7	1041.9	221.9	31.4

Variable	Minimum	Maximum	Q1	Q3
score	628.9	1577.1	877.7	1219.5

5. Some descriptive statistics for a set of test scores are shown above. For this test, a certain student has a standardized score of $z = -1.2$. What score did this student receive on the test?

   (A) 266.28
   (B) 779.42
   (C) 1008.02
   (D) 1083.38
   (E) 1311.98

6. In a test of H_0: $\mu = 8$ *versus* H_a: $\mu \neq 8$, a sample of size 220 leads to a *p*-value of 0.034. Which of the following must be true?

   (A) A 95% confidence interval for μ calculated from these data will not include $\mu = 8$.
   (B) At the 5% level if H_0 is rejected, the probability of a Type II error is 0.034.
   (C) The 95% confidence interval for μ calculated from these data will be centered at $\mu = 8$.
   (D) The null hypothesis should not be rejected at the 5% level.
   (E) The sample size is insufficient to draw a conclusion with 95% confidence.

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7. A summer resort rents rowboats to customers but does not allow more than four people to a boat. Each boat is designed to hold no more than 800 pounds. Suppose the distribution of adult males who rent boats, including their clothes and gear, is normal with a mean of 190 pounds and standard deviation of 10 pounds. If the weights of individual passengers are independent, what is the probability that a group of four adult male passengers will exceed the acceptable weight limit of 800 pounds?

   (A) 0.023
   (B) 0.046
   (C) 0.159
   (D) 0.317
   (E) 0.977

8. Consider a data set of positive values, at least two of which are not equal. Which of the following sample statistics will be changed when each value in this data set is multiplied by a constant whose absolute value is greater than 1?

   I. The mean
   II. The median
   III. The standard deviation

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

9. Each person in a simple random sample of 2,000 received a survey, and 317 people returned their survey. How could nonresponse cause the results of the survey to be biased?

   (A) Those who did not respond reduced the sample size, and small samples have more bias than large samples.
   (B) Those who did not respond caused a violation of the assumption of independence.
   (C) Those who did not respond were indistinguishable from those who did not receive the survey.
   (D) Those who did not respond represent a stratum, changing the simple random sample into a stratified random sample.
   (E) Those who did respond may differ in some important way from those who did not respond.

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10. In a certain game, a fair die is rolled and a player gains 20 points if the die shows a "6." If the die does not show a "6," the player loses 3 points. If the die were to be rolled 100 times, what would be the expected total gain or loss for the player?

    (A) A gain of about 1,700 points
    (B) A gain of about 583 points
    (C) A gain of about 83 points
    (D) A loss of about 250 points
    (E) A loss of about 300 points

11. The Attila Barbell Company makes bars for weight lifting. The weights of the bars are independent and are normally distributed with a mean of 720 ounces (45 pounds) and a standard deviation of 4 ounces. The bars are shipped 10 in a box to the retailers. The weights of the empty boxes are normally distributed with a mean of 320 ounces and a standard deviation of 8 ounces. The weights of the boxes filled with 10 bars are expected to be normally distributed with a mean of 7,520 ounces and a standard deviation of

    (A) $\sqrt{12}$ ounces
    (B) $\sqrt{80}$ ounces
    (C) $\sqrt{224}$ ounces
    (D) 48 ounces
    (E) $\sqrt{1,664}$ ounces

12. Exercise physiologists are investigating the relationship between lean body mass (in kilograms) and the resting metabolic rate (in calories per day) in sedentary males.

Predictor	Coef	StDev	T	P
Constant	264.0	276.9	0.95	0.363
Mass	22.563	6.360	3.55	0.005

S = 144.9 R-Sq = 55.7% R-Sq(adj) = 51.3%

Based on the computer output above, which of the following is the best interpretation of the value of the slope of the regression line?

    (A) For each additional kilogram of lean body mass, the resting metabolic rate increases on average by 22.563 calories per day.
    (B) For each additional kilogram of lean body mass, the resting metabolic rate increases on average by 264.0 calories per day.
    (C) For each additional kilogram of lean body mass, the resting metabolic rate increases on average by 144.9 calories per day.
    (D) For each additional calorie per day for the resting metabolic rate, the lean body mass increases on average by 22.563 kilograms.
    (E) For each additional calorie per day for the resting metabolic rate, the lean body mass increases on average by 264.0 kilograms.

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13. An investigator was studying a territorial species of Central American termites, *Nasutitermes corniger*. Forty-nine termite pairs were randomly selected; both members of each of these pairs were from the same colony. Fifty-five additional termite pairs were randomly selected; the two members in each of these pairs were from different colonies. The pairs were placed in petri dishes and observed to see whether they exhibited aggressive behavior. The results are shown in the table below.

	Aggressive	Nonaggressive	Total
Same colony	40 (33.5)	9 (15.5)	49
Different colonies	31 (37.5)	24 (17.5)	55
Total	71	33	104

A Chi-square test for homogeneity was conducted, resulting in $\chi^2 = 7.638$. The expected counts are shown in parentheses in the table. Which of the following sets of statements follows from these results?

(A) χ^2 is not significant at the 0.05 level.
(B) χ^2 is significant, $0.01 < p < 0.05$; the counts in the table suggest that termite pairs from the same colony are less likely to be aggressive than termite pairs from different colonies.
(C) χ^2 is significant, $0.01 < p < 0.05$; the counts in the table suggest that termite pairs from different colonies are less likely to be aggressive than termite pairs from the same colony.
(D) χ^2 is significant, $p < 0.01$; the counts in the table suggest that termite pairs from the same colony are less likely to be aggressive than termite pairs from different colonies.
(E) χ^2 is significant, $p < 0.01$; the counts in the table suggest that termite pairs from different colonies are less likely to be aggressive than termite pairs from the same colony.

14. Consider n pairs of numbers (x_1, y_1), (x_2, y_2), . . . , and (x_n, y_n). The mean and standard deviation of the x-values are $\bar{x} = 5$ and $s_x = 4$, respectively. The mean and standard deviation of the y-values are $\bar{y} = 10$ and $s_y = 10$, respectively. Of the following, which could be the least squares regression line?

(A) $\hat{y} = -5.0 + 3.0x$
(B) $\hat{y} = 3.0x$
(C) $\hat{y} = 5.0 + 2.5x$
(D) $\hat{y} = 8.5 + 0.3x$
(E) $\hat{y} = 10.0 + 0.4x$

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15. The mayor of a large city will run for governor if he believes that more than 30 percent of the voters in the state already support him. He will have a survey firm ask a random sample of n voters whether or not they support him. He will use a large sample test for proportions to test the null hypothesis that the proportion of all voters who support him is 30 percent or less against the alternative that the percentage is higher than 30 percent. Suppose that 35 percent of all voters in the state actually support him. In which of the following situations would the power for this test be highest?

    (A) The mayor uses a significance level of 0.01 and n = 250 voters.
    (B) The mayor uses a significance level of 0.01 and n = 500 voters.
    (C) The mayor uses a significance level of 0.01 and n = 1,000 voters.
    (D) The mayor uses a significance level of 0.05 and n = 500 voters.
    (E) The mayor uses a significance level of 0.05 and n = 1,000 voters.

16. George and Michelle each claimed to have the better recipe for chocolate chip cookies. They decided to conduct a study to determine whose cookies were really better. They each baked a batch of cookies using their own recipe. George asked a random sample of his friends to taste his cookies and to complete a questionnaire on their quality. Michelle asked a random sample of her friends to complete the same questionnaire for her cookies. They then compared the results. Which of the following statements about this study is <u>false</u>?

    (A) Because George and Michelle have a different population of friends, their sampling procedure makes it difficult to compare the recipes.
    (B) Because George and Michelle each used only their own respective recipes, their cooking ability is confounded with the recipe quality.
    (C) Because George and Michelle each used only the ovens in their houses, the recipe quality is confounded with the characteristics of the oven.
    (D) Because George and Michelle used the same questionnaire, their results will generalize to the combined population of their friends.
    (E) Because George and Michelle each baked one batch, there is no replication of the cookie recipes.

17. A large company is considering opening a franchise in St. Louis and wants to estimate the mean household income for the area using a simple random sample of households. Based on information from a pilot study, the company assumes that the standard deviation of household incomes is σ = \$7,200. Of the following, which is the least number of households that should be surveyed to obtain an estimate that is within \$200 of the true mean household income with 95 percent confidence?

    (A) 75
    (B) 1,300
    (C) 5,200
    (D) 5,500
    (E) 7,700

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18. Courtney has constructed a cricket out of paper and rubber bands. According to the instructions for making the cricket, when it jumps it will land on its feet half of the time and on its back the other half of the time. In the first 50 jumps, Courtney's cricket landed on its feet 35 times. In the next 10 jumps, it landed on its feet only twice. Based on this experience, Courtney can conclude that

    (A) the cricket was due to land on its feet less than half the time during the final 10 jumps, since it had landed too often on its feet during the first 50 jumps
    (B) a confidence interval for estimating the cricket's true probability of landing on its feet is wider after the final 10 jumps than it was before the final 10 jumps
    (C) a confidence interval for estimating the cricket's true probability of landing on its feet after the final 10 jumps is exactly the same as it was before the final 10 jumps
    (D) a confidence interval for estimating the cricket's true probability of landing on its feet is more narrow after the final 10 jumps than it was before the final 10 jumps
    (E) a confidence interval for estimating the cricket's true probability of landing on its feet based on the initial 50 jumps does not include 0.2, so there must be a defect in the cricket's construction to account for the poor showing in the final 10 jumps

Answers to Multiple-Choice Questions

1 – A	4 – B	7 – A	10 – C	13 – E	16 – D
2 – C	5 – B	8 – E	11 – C	14 – D	17 – C
3 – B	6 – A	9 – E	12 – A	15 – E	18 – D

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Free-Response Questions

In the free-response section of the AP Statistics Exam, students are asked to answer five questions and complete an investigative task. Each question is designed to be answered in approximately 12 minutes. The longer investigative task is designed to be answered in approximately 30 minutes.

Statistics is a discipline in which clear and complete communication is an essential skill. The free-response questions on the AP Statistics Exam require students to use their analytical, organizational, and communication skills to formulate cogent answers and provide students with an opportunity to:

- Relate two or more different content areas (i.e., elementary data analysis, experimental design and sampling, probability, and statistical inference) as they formulate a complete response or solution to a statistics or probability problem.
- Demonstrate their mastery of statistics in a response format that permits the students to determine *how* they will organize and present each response.

The purpose of the investigative task is not only to evaluate the student's understanding in several content areas but also to assess his or her ability to integrate statistical ideas and apply them in a new context or in a nonroutine way.

Scoring of Free-Response Questions

The evaluation of student responses on the free-response section of the AP Statistics Exam reflects the dual importance of statistical knowledge and good communication. The free-response questions and the investigative task are scored "holistically"; that is, each question's response is evaluated as "a complete package." With holistic scoring, after reading through the details of a student's response, the scorer makes a judgment about the *overall quality* of the response. This is different from "analytic" scoring, where the individual components to be evaluated in a student's response are specified in advance, and each component is given a value counting toward the overall score.

Holistic scoring is well suited for questions where the student is required to synthesize information and respond at least partially in written paragraphs, and for questions that could potentially generate multiple, and diverse, but equally correct, responses. For example, an open-ended question may present data from a real-life study and ask the student not only to analyze the data but also to comment on how the study's protocol might be improved. Comments on improving the protocol might focus on improving the sampling method, controlling confounding variables, or seeking more power by increasing the sample size. In this context, holistic scoring represents a recognition not only of the existence of multiple reasonable approaches to a statistical analysis, but a realization of the existence of a statistical synergy—i.e., that a quality student response is more than just the sum of its parts.

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The AP Statistics scoring guideline (rubric) for each free-response question has five categories, numerically scored on a 0 to 4 scale. Each of these categories represents a level of quality in the student response. These levels of quality are defined on two dimensions: statistical knowledge and communication. The specific rubrics for each question are tied to a general template, which represents the descriptions of the quality levels as envisioned by the Development Committee. This general template is given in the following table, "A Guide to Scoring Free-Response Statistics Questions."

A GUIDE TO SCORING FREE-RESPONSE STATISTICS QUESTIONS: THE CATEGORY DESCRIPTORS

Score Descriptors	Statistical Knowledge	Communication
	Identification of the important components of the problem Demonstration of the statistical concepts and techniques that result in a correct solution of the problem	Explanation of what was done and why, along with a statement of conclusions drawn
4 Complete	• shows complete understanding of the problem's statistical components • synthesizes a correct relationship among these components, perhaps with novelty and creativity • uses appropriate and correctly executed statistical techniques • May have minor arithmetic errors, but answers are still reasonable	• provides a clear, organized, and complete explanation, using correct terminology, of what was done and why • states appropriate assumptions and caveats • uses diagrams or plots when appropriate to aid in describing the solution • states an appropriate and complete conclusion

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3 Substantial	• shows substantial understanding of the problem's statistical components • synthesizes a relationship among these components, perhaps with minor gaps • uses appropriate statistical techniques • may have arithmetic errors, but answers are still reasonable	• provides a clear but not perfectly organized explanation, using correct terminology, of what was done and why, but explanation may be slightly incomplete • may miss necessary assumptions or caveats • uses diagrams or plots when appropriate to aid in describing the solution • states a conclusion that follows from the analysis but may be somewhat incomplete
2 Developing	• shows some understanding of the problem's statistical components • shows little in the way of a relationship among these components • uses some appropriate statistical techniques, but misses or misuses others • may have arithmetic errors that result in unreasonable answers	• provides some explanation of what was done, but explanation may be vague and difficult to interpret and terminology may be somewhat inappropriate • uses diagrams in an incomplete or ineffective way, or diagrams may be missing • states a conclusion that is incomplete
1 Minimal	• shows limited understanding of the problem's statistical components by failing to identify important components • shows little ability to organize a solution and may use irrelevant information • misuses or fails to use appropriate statistical techniques • has arithmetic errors that result in unreasonable answers	• provides minimal or unclear explanation of what was done or why it was done, and explanation may not match the presented solution • fails to use diagrams or plots, or uses them incorrectly • states an incorrect conclusion or fails to state a conclusion
0	• shows little to no understanding of statistical components	• provides no explanation of a legitimate strategy

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Some important points that students should remember when answering free-response questions on the AP Statistics Exam are given below.

1. Read the questions carefully and answer them in context; for example, the results of a hypothesis test should always be followed by a conclusion in context, and a confidence interval should always be followed by an interpretation of the interval in context. Explanations and conclusions in context are always required for a complete answer.
2. Know the vocabulary of statistics, and use that vocabulary correctly in all written responses.
3. Remember to define all symbols. Specifically, remember to distinguish between population parameters and sample statistics.
4. Remember to state and check all necessary assumptions when performing hypothesis tests and constructing interval estimates.
5. Be able to interpret data displayed in a variety of ways, including graphs and computer outputs. Be able to represent data in a variety of forms and base sound statistical arguments on these representations.

AP Central contains free-response questions, scoring guidelines, and selected student responses from past AP Statistics exams. This is an excellent place to become more familiar with the content of past free-response questions and how they were scored.

The following questions are examples of free-response questions. These questions were administered as part of a previous year's exam.

1. The summary statistics for the number of inches of rainfall in Los Angeles for 117 years, beginning in 1877, are shown below.

N	MEAN	MEDIAN	TRMEAN	STDEV	SE MEAN
117	14.941	13.070	14.416	6.747	0.624

MIN	MAX	Q1	Q3
4.850	38.180	9.680	19.250

(a) Describe a procedure that uses these summary statistics to determine whether there are outliers.

(b) Are there outliers in these data?
Justify your answer based on the procedure that you described in part (a).

(c) The news media reported that in a particular year, there were <u>only</u> 10 inches of rainfall. Use the information provided to comment on this reported statement.

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2. A department supervisor is considering purchasing one of two comparable photocopy machines, *A* or *B*. Machine *A* costs $10,000 and machine *B* costs $10,500. This department replaces photocopy machines every three years. The repair contract for machine *A* costs $50 per month and covers an unlimited number of repairs. The repair contract for machine *B* costs $200 per repair. Based on past performance, the distribution of the number of repairs needed over any one-year period for machine *B* is shown below.

Number of Repairs	0	1	2	3
Probability	0.50	0.25	0.15	0.10

You are asked to give a recommendation based on overall cost as to which machine, *A* or *B*, along with its repair contract, should be purchased. What would your recommendation be? Give a statistical justification to support your recommendation.

3. Every Monday a local radio station gives coupons away to 50 people who correctly answer a question about a news fact from the previous day's newspaper. The coupons given away are numbered from 1 to 50, with the first person receiving coupon 1, the second person receiving coupon 2, and so on, until all 50 coupons are given away. On the following Saturday, the radio station randomly draws numbers from 1 to 50 and awards cash prizes to the holders of the coupons with these numbers. Numbers continue to be drawn without replacement until the total amount awarded first equals or exceeds $300. If selected, coupons 1 through 5 each have a cash value of $200, coupons 6 through 20 each have a cash value of $100, and coupons 21 through 50 each have a cash value of $50.

   (a) Explain how you would conduct a simulation using the random number table provided below to estimate the distribution of the number of prize winners each week.

   (b) Perform your simulation three times. (That is, run three trials of your simulation.) Start at the leftmost digit in the first row of the table and move across. Make your procedure clear so that someone can follow what you did. You must do this by marking directly on or above the table. <u>Report the number of winners in each of your three trials</u>.

72749	13347	65030	26128	49067	02904	49953	74674	94617	13317
81638	36566	42709	33717	59943	12027	46547	61303	46699	76423
38449	46438	91579	01907	72146	05764	22400	94490	49833	09258

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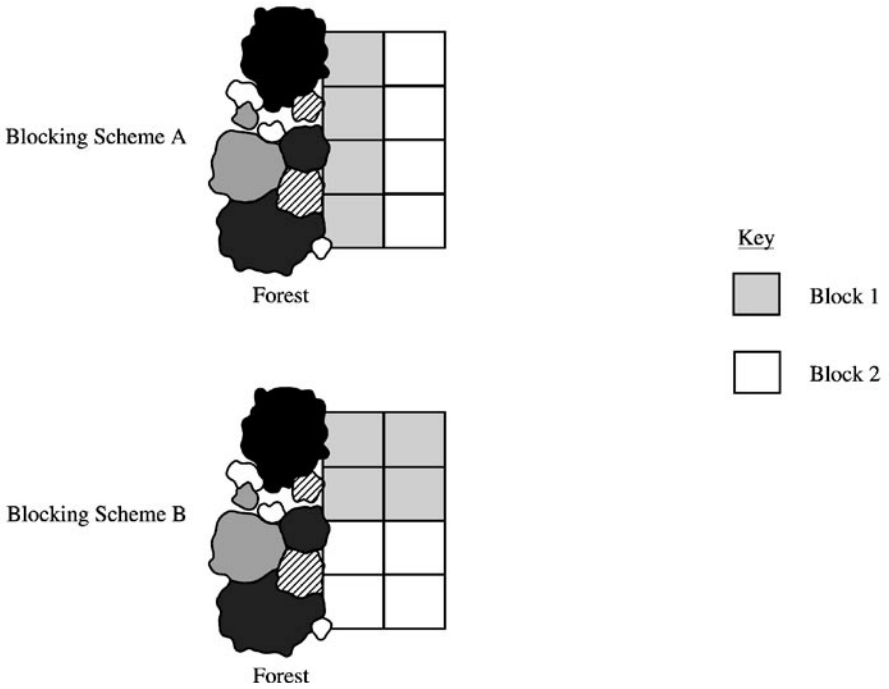
4. Students are designing an experiment to compare the productivity of two varieties of dwarf fruit trees. The site for the experiment is a field that is bordered by a densely forested area on the west (left) side. The field has been divided into eight plots of approximately the same area. The students have decided that the test plots should be blocked. Four trees, two of each of the two varieties, will be assigned at random to the four plots within each block, with one tree planted in each plot.

   The two blocking schemes shown below are under consideration.
   For each scheme, one block is indicated by the white region and the other block is indicated by the gray region in the figures.



   (a) Which of the blocking schemes, A or B, is better for this experiment? Explain your answer.
   (b) Even though the students have decided to block, they must randomly assign the varieties of trees to the plots within each block. What is the purpose of this randomization in the context of this experiment?

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5. A growing number of employers are trying to hold down the costs that they pay for medical insurance for their employees. As part of this effort, many medical insurance companies are now requiring clients to use generic brand medicines when filling prescriptions. An independent consumer advocacy group wanted to determine if there was a difference, in milligrams, in the amount of active ingredient between a certain "name" brand drug and its generic counterpart. Pharmacies may store drugs under different conditions. Therefore, the consumer group randomly selected ten different pharmacies in a large city and filled two prescriptions at each of these pharmacies, one for the "name" brand and the other for the generic brand of the drug. The consumer group's laboratory then tested a randomly selected pill from each prescription to determine the amount of active ingredient in the pill. The results are given in the following table.

ACTIVE INGREDIENT
(in milligrams)

Pharmacy	1	2	3	4	5	6	7	8	9	10
Name brand	245	244	240	250	243	246	246	246	247	250
Generic brand	246	240	235	237	243	239	241	238	238	234

Based on these results, what should the consumer group's laboratory report about the difference in the active ingredient in the two brands of pills? Give appropriate statistical evidence to support your response.

6. The statistics department at a large university is trying to determine if it is possible to predict whether an applicant will successfully complete the Ph.D. program or will leave before completing the program. The department is considering whether GPA (grade point average) in undergraduate statistics and mathematics courses (a measure of performance) and mean number of credit hours per semester (a measure of workload) would be helpful measures. To gather data, a random sample of 20 entering students from the past 5 years is taken. The data are given below.

Successfully Completed Ph.D. Program

Student	A	B	C	D	E	F	G	H	I	J	K	L	M
GPA	3.8	3.5	4.0	3.9	2.9	3.5	3.5	4.0	3.9	3.0	3.4	3.7	3.6
Credit hours	12.7	13.1	12.5	13.0	15.0	14.7	14.5	12.0	13.1	15.3	14.6	12.5	14.0

Did Not Complete Ph.D. Program

Student	N	O	P	Q	R	S	T
GPA	3.6	2.9	3.1	3.5	3.9	3.6	3.3
Credit hours	11.1	14.5	14.0	10.9	11.5	12.1	12.0

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The regression output below resulted from fitting a line to the data in each group. The residual plots (not shown) indicated no unusual patterns, and the assumptions necessary for inference were judged to be reasonable.

Successfully Completed Ph.D. Program

Predictor	Coef	StDev	T	P
Constant	23.514	1.684	13.95	0.000
GPA	–2.7555	0.4668	–5.90	0.000
S = 0.5658	R-Sq = 76.0%			

Did Not Complete Ph.D. Program

Predictor	Coef	StDev	T	P
Constant	24.200	3.474	6.97	0.001
GPA	–3.485	1.013	–3.44	0.018
S = 0.8408	R-Sq = 70.3%			

(a) Use an appropriate graphical display to compare the GPA's for the two groups. Write a few sentences commenting on your display.

(b) For the students who successfully completed the Ph.D. program, is there a significant relationship between GPA and mean number of credit hours per semester? Give a statistical justification to support your response.

(c) If a new applicant has a GPA of 3.5 and a mean number of credit hours per semester of 14.0, do you think this applicant will successfully complete the Ph.D. program? Give a statistical justification to support your response.

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AP® Program Essentials

The AP Reading

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AP Grades

The Readers' scores on the essay and problem-solving questions are combined with the results of the computer-scored multiple-choice questions, and the total raw scores are converted to a composite score on AP's 5-point scale:

AP GRADE	QUALIFICATION
5	Extremely well qualified
4	Well qualified
3	Qualified
2	Possibly qualified
1	No recommendation

Grade Distributions

Many teachers want to compare their students' grades with national percentiles. Grade distribution charts are available at AP Central, as is information on how the grade boundaries for each AP grade are established. Grade distribution charts are also available on the AP student site at www.collegeboard.com/apstudents.

Why Colleges Grant Credit, Placement, or Both for AP Grades

Colleges know that the AP grades of incoming students represent a level of achievement equivalent to that of students who take the same course in the colleges' own classrooms. That equivalency is ensured through several AP Program processes:

- College faculty serve on the committees that develop the Course Descriptions and exams in each AP course.
- College faculty are responsible for standard setting and are involved in the evaluation of student responses at the AP Reading.
- AP courses and exams are reviewed and updated regularly based on the results of curriculum surveys at up to 200 colleges and universities, collaborations among the College Board and key educational and disciplinary organizations, and the interactions of committee members with professional organizations in their discipline.

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- Periodic college comparability studies are undertaken in which the performance of college students on AP Exams is compared with that of AP students to confirm that the AP grade scale of 1 to 5 is properly aligned with current college standards.

In addition, the College Board has commissioned studies that use a "bottom-line" approach to validating AP Exam grades by comparing the achievement of AP students with non-AP students in higher level college courses. For example, in the 1998 Morgan and Ramist "21-College" study, AP students who were exempted from introductory courses and who completed a higher level course in college compared favorably, on the basis of their college grades, with students who completed the prerequisite first course in college, then took the second, higher level course in the subject area. Such studies answer the question of greatest concern to colleges: Are AP students who are exempted from introductory courses as well prepared to continue in a subject area as students who took their first course in college? To see the results of several college validity studies, visit apcentral.collegeboard.com/colleges/research. (The complete Morgan and Ramist study can be downloaded from the site.)

Guidelines on Setting Credit and Placement Policies for AP Grades

The College Board has created two useful resources for admissions administrators and academic faculty who need guidance on setting an AP policy for their college or university. The printed guide *AP and Higher Education* provides guidance for colleges and universities in setting AP credit and placement policies. The booklet details how to set an AP policy, summarizes AP research studies, and describes in detail course and exam development and the exam scoring process. AP Central has a section geared toward colleges and universities that provides similar information and additional resources, including links to all AP research studies, Released Exam questions, and sample student responses at varying levels of achievement for each AP Exam. Visit apcentral.collegeboard.com/highered.

The *Advanced Placement Policy Guide* for each AP subject is designed for college faculty responsible for setting their department's AP policy. These folios provide content specific to each AP Exam, including validity research studies and a description of the AP course curriculum. Ordering information for these and other publications can be found in the AP Publications and Other Resources section of this Course Description.

College and University AP Credit and Placement Policies

Each college and university sets its own AP credit and placement policies. The AP Program has created an online search tool, AP Credit Policy Info, that provides links to credit and placement policies at hundreds of colleges and universities. The tool helps students find the credit hours and advanced placement they can receive for qualifying exam scores within each AP subject. AP Credit Policy Info is available at www.collegeboard.com/ap/creditpolicy.

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AP Scholar Awards

The AP Program offers a number of AP Scholar Awards to recognize high school students who have demonstrated college-level achievement through consistently high performance on AP Exams. Although there is no monetary award, students receive an award certificate, and the achievement is acknowledged on grade reports sent to colleges following the announcement of the awards. For detailed information about AP Scholar Awards (including qualification criteria), visit AP Central or contact the College Board's national office. Students can find this information at www.collegeboard.com/apstudents.

AP Calendar

The *AP Program Guide* for education professionals and the *Bulletin for AP Students and Parents* provide important Program information and details on the key events in the AP calendar. Information on ordering or downloading these publications can be found at the back of this book.

Exam Security

All parts of every AP Exam must be kept secure at all times. Forty-eight hours after the exam has been administered, the inserts containing the free-response questions (Section II) can be made available for teacher and student review.* **However, the multiple-choice section (Section I) must remain secure both before and after the exam administration.** No one other than students taking the exam can ever have access to or see the questions contained in Section I—this includes AP Coordinators and all teachers. The multiple-choice section must never be shared, copied in any manner, or reconstructed by teachers and students after the exam. **Schools that knowingly or unknowingly violate these policies will not be permitted to administer AP Exams in the future and may be held responsible for any damages or losses the College Board and/or ETS incur in the event of a security breach.**

Selected multiple-choice questions are reused from year to year to provide an essential method of establishing high exam reliability, controlled levels of difficulty, and comparability with earlier exams. These goals can be attained only when the multiple-choice questions remain secure. This is why teachers cannot view the questions, and students cannot share information about these questions with anyone following the exam administration.

To ensure that all students have an equal opportunity to demonstrate their abilities on the exam, AP Exams must be administered in a uniform manner. **It is extremely important to follow the administration schedule and all procedures outlined in detail in the most recent *AP Coordinator's Manual*.** Please note that AP Studio Art portfolios and their contents are not considered secure testing materials; see the *AP Coordinator's Manual* and the appropriate *AP Examination Instructions* book for further information. The *Manual* also includes directions on how to handle misconduct and other security problems. All schools participating in AP automatically

*The free-response section of the alternate form (used for late-testing administration) is NOT released.

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receive printed copies of the *Manual*. It is also available in PDF format at apcentral.collegeboard.com/coordinators. Any breach of security should be reported to the Office of Testing Integrity immediately (call 800 353-8570 or 609 406-5427, fax 609 406-9709, or e-mail tsreturns@ets.org).

Teacher Support

AP Central® (apcentral.collegeboard.com)

You can find the following Web resources at AP Central (free registration required):

- AP Course Descriptions, AP Exam questions and scoring guidelines, sample syllabi, research reports, and feature articles.
- A searchable Institutes and Workshops database, providing information about professional development events. AP Central offers online events that participants can access from their home or school computers.
- The Course Home Pages (apcentral.collegeboard.com/coursehomepages), which contain insightful articles, teaching tips, activities, lab ideas, and other course-specific content contributed by colleagues in the AP community.
- In-depth FAQs, including brief responses to frequently asked questions about AP courses and exams, the AP Program, and other topics of interest.
- Links to AP publications and products (some available for immediate download) that can be purchased online at the College Board Store (store.collegeboard.com).
- Moderated electronic discussion groups (EDGs) for each AP course to facilitate the exchange of ideas and practices.
- Teachers' Resources database—click on the "Teachers' Resources" tab to search for reviews of textbooks, reference books, documents, Web sites, software, videos, and more. College and high school faculty write the reviews with specific reference to the value of the resources in teaching AP courses.

Online Workshops and Events

College Board online events and workshops are designed to help support and expand the high level of professional development currently offered to teachers in Pre-AP and AP workshops and AP Summer Institutes. Because of budgetary, geographical, and time constraints, not all teachers and administrators are able to take advantage of live, face-to-face workshops. The College Board develops and offers both standard and customized online events and workshops for schools, districts, and states in both live and recorded formats. Online events and workshops are developed and presented by experienced College Board consultants and college faculty. Full-day online workshops are equivalent to one-day, face-to-face workshops and participants can earn CEU credits. For more information, visit apcentral.collegeboard.com/onlineevents.

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Pre-AP®

Pre-AP® is a suite of K–12 professional development resources and services designed to help equip middle school and high school teachers with the strategies and tools they need to engage their students in high-level learning, thereby ensuring that every middle school and high school student has the opportunity to acquire a deep understanding of the skills, habits of mind, and concepts they need to succeed in college.

Pre-AP is based on the following premises. The first is the expectation that all students can perform at rigorous academic levels. This expectation should be reflected in the curriculum and instruction throughout the school so that all students are consistently being challenged to bring their knowledge and skills to the next level.

The second important premise of Pre-AP is the belief that educators can prepare every student for higher intellectual engagement by starting the development of skills and the acquisition of knowledge as early as possible. When addressed effectively, the middle school and high school years can provide a powerful opportunity to help all students acquire the knowledge, concepts, and skills needed to engage in a higher level of learning.

Pre-AP teacher professional development explicitly supports the goal of college as an option for every student. It is important to have a recognized standard for college-level academic work. The AP Program provides these standards for Pre-AP. Pre-AP professional development resources reflect the topics, concepts, and skills taught in AP courses and assessed in AP Exams.

The College Board does not design, develop, or assess courses or examinations labeled "Pre-AP." The College Board discourages the labeling of courses as "Pre-AP." Typically, such courses create a track, thereby limiting access to AP classes. The College Board supports the assertion that all students should have access to preparation for AP and other challenging courses. Courses labeled "Pre-AP" can inappropriately restrict access to AP and other college-level work and, as such, are inconsistent with the fundamental purpose of the College Board's Pre-AP initiatives.

Pre-AP Professional Development

Pre-AP professional development is available through workshops and conferences coordinated by the College Board's regional offices. Pre-AP professional development is divided into three categories:

1. **Vertical Teaming**—Articulation of content and pedagogy across the middle school and high school years. The emphasis is on aligning curricula and improving teacher communication. The intended outcome is a coordinated program of teaching skills and concepts over several years.
2. **Classroom Strategies**—Content-specific classroom strategies for middle school and high school teachers. Various approaches, techniques, and ideas are emphasized.

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3. **Instructional Leadership**—Administrators and other instructional leaders examine how to use Pre-AP professional development—especially AP Vertical Teams®—to create a system that challenges all students to perform at rigorous academic levels.

For a complete list of Pre-AP professional development offerings, please contact your regional office or visit apcentral.collegeboard.com/pre-ap.

AP Publications and Other Resources

A number of AP resources are available to help students, parents, AP Coordinators, and high school and college faculty learn more about the AP Program and its courses and exams. To identify resources that may be of particular use to you, refer to the following key.

AP Coordinators and Administrators . . . . . **A**
College Faculty . . . . . **C**
Students and Parents . . . . . **SP**
Teachers . . . . . **T**

Free Resources

Copies of the following items can be ordered free of charge at apcentral.collegeboard.com/freepubs. Items marked with a computer mouse icon can be downloaded for free from AP Central.

The Value of AP Courses and Exams **A, SP, T**

This brochure, available in English and Spanish, can be used by school counselors and administrators to provide parents and students with information about the many benefits of participation in AP courses and exams.

AP Tools for Schools Resource Kit **A**

This complimentary resource assists schools in building their AP programs. The kit includes the video *Experience College Success*, the brochure *The Value of AP Courses and Exams*, and brief descriptions of the AP Credit Policy Info search tool and the Parent's Night *PowerPoint* presentation.

Experience College Success is a six-minute video that provides a short overview of the AP Program, with commentary from admissions officers, college students, and high school faculty about the benefits of participation in AP courses. Each videotape includes both an English and Spanish version.

Bulletin for AP Students and Parents **SP**

This bulletin provides a general description of the AP Program, including information on the policies and procedures related to taking the exams. It describes each AP Exam, lists the advantages of taking the exams, describes the grade reporting process, and includes the upcoming exam schedule. The *Bulletin* is available in both English and Spanish.

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Get with the Program — SP

All students, especially those from underserved backgrounds, should understand the value of a high-quality education. Written especially for students and their families, this bilingual (Spanish/English) brochure highlights the benefits of participation in the AP Program. (The brochure can be ordered in large quantities for students in grades 8–12.)

AP Program Guide — A

This guide takes the AP Coordinator through the school year step-by-step—organizing an AP program, ordering and administering the AP Exams, AP Exam payment, and grade reporting. It also includes information on teacher professional development, AP resources, and exam schedules.

AP and Higher Education — A, C, T

This publication is intended to inform and help educational professionals at the secondary and postsecondary levels understand the benefits of having a coherent, equitable AP credit and placement policy. Topics included are development of AP courses and exams, grading of AP Exams, exam validation, research studies comparing the performance of AP students with non-AP students, uses of AP Exams by students in college, and how faculty can get involved in the AP Program.

Advanced Placement Policy Guides — A, C, T

These policy guides are designed for college faculty responsible for setting their department's AP policy, and provide, in a subject-specific context, information about AP validity studies, college faculty involvement, and AP course curricular content. There are separate guides for each AP subject field.

Priced Publications

The following items can be ordered through the College Board Store at store.collegeboard.com. Alternatively, you can download an AP Order Form from AP Central at apcentral.collegeboard.com/documentlibrary.

Course Descriptions — A, C, SP, T

Course Descriptions are available for each AP subject. They provide an outline of each AP course's content, explain the kinds of skills students are expected to demonstrate in the corresponding introductory college-level course, and describe the AP Exam. Sample multiple-choice questions with an answer key and sample free-response questions are included.

Note: PDF versions of current AP Course Descriptions for each AP subject may be downloaded free of charge from AP Central and the College Board's Web site for students. Follow the above instructions to purchase printed copies. (The Course Description for AP Computer Science is available in electronic format only.)

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Released Exams C, T

Periodically the AP Program releases a complete copy of each exam. In addition to providing the multiple-choice questions and answers, the publication describes the process of scoring the free-response questions and includes examples of students' actual responses, the scoring standards, and commentary that explains why the responses received the scores they did.

Teacher's Guides T

For those about to teach an AP course for the first time, or for experienced AP teachers who would like to get some fresh ideas for the classroom, the *Teacher's Guide* is an excellent resource. Each *Teacher's Guide* contains syllabi developed by high school teachers currently teaching the AP course and college faculty who teach the equivalent course at colleges and universities. Along with detailed course outlines and innovative teaching tips, you'll also find extensive lists of suggested teaching resources.

AP Vertical Team Guides A, T

AP Vertical Teams (APVT) are made up of teachers from different grade levels who work together to develop and implement a sequential curriculum in a given discipline. Teams help students acquire the skills necessary for success in AP courses. To assist teachers and administrators who are interested in establishing an APVT at their school, the College Board has published these guides: *AP Vertical Teams Guide for English; AP Vertical Teams Guide for Mathematics; AP Vertical Teams Guide for Science; AP Vertical Teams Guide for Social Studies; AP Vertical Teams Guide for World Languages and Cultures; AP Vertical Teams Guide for Fine Arts, Vol. 1: Studio Art; AP Vertical Teams Guide for Fine Arts, Vol. 2: Music Theory;* and *AP Vertical Teams Guide for Fine Arts, Vols. 1 and 2* (set).

Multimedia

APCD® (home version), (multinetwork site license) SP, T

These CD-ROMs are available for AP Calculus AB, AP English Literature, AP European History, and AP U.S. History. They each include actual AP Exams, interactive tutorials, exam descriptions, answers to frequently asked questions, and test-taking strategies. Also included are a listing of resources for further study and a planner to help students schedule and organize their study time.

The teacher version of each CD, which can be licensed for up to 50 workstations, enables you to monitor student progress and provide individual feedback. Included is a Teacher's Manual that gives full explanations along with suggestions for utilizing the APCD in the classroom.

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Electronic Publications

Additional supplemental publications are available in electronic format to be purchased and downloaded from the College Board Store. These include a collection of 13 AP World History Teaching Units, AP Calculus free-response questions and solutions from 1969 to 1997, the *Physics Lab Guide*, and a collection of Java syllabi for AP Computer Science.

Announcements of new electronic publications can be found on the AP Course Home Pages on AP Central (apcentral.collegeboard.com/coursehomepages).

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