

AP Statistics Exam Tips for Students

The AP Statistics Exam consists of two separate sections: Section I 40 Multiple-Choice questions 90 minutes counts 50 percent of exam score

SCORING Multiple Choice:

1 point for each correct answer
0 points for each question left blank
-1/4 point for each incorrect answer

Section II Free-Response questions 90 minutes counts 50 percent of exam score Questions are designed to test your statistical reasoning and your communication skills.

SCORING Free Response:

Five open-ended problems approximately 13 minutes; each count 15 percent of **free-response score**
One investigative task, Problem #6, approximately 25 minutes; counts 25 percent of **free-response score**

Each free-response question is scored on a 0 to 4 scale. General descriptors for each of the scores are: 4 Complete Response NO statistical errors and clear communication
3 Substantial Response Minor statistical error/omission or fuzzy communication
2 Developing Response Important statistical error/omission or lousy communication
1 Minimal Response A "glimmer" of statistical knowledge related to the problem
0 Inadequate Response No glimmer; statistically dangerous to himself and others

Your work is graded holistically, meaning that your entire response to a problem is considered before a score is assigned.

Read your statistics book. Most AP Exam questions start with a paragraph that describes the context of the problem. You need to be able to pick out important statistical cues. The only way you will learn to do that is through hands-on experience.

Practice writing about your statistical thinking. **Your success on the AP Exam depends on how well you explain your reasoning.**

Work as many problems as you can in the weeks leading up to the exam. Your biggest challenge will be determining what statistical technique to use on each question.

On the night before the exam

Get a good night's sleep.

Make sure your calculator is functioning properly. Insert new batteries, and make sure all systems are "go."

Bring a spare calculator if possible.

Relax, and take time to think! Remember that everyone else taking the exam is in a situation identical to yours. Realize that the problems will probably look considerably more complicated than those you have encountered in other math courses. That's because a **statistics course is, necessarily, a "wordy" course.**

Read each question carefully before you begin working. This is especially important for problems with multiple parts or lengthy introductions. Suggestion: Highlight key words and phrases as you read the questions.

Look at graphs and displays carefully. For graphs, note carefully **what is represented on the axes**, and be aware of number scale. Some questions that provide tables of numbers and graphs relating to the numbers can be answered simply by "reading" the graphs.

About graphing calculator use: Your graphing calculator is meant to be a tool, to be used sparingly on some exam questions. Your brain is meant to be your primary tool.

On free-response questions:

Do not feel pressured to work the free-response problems in a linear fashion, for example, 1, 2, 3, 4, 5, 6. Read all of the problems before you begin. Question 1 is meant to be straightforward, so you may want to start with it. Then move to another problem that you feel confident about. Whatever you do, don't run out of time before you get to **Question 6. This Investigative Task counts almost twice as much as any other question.**

Read each question carefully, sentence by sentence, and highlight key words or phrases.

You don't have to answer a free-response question in paragraph form. Sometimes an organized set of bullet points or an algebraic process is preferable.

Specific Advice on Free-Response Questions

On problems where you have to produce a graph:

Label and scale your axes! Do not copy a calculator screen verbatim onto the test.

Don't refer to a graph on your calculator that you haven't drawn. Transfer it to the exam paper. This is part of your burden of good communication.

Communicate your thinking clearly.

Organize your thoughts before you write, just as you would for an English paper.

Write neatly.

Write efficiently. Say what needs to be said, and move on. **Don't ramble.**

The burden of communication is on you. Don't leave it to the reader to make inferences.

Don't contradict yourself.

Avoid bringing your personal ideas and philosophical insights into your response.

When you finish writing your answer, look back. Does the answer make sense? Did you address the context of the problem?

About graphing calculator use:

Don't waste time punching numbers into your calculator unless you're sure it is necessary. Entering lists of numbers into a calculator can be time-consuming, and certainly doesn't represent a display of statistical intelligence.

Do not write directions for calculator button-pushing on the exam!

Avoid calculator syntax, such as normalcdf or 1-PropZTest.

Follow directions. If a problem asks you to "explain" or "justify," then be sure to do so.

Don't "cast a wide net" by writing down everything you know, because you will be graded on everything you write. **If part of your answer is wrong, you will be penalized.**

Don't give parallel solutions. Decide on the best path for your answer, and follow it through to the logical conclusion. **Providing multiple solutions to a single question is generally not to your advantage.** You will be graded on the lesser of the two solutions. Put another way, if one of your solutions is correct and another is incorrect, your response will be scored "incorrect."

The amount of space provided on the free-response questions does not necessarily indicate how much you should write.

If you cannot get an answer to part of a question, make up a plausible answer to use in the remaining parts of the problem.

Content-Specific Tips

I. Exploring Data

When you analyze one-variable data, always **discuss shape, center, and spread**.

Look for patterns in the data, and then for deviations from those patterns.

Don't confuse median and mean. They are both measures of center, but for a given data set, they may differ by a considerable amount.

(a) If distribution is skewed right, then mean is greater than median.

(b) If distribution is skewed left, then mean is less than median.

Mean $>$ median is not sufficient to show that a distribution is skewed right.

Mean $<$ median is not sufficient to show that a distribution is skewed left.

Don't confuse standard deviation and variance..

Know how **transformations of a data set affect summary statistics**.

(a) Adding (or subtracting) the same positive number k , to (from) each element in a data set increases (decreases) the mean and median by k . The standard deviation and IQR do not change.

(b) Multiplying all numbers in a data set by a constant k multiplies the mean, median, IQR, and standard deviation by k . For instance, if you multiply all members of a data set by four, then the new set has a standard deviation that is four times larger than that of the original data set, but a variance that is 16 times the original variance.

Simple examples:

Original data set Mean, St. Dev., Variance, Median, IQR, Range

{1,2,3,4,5} 3, 1.4, 1.96, 3, 3, 4

Add 7 to each element of the original data set:

New data set Mean, St. Dev., Variance, Median, IQR, Range

{8,9,10,11,12} 10, 1.4, 1.96, 10, 3, 4

Multiply each element of the original data set by four: New data set Mean, St. Dev., Variance, Median, IQR, Range

{4,8,12,16,20} 12, 5.65, 31.925, 12, 12, 16

Multiply elements of the original data set by four, then add seven: New data set Mean, St. Dev., Variance, Median, IQR, Range

{11,15,19,23,27} 19, 5.65, 31.925, 19, 12, 16

When commenting on shape:

Symmetric is not the same as "equally" or "uniformly" distributed.

Do not say that a distribution "is normal" just because it looks symmetric and unimodal.

Treat the word "normal" as a "four-letter word." You should only use it if you are really sure that it's appropriate in the given situation.

When describing a scatterplot:

Comment on the **direction, shape, and strength** of the relationship.

Look for patterns in the data, and then for deviations from those patterns.

A correlation coefficient near 0 doesn't necessarily mean there are no meaningful relationships between the two variables.

Consider the following data points:

X 2 3 4 5 6 7 8 9 10 11 12

Y 6 30 8 50 10 70 12 90 14 110 16

In this case, $r = .38$, indicating fairly weak correlation, but a scatterplot displays something quite interesting.
Moral of the story: Always plot your data.

Don't confuse correlation coefficient and slope of least-squares regression line.

A slope close to 1 or -1 doesn't mean strong correlation.

An r value close to 1 or -1 doesn't mean the slope of the linear regression line is close to 1 or -1.

The relationship between b (slope of regression line) and r (coefficient of correlation) is

This is on the formula sheet provided with the exam.

Remember that $r^2 > 0$ doesn't mean $r > 0$. For instance, if $r^2 = 0.81$, then $r = 0.9$ or $r = -0.9$.

You should know difference between a scatter plot and a residual plot.

For a residual plot, be sure to comment on:

The balance of positive and negative residuals

The size of the residuals relative to the corresponding y -values

Whether the residuals appear to be randomly distributed

Given a least squares regression line, you should be able to correctly interpret the slope and y -intercept in the context of the problem.

Remember properties of the least-squares regression line:

Contains the point (\bar{X}, \bar{y})

Minimizes the sum of the squared residuals (vertical deviations from the LSRL)

Residual = (actual y -value of data point) - (predicted y -value for that point from the LSRL) $y - \hat{y}$

Realize that logarithmic transformations can be practical and useful. Taking logs cuts down the magnitude of numbers. Also, if there is an exponential relationship between x and y ($y=ab^x$), then a scatterplot of the points $\{(x, \log y)\}$ has a linear pattern.

If the relationship between x and y is described by a power function ($y=ax^b$), then a scatterplot of $(\log x, \log y)$ will have a linear pattern.

II. Surveys, observational studies, and experiments

Know what is required for a sample to be a simple random sample (SRS). If each individual in the population has an equal probability of being chosen for a sample, it doesn't follow that the sample is an SRS. Consider a class of six boys and six girls. I want to randomly pick a committee of two students from this group. I decide to flip a coin. If "heads," I will choose two girls by a random process. If "tails," I will choose two boys by a random process. Now, each student has an equal probability ($1/6$) of being chosen for the committee. However, the two students are not an SRS of size two picked from members of the class. Why not? Because this selection process does not allow for a committee consisting of one boy and one girl. To have an SRS of size two from the class, each group of two students would have to have an equal probability of being chosen as the committee.

SRS refers to how you obtain your sample; random allocation is what you use in an experiment to assign subjects to treatment groups. They are not synonyms.

Well-designed experiments satisfy the principles of control, randomization, and replication.

Control for the effects of lurking variables by comparing several treatments in the same environment. Note: Control is not synonymous with "control group."

Randomization refers to the random allocation of subjects to treatment groups, and not to the selection of subjects for the experiment. Randomization is an attempt to "even out" the effects of lurking variables across the treatment groups. Randomization helps avoid bias.

Replication means using a large enough number of subjects to reduce chance variation in a study.

Note: In science, replication often means, "do the experiment again."

Distinguish the language of surveys from the language of experiments.

Stratifying:sampling vs Blocking:experiment Stratifying is for sample design. Blocking is for Experiments

It is not enough to memorize the terminology related to surveys, observational studies, and experiments. You must be able to apply the terminology in context. For example:

Blocking refers to a deliberate grouping of subjects in an experiment based on a characteristic (such as gender, cholesterol level, race, or age) that you suspect will affect responses to treatments in a systematic way. After blocking, you should randomly assign subjects to treatments within the blocks. Blocking reduces unwanted variability.

An experiment is double blind if neither the subjects nor the experimenters know who is receiving what treatment. A third party can keep track of this information.

Suppose that subjects in an observational study who eat an apple a day get significantly fewer cavities than subjects who eat less than one apple each week. A possible confounding variable is overall diet. Members of the apple-a-day group may tend to eat fewer sweets, while those in the non-apple-eating group may turn to sweets as a regular alternative. Since different diets could contribute to the disparity in cavities between the two groups, we cannot say that eating an apple each day causes a reduction in cavities.

III. Anticipating patterns: probability, simulations, and random variables

You need to be able to describe how you will perform a simulation in addition to actually doing it.

Create a correspondence between random numbers and outcomes.

Explain how you will obtain the random numbers (e.g., move across the rows of the random digits table, examining pairs of digits), and how you will know when to stop.

Make sure you understand the purpose of the simulation -- counting the number of trials until you achieve "success" or counting the number of "successes" or some other criterion.

Are you drawing numbers with or without replacement? Be sure to mention this in your description of the simulation and to perform the simulation accordingly.

If you're not sure how to approach a probability problem on the AP Exam, see if you can design a simulation to get an approximate answer.

Independent events are not the same as mutually exclusive (disjoint) events.

Two events, A and B, are independent if the occurrence or non-occurrence of one of the events has no effect on the probability that the other event occurs.

Events A and B are mutually exclusive if they cannot happen simultaneously.

Recognize a discrete random variable setting when it arises. Be prepared to calculate its mean (expected value) and standard deviation.

Recognize a **binomial situation** when it arises.

The four requirements for a chance phenomenon to be a binomial situation are:

There are a fixed number of trials.

On each trial, there are two possible outcomes that can be labeled "success" and "failure."

The probability of a "success" on each trial is constant.

The trials are independent.

Example: Consider rolling a fair die 10 times. There are 10 trials. Rolling a 6 constitutes a "success," while rolling any other number represents a "failure." The probability of obtaining a 6 on any roll is $1/6$, and the outcomes of successive trials are independent.

Using the TI-83, the probability of getting exactly three sixes is $(10C3)(1/6)^3(5/6)^7$ or $\text{binompdf}(10,1/6,3) = 0.155045$, or about 15.5 percent.

The probability of getting less than four sixes is $\text{binomcdf}(10,1/6,3) = 0.93027$, or about 93 percent. Hence, the probability of getting four or more sixes in 10 rolls of a single die is about 7 percent.

Realize that a binomial distribution can be approximated well by a normal distribution if the number of trials is sufficiently large. If n is the number of trials in a binomial setting, and if p represents the probability of "success" on each trial, then a good rule of thumb states that a normal distribution can be used to approximate the binomial distribution if np is at least 10 and $n(1-p)$ is at least 10.

The primary difference between a binomial random variable and a geometric random variable is what you are counting. A binomial random variable counts the number of "successes" in n trials. A geometric random variable counts the number of trials up to and including the first "success."

IV. Statistical Inference

You must be able to decide which statistical inference procedure is appropriate in a given setting. Working lots of review problems will help you.

You need to know the difference between a population parameter, a sample statistic, and the sampling distribution of a statistic.

On any hypothesis testing problem:

State hypotheses in words and symbols.

Identify the correct inference procedure and verify conditions for using it.

Calculate the test statistic and the P-value (or rejection region).

Draw a conclusion in context that is directly linked to your P-value or rejection region.

On any confidence interval problem:

Identify the population of interest and the parameter you want to draw conclusions about.

Choose the appropriate inference procedure and verify conditions for its use.

Carry out the inference procedure.

Interpret your results in the context of the problem.

You need to know the specific conditions required for the validity of each statistical inference procedure -- confidence intervals and significance tests.

Be familiar with the concepts of Type I error, Type II error, and Power of a test.

Type I error: Rejecting the null hypothesis when it is “true”.

Type II error: Failing to reject a null hypothesis when it is false.

Power of a test: Probability of correctly rejecting a null hypothesis

Power = 1 - P(Type II error).

You can increase the power of a test by increasing the sample size or increasing the significance level (the probability of a Type I error).