

## Hints for Success on the AP Statistics Exam. (Compiled by Zack Bigner)

### The Exam

The AP Stat exam has 2 sections that take 90 minutes each. The first section is 40 multiple choice questions, and the second section is 6 free response questions. Each section counts for half of the overall score. The last free response question counts for 25% of the Section II score.

You are allowed to use your calculator(s) throughout the exam, and a standard set of formulas and tables is printed right in the test booklet for your use.

### General tips for writing Free Response Answers

#### Understand your obligation as a test taker

You are being evaluated not only on the correctness of your answers, but also on your ability to communicate the methods you used to reach them. The answer is everything you write down, not just the last line or number at the end. Convince the reader that you understand the key concepts in the question. Don't just give them the numbers and hope they will assume you understand the concepts.

#### Be smart about multi-part questions

Most AP Stat questions have several parts. Read all the parts before you start answering and think about how they might be related (sometimes they aren't). If the last part asks you to answer a question based on your results to the previous parts, be sure to actually use your prior results to answer. If you couldn't do one of the previous parts, make up an answer and explain what you would have done.

#### Answer the question you are asked

The test writers spend over a year writing these questions. They word them carefully and specifically. Spend more time reading and less time writing to make sure you really understand what is being asked. When you have answered the question asked, stop writing. They give you much more space than you need. Don't panic because you haven't used all the space provided.

#### Answer in context

Most, if not all, AP Stat problems will have a real life context. Make sure your answers include the context. This is especially important when defining symbols/variables and writing conclusions.

#### Use vocabulary carefully

This isn't English class. There's no poetic license here. Terms like normal, independent, and sampling distribution have specific meanings. Don't say "normal" if you mean "approximately normal" and don't mix up populations and samples in either words or symbols.

#### Leave enough time for the last question

The last free response question counts for more points and is designed to take 20 to 30 minutes. At least read it first, and if you feel OK about it, go ahead and answer. If it looks hard, you can save it for the end, but no matter what, when there are 30 minutes left in the test, stop and go to the last question.

#### Relax

Having met many of the people who write the exam and grading standards, I can assure they are not out to trick you. They write challenging but straightforward questions designed to give you an opportunity to demonstrate what you have learned. Seize the opportunity and do your best. Keep in mind that you only need to earn roughly 65 to 70% (it varies from year to year) of the points on the exam to get a 5.

## Collecting Data

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There are 2 broad areas of data collection we cover in AP Stat, Experiments and Sampling. You are expected to know some general concepts and specific techniques related to each area.

### Experiments vs. Samples

Many students confuse experimentation with sampling or try to incorporate ideas from one into the other. This is not totally off-base since some concepts appear in both areas, but it is important to keep them straight.

The purpose of sampling is to estimate a population parameter by measuring a representative subset of the population. We try to create a representative sample by selecting subjects randomly using an appropriate technique.

The purpose of an experiment is to demonstrate a cause and effect relationship by controlling extraneous factors. Experiments are rarely performed on random samples because both ethics and practicality make it impossible to do so. For this reason, there is always a concern of how far we can generalize the results of an experiment. Generalizing results to a population unlike the subjects in the experiment is very dangerous.

### Blocking vs. Stratifying

Students (and teachers) often ask, "What is the difference between blocking and stratifying?" The simple answer is that blocking is done in experiments and stratifying is done with samples. There are similarities between the two, namely the dividing up of subjects before random assignment or selection, but the words are definitely not interchangeable.

### Blocking

In blocking we divide our subjects up in advance based on some factor we know or believe is relevant to the study and then randomly assign treatments within each block. The key things to remember:

1. You don't just block for the heck of it. You block based on some factor that you think will impact the response to the treatment
2. The blocking is not random. The randomization occurs within each block essentially creating 2 or more miniature experiments.
3. Blocks should be homogenous (i.e. alike) with respect to the blocking factor.

For example, I want to find out if playing classical music during tests will result in higher mean scores. I could randomly assign half my students to the room with the music and the other half to the normal room, but I know that my juniors consistently score higher than my seniors, and I want to account for this source of variation in the results. I block according to grade by separating the juniors and seniors first and then randomly assigning half the juniors to the music room and the other half to the normal room. I do the same with the seniors. For this design to be valid, I have to expect that each grade will respond to the music similarly. In other words, I know that juniors will score higher, but I expect to see a similar improvement or decline in both groups as a result of having the music. At the end of my study I can subtract out the effect of grade level to reduce the unaccounted for variation in the results.

You have learned how to analyze the results of one special type of blocked design, namely, matched pairs. In matched pairs you subtract each pair of values which eliminates the variation due to the subject. Similar techniques are available for fancier blocked designs.

## **Stratified Sampling vs. Cluster Sampling**

Many students confuse stratified and cluster sampling since both of them involve groups of subjects. There are 2 key differences between them. First, in stratified sampling we divide up the population based on some factor we believe is important, but in cluster sampling the groups are naturally occurring (I picture schools of fish). Second, in stratified sampling we randomly select subjects from each stratum, but in cluster sampling we randomly select one or more clusters and measure every subject in each selected cluster. (Note: There are more advanced techniques in which samples are taken within the cluster(s))

## **Final Thoughts**

It is especially important to stay focused when answering questions about design. Too many students get caught up in minor details but miss the big ideas of randomization and control. Always remember that your mission in responding to questions is to demonstrate your understanding of the major concepts of the course.

## **Describing Data**

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### **IQR is a number**

Many students write things like "The IQR goes from 15 to 32". Every AP grader knows exactly what you mean, namely, "The box in my boxplot goes from 15 to 32.", but this statement is not correct. The IQR is defined as  $Q3 - Q1$  which gives a single value. Writing the statement above is like saying "17 goes from 15 to 32." It just doesn't make sense.

### **Be able to construct graphs by hand**

You may be asked to draw boxplots (including outliers), stemplots, histograms, or other graphs by hand. The test writers have become very clever and present problems in such a way that you cannot depend on your calculator to graph for you.

### **Label, Label, Label**

Any graph you are asked to draw should have clearly labeled axes with appropriate scales. If you are asked to draw side-by-side boxplots, be sure to label which boxplot is which.

### **Refer to graphs explicitly**

When answering questions based on a graph(s), you need to be specific. Don't just say, "The female times are clearly higher than the male times.", instead say, "The median female time is higher than the first quartile of the male times." You can back up your statements by marking on the graph. The graders look at everything you write, and, often, marks on the graph make the difference between 2 scores.

### **Look at all aspects of data**

When given a set of data or summaries of data, be sure to consider the Center, Spread, Shape, and Outliers/Unusual Features. Often a question will focus on one or two of these areas. Be sure to focus your answer to match.

### **It's skewed which way?**

A distribution is skewed in the direction that the tail goes, not in the direction where the peak is. This sounds backwards to most people, so be careful.

### **Slow down**

The describing data questions appear easy, so many students dive in and start answering without making sure they know what the problem is about. Make sure you know what variable(s) are being measured and read the labels on graphs carefully. You may be given a type of graph that you have never seen before.

# Inference

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## **Not every problem involves inference**

You have spent most if not all of this semester on inference procedures. This leads many students to try to make every problem an inference problem. Be careful not to turn straightforward probability or normal distribution questions into full-blown hypothesis tests.

## **Hypotheses are about populations**

The point of a hypothesis test is to reach a conclusion about a population based on a sample from it. We don't need to make hypotheses about the sample. When writing hypotheses, conclusions, and formulas, be careful with your wording and symbols so that you do not get the population and sample mixed up. For example, *don't* write "Ho:  $\bar{x} = 12$ " or " $\mu =$  mean heart rate of study participants".

## **Check Assumptions/Conditions**

Checking assumptions/conditions is not the same thing as stating them. Checking means actually showing that the assumptions are met by the information given in the problem. For example, don't just write " $np > 10$ ". Write " $np = 150(.32) = 48 > 10$ ". Everyone knows you can do the math in your head or on your calculator, but writing it down makes it very clear to the reader that you're tying the assumption to the problem rather than just writing a list of things you memorized.

## **Confidence intervals have assumptions too**

Confidence intervals have the same assumptions as their matching tests, and you need to check them just as carefully.

## **Link conclusions to your numbers**

Don't just say "I reject Ho and conclude that the mean heart rate for males is greater than 78." This sentence doesn't tell us why you rejected Ho. Instead, say "Since the p-value of .0034 is less than .05, I reject Ho and ..."

## **Be consistent**

Make sure your hypotheses and conclusion match. If you find an error in your computations, change your conclusion if necessary. Even if your numbers are wrong, you will normally get credit for a conclusion that is correct for your numbers. If you get totally stuck and can't come up with a test statistic or p-value, make them up and say what you would conclude from them.

## **Interpreting a confidence interval is different than interpreting the confidence level**

Interpreting the confidence interval usually goes something like, "I am 95% confident that the proportion of AP Statistics students who are highly intelligent is between 88% and 93%" or "The superintendent should give seniors Fridays off since we are 99% confident that between 72% and 81% of parents support this plan."

Interpreting a confidence level usually goes something like "If this procedure were repeated many times, approximately 95% of the intervals produced would contain the true proportion of parents who support the plan."

# Regression

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## Graph First, Calculate Later

The most important part of the regression process is looking at plots. Regression questions will frequently provide a scatterplot of the original data along with a plot of residuals from a linear regression. Look at these plots before answering any part of the question and make sure you understand the scales used.

## Is it linear?

Remember that an  $r$  value is only useful for data we have already decided is linear. Therefore, an  $r$  value does not help you decide **if** data is linear. To determine if data is linear, look at a scatterplot of the original data and the residuals from a linear regression. If a line is an appropriate model, the residuals should appear to be randomly scattered.

## Computer Output

It is very likely that you will be given computer output for a linear regression. If you can read the output correctly, these questions are normally easy. You should be able to write the regression equation using the coefficients in the output and also be able to find the values of  $r$  and  $r^2$ . Most software packages provide the value of  $r^2$ . If you are asked for the value of  $r$ , you will need to take the square root and look at the slope to determine if  $r$  should be positive or negative.

## Interpreting $r$

If asked to interpret an  $r$  value, be sure to include strength, direction, type, and the context. A good interpretation will be something like, "There is a weak positive linear relationship between the number of math classes a person has taken and yearly income."

After you get a 5, be sure to take more statistics in college.