TPS4e AP EXAM TIPS for STUDENTS

Other Exam Tips:

- **"REVIEW TPS AP EXAM REVIEW CARDS"** – THEY HAVE ALL THE DEFINITIONS IN CONTEXT!
  - HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2012/09/TPS-AP-EXAM-REVIEW-CARDS.PDF
- **"COLLEGE BOARD AP STATISTICS COURSE CONTENT OVERVIEW"** – THE OFFICIAL SYLLABUS FOR THE EXAM
  - HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2015/05/COLLEGE-BOARD-AP-STATISTICS-COURSE-CONTENT-OVERVIEW.PDF
- **FORMULAS AND CONDITIONS FOR INFERENCE (CI & TOH)**
  - HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2012/09/AP-STATS-SUMMARY-OF-INFERENCE-TESTS-TPS.PDF

Section I: Exploring Data (20-30%) *CHAPTERS 1-3*

Chapter 1

- If you learn to distinguish categorical from quantitative variables now, it will pay big rewards later. The type of data determines what kinds of graphs and which numerical summaries are appropriate. You will be expected to analyze categorical and quantitative data effectively on the AP exam. (page 3)
- When comparing distributions of quantitative data, it's not enough just to list values for the center and spread of each distribution. You have to explicitly *compare* these values, using words like "greater than," "less than," or "about the same as." Remember CUSS and BS (must have comparative statements in context for center, spread, and shape)! (page 32)
- If you're asked to make a graph on a free-response question, be sure to label and scale your axes. Remember key for stem plots (e.g. 4|7=47). Unless your calculator shows labels and scaling, don't just transfer a calculator screen shot to your paper. (page 39)
- You may be asked to determine whether a quantitative data set has any outliers. Be prepared to state and use the rule **(Q3+1.5*IQR or Q1-1.5*IQR)** for identifying outliers. (pg. 58)
- Use statistical terms carefully and correctly on the AP exam.
  - Don't say "mean" if you really mean "median."
  - Range is a **single number**; so are *Q1*, *Q3*, and *IQR*. Know the 5-number summary.
  - Avoid colloquial use of language, like "the outlier *skews* the mean." Skewed is a shape. If you misuse a term, expect to lose some credit. (page 67)

Chapter 2

- Don't use "calculator speak" when showing your work on free response questions.
  - Writing **normalcdf(305, 325, 304, 8)** will not earn you credit for a Normal calculation.
  - At the very least, you must indicate what each of those calculator inputs represents. For example, "I used normalcdf on my calculator with lower bound 305, upper bound 325, mean 304, and standard deviation 8." **At a minimum label each of the parameters above the calculator command – *LB*, *UB*, *Mean*, *SD*).**
  - Better yet, sketch & label a Normal curve to show what you're finding.(pg. 124)
- Review calculating percentiles and the 68-95-99.7 rule. See example online
  - HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2012/09/AP-STATS-EMPIRICAL-RULE-68-95-99.7.JPG

- Normal probability plots are not included on the AP Statistics course outline. However, these graphs are very useful tools for assessing Normality. You may use them on the AP exam if you wish-just be sure that you know what you're looking for (linear pattern). (page 127)

Chapter 3

- If you're asked to make a scatterplot on a free-response question, be sure to label and scale both axes. Don't copy an unlabeled calculator graph directly onto your paper. (page 150)
- If you're asked to "***interpret a correlation or describe the relationship***," start by looking at scatterplot of the data.
  - Then be sure to addresses ***the association*** between the variables. Include direction, form, strength, & outliers and put your answer in context. (pg. 154)
- Students often have a hard time interpreting the value of r^2 on AP exam questions. They frequently leave out key words in the definition. Our advice: Treat this as a fillin-the-blank exercise.
  - r^2, in context, write "__% of the variation in [response variable name] is accounted for by the regression line." (page 182)
  - ***"r"*** describes the association between the variables.
  - "r^2"describes the strength of the model.
  - Remember if you are given "r^2" and asked for ***"r"*** then the sign of ***"r"*** is the same as the slope.
- There's no firm rule for how many decimal places to show for answers on the AP exam. *Our advice:* Give your answer correct to two or three nonzero decimal places. *Exception:* If you're using one of the tables in the back of the book, give the value shown in the table. (page 169)
- The formula sheet for the AP exam uses different notation for the equations of the slope and y-intercept of the least-squares regression line are $b_1 = r\frac{s_y}{s_x}$ and $b_0 = \bar{y} + b_1\bar{x}$. That's because the least squares line is written $\hat{y} = b_0 + b_1 x$. We prefer the simpler version without the subscripts: $\hat{y}$ = a +bx. (page 172)
- It is important to know how to read computer output (pg. 182) "Beer and Blood Alcohol"
- You need to understand 2 standard deviations. (pg. 182)
  - **s = 0.0204.** "s" is standard deviation of the residuals (units are same as response variable)
    - Interpret "s" in context: **Option 1:** The "standard deviation of the residuals (s)" tells how far off the predicted value for BAC is from the actual BAC on average is about .02 units.
    - **Option 2:** "s" is the typical or average prediction error for BAC. In this case, the standard deviation of the predicting blood alcohol level is roughly .02 units.
  - **S_b= SE_b=.0024.** S_b is the standard error of the slope β. Use this for finding the CI : b±t*SE_b
- Don't forget to put a "hat" on the response variable when you write a regression equation. Calculator and computer output for regression usually doesn't do this. For the regression in Figure 3.17 (page 182), you should write

$$\hat{fat\,gain} = 3.505 - 0.00344(\text{NEA})$$

Section II: Planning a Study (10-15%) *CHAPTERS 4*

Chapter 4

- **Review experimental design concepts**:
  - A VERY GOOD REVIEW OF KEY CONCEPTS. **SEE "REVIEW TPS AP EXAM REVIEW CARDS"**
  - See flowchart online HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2012/08/EXPERIENTAL-DESIGN1.JPG
  - Good HW examples to review – "AP Stats HW 4.2 answers (TPS4e)" HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2012/08/AP-STATS-HW-4.2-ANSWERS-TPS4E1.PDF

- If you are asked to explain the design on an SRS, use the "hat method."
- If you're asked to describe how the design of a study leads to bias, you're expected to identify the **direction** of the bias. Suppose you were asked, "Explain how using a convenience sample of students in your statistics class to estimate the proportion of all high school students who own a graphing calculator could result in bias." You might respond, "This sample would probably include a much higher proportion of students with a graphing calculator than in the population at large because a graphing calculator is required for the statistics class. That is, this method would probably lead to an overestimate of the actual population proportion." (pg. 210)
- If you're asked to identify a possible confounding variable in a given setting, you are expected to explain how the variable you choose (1) is associated with the explanatory variable and (2) affects the response variable. (page 233)
- If you're asked to describe the design of an experiment on the AP exam, you won't get full credit for a diagram like Figure 4.5 (page 239). You are expected to describe how the treatments are assigned to the experimental units and to clearly state what will be measured or compared. Some students prefer to start with a diagram and then add a few sentences. Others choose to skip the diagram and put their entire response in narrative form. (page 239)
- Don't mix the language of experiments and the language of sample surveys or other observational studies. You will lose credit for saying things like "use a randomized block design to select the sample for this survey" or "this experiment suffers from nonresponse since some subjects dropped out during the study." (page 248)

Section III: Anticipating Patterns (20-30%) *CHAPTERS 5-7*

Chapter 5

- **Review probability concepts**: **Tip: Use Tables and Tree Diagrams**
  - A VERY GOOD REVIEW OF KEY DEFINITIONS. **SEE "REVIEW TPS AP EXAM REVIEW CARDS"**
  - Good HW examples to review –
    - "AP Stats HW 5R answers (TPS4e)"
      HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2012/11/AP-STATS-HW-5R-ANSWERS-TPS4E4.PDF
    - "AP Stats HW 5.3 answers (TPS4e)"
      HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2012/11/AP-STATS-HW-5.3-ANSWERS-TPS4E3.PDF

- On the AP exam, you may be asked to describe how you will perform a simulation using rows of random digits. If so, provide a clear enough description of your simulation process for the reader to get the same results you did from *only* your written explanation. (page 291)
- Many probability problems involve simple computations that you can do on your calculator. It may be tempting to just write down *your final answer without showing the supporting work*. Don't do it! A "naked answer," even if it's correct, will usually earn you no credit on a free-response question. (page 308)
- On probability questions, you may usually choose whether to use words or symbols when showing your work. You can write statements like P(A|B) if events A and B are defined clearly, or you can use a verbal equivalent, such as P(reads New York Times I reads USA Today). Use the approach that makes the most sense to you. (page 325)

Chapter 6 *Random Variables (RVs)*

- ***Examples to Review***
  - ***E(X) Expected Value for a discrete RV (in context) (pg. 346)*** *EASY TO CALCULATE BY HAND*
  - ***SD(X) Standard Deviation for a discrete RV (in context) (pg. 347)***
  - ***Know how to calculate E(X) and SD(X) and graph with list [L1] and [L2] (pg. 348)***
  - ***Linear transformations (pg 363)***
  - ***Rules for adding independent RV's (pg 368)*** ← **For SD's think of the Pythagorean Theorem of Stats**
  - ***Rules for subtracting independent RV's (pg 372)*** ← **always add the variances!**
  - ***Sum of Normal RV's (pg 374)*** ← **For SD's, you must find the combined variance 1st then sq.root.**
  - ***Difference of Normal RV's (pg 375)*** ← **remember,always add the variances!**
  - ***Calculate binomial probabilities with the formula on the green sheet (pg388)***
    - **See technology note at top of pg. 388 to find the binomial coefficient**
    - **See technology note at pg. 389 to review BINOMPDF & BINOMCDF commands**

- If the mean of a random variable has a non-integer value, but you report it as an integer, your answer will be marked as incorrect. (page 346)
- When you solve problems involving random variables,
  1. start by defining the random variable of interest. For example, let X= the Apgar score of a randomly selected baby or let Y = the height of a randomly selected young woman.
  2. Then state the probability you're trying to find in terms of the random variable: $P(X \geq 7)$ or $P(68 \leq Y \leq 70)$. (page 352)
- If you have trouble solving problems involving sums and difference of Normal random variables with the algebraic methods of Section 6.2, use the simulation strategy from the Technology Corner on page 376 to earn some (or possibly full) credit. (page 376)
- Don't rely on "calculator speak" when showing your work on free-response questions. Writing binompdf = 0.08789 will not earn you full credit for a binomial probability calculation.
  - At the very least, you must indicate what each of those calculator inputs represents. For example, "I used binompdf (5, 0. 25, 3) on my calculator with n = 5, p = 0.25, and k = 3." Better yet, show the binomial probability formula with these numbers plugged in. (page 389)
- Remember BINS for a binomial model "B(n,p)" and BITS for a geometric model G(p).
- Use the green sheet to find the mean(μ_x) and standard deviation(σ_x) , after checking BINS, for a binomial model. Remember to define the RV with a capital letter. You do not need to know how to find the mean and standard deviation for geometric models.
- For binomial models, using a binomial distribution (page 392) versus the normal approximation (page 396). The binomial probability is more accurate (page 397).
- For geometric models, review the calculator command (page 400) and example (page 399)

Chapter 7

- ***Examples to Review***
  - ***Review key concepts on my website:***
    HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2012/12/CHAPTER-7-SAMPLING-DISTRIBUTIONS.JPG
  - ***Know where to find mean and standard deviation calculations on your green sheet:***
    - $\mu_{\hat{p}} = p \qquad \sigma_{\hat{p}} = \sqrt{np(1-p)}$
    - $\mu_{\bar{x}} = \mu \qquad \sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$
  - ***Sampling Distribution for a Sample Mean (pg. 447)***
  - ***Very good HW problems to review – "****AP Stats Chapter 7 Review HW answers (TPS4e)****"***
    HTTP://WWW.BRUNSWICK.K12.ME.US/PGROVES/FILES/2012/12/AP-STATS-R7-HW-ANSWERS2.PDF

- Terminology matters. Don't say "sample distribution" when you mean sampling distribution. You will lose credit on free-response questions for misusing statistical terms. (page 420)
- Notation matters. The symbols $\hat{p}$, $\bar{x}$, s_x, p, μ, σ, $\mu_{\hat{p}}$, $\sigma_{\hat{p}}$, $\mu_{\bar{x}}$, and $\sigma_{\bar{x}}$ all have specific and different meanings. Either use notation correctly or don't use it at all. You can expect to lose credit if you use incorrect notation. (page 444)

Section IV: Statistical Inference (30-40%) *CHAPTERS 8-12*

Chapter 8

- ***Examples to Review***
  - ***1 sample CI for proportions - p (pg. 491)***
  - ***1 sample CI for means - μ (pg. 491)***
  - ***determine sample for proportions – if p not given use ½ (pg. 493)***
  - ***determine sample for means – (pg. 500)***

- On a given problem, you may be asked to interpret the confidence interval, the confidence level, or both. Be sure you understand the difference:
  - the confidence level describes the long-run capture rate of the method and
  - the confidence interval gives a set of plausible values for the parameter (page 474&476).
- If a free-response question asks you to construct and interpret a confidence interval, you are expected to do the entire 4-step process. That includes clearly defining the parameter and check the conditions (page 491)
- You may use your calculator to compute a confidence interval on the AP exam. But there's a risk involved. If you just give the calculator answer with no work, you'll get either full credit for the "Do" step (if the interval is correct) or no credit (if it's wrong). We recommend showing the calculation with the appropriate formula and then checking with your calculator. If you opt for the calculator-only method, be sure to name the procedure (e.g., one proportion z interval) and to give the interval (e.g., 0.514 to 0.606). (page 492)

Chapter 9

- ***Examples to Review***
  - ***1 sample z-test for proportions - p (pg. 553)***
  - ***1 sample t-test for means- μ (pg. 571)***
  - ***1 sample paired*** ***(each respondent gets both treatments randomly assigned)*** ***t-test for means- μ_D (specify T1-T2) (pg. 577)***
  - ***a CI compare to a 2-tail TOH – CI gives more information (pg. 576&560)***

- The conclusion to a significance test should always include three components:
  (1) an explicit comparison of the P-value to a stated significance level OR an interpretation of the P-value as a conditional probability,
  (2) a decision about the null hypothesis: reject or fail to reject H0 , and
  (3) an explanation of what the decision means in context. (page 536)
- When a significance test leads to a fail to reject Ho decision, as in this example, be sure to interpret the results as "we don't have enough evidence to conclude Ha." Saying anything that sounds like you believe Ho is (or might be) true will lead to a loss of credit. And don't write text-message-type responses, like "FTR the Ho." (page 554)
- You can use your calculator to carry out the mechanics of a significance test on the AP exam. But there's a risk involved. If you just give the calculator answer with no work, and one or more of your values is incorrect, you will probably get no credit for the "Do" step. We recommend doing the calculation with the

appropriate formula and then checking with your calculator. If you opt for the calculator-only method, be sure to name the procedure (one-proportion z test) and to report the test statistic (z=1.15) and P-value (0.1243). (page 556)

- Remember: if you just give calculator results with no work, and one or more values are wrong, you probably won't get any credit for the "Do" step. We recommend doing the calculation with the appropriate formula and then checking with your calculator. If you opt for the calculator-only method, name the procedure (t test) and report the test statistic (t =-0.94), degrees of freedom (df=14), and P-value (0.1809). (page 573)

Chapter 10

- ***Examples to Review***
  - ***Sampling distributions for $\hat{p}_1 - \hat{p}_2$ (pg. 607)*** ← **IMPORTANT TO REVIEW**
  - ***2 sample z-interval for proportions – p_1-p_2 (pg. 609)*** ← **remember you must state the pooled $\hat{p}_c$**
  - ***2 sample z-test for proportions – p_1-p_2 (pg. 614)***
  - ***Sampling distributions for $\bar{x}_1 - \bar{x}_2$(pg. 631)*** ← **IMPORTANT TO REVIEW**
  - ***2 sample t-interval for means – μ_1-μ_2 (pg. 635)***
  - ***2 sample t-test for means – μ_1-μ_2 (pg. 639)***

- You may use your calculator to compute a confidence interval on the AP exam. But there's a risk involved. If you just give the calculator answer with no work, you'll get either full credit for the "Do" step (if the interval is correct) or no credit (if it's wrong). If you opt for the calculator method, be sure to name the procedure (e.g. 2 sample z-interval for proportions) and give the interval (e.g. 0.223 to 0.297). (page 611)
- When checking the Normal condition on the AP exam involving inference about means, be sure to include a graph. Don't expect to receive full credit for describing a graph you made on your calculator but did not put on paper.
- When a significance test leads to reject Ho decision, be sure to interpret the results as "We don't have enough evidence to conclude Ha. "Saying anything that sounds like you believe Ho is (or might be) true will lead to a loss of credit (pg. 640)

Chapter 11

- ***Examples to Review***
  - ***Chi-Square Test of Goodness of Fit (pg. 686)*** ← **1 sample, 1 variable**
  - ***Chi-Square Test of Homogeneity (pg. 706)*** ← **2+ sample or treatments, 1 variable**
  - ***Chi-Square Test of Independence (pg. 717)*** ← **1 sample, 2 variable**

- In the "Do" step, you aren't required to show every term in the chi-square statistic.
  - Writing the first few terms of the sum and the last term, separated by ellipsis, is considered as "showing work." We suggest that you do this and then let your calculator tackle the computations. (page 702)
- If you have trouble distinguishing the two types of chi-square tests for two-way

tables, you're better off just saying "chi-square test" than choosing the wrong type and write the formula: $X = \sum \frac{(OBS - EXP)^2}{EXP}$. Better yet, learn to tell the difference! (page 718)

- Know how to read computer output and do a follow-up analysis (if asked to). Give the largest Chi-Square contributions as well as how the impact expected and observed counts (e.g. We expected 10 bottles of Italian wine purchase with French music but observed much less, only 1, bottle). (page 709)

Chapter 12

- ***Examples to Review for Regression Inference***
  - ***Confidence Interval for Slope β (pg. 749)***
  - ***Significance Test for Slope β (pg. 753)*** ← **IMPORTANT TO KNOW HOW TO READ COMPUTER OUTPUT (PG 182) … s=.7398(SD of residuals) & s_b=.00074(SD of slope β)**

- AP exam formula sheet gives $\hat{y} = b_0 + b_1 x$ for the equation of the sample (estimated) regression line. We will stick with our simpler notation, $\hat{y} = a + bx$, which is also used by TI calculators. Just remember: the coefficient of x is always the slope, no matter what symbol is used. (page 744)

- When you see a list of data values on an exam question, don't just start typing the data into your calculator. Read the question first. Often, additional information is provided that makes it unnecessary for you to enter the data at all. This can save you valuable time on the AP exam. (page 752)

- ***Examples to Review for Transforming to Achieve Linearity***
  - ***Exponential Model (pg. 772)***
  - ***Power Model (pg. 753)***

- You are responsible for understanding transformation to achieve linearity using log and power transformations.
- Focus on interpreting data, graphs and computer output provided.
- Developing this type of model will only appear in a Question 6.
- Know how to use both natural logs and base-10 logs (page 789 #'s 39 & 40).

#39) $\log\hat{y} = 1.01 + .72 * \log(127) \rightarrow \log\hat{y} = 2.525 \rightarrow 10^{\log\hat{y}} = 10^{2.525} \rightarrow \hat{y} = \mathbf{334.97g}$

#40) $\ln\hat{y} = -2.00 + 2.42 * \ln(30) \rightarrow \ln\hat{y} = 6.231 \rightarrow e^{\ln\hat{y}} = e^{6.231} \rightarrow \hat{y} = \mathbf{508.26kg}$