Florida Virtual School

AP Statistics

Module 7 Free Response and Essay Tips

Below you will find a breakdown of different AP topics for this module. The sections include expectations for answering questions over each topic and examples of how these areas should be handled:

BASICS FOR T TESTS AND T CONFIDENCE INTERVALS

Actual AP Exam Expectations	Notes
T test and interval conditions	State if: Population standard deviation is unknown, SRS, normality, independence, Pop > 10n **Create a boxplot and state the shape and if any outliers** *If n<15 the data must give an approx. normal distribution with little skewness and outliers. PROCEED WITH EXTREME CAUTION! *If 15<n<40 the data must give a distribution that does not have extreme outliers or extreme skewness. PROCEED WITH CAUTION!! *If n > 40 , it is justified to use a t procedure because the CLT applies

CONFIDENCE INTERVALS -- 1 sample and 2 sample and MARGIN OF ERROR

Actual AP Exam Expectations	Notes
1. SHOW all steps of the confidence interval	1) Parameter: **1 sample t interval** "We want to estimate the mean, µ, of _context of problem_ " **Matched pairs (1 sample t interval)** "We want to estimate the mean difference of __context__ between sample 1 and sample 2 in context. **2 sample t interval** "We want to estimate the mean difference between _population 1 and population 2 in context of problem " 2) Conditions ** For 2 sample T interval, you must check and state conditions for both populations** *Population standard deviation is unknown *SRS: If stated in problem, tell the grader, if not, then you should say: **We are not told if SRS of all _____, so proceed with caution!** *Normality – n<15, 15<n<40, n>40 SEE #3 ABOVE in condition section *Independence – Each observation is independent and population > 10n **ie: if I have 100 calculators, we tell AP Grader, we can assume that each calculator is independent and there are more than 10(100) or 1000 calculators** Name the interval: One sample t interval or 2 sample t interval

	3) Show all work: If you use you the formula, you must do all work by hand and show the **equation**. If you use the calculator you must **NAME** the test/interval that you selected, ALL inputted information, and ALL output information If DATA is given, graph and describe 4) Interpret the results in the context of the problem and make a connection to the given information. **Remember the 3 C's: Context, connections and conclusion.**
2. Degrees of Freedom	**1 sample t interval:** Sample size – 1, which is n-1 **2 sample t interval**: find the degrees of freedom on your calculator when you compute the interval
3. Interpret the results of the confidence interval	Conclusions should be given in terms of the context of the question. **1 sample t interval:** We are _____% confident that the true population mean μ of ___context_____ will be between _lower value_ and _upper value_ **Matched pairs (1 sample t interval):** We are ______% confident that the mean of the population differences of ___context____ is between _lower value_ and _upper value_ **2 sample t interval:** We are _____% confident that the true difference between the population mean μ_1 of _____context_____ and the population mean μ_2 of ____context_____ is between _lower value_ and _upper value_
4. T interval equations	1 sample T interval: $\bar{x} \pm critical\ value\ (\frac{s}{\sqrt{n}})$ Matched Pairs (1 sample T interval): $\overline{x_d} \pm \frac{s_d}{\sqrt{n}}$ *use the mean and standard deviation of the differences* 2 sample T interval: $(\bar{x}_1 - \bar{x}_2) \pm t^* \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$
5. Margin of error	Everything after the +/- in the confidence interval This value shows how accurate we believe our guess is and is based on the variability of the estimate
6. Find the t* for the confidence interval	Using the calculator: Subtract the level of significance from 1. So 1-α and then divide that value by 2. On the calculator DISTR-> INV T -> AREA: ((1-α)/2) df: n -1 -> ENTER This will give you the critical value t*

AP Statistics

Module 7 Free Response and Essay Tips

- The Margin of error decreases when: t* decreases, confidence level decreases, sample size (n) increases
- Increasing the sample size decreases the width of a confidence interval and the variability
- Use t when you are not given the population standard deviation.
- Use a one sample t interval when you have matched pairs – **one sample** that is being analyzed at two different times, and we are analyzing the actual <u>difference</u> amount.
- Use a two sample t interval when you have **two different samples** that are being analyzed and compared to one another to see if they are different.
- When 0 is in the confidence interval, we can assume that there is no difference between the 2 means.
- Here is a video specific to this topic. It includes examples and how to be most successful on the AP exam for the topic.

7.01: Standard Error and T Intervals

https://sas.elluminate.com/site/external/jwsdetect/playback.jnlp?psid=2015-01-24.0743.M.02B50E368656D296A2DCBFED1F5B9E.vcr&sid=679

TESTS OF SIGNIFICANCE – One sample T test and 2 sample T test

1. SHOW all steps of the test	1) Parameter: **same as confidence intervals** 2) Conditions ** For 2 sample T test, you must check and state conditions for both populations** **(see above interval #1 for specifics on each of these)** * Population standard deviation is unknown *SRS *Normality *Independence Name the test: One sample t test or 2 sample t test State the null (Ho) and alternative hypotheses (Ha) in context. **Note**: H_o: null hypothesis is ALWAYS = to H_a: alternative is < > or ≠ 3) Show all work: **same as for confidence intervals** 4) Interpret the results in the context of the problem and make a connection to the given information. **Remember the 3 C's**

AP Statistics

Module 7 Free Response and Essay Tips

2. State hypotheses in context	**1 sample t test:** **Ho:** The true population mean of ___context____ is equal to ____. $\mu = \mu_0$ * You must at least define what μ is* **Ha:** The true population mean of ___context___ is < > ≠ ____. $\mu < > \neq \mu_0$ **Matched pairs t test:** **Ho:** The mean of the differences between __context population 1 and context population 2__ is 0. $\mu_1 - \mu_2 = 0$ or $\mu_1 = \mu_2$ *You must define what μ_1 and μ_2 are* **Ha:** The mean of the of the differences between __context population 1 and context population 2__ is __< > ≠ 0. $\mu_1 - \mu_2 < > \neq 0$ or $\mu_1 < > \neq \mu_2$ **2 sample t test:** **Ho:** The mean context population 1 is equal to the mean context population 2__ . $\mu_1 - \mu_2 = 0$ or $\mu_1 = \mu_2$ *You must define what μ_1 and μ_2 are* **Ha:** The mean context population 1 is < > ≠ to the mean context population 2. $\mu_1 - \mu_2 < > \neq 0$ or $\mu_1 < > \neq \mu_2$
3. T test equation (1 sample)	1 sample T test: $\frac{\bar{x}-\mu}{\frac{s}{\sqrt{n}}}$ Matched Pairs (1 sample T test): $\frac{\overline{x_d}-\mu_0}{\frac{s_d}{\sqrt{n}}}$ *use the mean and standard deviation of the differences*
4. T test equation (2 sample)	2 sample T test: $\frac{(\bar{x}_1-\bar{x}_2)}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}$
5. Interpret the results of a t test	Conclusions should be given in terms of the context of the question. **1 sample t test:** Reject or Fail to reject the null hypothesis that _____context of the problem___ because the p-value is < > ≠ level of significance. There is/is not sufficient evidence to suggest that ____restate the null hypothesis______.

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Interpret the results of a t test	**Matched pairs t test:** Reject or Fail to reject the null hypothesis that the mean differences of _sample 1 and sample 2 is equal to 0 because the p value is > < ≠ level of significance. There is/is not sufficient evidence to suggest that ____restate the null hypothesis______. **2 sample t test:** Reject or Fail to reject the null hypothesis that the difference in the population mean of __population 1__ and the population mean of _population 2__ is equal to 0 because the p value is > < ≠ level of significance. There is/is not sufficient evidence to suggest that ____restate the null hypothesis______.

- **P-value:** The probability of seeing a result from a random sample that is as extreme as or more extreme than the result you got from your random sample, if the null hypothesis is true.
- You can also find the p value, once you have the t score, by using 2^{nd} -> Distr -> tcdf(lower, upper, df)
- Increasing the sample size decreases the p-value of the test (making the rejection of the null more convincing). As n increases, so does the power of the test.
- Use a two sample t test when you have **two different samples** that are being analyzed and compared to one another.
- Use a one sample t interval when you have matched pairs – **one sample** that is being analyzed at two different times, and we are analyzing the actual difference amount.
- Here is a video specific to this topic. It includes examples and how to be most successful on the AP exam for the topic

7.02-7.06: Significance tests and Difference of Means

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Florida Virtual School

AP Statistics

Module 7 Free Response and Essay Tips

CONFIDENCE INTERVALS -- 1 and 2 proportions and MARGIN OF ERROR

Actual AP Exam Expectations	Notes
1. SHOW all steps of the confidence interval	1) Parameter: "We want to estimate the mean proportion, p, of _context of problem__" 2) Conditions ** For 2 proportion intervals, you must check and state conditions for both populations** *SRS: If stated in problem, tell the grader, if not, then you should say: **We are not told if SRS of all _____, so proceed with caution!** *Normality – np > 5 and n(1-p)>5 If these are satisfied then we must say that we assume normality. *Independence – Each observation is independent and population > 10n Name the interval: One proportion or 2 proportion interval 3) Show all work: **same as t intervals** 4) Interpret the results in the context of the problem and make a connection to the given information. **Remember the 3 C's: Context, connections and conclusion.**
2. Interpret the results of the confidence interval	Conclusions should be given in terms of the context of the question. **1 proportion interval:** We are _____% confident that the true population proportion of ____context_____ will be between _lower value_ and _upper value **2 proportion interval:** We are _____% confident that the true difference between ______context_____and _____context______ is between _lower value_ and _upper value .
3. 1 proportion interval	$\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$
4. 2 proportion interval	$\hat{p}_1 - \hat{p}_2 \pm z^* \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$
5. Margin of error	Everything after the +/- in the confidence interval This value shows how accurate we believe our guess is and is based on the variability of the estimate
6. Equation to find sample size	$z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \leq$ m *You will be given m (margin of error)

AP Statistics
Module 7 Free Response and Essay Tips

- When 0 is in the confidence interval, we can assume that there is no difference between the 2 proportions.
- If p is or $\hat{p}$ is not stated, we assume it is 0.5
- When estimating sample size, round up ALWAYS!
- $\hat{p} = \frac{total\ number\ of\ successes\ in\ the\ sample}{total\ number\ of\ individuals\ in\ the\ sample}$
- Here is a video specific to this topic. It includes examples and how to be most successful on the AP exam for the topic

7.08, 7.10, 7.11: Confidence Intervals and Proportions, Sample Size, and Margin of Error
https://sas.elluminate.com/site/external/jwsdetect/playback.jnlp?psid=2015-01-24.1112.M.02B50E368656D296A2DCBFED1F5B9E.vcr&sid=679

TESTS OF SIGNIFICANCE -- 1 and 2 proportion Z test

Actual AP Exam Expectations	Notes
1. SHOW all steps of the test	1. Parameter: **same as confidence intervals for proportions** 2. Conditions ** For 2 proportion tests, you must check and state conditions for both populations** **Same as confidence intervals for proportions** *SRS *Normality *Independence Name the test: One proportion z test or 2 proportion z test State the null (Ho) and alternative hypotheses (Ha) in context. **Note**: H_o: null hypothesis is ALWAYS = to H_a: alternative is < > or ≠ 3. Show all work: **same as t test** 4. Interpret the results in the context of the problem and make a connection to the given information. **Remember the 3 C's**
2. 1 proportion z test	$\frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$

AP Statistics

Module 7 Free Response and Essay Tips

3. 2 proportion z test	$$\frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}(1-\hat{p})\frac{1}{n_1} + \frac{1}{n_2}}}$$ $*\hat{p} = \frac{total\ \#\ of\ successes\ from\ both\ samples}{total\ number\ of\ individuals\ in\ both\ samples}$
6. State hypotheses in context	**1 proportion z test:** **Ho:** The true population proportion of ___context_ is equal to ____. p = p_0 * You must at least define what p is* **Ha:** The true population proportion of ___context___ is < > ≠ ____. p < > ≠ p_0 **2 proportion z test:** **Ho:** The proportion of successes for context population 1 is equal to the proportion of successes for context population 2__ . $p_1 - p_2 = 0$ or $p_1 = p$ *You must define what p_1 and p_2 are* **Ha:** The proportion of successes for context population 1 is < > ≠ to the proportion of successes for context population 2. $p_1 - p_2 < > \neq 0$ or $p_1 < > \neq p_2$
4. Interpret the results of the test	Conclusions should be given in terms of the context of the question. **1 proportion z test:** Reject or Fail to reject the null hypothesis that proportion of _context of the problem__ is = to p_0 because the p-value is < > ≠ level of significance. There is/is not sufficient evidence to suggest that ____restate the null hypothesis______. **2 proportion z test::** Reject or Fail to reject the null hypothesis that the difference in the proportion of _context population 1 and context population 2_ is equal because the p-value is < > ≠ level of significance. There is/is not sufficient evidence to suggest that ____restate the null hypothesis______.

- **Errors:** Type 1 error: rejecting Ho, when it is true
  Type 2 error: failing to reject Ho, when it is false
  If Ho is true, the probability of a Type 1 error = α
  The power of a test is the probability of correctly rejecting the Ho

- Here is a video specific to this topic. It includes examples and how to be most successful on the AP exam for the topic

7.09 – 7.12: Significance Tests for 1 and 2 Proportions
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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^*.

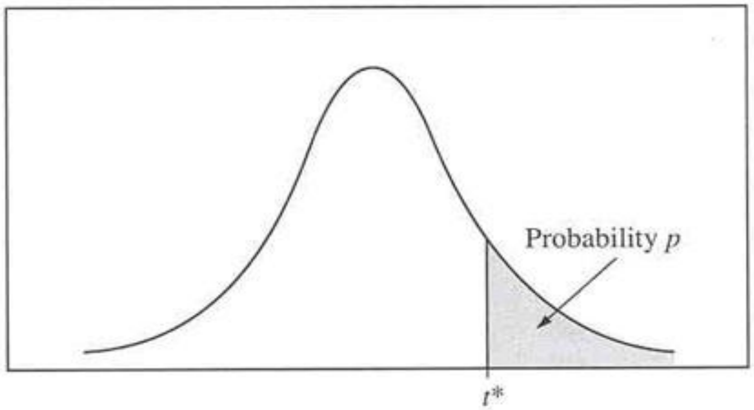

Table B *t* **distribution critical values**

df	Tail probability p											
	.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											