AP Statistics
Module 8 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 X^2 TESTS

Actual AP Exam Expectations	Notes
1. Verify all conditions	The sample is a random sample. *State expected counts* All expected counts are at least 1. No more than 20% of expected counts are less than 5.
2. Use the correct distribution	**Goodness of Fit:** Compares the observed distribution of a single categorical variable to an expected distribution for one sample. No two way table is given. **Independence:** Examines counts from a single sample for evidence of an association between two categorical variables. Uses a two way table. **Homogeneity:** Compares the distribution of two samples for one categorical variable. Uses a two way table.

TESTS OF SIGNIFICANCE

1. SHOW all steps of the test	1) Parameter: **Chi Squared Goodness of Fit (GOF)** "We want to test if __context of problem__ are all equal in the population." **Chi Squared test of Homogeneity** "We want to test if the __variable in context__ are equal for the two populations in context." **Chi Squared test of Independence** "We want to test if there is evidence of association between variable 1 and variable 2 in context of problem " 2) Conditions **(see above BASICS #1 for specifics on each of these)** *SRS *Expected Counts Name the test: Chi Squared GOF, Homogeneity, or Independence and state the degrees of freedom

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SHOW all steps of the test	State the null (Ho) and alternative hypotheses (Ha) in context. **GOF** H_0:The variable proportions are equal. H_a:The variable proportions are not equal. **Homogeneity** H_0: The proportion of variable in context is equal for every context populations. H_a: For at least one of the context populations, the variable in context is different. **Independence** H_0: The variable 1 in context is independent of variable 2 in context. H_a: The variable 1 in context is not independent of the variable 2 in context. 3) Show all work: Write down ALL input information, and ALL output information 4) Interpret the results in the context of the problem and make a connection to the given information. **Remember the 3 C's**
2. GOF equation and degrees of freedom	$$X^2 = \sum \frac{(O-E)^2}{E}$$ $$df = n - 1$$ * n represents the number of categories
3. Independence and Homgeneity equation and degrees of freedom	$$X^2 = \sum \frac{(O-E)^2}{E}$$ $$df = (r - 1)(c - 1)$$ *r represents number of rows and c represents number of columns
4. Interpret the results of the test	Conclusions should be given in terms of the context of the question. **GOF:** Reject or Fail to reject the null hypothesis that the context of the problem are not equal because the p-value is < > level of significance. There is/is not sufficient evidence to suggest that restate the null hypothesis . **Homogeneity:** Reject or Fail to reject the null hypothesis that the variable 1 in context is independent of variable 2 in context because the p value is > < level of significance. There is/is not sufficient evidence to suggest that restate the null hypothesis .

Interpret the results of the test	**Independence:** Reject or Fail to reject the null hypothesis that the proportion of variable in context is equal for every context populations 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 chi square value, by using 2nd -> Distr -> xcdf(lower, upper, df)
- The chi square distribution gives the probability to the right of the test statistic.
- As the degrees of freedom increase, the distribution becomes less skewed and more like a normal distribution.
- Sketch the curve and label the x^2 value and shade the probability to the right

TEST OF SIGNIFICANCE -- Linear Regression

Actual AP Exam Expectations	Notes
1. SHOW all steps of the test	1. **Parameter:** Identify the x variable that we are analyzing as the sample statistic. **2. Conditions:** *Normality – The values of the response variable y are normally distributed. *Independence – The values of the response variable y are independent. *Linear – There is a linear relationship between x and y represented by $\mu_y = \alpha + \beta x$ Name the test: Linear Regression T test

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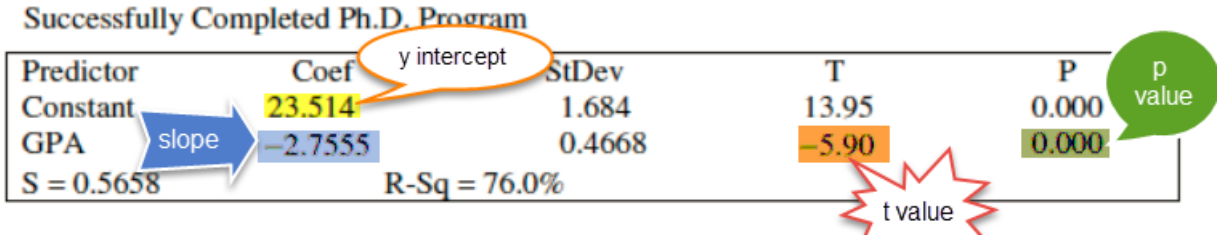
SHOW all steps of the test	State the null (Ho) and alternative hypotheses (Ha) in context. **Note**: H_o: Let β = the true slope of the regression line for prediction _y variable_ on _x variable_. β = 0 The slope of the true regression line is equal to zero. H_a: β > < ≠ 0 The slope of the true regression line is ____ to zero. 3. **Show all work:** ALL inputted information, and ALL output information 4. **Conclusion:** Interpret the results in the context of the problem and make a connection to the given information. *Reject or Fail to reject the null hypothesis that the slope of the true regression line for _y variable on x variable_ is = 0 because p < > level of significance. There is/is not evidence that the true slope of the regression line is ____.
2. Regression t equation	$t = \frac{b_1 - \beta}{s_{b1}}$ * b_1 and s_{b1} come from the sample
3. Standard error of the slope	$s_{b1} = \frac{b_1}{t}$ * b_1 is from the LSRL and t is from the calculator
4. Degrees of freedom	n – 2 *n is the number of points in the sample

- Most linear regression inference questions will include a computer printout for you to read in order to get your statistics. Here is an example of what information you would need:



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CONFIDENCE INTERVAL -- Linear Regression

Actual AP Exam Expectations	Notes
1. SHOW all steps of the interval	1. **Parameter:** Identify the x variable that we are analyzing as the sample statistic. **2. Conditions: Same as Significance Test** *Normality *Independence *Linear Name the interval: Linear Regression T Interval 3. **Show all work:** ALL inputted information, and ALL output information 4. **Conclusion:** Interpret the results in the context of the problem and make a connection to the given information. *We are _____% confident that the slope of the true linear relationship between _y variable_ and __x variable_ is between _lower value_ and _upper value_
2. Regression t interval	$b_1 \pm t^* s_{b1}$ * b_1 and s_{b1} come from the sample
3. 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 -2 -> ENTER This will give you the critical value t*

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

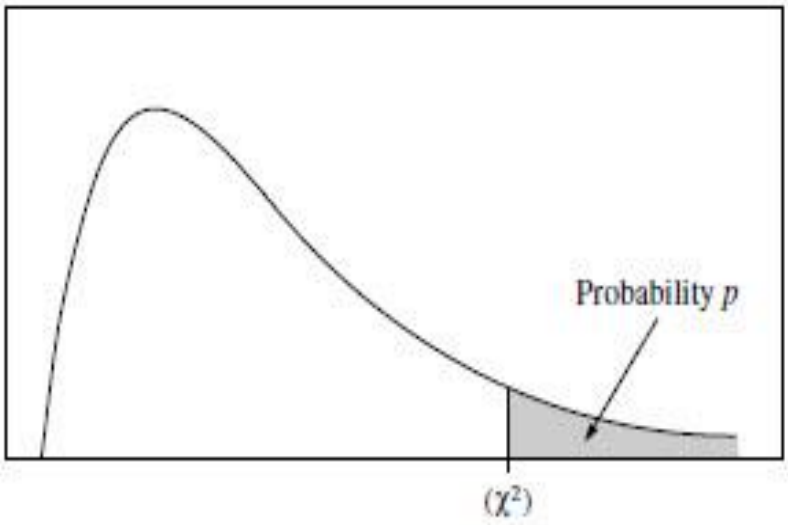

Table C χ^2 critical values

	Tail probability p											
df	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
1	1.32	1.64	2.07	2.71	3.84	5.02	5.41	6.63	7.88	9.14	10.83	12.12
2	2.77	3.22	3.79	4.61	5.99	7.38	7.82	9.21	10.60	11.98	13.82	15.20
3	4.11	4.64	5.32	6.25	7.81	9.35	9.84	11.34	12.84	14.32	16.27	17.73
4	5.39	5.99	6.74	7.78	9.49	11.14	11.67	13.28	14.86	16.42	18.47	20.00
5	6.63	7.29	8.12	9.24	11.07	12.83	13.39	15.09	16.75	18.39	20.51	22.11
6	7.84	8.56	9.45	10.64	12.59	14.45	15.03	16.81	18.55	20.25	22.46	24.10
7	9.04	9.80	10.75	12.02	14.07	16.01	16.62	18.48	20.28	22.04	24.32	26.02
8	10.22	11.03	12.03	13.36	15.51	17.53	18.17	20.09	21.95	23.77	26.12	27.87
9	11.39	12.24	13.29	14.68	16.92	19.02	19.68	21.67	23.59	25.46	27.88	29.67
10	12.55	13.44	14.53	15.99	18.31	20.48	21.16	23.21	25.19	27.11	29.59	31.42
11	13.70	14.63	15.77	17.28	19.68	21.92	22.62	24.72	26.76	28.73	31.26	33.14
12	14.85	15.81	16.99	18.55	21.03	23.34	24.05	26.22	28.30	30.32	32.91	34.82
13	15.98	16.98	18.20	19.81	22.36	24.74	25.47	27.69	29.82	31.88	34.53	36.48
14	17.12	18.15	19.41	21.06	23.68	26.12	26.87	29.14	31.32	33.43	36.12	38.11
15	18.25	19.31	20.60	22.31	25.00	27.49	28.26	30.58	32.80	34.95	37.70	39.72
16	19.37	20.47	21.79	23.54	26.30	28.85	29.63	32.00	34.27	36.46	39.25	41.31
17	20.49	21.61	22.98	24.77	27.59	30.19	31.00	33.41	35.72	37.95	40.79	42.88
18	21.60	22.76	24.16	25.99	28.87	31.53	32.35	34.81	37.16	39.42	42.31	44.43
19	22.72	23.90	25.33	27.20	30.14	32.85	33.69	36.19	38.58	40.88	43.82	45.97
20	23.83	25.04	26.50	28.41	31.41	34.17	35.02	37.57	40.00	42.34	45.31	47.50
21	24.93	26.17	27.66	29.62	32.67	35.48	36.34	38.93	41.40	43.78	46.80	49.01
22	26.04	27.30	28.82	30.81	33.92	36.78	37.66	40.29	42.80	45.20	48.27	50.51
23	27.14	28.43	29.98	32.01	35.17	38.08	38.97	41.64	44.18	46.62	49.73	52.00
24	28.24	29.55	31.13	33.20	36.42	39.36	40.27	42.98	45.56	48.03	51.18	53.48
25	29.34	30.68	32.28	34.38	37.65	40.65	41.57	44.31	46.93	49.44	52.62	54.95
26	30.43	31.79	33.43	35.56	38.89	41.92	42.86	45.64	48.29	50.83	54.05	56.41
27	31.53	32.91	34.57	36.74	40.11	43.19	44.14	46.96	49.64	52.22	55.48	57.86
28	32.62	34.03	35.71	37.92	41.34	44.46	45.42	48.28	50.99	53.59	56.89	59.30
29	33.71	35.14	36.85	39.09	42.56	45.72	46.69	49.59	52.34	54.97	58.30	60.73
30	34.80	36.25	37.99	40.26	43.77	46.98	47.96	50.89	53.67	56.33	59.70	62.16
40	45.62	47.27	49.24	51.81	55.76	59.34	60.44	63.69	66.77	69.70	73.40	76.09
50	56.33	58.16	60.35	63.17	67.50	71.42	72.61	76.15	79.49	82.66	86.66	89.56
60	66.98	68.97	71.34	74.40	79.08	83.30	84.58	88.38	91.95	95.34	99.61	102.7
80	88.13	90.41	93.11	96.58	101.9	106.6	108.1	112.3	116.3	120.1	124.8	128.3
100	109.1	111.7	114.7	118.5	124.3	129.6	131.1	135.8	140.2	144.3	149.4	153.2