Final Exam – May 9, 2016 **Spring 2016**
Math 282

Problem	Possible	Earned
1	10	
2	15	
3	8	
4	12	
5	12	
6	23	
7	12	
8	14	
9	12	
10	18	
11	20	
12	20	
13	24	
Total	200	

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Name: ______________________________

Instructor: ___________________________

Section: _____________________________

Please check to make sure that your copy of the examination has one cover sheet and all seven (7) pages with problems numbered 1 through 13. The last page is double-sided and has the tables needed for this exam.

Work in a neat and well-organized manner. Show your work on all problems. Full credit will not be given unless your work is clearly shown.

Only an approved (TI-30) scientific calculator will be permitted on the final examination for this course; however, calculators or computers with graphic, word-processing, symbolic manipulation or programming capabilities will not be allowed for this exam. The use of books, notes or other resource materials will not be permitted on the final examination.

All cell phones and electronic devices are PROHIBITED during the final exam.

Formulas

$\bar{x} = \frac{\sum x}{n}$ $\quad s^2 = \frac{\sum (x-\bar{x})^2}{n-1}$ $\quad$ z-score $= \frac{value - mean}{standarddeviation}$ $\quad IQR = Q_3 - Q_1$

confidence interval $\bar{x} \pm z^* \frac{\sigma}{\sqrt{n}}$, $\bar{x} \pm t^* \frac{s}{\sqrt{n}}$, sample size $n = (\frac{z^* \sigma}{m})^2$

test statistics $z = \frac{\bar{x} - \mu_0}{\frac{\sigma}{\sqrt{n}}}$, $t = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}}$

two sample confidence interval and test statistics
$(\bar{x}_1 - \bar{x}_2) \pm z^* \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$, $\quad (\bar{x}_1 - \bar{x}_2) \pm t^* \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$, $\quad z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$, $\quad t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$

Proportion problems: $\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ $\quad n = (\frac{z^*}{m})^2 p * (1 - p*)$

Proportion problems for two populations:
$(\hat{p}_1 - \hat{p}_2) \pm z^* \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$ $\quad z = \frac{(\hat{p}_1 - \hat{p}_2)}{\sqrt{\hat{p}(1-\hat{p})(\frac{1}{n_1} + \frac{1}{n_2})}}$ $\quad \hat{p} = \frac{x_1 + x_2}{n_1 + n_2}$ $\quad Z = \frac{\hat{\rho} - \rho_o}{\sqrt{\frac{\rho_o(1-\rho_o)}{n}}}$

Regression:
$r = \frac{1}{n-1} \sum (\frac{x-\bar{x}}{s_x}).(\frac{y-\bar{y}}{s_y}) = \frac{1}{n-1} \sum Z_x.Z_y$, $\quad \hat{y} = a + bx$ where $b = r\frac{s_y}{s_x}$, and $a = \bar{y} - b\bar{x}$

Chi-Square Testing:
$\chi^2 = \sum \frac{(Obs. - Exp.)^2}{Exp.}$, where $Exp. = \frac{\text{(row total)(column total)}}{\text{overall total}}$, and $df = (r-1)(c-1)$

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SHOW ALL WORK *Keep three decimal places in most calculations*

1. Here are the travel times (in minutes) to work for 7 workers in a small town:

   4 9 12 15 18 7 5

   a) [5] Find the sample mean of the times.

   b) [5] Find the sample standard deviation of the times.

2. Use the following data

   20 25 32 14 35 46 36 50 58 85 22 30 55 52

a) [10] Find the *five-number summary*

b) [5] Is there any outlier in this data set? If any, which value? Use 1.5 IQR rule.

3. The probability distribution of the first digits of numbers in legitimate records is below.

First digit	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
probability	0.301	?	0.125	0.097	0.079	0.067	0.058	0.051	0.046

a) [4] What is the probability that the first digit is 2?

b) [4] Find the probability that the first digit is greater than or equal to 6.

4. The following table gives the sex and age group of college students at a Midwestern university.

	Female	Male	Total
15 to 17 years	89	61	150
18 to 24 years	5,668	4,697	10,365
25 to 34 years	1,904	1,589	3,493
35 years or older	1,660	970	2,630
Total	9,321	7,317	16,638

A student is to be selected at random.

a) [6] Find the probability that the selected student is a female.

b) [6] Given that the selected student is female, find the conditional probability that she is 25 to 34 years old.

5. A multiple choice test has five questions, each with four answer choices. One of these choice is the correct answer. Assume you make random guesses. Let x be the number of questions you guessed correctly, then X has a binomial distribution with $n = 5$, $p = 0.25$.

a) [6] Find the probability that you guessed exact 3 questions correctly.

b) [6] Find the probability that you guessed at least one question correctly.

6. Birth weights, X, at a local hospital have a Normal distribution with a mean of 110 oz. and a standard deviation of 13 oz.

a) [7] Find the probability that a randomly chosen newborn has weight more than 120 oz.

b) [6] How much must a newborn weigh to be in the top 10%?

c) [3] Consider an SRS of 16 newborns in this hospital. What is the distribution of $\bar{X}$?

d) [7] Find $P(110 < \bar{X} < 120)$.

7. Suppose we use the fat content x to predict the calorie content y (in grams) of some food. The correlation $r = 0.979$. A summary of a random sample is:

variable	mean	standard deviation
Fat content x	$\bar{x}$ =40.35	s_x =27.99
Calorie content y	$\bar{y}$ =662.88	s_y =324.90

a) [8] Find the intercept and slope of the least square line.

b) [4] Write the equation of the regression line.

8. A simple random sample of 30 Chancellor's Scholarship recipients at SIU yields an average ACT score $\bar{x}$ = 33 and sample standard deviation ***s*** =2. Answer the questions below and make a 95% confidence interval for μ, which is the mean ACT score of all Chancellor's Scholarship recipients at SIU.

a) [4] To make the confidence interval, do you use a T-procedure or a Z- procedure?

b) [5] Calculate the margin of error.

c) [5] Make a 95% confidence interval for μ.

9. Find the p-value (exactly for the normal distribution, and a range for the *t* distribution) in each of the following hypotheses testing problems:

a) [6] Testing H_0 : μ =15 versus H_a : μ ≠ 15; sample size *n* = 25, test statistic *z* = 1.75.

b) [6] Testing H_0 : μ =15 versus H_a : μ > 15; sample size *n* = 25, test statistic *t* = 2.96.

10. An inspector inspects large truckloads of potatoes to determine the proportion *p* in the shipment with major defects prior to using the potatoes to make potato chips. Unless there is clear evidence that *p* is less than 0.10, he will reject the shipment. He selects an SRS of 200 potatoes from the truck. Suppose that 12 of the potatoes are found to have major defects.
Do the hypotheses test: H_0: p = 0.10, H_a: p < 0.10, and help him to make a decision.

a) [4] Calculate the sample proportion $\hat{p}$.

b) [5] Calculate the test statistic.

c) [5] Find the p-value.

d) [4] Given α=0.05, what is your conclusion? Should he reject the shipment?

11. A researcher suspects that the new drug results in greater average reduction in blood pressure (μ_1) than the old drug does (μ_2). In an experiment, 21 subjects were assigned randomly to the treatment group receiving the new drug. The other 23 subjects were assigned to the control group receiving the old drug. After a suitable period of time, the reduction in blood pressure for each subject was recorded. The output below is based on the data collected from the experiment. Let $mud = \mu_1 - \mu_2$.

test	*alternative*	*T-value*	*p-value*	*95% CI*	*mud=mu1-mu2*
matched pairs :	*mud not = 0*	*3.130*	*0.0055*	*(0.696,*	*3.504)*
matched pairs :	*mud > 0*	*3.130*	*0.0028*	*(0.696,*	*3.504)*
matched pairs :	*mud < 0*	*3.130*	*0.997*	*(0.696,*	*3.504)*
2 sample t :	*mud not = 0*	*2.159*	*0.037*	*(0.318,*	*9.602)*
2 sample t :	*mud > 0*	*2.159*	*0.018*	*(0.318,*	*9.602)*
2 sample t :	*mud < 0*	*2.159*	*0.981*	*(0.318,*	*9.602)*

a) [4] To test the researcher's suspect, which procedure should be used?

b) [12] Using the output above do a 4 step hypotheses test. (α= 0.05)

c) [4] Give a 95% confidence interval for the difference in means of blood pressure deduction.

12. Recent revenue shortfalls in a southern state led to a reduction in the state budget for higher education. To offset the reduction, a state university proposed a 20% tuition increase. To test whether there was any relationship between student year in school and student opinion, a simple random sample of 170 students from the university were asked whether they were strongly opposed to the increase. The table below is the summary of the data.

Strongly opposed		Freshman	Sophomore	Junior	Senior	total
Yes	Observed	39	30	29	8	106
	Expected	(31.176)	(24.941)	(31.176)	( )	
	Cell chisq	(1.964)	(1.026)	(0.152)	( )	
No	Observed	11	10	21	22	64
	Expected	(18.824)	(15.059)	(18.824)	(11.294)	
	Cell chisq	(3.252)	(1.700)	(0.252)	( )	
total		50	40	50	30	170

a) [4] State the hypotheses

H_0 :

H_a :

b) [4] Find the value of the expected count that is not given in the table. Find the 2 cell chi square contribution that needs to be computed. Show work. (use three decimal places)

c) [5] Calculate the test statistic χ^2.

d) [5] Find a range for the p-value of the test.

e) [2] Given α= 0.05, what is your conclusion?

13. [24] Circle the correct answer.

1) Which of the following indicates the strongest linear relationship?

A) r = .5 B) r = .09 C) r = - .8

2) A stemplot is most similar to

A) A boxplot B) a time plot C) a histogram where the stems are the classes

3) A Math Department can send 10 people to a national convention. The department decided to select 5 students and 5 faculty members at random. Identify the type of sampling used.

A) Convenience B) Stratified C) Simple Random D) voluntary Response

4) A sample was collected from 98 calls made by local listeners. The sampling technique used was

A) Convenience B) Stratified C) Simple Random D) voluntary Response

5) Let X be the number of births until the first boy is born in a large hospital, then X has a binomial distribution.

A) true B) false

6) The distribution of adult women's heights is approximately normal with a mean of 64 inches and a standard deviation of 2.7 inches. Heights of 10 year old girls follow an approximately normal distribution with a mean of 54 inches and a standard deviation of 2.5 inches. Alice's height is 65 inches, and her 10 year old daughter's height is 57 inches. Who is relatively higher?

A) Alice B) her daughter

7) The sample data appears to come from a normal distributed population with standard deviation $\sigma = 28$.

Claim: $\mu \neq 977$. Determine whether the hypothesis test involves a t-test, z-test, neither.

A) T-test B) Z-test C) Neither

8) A and B are two disjoint events and P(A) = 0.5, P(B) = 0.3. P(A or B) is equal:

A) 0.65 B) 0.3 C) 0.8 D) 0.5

Table entry for z is the area under the standard Normal curve to the left of z.

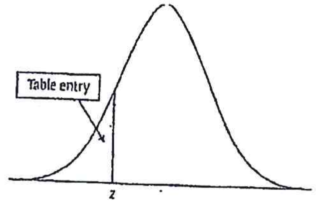

TABLE A STANDARD NORMAL CUMULATIVE PROPORTIONS

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

Table entry for z is the area under the standard Normal curve to the left of z.

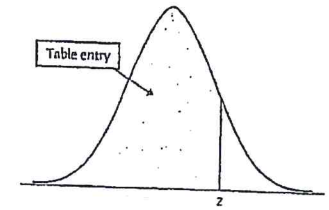

TABLE A STANDARD NORMAL CUMULATIVE PROPORTIONS (CONTINUED)

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Table entry for C is the critical value t^* required for confidence level C. To approximate one- and two-sided P-values, compare the value of the t statistic with the critical values of t^* that match the P-values given at the bottom of the table.

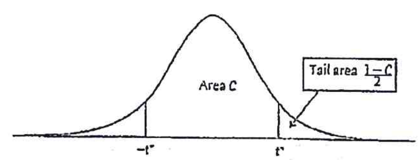

TABLE C t DISTRIBUTION CRITICAL VALUES

DEGREES OF FREEDOM	CONFIDENCE LEVEL C											
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9%
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	0.816	1.061	1.386	1.886	2.920	4.303	4.849	6.965	9.925	14.09	22.33	31.60
3	0.765	0.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	0.741	0.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	0.727	0.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	0.718	0.906	1.134	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	0.706	0.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	0.703	0.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	0.700	0.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	0.697	0.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	0.694	0.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	0.691	0.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	0.690	0.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	0.689	0.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	0.688	0.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	0.688	0.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	0.687	0.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	0.686	0.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	0.686	0.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	0.685	0.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	0.685	0.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	0.684	0.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	0.684	0.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	0.684	0.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	0.683	0.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	0.683	0.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	0.681	0.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	0.679	0.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	0.679	0.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	0.678	0.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	0.677	0.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.390
1000	0.675	0.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.300
z^*	0.674	0.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.291
One-sided P	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
Two-sided P	.50	.40	.30	.20	.10	.05	.04	.02	.01	.005	.002	.001

Table entry for p is the critical value χ^* with probability p lying to its right.

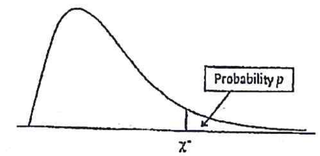

TABLE D CHI-SQUARE DISTRIBUTION CRITICAL VALUES

df	p											
	.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