Your name: ____

Quiz rules:

(a) This quiz is closed book, but you are allowed a two-sided sheet of paper of notes and a calculator.
(b) Each question is worth 6 points.
(c) A normal table is provided on the last page
(d) You have 50 minutes to complete this quiz.
(e) If you fail to show your work and/or explain how you arrived at your answer then no points will be awarded.

On Quiz 2 we heard about a study to determine the effect of a new dog food on the growth of puppies over the first year of life.

Recall: Researchers decide to run a randomized study. The researchers recruit 36 dogs – twelve large (Bernese Mountain Dogs), twelve medium (English Bulldog) and twelve small (West Highland Terrier). Half the dogs were randomly assigned to treatment, the other half to control.

		Baseline (total lbs)	**Final (total lbs)**
Treatment Group	• 8 Bernese • 8 Bulldogs • 2 Westies	332	1318
Control Group	• 4 Bernese • 4 Bulldogs • 10 Westies	220	812

1. On Quiz 2, we discussed how there was a noticeable imbalance between the types of dogs in the treatment vs. control. Looking at this data, would you reject the assertion that the dogs were randomly assigned to treatment and control? Provide a statistical test justifying your answer.

2. Continuing with the dog food example: A statistician suggests they run a new study using a matched pair design. In a matched pair design, each dog is paired with another dog such that they are of the same breed and had an identical birth weight. The observational unit becomes the pair, not an

individual dog. The pairs are then tested using a one-sample test of the null that the average difference is zero. The data for 6 of the 18 pairs are reported below.

Pair	Breed	Control (lbs increase)	Treated (lbs increase)
1	Bernese	68	73
2	Bernese	69	70
3	Bulldog	42	47
4	Bulldog	44	45
5	Westie	21	22
6	Westie	17	22
SD		20.3	20.2
AVE		43.5	46.5

(a) What would the SE be if you compared treatment vs control using a two-sample z-test? What about if you used a matched pairs z-test?

(b) Why are the two SEs you calculated in (a) so different?

3. Now let's analyze the data from Question 2 using a matched pairs test. Although you calculated the SE assuming a z-test in the previous question, you should really use a t-test here because the sample size is small. Be sure to state the null and alternative hypotheses.
(If you weren't able to calculate the SD of the differences in Question 2, please assume SD=7.3.)

4. A parking lot has 200 cars. All of the cars have the same kind of car alarm. You may assume that each car runs a hypothesis test (independently of all the other cars) before deciding whether to sound its alarm.

   (a) Unfortunately, the car alarms go off quite frequently. The neighbors are honked off and request that a local ordinance be created modifying the threshold at which the alarms go off. Assuming this is a no-crime area, which one of the following is the **most** appropriate statistical term to indicate what the ordinance is seeking to modify: (i) observed significance level, (ii) the P-value, or (iii) the alpha level? Explain your selection in a few sentences.

   (b) Explain the statistical reason why the car owners may not like this new ordinance. Full points will be awarded to only those solutions correctly using hypothesis testing terminology.

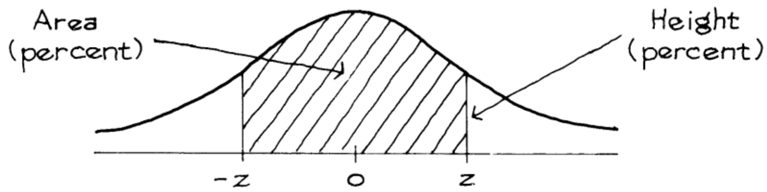
5. An instructor would like to know if grades on an exam follow the normal curve. In a class with 241 students, he finds that 157 students scored within 1 SD of the average and 230 students scored within 2 SDs of the average. Propose a hypothesis test and carry it out. Can you conclude that the data do not follow the normal curve?

6. Tom and Joe are twins. Recently Tom has been living in Australia and Joe here in the USA. Given their divergent lifestyles, they're curious if they still are so "identical." To assess this they decide to measure their weights. Naturally, they have to use different scales. Both scales are known to have measurement error that is well approximated by the Gauss model. The SDs of the chance errors are known to be 1lb for Tom's scale and 2lbs for Joe's scale.

   Each twin does 36 measurements on his own scale. Tom's measurements have an average of 143lbs and an observed standard deviation of 2lbs. Joe's measurements have an average of 142lbs and an observed standard deviation of 2lbs.

   (a) State the null and alternative hypotheses for this test. Run the test at the 0.05 level and state your conclusion.

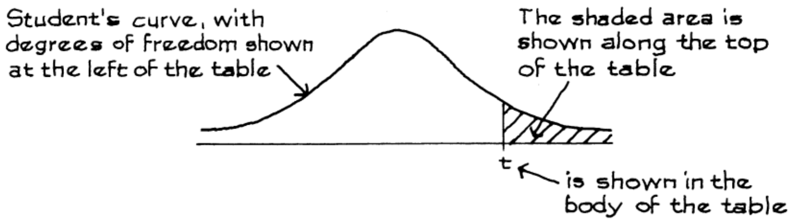
   (b) The test for the difference between the averages was highly significant. State in plain English what this P-value means in the context of this problem. How important is the observed difference?



A NORMAL TABLE

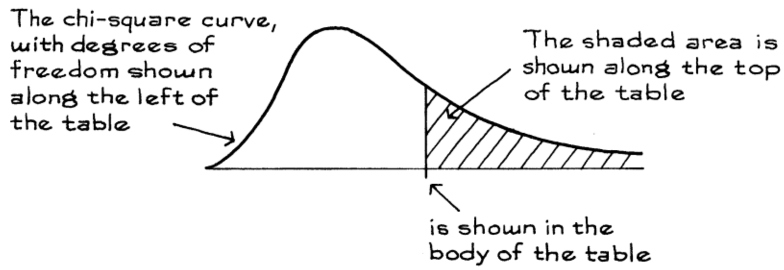
z	*Height*	*Area*	*z*	*Height*	*Area*	*z*	*Height*	*Area*
0.00	39.89	0	1.50	12.95	86.64	3.00	0.443	99.730
0.05	39.84	3.99	1.55	12.00	87.89	3.05	0.381	99.771
0.10	39.69	7.97	1.60	11.09	89.04	3.10	0.327	99.806
0.15	39.45	11.92	1.65	10.23	90.11	3.15	0.279	99.837
0.20	39.10	15.85	1.70	9.40	91.09	3.20	0.238	99.863
0.25	38.67	19.74	1.75	8.63	91.99	3.25	0.203	99.885
0.30	38.14	23.58	1.80	7.90	92.81	3.30	0.172	99.903
0.35	37.52	27.37	1.85	7.21	93.57	3.35	0.146	99.919
0.40	36.83	31.08	1.90	6.56	94.26	3.40	0.123	99.933
0.45	36.05	34.73	1.95	5.96	94.88	3.45	0.104	99.944
0.50	35.21	38.29	2.00	5.40	95.45	3.50	0.087	99.953
0.55	34.29	41.77	2.05	4.88	95.96	3.55	0.073	99.961
0.60	33.32	45.15	2.10	4.40	96.43	3.60	0.061	99.968
0.65	32.30	48.43	2.15	3.96	96.84	3.65	0.051	99.974
0.70	31.23	51.61	2.20	3.55	97.22	3.70	0.042	99.978
0.75	30.11	54.67	2.25	3.17	97.56	3.75	0.035	99.982
0.80	28.97	57.63	2.30	2.83	97.86	3.80	0.029	99.986
0.85	27.80	60.47	2.35	2.52	98.12	3.85	0.024	99.988
0.90	26.61	63.19	2.40	2.24	98.36	3.90	0.020	99.990
0.95	25.41	65.79	2.45	1.98	98.57	3.95	0.016	99.992
1.00	24.20	68.27	2.50	1.75	98.76	4.00	0.013	99.9937
1.05	22.99	70.63	2.55	1.54	98.92	4.05	0.011	99.9949
1.10	21.79	72.87	2.60	1.36	99.07	4.10	0.009	99.9959
1.15	20.59	74.99	2.65	1.19	99.20	4.15	0.007	99.9967
1.20	19.42	76.99	2.70	1.04	99.31	4.20	0.006	99.9973
1.25	18.26	78.87	2.75	0.91	99.40	4.25	0.005	99.9979
1.30	17.14	80.64	2.80	0.79	99.49	4.30	0.004	99.9983
1.35	16.04	82.30	2.85	9.69	99.56	4.35	0.003	99.9986
1.40	14.97	83.85	2.90	0.60	99.63	4.40	0.002	99.9989
1.45	13.94	85.29	2.95	0.51	99.68	4.45	0.002	99.9991

A t-TABLE



Degrees of freedom	*25%*	*10%*	*5%*	*2.5%*	*1%*	*0.5%*
1	1.00	3.08	6.31	12.71	31.82	63.66
2	0.82	1.89	2.92	4.30	6.96	9.92
3	0.76	1.64	2.35	3.18	4.54	5.84
4	0.74	1.53	2.13	2.78	3.75	4.60
5	0.73	1.48	2.02	2.57	3.36	4.03
6	0.72	1.44	1.94	2.45	3.14	3.71
7	0.71	1.41	1.89	2.36	3.00	3.50
8	0.71	1.40	1.86	2.31	2.90	3.36
9	0.70	1.38	1.83	2.26	2.82	3.25
10	0.70	1.37	1.81	2.23	2.76	3.17
11	0.70	1.36	1.80	2.20	2.72	3.11
12	0.70	1.36	1.78	2.18	2.68	3.05
13	0.69	1.35	1.77	2.16	2.65	3.01
14	0.69	1.35	1.76	2.14	2.62	2.98
15	0.69	1.34	1.75	2.13	2.60	2.95
16	0.69	1.34	1.75	2.12	2.58	2.92
17	0.69	1.33	1.74	2.11	2.57	2.90
18	0.69	1.33	1.73	2.10	2.55	2.88
19	0.69	1.33	1.73	2.09	2.54	2.86
20	0.69	1.33	1.72	2.09	2.53	2.85
21	0.69	1.32	1.72	2.08	2.52	2.83
22	0.69	1.32	1.72	2.07	2.51	2.82
23	0.69	1.32	1.71	2.07	2.50	2.80
24	0.68	1.32	1.71	2.06	2.49	2.80
25	0.68	1.32	1.71	2.06	2.49	2.79

A CHI-SQUARE TABLE



Degrees of freedom	*99%*	*95%*	*90%*	*70%*	*50%*	*30%*	*10%*	*5%*	*1%*
1	0.00016	0.0039	0.016	0.15	0.46	1.07	2.71	3.84	6.64
2	0.020	0.10	0.21	0.71	1.39	2.41	4.60	5.99	9.21
3	0.12	0.35	0.58	1.42	2.37	3.67	6.25	7.82	11.34
4	0.30	0.71	1.06	2.20	3.36	4.88	7.78	9.49	13.28
5	0.55	1.14	1.61	3.00	4.35	6.06	9.24	11.07	15.09
6	0.87	1.64	2.20	3.83	5.35	7.23	10.65	12.59	16.81
7	1.24	2.17	2.83	4.67	6.35	8.38	12.02	14.07	18.48
8	1.65	2.73	3.49	5.53	7.34	9.52	13.36	15.51	20.09
9	2.09	3.33	4.17	6.39	8.34	10.66	14.68	16.92	21.67
10	2.56	3.94	4.86	7.27	9.34	11.78	15.99	18.31	23.21
11	3.05	4.58	5.58	8.15	10.34	12.90	17.28	19.68	24.73
12	3.57	5.23	6.30	9.03	11.34	14.01	18.55	21.03	26.22
13	4.11	5.89	7.04	9.93	12.34	15.12	19.81	22.36	27.69
14	4.66	6.57	7.79	10.82	13.34	16.22	21.06	23.69	29.14
15	5.23	7.26	8.55	11.72	14.34	17.32	22.31	25.00	30.58
16	5.81	7.96	9.31	12.62	15.34	18.42	23.54	26.30	32.00
17	6.41	8.67	10.09	13.53	16.34	19.51	24.77	27.59	33.41
18	7.00	9.39	10.87	14.44	17.34	20.60	25.99	28.87	34.81
19	7.63	10.12	11.65	15.35	18.34	21.69	27.20	30.14	36.19
20	8.26	10.85	12.44	16.27	19.34	22.78	28.41	31.41	37.57

Source: Adapted from p. 112 of Sir R. A. Fisher, *Statistical Methods for Research Workers* (Edinburgh: Oliver & Boyd. 1958).