Math 2200
Midterm Examination 3 – April 13, 2010

General Instructions: You may use any calculator you like. You may have a 3x5 card, but no other notes. Only the answer on the answer card will be graded.

Problems 1-20: Multiple choice. Each problem is worth 4 points.

1. The following table of data gives the calcium concentration in the water of 10 U.K. towns north of Derby, and of ten towns south of Derby.

Derby	Calcium									
North	6	7	8	13	14	15	27	49	71	75
South	5	44	50	59	60	68	90	101	107	133

Is there a difference between the average calcium levels of the two populations? Perform a 2-sided 2-sample t-test and find the P-value.

(a) 1.0000
(b) 0.0679
(c) 0.0412
(d) 0.0082
(e) 0.0076
(f) 0.0027
(g) 0.0016
(h) 0.0000

2. Perform a (2-sided) Wilcoxon rank-sum test on the data from Question 1 and find the P-value.

   (a) 1.0000
   (b) 0.8683
   (c) 0.6962
   (d) 0.0284
   (e) 0.0082
   (f) 0.0076
   (g) 0.0000
   (h) The test doesn't apply.

3. Perform Tukey's quick test on the data from Question 1 and report the test statistic (the count).

   (a) 0
   (b) 1
   (c) 2
   (d) 3
   (e) 4
   (f) 5
   (g) 6
   (h) The test doesn't apply.

4. A telemarketer is told to expect making a sale on about 10% of calls. What is the probability that, out of 90 calls, she makes exactly 5 sales? Use the binomial model directly.

   (a) 1.0000
   (b) 0.3269
   (c) 0.1067
   (d) 0.0567
   (e) 0.0318
   (f) 0.0125
   (g) 0.0045
   (h) 0.0000

5. What is the probability that the telemarketer from Question 4 makes <u>at most</u> 50 sales out of 500 calls? Use the normal approximation for the binomial model, and round to the nearest 0.1.

   (a) 1.0
   (b) 0.8
   (c) 0.5
   (d) 0.4
   (e) 0.3
   (f) 0.2
   (g) 0.1
   (h) 0.0

6. Suppose the SAT scores of Washington University in St. Louis students can be described by a normal model with mean 2200 and standard deviation 150 points. What is the probability that the average SAT score of 4 randomly selected Wash U students is at least 2250? (Use the normal model for the sample mean.)

   (a) 1.0000
   (b) 0.6666
   (c) 0.3694
   (d) 0.3333
   (e) 0.2525
   (f) 0.1010
   (g) 0.0500
   (h) 0.0000

7. April showers bring May flowers. Which city receives the most April showers? You estimate that St. Louis on average receives 3.7 inches of rainfall in April, with a margin of error of ± 1.5 inches at the 95% confidence level.
   What is the best description of the meaning of this margin of error?

   (a) We're 95% confident that St. Louis receives 3.7 inches of rainfall every April.
   (b) St. Louis receives between 2.2 and 5.2 inches of rainfall every April.
   (c) We're 95% confident that it'll rain a lot in April.
   (d) We're 95% confident that the rain this April will be between 2.2 inches and 5.2 inches.
   (e) We're 95% confident that the average amount of rain in St. Louis during April is between 2.2 inches and 5.2 inches.
   (f) We're 95% confident that the average amount of rain in St. Louis during April is between 1.5 inches and 3.7 inches.
   (g) In 95% of Aprils the amount of rain in St. Louis will be between 2.2 inches and 5.2 inches.
   (h) In 95% of Aprils the amount of rain in St. Louis will between 1.5 inches and 3.7 inches.

8. A Gallup Pool reported that 40% of a random sample of 900 adults said they believe in ghosts. Find the upper bound of a 97% confidence interval for the percentage of adults who believe in ghosts.

   (a) 99.99%
   (b) 44.45%
   (c) 43.54%
   (d) 43.20%
   (e) 43.07%
   (f) 42.89%
   (g) 40.00%
   (h) 0.00%

9. You are designing a poll to measure the proportion of St. Louis voters who support a certain proposition. Previous polls have shown this proportion hovering near 50%. Rounding up to the next higher thousand, how many voters will you need to sample to ensure a margin of error of 1% (at the 95% confidence level)?

   (a) 14,000
   (b) 12,000
   (c) 10,000
   (d) 8,000
   (e) 7,000
   (f) 6,000
   (g) 5,000
   (h) 3,000

10. National data in the 1960s showed that about 45% of the adult population had never smoked cigarettes. A recent poll of 1011 adults found that 52% had never smoked.
Has there been a change of behavior among Americans? Find the P-value for the appropriate hypothesis test.

(a) 0.9999

(b) 0.8484

(c) 0.5200

(d) 0.4500

(e) 0.4492

(f) 0.3159

(g) 0.0016

(h) 0.0000

11. The Brussel Sprout Research Institute reports that 25% of men report that they enjoy brussel sprouts, while only 20% of women enjoy the tasty cabbage-like vegetable. If these results reflect samples of 240 people of each gender, then is this strong evidence that men and women have different outlooks? What P-value do you find in an appropriate hypothesis test?

(a) 0.1896

(b) 0.1246

(c) 0.0948

(d) 0.0736

(e) 0.0528

(f) 0.0368

(g) 0.0264

(h) 0.0159

12. In Question 11, the Brussel Sprout Research Institute publishes their estimate that the proportion of men who enjoy brussel sprouts is about 5% higher than the proportion of women. Find the margin of error for this estimate corresponding to the 95% confidence level.

    (a) 40.61%
    (b) 40.50%
    (c) 31.63%
    (d) 25.43%
    (e) 18.96%
    (f) 10.54%
    (g) 7.46%
    (h) 5.48%

13. In the 1960s, the <u>mean</u> age at which American men first married was 23.3. The following table represents the ages of a random selection of 11 men who married for the first time in 2009.

    21 22 22 24 26 26 28 29 32 36 40

    Has the mean age of first marriage changed since 1960? What P-value do you find in an appropriate 2-sided hypothesis test?

    (a) 1.0000
    (b) 0.2373
    (c) 0.0471
    (d) 0.0334
    (e) 0.0167
    (f) 0.0137
    (g) 0.0068
    (h) 0.0000

14. In the 1960s, the median age at which American men first married was 22.8. Has the median age of first marriage changed? Using the data from Question 13, what P-value do you find in an appropriate 2-sided sign test?

(a) 1.0000
(b) 0.7630
(c) 0.1317
(d) 0.0868
(e) 0.0209
(f) 0.0062
(g) 0.0009
(h) 0.0000

15. To test whether cars get higher mileage per gallon with premium gas (as opposed to regular), we test 8 cars with a tankful of each of regular and premium gasoline. The resulting mileage (in miles per gallon) is below:

Regular	16	19	20	21	23	27	27	28
Premium	19	21	23	23	25	26	29	31

Do cars get better average mileage with premium gasoline? Find the P-value from the appropriate 1-sided hypothesis test.

(a) 1.0000
(b) 0.9982
(c) 0.9830
(d) 0.1876
(e) 0.1780
(f) 0.0169
(g) 0.0017
(h) 0.0000

16. Consider the data from Question 15 again. Do more than half of car models get better mileage with premium gasoline? Find the P-value from an appropriate 1-sided signed hypothesis test.

   (a) 1.0000
   (b) 0.9982
   (c) 0.9830
   (d) 0.1876
   (e) 0.1780
   (f) 0.0169
   (g) 0.0017
   (h) 0.0000

17. After getting trounced by your little brother while playing "Monopoly: the Famous Statisticians Edition", you suspect that the die he gave you was unfair. To check, you roll it 90 times, recording the number of times each face appears:

Face	1	2	3	4	5	6
Count	13	17	11	21	16	12

   Do these results cast doubt on the die's fairness? Find the P-value of an appropriate χ^2 test.

   (a) 1.0000
   (b) 0.9462
   (c) 0.5872
   (d) 0.4579
   (e) 0.1585
   (f) 0.0929
   (g) 0.0002
   (h) 0.0000

18. According to recent polls, about 35% of US voters are Democrats, 32% are Republicans, and 33% are independent. In your own poll of 1000 voters, you find that 330 are Democrats, 328 are Republicans, and 344 are independent. Do these results cast doubt on the 35-32-33 model? Find the P-value of an appropriate χ^2 test.

(a) 1.0000
(b) 0.9987
(c) 0.9515
(d) 0.9276
(e) 0.7945
(f) 0.5856
(g) 0.3797
(h) 0.0000

19. You decide to compare the number of chocolate chips in an 18 oz box of Chip Ahoy! cookies with the number of chocolate chips in an 18 oz box of the supermarket brand. You painstakingly count the number of chips in 6 boxes of each, as summarized in the following table:

Chips Ahoy!	1214	1087	1419	1121	1345	1325
Supermarket	1039	1173	1138	951	1011	1341

Is $\mu_{\text{Chips Ahoy!}}$ at least 100 greater than $\mu_{\text{Supermarket}}$? Perform an appropriate 1-sided hypothesis test and find the P-value.

(a) 1.0000
(b) 0.7529
(c) 0.2985
(d) 0.2071
(e) 0.0512
(f) 0.0497
(g) 0.0431
(h) 0.0000

20. Let X be a random variable with Poisson distribution and $E(X) = 3$. What is $\text{Var}(X)$?

    (a) 0
    (b) 1
    (c) 1.7
    (d) 2
    (e) 2.5
    (f) 3
    (g) 4
    (h) 4.5

Problems 21-30: True/false. Each problem is worth 2 points.

21. True/false: After sampling 100 married couples, you want to test the null hypothesis H_0 that men and women earn the same amount. You will use a 2 sample t-test.

    (a) True
    (b) False

22. True/false: If the probability that a randomly chosen person has tuberculosis is 0.00005, then the number of cases of tuberculosis in greater St. Louis (population about 2.8 million) cannot be modeled with the normal distribution, and must be modeled with the Poisson distribution instead.

    (a) True
    (b) False

23. True/false: Purchase amounts at Schnucks grocery stores have a skewed unimodal distribution with a mean of \$35 and standard deviation of \$20. If in a particular day Schnucks sees 312 customers, it is reasonable to model the mean purchase of these 312 customers with a normal distribution.

    (a) True
    (b) False

24. True/false: Performing a hypothesis test at a lower significance level will lead to a lower probability of a Type II error.

    (a) True
    (b) False

25. True/false: Increasing the sample size used in a hypothesis test will lead to a lower probability of a Type I error.

    (a) True
    (b) False

26. True/false: A recent study on perfect pitch sampled 2700 students, and found that 7% of non-Asians and 32% of Asians have perfect pitch. A 2-proportion z-test gave a P-value of < 0.0001. We conclude that genetic differences cause the difference in frequency of perfect pitch.

    (a) True
    (b) False

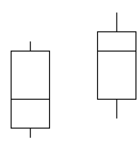
27. True/false: A 99% confidence interval for $\hat{p}$ will be wider than the 90% confidence interval for $\hat{p}$.

    (a) True
    (b) False

28. True/false: The 99% confidence interval for $\bar{x}$ will be wider than the 90% confidence interval for $\bar{x}$.

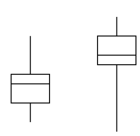
    (a) True
    (b) False

29. True/false: The following boxplot represents two samples of size 40. We conclude from Tukey's quick test that we can reject the null hypothesis (that the means are equal) at a signficance level of 0.001.



    (a) True
    (b) False

30. True/false: The following boxplot represents two samples of size 40. We conclude from Tukey's quick test that we can reject the null hypothesis (that the means are equal) at a signficance level of 0.001.



    (a) True
    (b) False