**Stat 1040, Spring 2008** **Name:** ____________________

**Final Test, May 1, 1:30pm–3:20pm**

100 → $\boxed{400}$

*Show your work. The test is out of 100 points and you have 110 minutes to finish.*

8 → $\boxed{32}$ 1. **Does Aspartame Cause Cancer?** Aspartame is an artificial sweetener found in thousands of products – sodas, chewing gum, dairy products and even many medicines. Some research has suggested that aspartame can cause lymphoma or leukemia in rats.

A recent study by the National Cancer Institute involved 340,045 men and 226,945 women, ages 50 to 69. From surveys they filled out in 1995 and 1996 detailing food and beverage consumption, researchers calculated how much aspartame they consumed. Over the next five years, 2,106 developed cancers such as lymphoma or leukemia. No association was found between aspartame consumption and occurrence of these cancers.

5

$\boxed{8}$ (a) (2 points) Was the study a controlled experiment or an observational study? Why?

There was no intervention. The subjects decided themselves what to eat and to drink. 3

$\boxed{16}$ (b) (4 points) Suggest a possible confounding factor for this study and explain why your confounding factor might make you doubt their results.

10 for 1 valid factor
6 for explanation

There might be various confounding factors, e.g.

- race: some types of cancer are more frequent in one race than in other races
- environment & work place: subjects may have been exposed to other chemicals or pollutants at home or at their work place and these chemicals or pollutants may have contributed to their cancer
- genetics: certain genetic diseases may be associated with this type of cancer

$\boxed{8}$ (c) (2 points) "It's very reassuring. It's a large study with a lot of power," said Richard Adamson, a senior science consultant to the American Beverage Association, the leading industry group. Does the large sample size prove that aspartame does not cause cancers such as lymphoma or leukemia? Explain.

5 No! – An invalid study remains invalid no matter what the sample size is. Here, they have ignored several confounding factors at a large scale. 3

6 → 24 2. A randomized, controlled, double-blind study published in March, 2008 shows the well-known "placebo effect" works even better if the placebo costs more. In the study, volunteers were given an electric shock and took a pill. Volunteers in the treatment group were told it was an expensive painkiller, while those in the control group were told it was a discounted painkiller. In fact, all the pills were placebos, but 85% of the volunteers who thought they were getting an expensive painkiller said they felt less pain after taking it, compared to 61% of those who thought they were getting a discounted painkiller.

4 (a) (1 point) What is a placebo?

A placebo is a drug or vaccination (e.g., a sugar pill or a salt water injection) that resembles the treatment, but has no medical effect.

2 2

12 (b) (3 points) Why is a placebo used in a controlled experiment?

It is used such that the subjects' response will be related to the treatment itself and <u>not</u> to the <u>idea</u> of the treatment. 12

8 (c) (2 points) What sort of a test would you use if you wanted to test whether the difference between the two percentages could be due to chance error? (Circle the correct answer)

- one-sample z-test
- one-sample t-test
- two-sample z-test 8
- Chi-square test

4 → 16 3. (4 points) In a flyer by Horizon Textbook Publishing, a customized textbook manufacturer, they cite Dr. Blount, Gaston College, as follows:

> "After 4 years with my Horizon customized textbook, I've witnessed an increase in both grade point averages and instructor evaluation scores. Thanks, Horizon!"

Assuming that his grade point averages and instructor evaluation scores really did increase, can we attribute the increase to the Horizon customized textbook? Yes / No? Circle your answer and explain, using the appropriate statistical terms. Provide two *different* reasons to justify your answer.

8 No - association is not the same as causation. There might be various confounding factors such as:

4 for each valid reason

(i) an improved teaching style of the instructor after having taught the same course for 4 years

(ii) a possible general increase in students' GPAs (e.g., after the university toughened its general admissions rules).

Finally, (iii) are the observed improvements indeed statistically significant or could the observed improvements just be chance error?

8 → $\boxed{32}$

4. (8 points) The following table summarizes the lengths of 24 male painted turtles. Class intervals include the left endpoint but not the right.

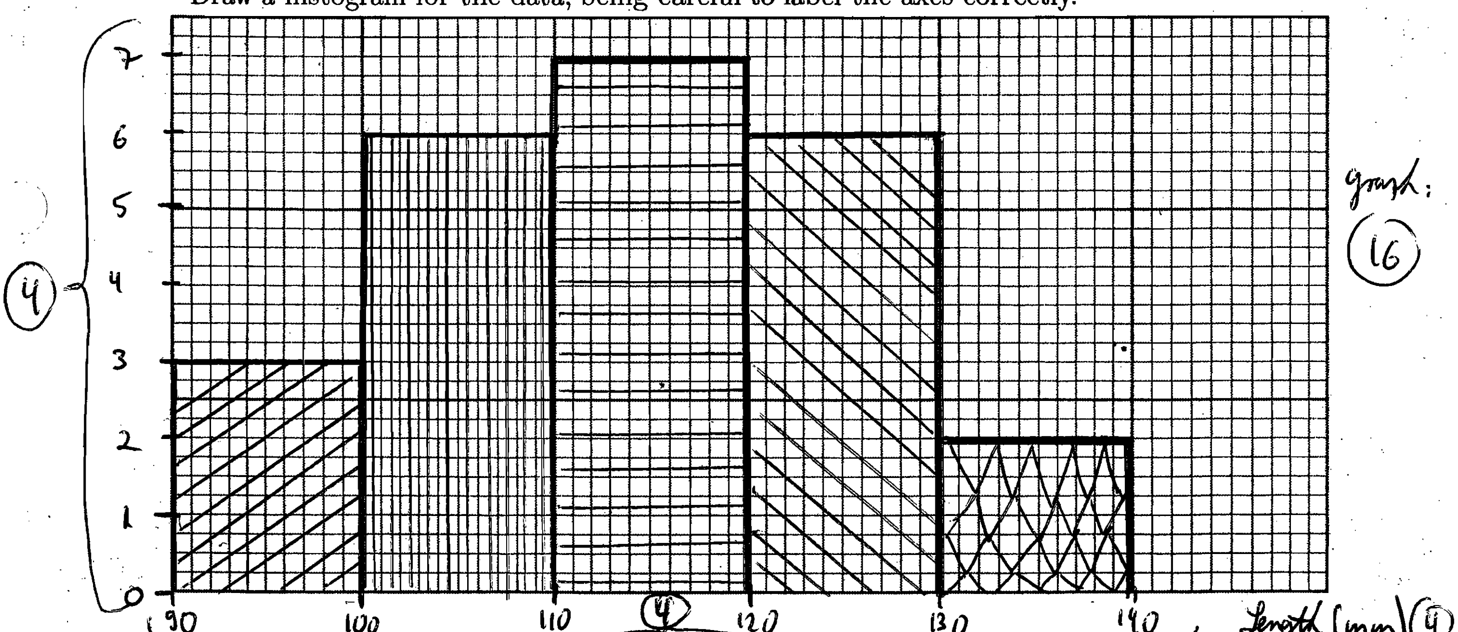
| Length (mm) | Number of turtles |
|---|---|
| 90 to 100 | 3 |
| 100 to 110 | 6 |
| 110 to 120 | 7 |
| 120 to 130 | 6 |
| 130 to 140 | 2 |

As each class is equally wide, we can just draw frequencies on the vertical axis (no need for the density scale - but, of course, you can use it if you really want to).

(4)

Count (or Frequency or Number)

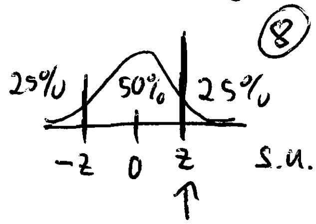
Draw a histogram for the data, being careful to label the axes correctly.




7 → $\boxed{28}$

5. (7 points) The length of female painted turtles follows the normal curve with an average of 136 mm and an SD of 21 mm. If the length of one of these turtles is at the 75th percentile, what is her length?

(8)




area between −0.65 and 0.65 : 48.43% (closest to 50%)

original units: $0.65 \cdot 21 + 136 = \underline{149.65 \text{ mm}}$

(10) (2) (3) (2) (3)

−2 for each calculation error

$6 \to \boxed{24}$ 6. The length and width of 24 male painted turtles have the following summary statistics:

X Length: average = 113 mm SD = 12 mm r = 0.95

Y Width: average = 88 mm SD = 7 mm

The scatter-diagram is football-shaped.

−2 for each calculation error

$\boxed{20}$ (a) (5 points) Predict the width of a turtle that is 130 mm in length.

$$\text{slope} = r \cdot \frac{SD_Y}{SD_X} = 0.95 \cdot \frac{7}{12} = 0.554 \quad (7)$$

$$\text{intercept} = \text{avg}_Y - \text{slope} \cdot \text{avg}_X = 88 - 0.554 \cdot 113 = 25.4 \quad (7)$$

$$\text{regression equation: } y = 25.4 + 0.554 \cdot X$$

$$\text{width for 130 mm in length: } y = 25.4 + 0.554 \cdot 130 \overset{(6)}{=} \underline{\underline{97.42 \text{ mm}}}$$

$\boxed{4}$ (b) (1 point) What is the rms error for your prediction in part (a)?

$$\text{rms error} = \sqrt{1-r^2} \cdot SD_Y$$

$$= \sqrt{1-0.95^2} \cdot 7 \overset{(4)}{=} \underline{\underline{2.19 \text{ mm}}}$$

$9 \to \boxed{36}$ 7. A class of 26 fourth-graders has 14 boys and 12 girls. This class goes on a field trip. Two children are chosen at random to ride with the teacher.

−2 for each calculation error

$\boxed{4}$ (a) (1 point) What is the chance the first child is a boy?

$$\overset{\text{1st boy}}{\frac{14}{26}} \ (4) = 0.538 = \underline{\underline{53.8\%}}$$

$\boxed{8}$ (b) (2 points) What is the chance the second child is a boy?

$$\overset{\text{2nd boy}}{\frac{14}{26}} \ (8) = 0.538 = \underline{\underline{53.8\%}}$$

$\boxed{8}$ (c) (2 points) What is the chance both children are boys?

$$\overset{\text{1st boy}}{\frac{14}{26}} \ (3) \ \overset{\text{and}}{\cdot} \ (2) \ \overset{\text{2nd boy}}{\frac{13}{25}} \ (3) = \frac{182}{650} = 0.280 = \underline{\underline{28.0\%}}$$

$\boxed{8}$ (d) (2 points) What is the chance neither of the children are boys?

$$= \text{chance both are girls} = \overset{\text{1st girl}}{\frac{12}{26}} \ (3) \ \overset{\text{and}}{\cdot} \ (2) \ \overset{\text{2nd girl}}{\frac{11}{25}} \ (3) = \frac{132}{650} = 0.203 = \underline{\underline{20.3\%}}$$

$\boxed{8}$ (e) (2 points) What is the chance one of the children is a boy and the other is a girl?

$$= 1 - \text{both boys} - \text{both girls}$$

$$= \underset{(2)}{1} - \underbrace{0.280}_{(3)} \underbrace{- 0.203}_{(3)} = 0.517 = \underline{\underline{51.7\%}}$$

32 → $\boxed{128}$

8. **German Internet Study** This question relates to a study published in April 2008 at `http://www.sevenoneinteractive.de/`. This was a telephone survey in which 1,009 Germans were asked questions about how they used the internet at home.

$\boxed{48}$ (a) (12 points) One of the questions asked people how many Web sites they frequently revisited. For the 505 men in the study, the average was 9.4 with an SD of 8.3. For the 504 women in the study, the average was 6.4 with an SD of 6.0. Is this evidence that the average for all German men is higher than the average for all German women, or could the result just be due to chance error? (Assume these are two independent simple random samples from all German men and women.)

2-sample z-test:

−36 for incorrect test
−4 if null, alt. swapped
−2 for each calculation error

i. Clearly state the null and alternative (M W) hypotheses.

1) null: men & women revisit on avg the same number of Web sites (3)
i.e., box avg$_M$ − box avg$_W$ = 0 (1)
alternative: men revisit on avg more Web sites than women (3)
i.e., box avg$_M$ − box avg$_W$ > 0 (1)

ii. Calculate the appropriate test statistic.

2)

| Men (M) | Women (W) |
|---|---|
| sample size M = 505 | sample size W = 504 |
| sample avg M = 9.4 | sample avg W = 6.4 |
| sample SD M = 8.3 | sample SD W = 6.0 |

$SE_{sum_M} = \sqrt{505} \cdot 8.3 = 186.5$ (2) $SE_{sum_W} = \sqrt{504} \cdot 6.0 = 134.7$ (2)

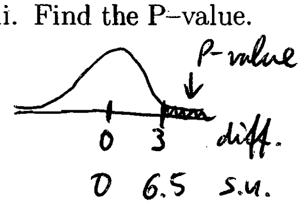
$SE\ avg_M = \frac{186.5}{505} = 0.37$ (2) $SE\ avg_W = \frac{134.7}{504} = 0.27$ (2)

$SE_{diff} = \sqrt{0.37^2 + 0.27^2} = 0.46$ (4)

$z = \frac{9.4 - 6.4}{0.46} = 6.5$ (4)

iii. Find the P–value.

3)




area between −6.5 and 6.5: almost 100% (4)
area above 6.5: about 0% = P-value (4)

iv. Do you reject the null hypothesis? Explain why or why not.

4) • reject the null (4) (P-value < 5%) (4)

v. State your conclusions.

• result is <u>highly</u> stat. significant (4) (P-value < 1%)
• men revisit on avg more Web sites than women (4)

−30 for incorrect test
−4 if null, alt swapped
−2 for each calculation error

$\boxed{40}$ (b) (10 points) According to an earlier study, German men visit an average of 20 new Web sites in a typical month. For the 505 men in the new study, the average number of new Web sites visited in a typical month was 20.8 with an SD of 21.6. Does the new study justify the following newspaper headline: "New study shows that German men visit an average of **more than 20** new Web sites in a typical month."? (Assume this is a simple random sample from all German men.)

z-test:
sample size > 30

i. Clearly state the null and alternative hypotheses.

1| null: men visit on avg 20 new Web sites per month, (3)
i.e., box avg = 20 (1)
alternative: men visit on avg more than 20 new Web sites per month, (3)
i.e., box avg > 20 (1)

ii. Calculate the appropriate test statistic.

2| observed (avg) = 20.8
expected (avg) = 20
SD = 21.6

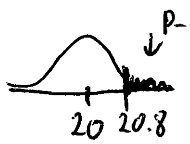
$SE_{sum} = \sqrt{505} \cdot 21.6 = 485.4$ (4)

$SE_{avg} = \frac{485.4}{505} = 0.96$ (4)

$z = \frac{20.8 - 20}{0.96} = 0.83$ (4)

iii. Find the P–value.

3|




area between −0.85 and 0.85: 60.47% (4)

area above 0.85: $\frac{100\% - 60.47\%}{2} = 19.77\%$ = P-value (4)

iv. Do you reject the null hypothesis? Explain why or why not.

4| • do not reject the null (4) (P-value > 5%) (4)

v. State your conclusions.

• men visit on avg 20 new Web sites per month, (4)
i.e., the newspaper headline is not justified

32 (c) (8 points) Among the 350 people in this study aged 20 to 29 years, 12.6% visit more than 50 new Web sites in a typical month. Find an 85% confidence interval for the percentage of all Germans aged 20 to 29 years who visit more than 50 new Web sites in a typical month. (Assume this is a simple random sample of all Germans aged 20 to 29 years.)

sample % = 12.6% — −2 for each calculation error

$SD = \sqrt{0.126 \cdot 0.874} = 0.332$ (4)

$SE_{sum} = \sqrt{350} \cdot 0.332 = 6.21$ (4)

$SE\% = \frac{6.21}{350} \cdot 100\% = 1.77\%$ (4)

85% CI: $12.6\% \pm 1.45 \cdot 1.77\% = \underline{10.03\%}$ to $\underline{15.17\%}$

(4) . (2) (4) (2) (4) (2) (2)

8 (d) (2 points) Suppose we found out that the samples really came from an online questionnaire exclusively available to people who visited the German version of "myspace" (myspace.de). Which, if any, of the results from the previous three questions are still valid? Explain.

(5) None of these results would be valid any longer as we no longer are dealing with a SRS of all Germans. myspace.de most likely favors a certain group of internet users. Moreover, a survey posted on a Web site results in a convenience sample where most likely people with particular opinions will respond, e.g., people who spend a lot of time on the Web. (3)

8 → 32 9. (8 points) For Utah men aged 50–80, the average number of hours of hard physical activity a week is 14 hours, with an SD of 15 hours. I plan to take a simple random sample of 225 Utah men aged 50-80. What is the chance that the average number of hours of hard physical activity a week for the men in the sample lies between 12.5 and 15.5?

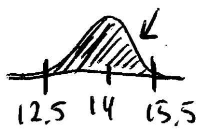
−2 for each calculation error

$EV_{avg} = 14$

$SD = 15$

$SE_{sum} = \sqrt{225} \cdot 15 = 225$ (6)

$SE_{avg} = \frac{225}{225} = 1.0$ (6)




s.u.: $\frac{12.5-14}{1.0} = -1.5$ (6) $\frac{15.5-14}{1.0} = 1.5$ (6)

area between −1.50 and 1.50 = $\underline{86.64\%}$ (8)

$① = \frac{559 \cdot 445}{1236} = 201$ $② = \frac{559 \cdot 588}{1236} = 266$ $③ = 559 - 201 - 266 = 92$

$④ = 445 - 201 = 244$ $⑤ = 588 - 266 = 322$ $⑥ = 203 - 92 = 111$

12 → $\boxed{48}$ 10. (12 points) In one analysis of the data from the Utah Study of Nutrition and Bone Health they looked at the relationship between BSM1 vitamin D receptor genotype and whether or not a person has a hip fracture. The data for the women in the study are summarized in the table below. Assume this is a simple random sample from the population.

$\chi^2$-test for independence:

obs. count

| | | Genotype | | | |
|---|---|---|---|---|---|
| | | +/+ | +/- | -/- | Total |
| Hip Fracture? | Yes | 183 | 281 | 95 | 559 |
| | No | 262 | 307 | 108 | 677 |
| | Total | 445 | 588 | 203 | 1236 |

④ for Totals

exp. count

| | | | |
|---|---|---|---|
| ① 201 | ② 266 | ③ 92 | 559 |
| ④ 244 | ⑤ 322 | ⑥ 111 | 677 |
| 445 | 588 | 203 | 1236 |

6 × ① = ⑥

We are interested in whether or not genotype and hip fracture are independent in this population.

−36 for incorrect test
−4 if null, alt swapped
−2 for each calculation error

(a) Clearly state the null and alternative hypotheses.

1, null: genotype and hip fractures are independent, ③
i.e., boxes are identical ①
alternative: genotype and hip fractures are not independent, ③
i.e., at least one box is different ①

(b) Calculate the appropriate test statistic.

2, expected: → see above

$$\chi^2 = \text{sum of } \frac{(\text{obs} - \text{exp})^2}{\text{exp}}$$

$$= \frac{(183-201)^2}{201} + \frac{(281-266)^2}{266} + \frac{(95-92)^2}{92} + \frac{(262-244)^2}{244} + \frac{(307-322)^2}{322} + \frac{(108-111)^2}{111}$$ ⑥

$= 4.66$

(c) Find the P–value. ④

3, $df = (2-1)\cdot(3-1) = 2$ ④

$\chi^2 = 4.66$ is between 4.60 and 5.99 ④

P-value is between 10% and 5%

(d) Do you reject the null hypothesis? Explain why or why not.

4, • do not reject the null ④ (P-value > 5%) ④

(e) State your conclusions. ④

• genotype and hip fractures are independent