Math 121 **Test #1** **Spring 2008**

1. (20 pts) A recent study investigated the relationship between poor sleep and the body's insulin production. According to ABC News, "researchers monitored sleeping volunteers' brain waves. When they reached slow-wave sleep, the researchers blared sounds loud enough to rouse the volunteers into a lighter sleep stage, but not loud enough to wake them up – a forced sleep apnea of sorts."[1] The article goes on to state that the researchers found that "after three nights of poor sleep, healthy people can lose their ability to process sugar by 23 percent – a problem that in the long-term could lead to weight gain and diabetes."

   (a) (4 pts) Identify an explanatory variable and a response variable in this study.

   (b) (4 pts) Is this study an observational study or an experiment? Explain.

   (c) (4 pts) State an appropriate null hypothesis and an appropriate alternative hypothesis for this study.

   (d) (4 pts) Which hypothesis was supported by the study?

   (e) (4 pts) Describe a Type I error in the context of this study.

2. (20 pts) A recent survey has found that parents of obese children often do not perceive their children to be overweight. According to Fox News, the survey found that "Among parents with an obese, or extremely overweight, child ages 6 to 11, 43 percent said their child was 'about the right weight,' 37 percent responded 'slightly overweight,' and 13 percent said 'very overweight.' Others said 'slightly underweight.' For those with an obese child ages 12 to 17, the survey found more awareness that weight was a problem. Fifty-six percent said their child was 'slightly overweight,' 31 percent responded 'very overweight,' 11 percent said 'about the right weight' and others said 'slightly underweight.'"[2]

   (a) (3 pts) Describe the population of interest in this study.

   (b) (4 pts) Identify the variable of interest in this study and list the different possible values that it could take on for a member of the population.

   (c) (3 pts) Is the variable described in the previous part qualitative or quantitative?

   (d) (6 pts) Draw an appropriate graphical display that facilitates the comparison of responses of parents of children ages 1 to 11 to the responses of parents of children ages 12 to 17. Be sure to label the appropriate parts of the diagram.

   (e) (4 pts) If the researchers were using this survey to determine whether the children truly were obese, what type of bias would be present? Explain.

[1] http://abcnews.go.com/Health/DiabetesResource/story?id=4069909&page=1

[2] http://www.foxnews.com/story/0,2933,318391,00.html

3. (16 pts) Every year since 2001, Virginia Commonwealth University has conducted a survey on people's attitudes towards stem-cell research. They survey by telephone 1000 adults from across the nation. The 2007 survey found that "strong" support for stem cell research dropped to 21% from a high of 27% in 2005.[3]

   (a) (4 pts) Is the figure of 21% a parameter or a statistic? Explain.

   (b) (3 pts) The researchers divided their sample of 1000 adults into groups according to how often they attend religious services (more than once a week, once a week, once or twice a month, etc.). If the researchers intentionally selected at random a specified number of adults from each of these groups, then what sampling method would this be?

   (c) (4 pts) Would the sampling method described in the previous part be a sensible way to design the study? Explain.

   (d) (5 pts) Suppose that we wish to conduct a similar study on the HSC campus. We find that there are exactly 1500 adults on campus, counting all students, faculty, and staff. We number them 1 through 1500 and use the TI-83 to select a simple random sample of 100 of them. Using a seed of 142, find the first 5 people to be selected for our sample. (Find their numbers.)

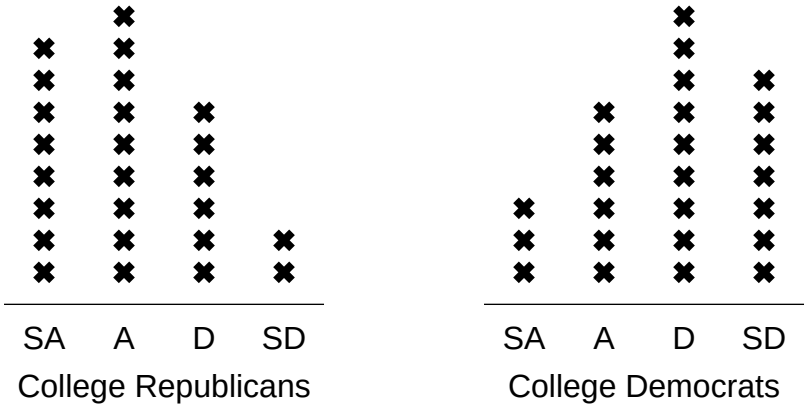
4. (4 pts) The survey mentioned in the previous problem also asked whether the subjects agreed with the statement

   "Scientific research these days doesn't pay enough attention to the moral values of society."

   The sample contained 301 Democrats, 280 Republicans, and 341 Independents. (Ignore the remaining 78 people.) The researchers found that 13% of Democrats strongly disagreed with the statement, 5% of Republicans strongly disagreed with it, and 11% of Independents strongly disagreed with it. Use these figures to compute the best estimate of the overall proportion of people who strongly disagree with the statement. Give your answer to four significant digits (e.g., 0.1234 or 12.34%).

[3] `http://www.vcu.edu/lifesci/images2/survey2007.pdf`

5. (18 pts) Suppose that the College Republicans and the College Democrats are meeting in two rooms (Room A and Room B) at the same time. Each room contains 25 individuals and they all look pretty much alike. However, regarding agreement with the statement in the previous problem, the distributions of opinions among the Democrats and among the Republicans are



where SA = strongly agree, A = agree, D = disagree, and SD = strongly disagree. (In reality the two groups have very similar distributions. I had to misrepresent the groups in order to make the problem interesting. Sorry.) We do not know which group is meeting in which room. We are embarrassed to walk into one of the rooms and ask which group is in the room. So we go into one of the rooms and ask one person his or her opinion about the above statement. If the person strongly disagrees, then we will conclude that the group is the College Democrats. Otherwise, we will conclude that the group is the College Republicans. Our hypotheses are

H_0: We are in the room of College Republicans.

H_1: We are in the room of College Democrats.

(a) (3 pts) What is the direction of extreme in this situation.

(b) (4 pts) What is the value of α based on our decision rule?

(c) (4 pts) What is the value of β?

(d) (4 pts) If the person responds "Disagree," (response D) what is the p-value of that observation?

(e) (3 pts) Describe a Type II error in this situation.

6. (10 pts) Three sections of a statistics course have a total of 60 students. The students all take a statistics exam worth 100 points. With the students labeled 1 through 60, their scores are as follows.

Std	Scr	Std	Scr	Std	Scr	Std	Scr	Std	Scr	Std	Scr
1	79	11	88	21	100	31	63	41	77	51	66
2	51	12	92	22	100	32	100	42	74	52	56
3	64	13	95	23	65	33	97	43	84	53	100
4	69	14	80	24	90	34	70	44	70	54	77
5	72	15	57	25	100	35	90	45	28	55	100
6	53	16	24	26	84	36	37	46	98	56	79
7	83	17	100	27	62	37	90	47	79	57	66
8	96	18	71	28	100	38	96	48	50	58	42
9	78	19	85	29	92	39	78	49	64	59	76
10	100	20	85	30	93	40	87	50	100	60	100

   (a) (4 pts) Beginning with a seed of 362, use the TI-83 or I-84 to select a systematic 1-in-4 sample from this population. Circle your choices in the table above.

   (b) (6 pts) Draw a histogram of the values in the sample that you selected in the previous part.

7. (12 pts) In each of the following situations, identify the type of bias that is most likely and explain why it would be likely to occur. (There may be more than one possible answer.) Then tell how the design could be modified to remove or minimize the bias.

   (a) (4 pts) In order to determine the level of illegal drug use among high school students, researchers go to a particular high school and select 100 students at random and ask them whether they have used illegal drugs in the past 30 days.

   (b) (4 pts) In order to determine the effectiveness of a new drug, 100 patients suffering from the disease volunteer to undergo drug trials.

   (c) (4 pts) A survey is mailed out to 100 residents in a town asking them for their opinion of the recent reassessment of property values.