MATH 300: Unit 1 Exam (Take-home portion) Name: _____

Show all supporting work and circle your final answer. DO NOT WORK WITH OTHER STUDENTS OR LIVING HUMANS.

17. A study was conducted to determine whether or not smoking increases an individual's chance of developing ocular diseases. The following three tables summarize some of the information obtained from the 234 adults in the study.
Source: Solberg, Y., Rosne, M., & Belkin, M. (1998). The association between cigarette smoking & ocular diseases. *Surv Ophthalmol*, 42(6): 535-547.

(Table 1)	Smokes < 12 cigarettes per day	Smokes >12 cigarettes per day	Total
Ages 20-39	14	94	108
Ages 40-80	18	108	126
Total	32	202	234

(Table 2)	Smokes < 12 cigarettes per day	Smokes >12 cigarettes per day	Total
Male	11	99	110
Female	21	103	124
Total	32	202	234

(Table 3)	Ages 20-39	Ages 40-80	Total
Male	47	63	110
Female	61	63	124
Total	108	126	234

Suppose we randomly select one subject from this study. Calculate the following probabilities:

$P(\text{male} \cup \text{smokes} < 12 \text{ per day}) =$ _____ (0.5 points)

$P(\text{female} \mid \text{ages } 20\text{-}39) =$ _____ (0.5 points)

$P(\text{female} \cap \text{ages } 20\text{-}39) =$ _____ (0.5 points)

$P(\text{ages } 20\text{-}39 \mid \text{female}) =$ _____ (0.5 points)

$P[(\text{ages } 20\text{-}39 \cap \text{female}) \cup (\text{ages } 40\text{-}80 \cap \text{male})] =$ _____ (0.5 points)

$P[(\text{smokes} > 12 \cap \text{male}) \mid (\text{ages } 40\text{-}80)] =$ _____ (0.5 points)

use table

18. Suppose that American adults who smoke 12 or more cigarettes per day have a 15% chance of developing an ocular disease. Suppose that American adults who smoke less than 12 cigarettes per day have only a 3.5% chance of developing an ocular disease. Furthermore, suppose 19% of American adults smoke more than 12 cigarettes per day. If we randomly select an American adult, what's the probability that he or she will develop an ocular disease? (2 points)

19. Three types of students take this course: math majors, engineering majors, and other majors. Approximately 45% of all students are engineering majors, 35% are math majors, and 20% are other majors. Furthermore, 78% of engineering majors pass the course, 84% of math majors pass the course, and 67% of the other majors pass the course. If we randomly select a student who has taken this course and find out this student has passed the course, what's the probability it was an engineering major? (2 points)

20. According to a Rasmussen poll taken on September 1, 2011, 33.0% of Americans identify themselves as Democrats, 33.5% identify themselves as Republicans, and 33.5% identify themselves as unaffiliated voters. Another Rasmussen poll taken that same day shows that 42% of Americans strongly disapprove of President Obama's performance. The poll further shows that 73% of Republicans and 42% of unaffiliated voters strongly disapprove of the president's performance. The report does not indicate the percentage of Democrats who strongly disapprove of the president's performance.

Sources: http://www.rasmussenreports.com/public_content/politics/obama_administration/obama_approval_index_month_by_month
http://www.rasmussenreports.com/public_content/politics/mood_of_america/partisan_trends

a) If we select a Democrat at random, what's the probability that Democrat strongly disapproves of President Obama's performance? (1 point)

b) A person chosen at random is found to strongly disapprove of the president's performance. What's the probability that individual identifies as being Republican? (1 point)

21. I need to schedule a job interview for someone who wants to teach math at St. Ambrose. For the day of the interview, I need to schedule six activities for the candidate:

- Meet the Vice President of Academic and Student Affairs
- Talk with faculty in the Math Department
- Tour the campus
- Teach a lesson to students in a math class
- Take one 15-minute break
- Take one 30-minute break

As I look at the activities, I realize that it wouldn't make sense to have a break at the beginning or end of the schedule. With that in mind, how many unique schedules could I create if I cannot schedule a break at the beginning or end? Assume that I must schedule each of the six activities only once. (1 point)

22. To investigate whether rhesus monkeys have the ability to understand gestures made by humans, a researcher placed 2 boxes an equal distance from a monkey. The researcher placed food in one of the boxes, making sure that the monkey could tell that one of the boxes received food without revealing which box. Finally, the researcher made eye contact with the monkey and then gestured towards the box with the food by jerking his head towards that box.

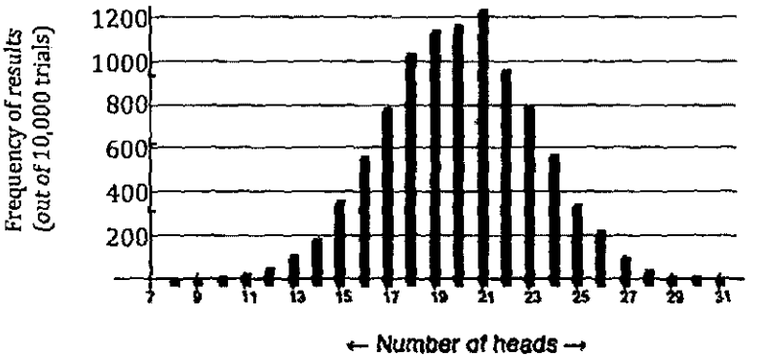
This process was repeated with a total of 40 rhesus monkeys. It turns out that 30 of the monkeys approached the box that the human had gestured towards and 10 approached the other box.

a) Fill-in-the-blank to complete the null hypothesis for this study. (1 point)

H_0: The probability that a rhesus monkey chooses the box with the food is _____

b) Describe how you could use a coin to conduct a simulation analysis of this study and its result. Give enough detail that someone else could do your simulation. Be sure to indicate how you would decide whether the observed data (30 of 40 monkeys choosing the box with food) provide convincing evidence that rhesus monkeys can interpret human gestures. (2 points)

c) Using the coin toss simulation website we used the first day of class, I simulated the coin toss experiment 10,000 times. The resulting distribution is shown below.



Using this distribution, provide an estimate of the p-value for this study (the probability of observing results as extreme as what we observed, assuming the null hypothesis is true). Based on the distribution and your p-value, what conclusions can you make regarding rhesus monkeys? (2 points)

I estimate the p-value of this study to be: _____

My conclusions:

d) Calculate the exact p-value. In other words, use the binomial distribution to calculate the probability that 30 or more rhesus monkeys (out of 40) would choose the box with food (assuming they are just randomly choosing one of the two boxes). (1 point)

23. Last semester, I made lots of changes to this course. To determine if the changes were effective, I had students take an online pre-test at the beginning of the semester. At the end of the semester, they took a post-test.

Suppose I've had students take this pre-test and post-test for the past 10 years. Over the course of these 10 years, 70% of students scored higher on the post-test than they did on the pre-test (demonstrating that I'm somewhat effective in teaching statistics).

Now suppose that of the 32 students in (the new, experimental) MATH 300 last semester, 25 scored higher on the post-test than they did on the pre-test.

I'm interested in determining if the new, experimental MATH 300 last semester is more effective than the traditional MATH 300 classes I taught previously.

a) State the null hypothesis in this study. (1 point)

H_0: The probability that a student in this new MATH 300 scores higher on the post-test than the pre-test is _____

b) Conduct a binomial test and report the p-value. (2 points)

c) Write out any conclusions you can make from this analysis. (1 point)

24. As you may have noticed by now, probabilities can be much easier to calculate if we create tables or Venn Diagrams. These tables or diagrams are easy to create when we're interested in 2 or 3 dimensions, but they can easily be extended to more dimensions. The first question on this take-home portion of the test shows one way (not the best way) to display 3 dimensions across multiple tables. This question will give you a single table that displays 4 dimensions.

Suppose we're interested in the following 4 dimensions of students in a local high school:

(1) Gender = male or female
(2) Socioeconomic status (SES) = low, middle, or high
(3) Whether a student is enrolled in an honors English course = enrolled or not enrolled
(4) The general plan of study for the student = general, academic, or vocational

I found a dataset containing these variables for 200 high school students. Using a little creativity, I managed to get all the data into a single table:

	Gender and SES					
	male			female		
	low	middle	high	low	middle	high
not enrolled						
general	7	10	2	7	8	4
academic	3	17	12	9	16	8
vocation	4	14	4	6	14	2
enrolled						
general			2	2	2	1
academic	1	5	9	6	6	13
vocation		1		2	2	1

From this table, I can see that there are 91 males and 109 females. Use this table to find the following probabilities (assuming we select one of these 200 students at random):

a) P(male | vocational program AND not enrolled in honors English AND low SES) = _____ (0.5 points)

b) P(vocational program AND not enrolled in honors English AND low SES | male) = _____ (0.5 points)

c) P(high SES AND female | academic program AND enrolled in honors English) = _____ (0.5 points)

d) P(low SES AND male | academic program AND enrolled in honors English) = _____ (0.5 points)

MATH 300: Unit 1 Exam (Extra credit questions) Name: _____

Show all supporting work and circle your final answer. DO NOT WORK WITH OTHER STUDENTS OR LIVING HUMANS.

25. Suppose I have 3 coins in my pocket. Two of the coins are fair and the third coin is a double-headed coin (it always lands heads). The coins look identical.


Fair coin


Fair coin


Counterfeit coin

I reach into my pocket and randomly choose a coin. At this point, the probability of choosing the counterfeit coin is 1/3.

I flip the coin 3 times and it lands heads each time. Given you have these results (3 heads in 3 flips), what's the probability the coin you chose is the counterfeit coin?

P(counterfeit coin | 3 heads) = _____ (1.5 extra credit points)

26. For a couple days, you've been suffering with a stiff neck and a high fever. While you might simply have a cold or the flu, you know these are also symptoms of meningitis (an infection of the central nervous system that can be fatal).

Suppose we know the following:

P(M) = P(meningitis) = 1/40000 = 0.000025

P(S | M) = P(symptoms given you have meningitis) = 3/4 = 0.75

P(S | M') = P(symptoms given you do not have meningitis) = 1/50 = 0.02

Given you have these symptoms, calculate the probability that you have meningitis:

P(meningitis | symptoms) = _____ (0.5 extra credit points)

Look at the probability you just calculated. That's our best (updated) estimate of the probability you have meningitis. Suppose a doctor gives you a test for meningitis. Based on research, we know:

P(M) = P(meningitis) = your answer to the previous question

P(+ | M) = P(positive test result given you have meningitis) = 0.95

P(S+| M') = P(positive test result given you do not have meningitis) = 0.07

If the test comes back positive (indicating you have meningitis), what's the probability that you have meningitis?

P(meningitis | + test result) = _____ (1 extra credit point)