Hypothesis Testing of Two Means and Two Proportions: Homework

For questions (1) - (10), indicate which of the following choices best identifies the hypothesis test.

A. independent group means, population standard deviations and/or variances known
B. independent group means, population standard deviations and/or variances unknown
C. matched or paired samples
D. single mean
E. 2 proportions
F. single proportion

EXERCISE 1

A powder diet is tested on 49 people and a liquid diet is tested on 36 different people. The population standard deviations are 2 pounds and 3 pounds, respectively. Of interest is whether the liquid diet yields a higher average weight loss than the powder diet.

EXERCISE 2

A new chocolate bar is taste-tested on consumers. Of interest is whether the percentage of children that like the new chocolate bar is greater than the percentage of adults that like it.

EXERCISE 3

The average number of English courses taken in a two–year time period by male and female college students is believed to be about the same. An experiment is conducted and data are collected from 9 males and 16 females.

EXERCISE 4

A football league reported that the average number of touchdowns per game was 5. A study is done to determine if the average number of touchdowns has decreased.

EXERCISE 5

A study is done to determine if students in the California state university system take longer to graduate than students enrolled in private universities. 100 students from both the California state university system and private universities are surveyed. From years of research, it is known that the population standard deviations are 1.5811 years and 1 year, respectively.

EXERCISE 6

According to a YWCA Rape Crisis Center newsletter, 75% of rape victims know their attackers. A study is done to verify this.

EXERCISE 7

According to a recent study, U.S. companies have an average maternity-leave of six weeks.

EXERCISE 8

A recent drug survey showed an increase in use of drugs and alcohol among local high school students as compared to the national percent. Suppose that a survey of 100 local youths and 100 national youths is conducted to see if the percentage of drug and alcohol use is higher locally than nationally.

EXERCISE 9

A new SAT study course is tested on 12 individuals. Pre-course and post-course scores are recorded. Of interest is the average increase in SAT scores.

EXERCISE 10

University of Michigan researchers reported in the *Journal of the National Cancer Institute* that quitting smoking is especially beneficial for those under age 49. In this American Cancer Society study, the risk (probability) of dying of lung cancer was about the same as for those who had never smoked.

For each problem below, fill in a hypothesis test solution sheet.

NOTE: If you are using a student-t distribution for a homework problem below, including for paired data, you may assume that the underlying population is normally distributed. (In general, you must first prove that assumption, though.)

EXERCISE 11

A powder diet is tested on 49 people and a liquid diet is tested on 36 different people. Of interest is whether the liquid diet yields a higher average weight loss than the powder diet. The powder diet group had an average weight loss of 42 pounds with a standard deviation of 12 pounds. The liquid diet group had an average weight loss of 45 pounds with a standard deviation of 14 pounds.

EXERCISE 12

The average number of English courses taken in a two–year time period by male and female college students is believed to be about the same. An experiment is conducted and data are collected from 29 males and 16 females. The males took an average of 3 English courses with a standard deviation of 0.8. The females took an average of 4 English courses with a standard deviation of 1.0. Are the averages statistically the same?

EXERCISE 13

A study is done to determine if students in the California state university system take longer to graduate than students enrolled in private universities. 100 students from both the California state university system and private universities are surveyed. Suppose that from years of research, it is known that the population standard deviations are 1.5811 years and 1 year, respectively. The following data are collected. The California state university system students took on average 4.5 years with a standard deviation of 0.8. The private university students took on average 4.1 years with a standard deviation of 0.3.

EXERCISE 14

A new SAT study course is tested on 12 individuals. Pre-course and post-course scores are recorded. Of interest is the average increase in SAT scores. The following data are collected:

Pre-course score	Post-course score
1200	1300
960	920
1010	1100
840	880
1100	1070
1250	1320
860	860
1330	1370
790	770
990	1040
1110	1200
740	850

EXERCISE 15

A recent drug survey showed an increase in use of drugs and alcohol among local high school seniors as compared to the national percent. Suppose that a survey of 100 local seniors and 100 national seniors is conducted to see if the percentage of drug and alcohol use is higher locally than nationally. Locally, 65 seniors reported using drugs or alcohol within the past month, while 60 national seniors reported using them.

EXERCISE 16

A student at a four-year college claims that average enrollment at four–year colleges is higher than at two–year colleges in the United States. Two surveys are conducted. Of the 35 two–year colleges surveyed, the average enrollment was 5068 with a standard deviation of 4777. Of the 35 four-year colleges surveyed, the average enrollment was 5466 with a standard deviation of 8191. (Source: *Microsoft Bookshelf*)

EXERCISE 17

A study was conducted by the U.S. Army to see if applying antiperspirant to soldiers' feet for a few days before a major hike would help cut down on the number of blisters soldiers had on their feet. In the experiment, for three nights before they went on a 13-mile hike, a group of 328 West Point cadets put an alcohol-based antiperspirant on their feet. A "control group" of 339 soldiers put on a similar, but inactive, preparation on their feet. On the day of the hike, the temperature reached 83° F. At the end of the hike, 21% of the soldiers who had used the antiperspirant and 48% of the control group had developed foot blisters. Conduct a hypothesis test to see if the percent of soldiers using the antiperspirant was significantly lower than the control group. (Source: U.S. Army study reported in *Journal of the American Academy of Dermatologists*)

EXERCISE 18

We are interested in whether the percents of female suicide victims for ages 15 to 24 are the same for the white and the black races in the United States. We randomly pick one year, 1992, to compare the races. The number of suicides estimated in the United States in 1992 for white females is 4930. 580 were aged 15 to 24. The estimate for black females is 330. 40 were aged 15 to 24. We will let female suicide victims be our population. (Source: the National Center for Health Statistics, U.S. Dept. of Health and Human Services)

EXERCISE 19

At Rachel's 11th birthday party, 8 girls were timed to see how long (in seconds) they could hold their breath in a relaxed position. After a two-minute rest, they timed themselves while jumping. The girls thought that the jumping would not affect their times, on average. Test their hypothesis.

Relaxed time	Jumping time

(seconds)	(seconds)
26	21
47	40
30	28
22	21
23	25
45	43
37	35
29	32

EXERCISE 20

Elizabeth Mjelde, an art history professor, was interested in whether the value from the Golden Ratio formula ((larger + smaller dimension)/larger dimension) was the same in the Whitney Exhibit for works from 1900 – 1919 as for works from 1920 – 1942. 37 early works were sampled. They averaged 1.74 with a standard deviation of 0.11. 65 of the later works were sampled. They averaged 1.746 with a standard deviation of 0.1064. Do you think that there is a significant difference in the Golden Ratio calculation? (Source: data from Whitney Exhibit on loan to San Jose Museum of Art)

EXERCISE 21

One of the questions in a study of marital satisfaction of dual–career couples was to rate the statement, "I'm pleased with the way we divide the responsibilities for childcare." The ratings went from 1 (strongly agree) to 5 (strongly disagree). Below are ten of the paired responses for husbands and wives. Conduct a hypothesis test to see if the average difference in the husband's versus the wife's satisfaction level is negative (meaning that, within the partnership, the husband is happier than the wife).

Wife's score	2	2	3	3	4	2	1	1	2	4
Husband's score	2	2	1	3	2	1	1	1	2	4

EXERCISE 22

Ten individuals went on a low–fat diet for 12 weeks to lower their cholesterol. Evaluate the data below. Do you think that their cholesterol levels were significantly lowered?

Starting cholesterol level	Ending cholesterol level
140	140
220	230
110	120
240	220

200	190
180	150
190	200
360	300
280	300
260	240

EXERCISE 23

Average entry level salaries for college graduates with mechanical engineering degrees and electrical engineering degrees are believed to be approximately the same. (Source: http:// www.graduatingengineer.com). A recruiting office thinks that the average mechanical engineering salary is actually lower than the average electrical engineering salary. The recruiting office randomly surveys 50 entry level mechanical engineers and 60 entry level electrical engineers. Their average salaries were $46,100 and $46,700, respectively. Their standard deviations were $3450 and $4210, respectively. Conduct a hypothesis test to determine if you agree that the average entry level mechanical engineering salary is lower than the average entry level electrical engineering salary.

EXERCISE 24

A recent year was randomly picked from 1985 to the present. In that year, there were 2051 Hispanic students at Cabrillo College out of a total of 12,328 students. At Lake Tahoe College, there were 321 Hispanic students out of a total of 2441 students. In general, do you think that the percent of Hispanic students at the two colleges is basically the same or different? (Source: Chancellor's Office, California Community Colleges, November 1994)

EXERCISE 25

Eight runners were convinced that the average difference in their individual times for running one mile versus race walking one mile was at most 2 minutes. Below are their times. Do you agree that the average difference is at most 2 minutes?

Running time (minutes)	Race walking time (minutes)
5.1	7.3
5.6	9.2
6.2	10.4
4.8	6.9
7.1	8.9
4.2	9.5
6.1	9.4
4.4	7.9

EXERCISE 26

Marketing companies have collected data implying that teenage girls use more ring tones on their cellular phones than teenage boys do. In one particular study of 40 randomly chosen teenage girls and boys (20 of each) with cellular phones, the average number of ring tones for the girls was 3.2 with a standard deviation of 1.5. The average for the boys was 1.7 with a standard deviation of 0.8. Conduct a hypothesis test to determine if the averages are approximately the same or if the girls' average is higher than the boys' average.

EXERCISE 27

While her husband spent 2½ hours picking out new speakers, a statistician decided to determine whether the percent of men who enjoy shopping for electronic equipment is higher than the percent of women who enjoy shopping for electronic equipment. The population was Saturday afternoon shoppers. Out of 67 men, 24 said they enjoyed the activity. 8 of the 24 women surveyed claimed to enjoy the activity. Interpret the results of the survey.

EXERCISE 28

We are interested in whether children's educational computer software costs less, on average, than children's entertainment software. 36 educational software titles were randomly picked from a catalog. The average cost was $31.14 with a standard deviation of $4.69. 35 entertainment software titles were randomly picked from the same catalog. The average cost was $33.86 with a standard deviation of $10.87. Decide whether children's educational software costs less, on average, than children's entertainment software. (Source: *Educational Resources*, December catalog)

EXERCISE 29

Parents of teenage boys often complain that auto insurance costs more, on average, for teenage boys than for teenage girls. A group of concerned parents examines a random sample of insurance bills. The average annual cost for 36 teenage boys was $679. For 23 teenage girls, it was $559. From past years, it is known that the population standard deviation for each group is $180. Determine whether or not you believe that the average cost for auto insurance for teenage boys is greater than that for teenage girls.

EXERCISE 30

A group of transfer bound students wondered if they will spend the same average amount on texts and supplies each year at their four-year university as they have at their community college. They conducted a random survey of 54 students at their community college and 66 students at their local four-year university. The sample means were $947 and $1011, respectively. The population standard deviations are known to be $254 and $87, respectively. Conduct a hypothesis test to determine if the averages are statistically the same.

EXERCISE 31

Joan Nguyen recently claimed that the proportion of college–age males with at least one pierced ear is as high as the proportion of college–age females. She conducted a survey in her classes. Out of 107 males, 20 had at least one pierced ear. Out of 92 females, 47 had at least one pierced ear. Do you believe that the proportion of males has reached the proportion of females?

EXERCISE 32

Some manufacturers claim that non-hybrid sedan cars have a lower average miles per gallon (mpg) than hybrid ones. Suppose that consumers test 21 hybrid sedans and get an average 31 mpg with a standard deviation of 7 mpg. Thirty-one non-hybrid sedans average 22 mpg with a standard deviation of 4 mpg. Suppose that the population standard deviations are known to be 6 and 3, respectively. Conduct a hypothesis test to the manufacturers claim.

Questions 33 – 37 refer to the Terri Vogel's data set (see Table of Contents).

EXERCISE 33

Using the data from Lap 1 only, conduct a hypothesis test to determine if the average time for completing a lap in races is the same as it is in practices.

EXERCISE 34

Repeat the test in (33), but use Lap 5 data this time.

EXERCISE 35

Repeat the test in (33), but this time combine the data from Laps 1 and 5.

EXERCISE 36

In 2 – 3 complete sentences, explain in detail how you might use Terri Vogel's data to answer the following question. "Does Terri Vogel drive faster in races than she does in practices?"

EXERCISE 37

Is the proportion of race laps Terri completes slower than 130 seconds less than the proportion of practice laps she completes slower than 135 seconds?

EXERCISE 38

To Breakfast or Not to Breakfast?
By Richard Ayore

In the American society, birthdays are one of those days that everyone looks forward to. People of different ages and peer groups gather to mark the 18th, 20th, … birthdays. During this time, one looks back to see what he or she had achieved for the past year, and also focuses ahead for more to come.

If, by any chance, I am invited to one of these parties, my experience is always different. Instead of dancing around with my friends while the music is booming, I get carried away by memories of my family back home in Kenya. I remember the good times I had with my brothers and sister while we did our daily routine.

Every morning, I remember we went to the shamba (garden) to weed our crops. I remember one day arguing with my brother as to why he always remained behind just to join us an hour later. In his defense, he said that he preferred waiting for breakfast before he came to weed. He said, "This is why I always work more hours than you guys!"

And so, to prove his wrong or right, we decided to give it a try. One day we went to work as usual without breakfast, and recorded the time we could work before getting tired and stopping. On the next day, we all ate breakfast before going to work. We recorded how long we worked again before getting tired and stopping. Of interest was our average increase in work time. Though not sure, my brother insisted that it is more than two hours. Using the data below, solve our problem.

Work hours with breakfast	Work hours without breakfast
8	6
7	5
9	5
5	4
9	7
8	7
10	7
7	5
6	6
9	5

Try these multiple choice questions.

For questions 39 – 40, use the following information.

A new AIDS prevention drugs was tried on a group of 224 HIV positive patients. Forty-five (45) patients developed AIDS after four years. In a control group of 224 HIV positive patients, 68 developed AIDS after four years. We want to test whether the method of treatment reduces the proportion of patients that develop AIDS after four years or if the proportions of the treated group and the untreated group stay the same. .

Let the subscript **t** = treated patient and **ut** = untreated patient.

EXERCISE 39

The appropriate hypotheses are:

A. Ho: $p_t < p_{ut}$ Ha: $p_t \geq p_{ut}$
B. Ho: $p_t \leq p_{ut}$ Ha: $p_t > p_{ut}$
C. Ho: $p_t = p_{ut}$ Ha: $p_t \neq p_{ut}$
D. Ho: $p_t = p_{ut}$ Ha: $p_t < p_{ut}$

EXERCISE 40

If the p-value is 0.0062 what is the conclusion (use $\alpha = 5\%$)?

A. The method has no effect.
B. The method reduces the proportion of HIV positive patients that develop AIDS after four years.
C. The method increases the proportion of HIV positive patients that develop AIDS after four years.
D. The test does not determine whether the method helps or does not help.

EXERCISE 41

Lesley E. Tan investigated the relationship between left-handedness and right-handedness and motor competence in preschool children. Random samples of 41 left-handers and 41 right-handers were given several tests of motor skills to determine if there is evidence of a difference between the children based on this experiment. The experiment produced the means and standard deviations shown below. Determine the appropriate test and best distribution to use for that test.

	Left-handed	Right-handed
Sample size	41	41
Sample mean	97.5	98.1
Sample standard deviation	17.5	19.2

A. Two independent means, normal distribution
B. Two independent means, student-t distribution
C. Matched or paired samples, student-t distribution
D. Two population proportions, normal distribution

For questions 42 – 43, use the following information.

An experiment is conducted to show that blood pressure can be consciously reduced in people trained in a "biofeedback exercise program." Six (6) subjects were randomly selected and the blood pressure measurements were recorded before and after the training. The difference between blood pressures was calculated (after – before) producing the following results: $\bar{x}_d$ = -10.2 s_d = 8.4. Using the data, test the hypothesis that the blood pressure has decreased after the training,

EXERCISE 42

The distribution for the test is

A. t_5
B. t_6
C. N(-10.2, 8.4)
D. N(-10.2, $\frac{8.4}{\sqrt{6}}$)

EXERCISE 43

If $\alpha = 0.05$, the p-value and the conclusion are

A. 0.0014; The blood pressure decreased after the training
B. 0.0014; The blood pressure increased after the training
C. 0.0155; The blood pressure decreased after the training
D. 0.0155; The blood pressure increased after the training

For questions 44 – 45, use the following information.

The Eastern and Western Major League Soccer conferences have a new Reserve Division that allows new players to develop their skills. As of May 25, 2005, the Reserve Division teams scored the following number of goals for 2005.

Western		Eastern	
Los Angeles	9	D.C. United	9
FC Dallas	3	Chicago	8
Chivas USA	4	Columbus	7
Real Salt Lake	3	New England	6
Colorado	4	MetroStars	5
San Jose	4	Kansas City	3

Conduct a hypothesis test to determine if the Western Reserve Division teams score, on average, fewer goals than the Eastern Reserve Division teams. Subscripts: **1** Western Reserve Division (**W**); **2** Eastern Reserve Division (**E**)

EXERCISE 44

The **exact** distribution for the hypothesis test is:

A. The normal distribution.
B. The student-t distribution.
C. The uniform distribution.
D. The exponential distribution.

EXERCISE 45

If the level of significance is 0.05, the conclusion is:

A. The **W** Division teams score, on average, fewer goals than the **E** teams.
B. The **W** Division teams score, on average, more goals than the **E** teams..
C. The **W** teams score, on average, about the same number of goals as the **E** teams score.
D. Unable to determine.

Questions 46 – 48 refer to the following:

A researcher is interested in determining if a certain drug vaccine prevents West Nile disease. The vaccine with the drug is administered to 36 people and another 36 people are given a vaccine that does not contain the drug. Of the group that gets the vaccine with the drug, one (1) gets West Nile disease. Of the group that gets the vaccine without the drug, three (3) get West Nile disease. Conduct a hypothesis test to determine if the proportion of people that get the vaccine without the drug and get West Nile disease is more than the proportion of people that get the vaccine with the drug and get West Nile disease. "drug" subscript: group who get the vaccine with the drug. "no drug" subscript: group who get the vaccine without the drug

EXERCISE 46

This is a test of

A. A test of two proportions
B. A test of two independent means
C. A test of a single mean
D. A test of matched pairs.

EXERCISE 47

An appropriate null hypothesis is

A. $p_{\text{no drug}} \leq p_{\text{drug}}$
B. $p_{\text{no drug}} \geq p_{\text{drug}}$
C. $\mu_{\text{no drug}} \leq \mu_{\text{drug}}$
D. $p_{\text{no drug}} > p_{\text{drug}}$

EXERCISE 48

The p-value is 0.1517. At a 1% level of significance, the appropriate conclusion is

A. The proportion of people that get the vaccine without the drug and get West Nile disease is less than the proportion of people that get the vaccine with the drug and get West Nile disease.
B. The proportion of people that get the vaccine without the drug and get West Nile disease is more than the proportion of people that get the vaccine with the drug and get West Nile disease.
C. The proportion of people that get the vaccine without the drug and get West Nile disease is more than or equal to the proportion of people that get the vaccine with the drug and get West Nile disease.

D. The proportion of people that get the vaccine without the drug and get West Nile disease is no more than the proportion of people that get the vaccine with the drug and get West Nile disease.

Questions 49 and 50 refer to the following:

A golf instructor is interested in determining if her new technique for improving players' golf scores is effective. She takes four (4) new students. She records their 18-holes scores before learning the technique and then after having taken her class. She conducts a hypothesis test. The data are as follows.

	Player 1	Player 2	Player 3	Player 4
Average score before class	83	78	93	87
Average score after class	80	80	86	86

EXERCISE 49

This is a test of

A. A test of two independent means
B. A test of two proportions
C. A test of a single proportion
D. A test of matched pairs.

EXERCISE 50

The correct decision is

A. Reject Ho
B. Do not reject Ho
C. The test is inconclusive

Questions 51 and 52 refer to the following:

Suppose a statistics instructor believes that there is no significant difference between the average class scores of her two classes on Exam 2. The average and standard deviation for her 8:30 class of 35 students were 75.86 and 16.91. The average and standard deviation for her 11:30 class of 37 students

were 75.41 and 19.73. "8:30" subscript refers to the 8:30 class. "11:30" subscript refers to the 11:30 class.

EXERCISE 51

An appropriate alternate hypothesis for the hypothesis test is

A. $\mu_{8:30} > \mu_{11:30}$
B. $\mu_{8:30} < \mu_{11:30}$
C. $\mu_{8:30} = \mu_{11:30}$
D. $\mu_{8:30} \neq \mu_{11:30}$

EXERCISE 52

A concluding statement is

A. The 11:30 class average is better than the 8:30 class average.
B. The 8:30 class average is better than the 11:30 class average.
C. There is no significant difference between the averages of the two classes.
D. There is a significant difference between the averages of the two classes.