Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Period: \_\_\_\_\_\_\_Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 A murder has occurred in San Antonio! Not just any murder, mind you. Flibbergibit, the amazing robot, was found early this morning with all of his circuit boards fried. The Warren High School robotics teams were shocked and saddened that their creation, a miracle of science, technology, and mechanics, was a victim of roboticide.

The robot division of the SAPD were called in to investigate, but the clues were meager. Only a miracle could help them solve this case. As it happens, a miracle was at hand, though the detectives on the case didn’t know it.

Mr. Griffith’s world-famous statistical detectives were the miracle needed. As soon as they heard about the case, they immediately contacted the robot division of the SAPD to get the case file. The detective in charge, Xavier Xentopholous, a.k.a. , was grateful for the help of such international experts.

Mr. Griffith assembled his team of ace investigators:

1. **Richard the Incredibly Brilliant Slacker** – aka “RIBS.” He was brilliant. He was lazy. Perhaps he was lazy because he was brilliant, or could it have been the other way around?
2. **Jen Doubletree** – the unquestioned leader of the group, she was smart, serious, intimidating, and quiet. No one really knew how she could be such a good leader without saying much, but no one questioned her spot on the team.
3. **Terri and Terry Tennenbaum** – fraternal twins who do not look remotely like each other, nor do they act alike. Terri is social, friendly, and happy; Terry is surly and aloof. Although they are nothing alike, they are fiercely protective of each other.
4. **Robert Riva** – known as *R*2 to his friends, Robert is the numbers genius of the group. He can add, subtract, multiply, or divide incredibly ugly numbers mentally, supplying the group with instant insight. Unlike Robert, you will have to show your work!
5. **Becca Solinski** – a.k.a. “BS,” Becca could talk her way out of anything. Solinski is the daughter of two professional statisticians, so her knowledge of statistics is phenomenal.
6. **Nicolas de Tiempo** – a.k.a. “Nick of Time,” de Tiempo is quick-witted, quick-tempered, and slow to forgive. He is, though, quite brilliant when it comes to using the statistical package in the TI calculators.

The team quickly developed a list of possible suspects, locations, and weapons.

|  |  |  |
| --- | --- | --- |
| **Suspects** | **Locations** | **Weapons** |
| Null Zero | The Alamo | Oil |
| Mean Mrs. Median | Fiesta, Tx | Water |
| Melvin Stickbody | The Riverwalk | Electrical Surges |
| Ford Persnickety | Haunted Railroad Crossing | Cold Temperature |
| Prudence Hattersfield |  | Stress Points |

Use your statistical knowledge to help the team solve the crime.

**Case File #1: Scene of the Crime**

Flibbergibit, the robot that can drive, was probably done in at around midnight, according to the case files. Flibbergibit was known to have left his robot house en route to either The Alamo or Fiesta, Texas.

To get to The Alamo, Flibbergibit had to go through 7 stoplights. The probability that each stoplight is red is 0.773. For Flibbergibit to arrive at The Alamo at what is considered to be the time of death, he could stop at no more than 3 of the stoplights. What is the probability that Flibbergibit stopped at no more than 3 stoplights?

To get to Fiesta, Texas at the probable time of death, Flibbergibit had to park and walk to the entrance, then he had to wait in line to get a ticket. What is the probability that Flibbergibit parked and walked, and waited in line for 4 minutes, given that he spent 3 or 4 minutes to park and walk to the entrance? The probability distribution for each of the two events at Fiesta, Texas are as follows:

Park & Walk to Entrance

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *X* (minutes) | 1 | 2 | 3 | 4 | 5 |
| *P(X)* | .01 | .08 | .31 | .35 | .25 |

Wait In Line for Ticket

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *X* (minutes) | 0 | 1 | 2 | 3 | 4 |
| *P(X)* | .03 | .22 | .25 | .35 | .15 |

**Eliminate the location that has the lowest probability of success:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Case File #2: Gray Matter Matters**

The killer, it was discovered, must be an intelligent person. Four of the five suspects had recently taken four different I.Q. tests. All of the I.Q. tests have approximately normal distributions. The following data was uncovered during the investigation:

1. Null Zero took a traditional I.Q. test. The mean for this test is 100, with a standard deviation of 14. Null Zero score 111 on this test. Find his *z*-score, and multiply it by 500.

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Mean Mrs. Median took the Dim-Sum Intelligence Test. This test has a mean of 366, with a standard deviation of 37. Her *z*-score was 0.7838. Find her test score.

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Melvin Stickbody took the Bureaucratic Boondoggle Test for Alleged Intelligence. He scored 55.4, and his *z*-score was 0.7907. If the standard deviation of this test is 4.3, find the mean of this test, and multiply it by 7.

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Ford Persnickety took the C-Major Test for Intellectual Measurement. This test has a mean of 1238. If his *z-*score was 0.78076 and he scored 1324 on the test, find the standard deviation of the test and add 250 to it.

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Eliminate the suspect whose missing value is closest to ∞**. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Case File #3: Oil and Water Don’t Mix**

 It was discovered through very thorough investigation and collaboration with the high school robotics team that the oil used to keep Flibbergibit operating smoothly must have a certain viscosity, or thickness. If the oil has a density thinner than  or a density heavier than , Flibbergibit will “freeze up,” thereby causing him to still try to move, even though he cannot. This will have the effect of burning up his circuits through overheating.

Thousands of oil samples found near the alleged scenes of the crime have differing viscosities that are normally distributed, with a mean of  and a standard deviation of . Find the probability that the oil in Flibbergibit was either too thin or too heavy.

The probability that water was found in any reservoir in Flibbergibit is 0.2. If water is found in at least 4 of Flibbergibit’s 12 reservoirs, the accumulated moisture will short out his circuits.

**Eliminate the murder device with the lowest probability of success. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Case File #4: Scene of the Crime, Part II**

Flibbergibit, the robot that can drive, was probably done in at around midnight, according to the case files. Flibbergibit was known to have left his robot home en route to either the Riverwalk or the haunted railroad tracks. Listed below are the times it took Flibbergibit to drive to these two places on several different occasions, at approximately the same time for each trip:

|  |  |  |
| --- | --- | --- |
| **Haunted Railroad Tracks** |  | **The Riverwalk** |
| Trial Number | Time (minutes) |  | Trial Number | Time (minutes) |
| 1 | 23 |  | 1 | 17 |
| 2 | 19 |  | 2 | 16 |
| 3 | 25 |  | 3 | 23 |
| 4 | 21 |  | 4 | 25 |
| 5 | 20 |  | 5 | 18 |
| 6 | 24 |  | 6 | 21 |
| 7 | 21 |  | 7 | 20 |
|  |  | 8 | 17 |
|  | 9 | 19 |
|  | 10 | 19 |
|   |  |  |  |  |
| s |  |  | s |  |

Find a 90% confidence interval for the difference in the mean time for driving time between the two listed locations.

If there is no significant difference in the mean times, then **eliminate the location with the smallest standard error**.

If there is a significant difference in mean times, then **eliminate the location with the largest standard error**.

 **Location Eliminated: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Case File #5: A Steady Hand**

 The evidence shows that the killer must have a steady hand; only the steadiness of a skilled surgeon could incorporate the deadly murder weapon into Flibbergibit’s housing.

Prudence Hattersfield takes a manual dexterity test. To have the requisite dexterity to do in Flibbergibit, experts agree that 35% of the manual tasks assigned must be successfully completed.

Melvin Stickbody, though, is left-handed. He must take a completely different type of manual dexterity test, one in which the experts agree that 85% of the manual tasks assigned must be successfully completed.

Prudence was successful in 10 of the 35 tasks assigned, and Melvin was successful in 31 of the 43 tasks assigned. Is Prudence too uncoordinated to be the killer? Is Melvin too uncoordinated to be the killer?

1. **Using an -level of .05, write *H*0 and *H*A for each suspect.**
2. **Determine which one will have *H*0 rejected.**
3. **Eliminate this uncoordinated suspect.**

|  |  |
| --- | --- |
| Prudence | Melvin |
| Ho:Ha: | Ho:Ha: |
|  |  |
|  |  |

 **Eliminate : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Elimination Task #1: Which Test Is Best?**

Choose the proper test or procedure for each scenario. The correct answers will spell out a clue.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **N** | One-Sample mean t-interval | **D** | 1-proportion z-interval | **E** |  test for independence |
| **T** |  GOF | **P** | 1-proportion *z*-test | **R** | 1-sample mean *t*-test |
| **K** | 2-proportion z-interval | **E** |  test for homogeneity | **U** | Line of Best Fit |
| **O** | 2-proportion *z*-test | **S** | 2-sample mean t-interval | **T** | ANOVA |
| **N** | 2-sample *t*-test | **C** | Matched-Pairs *t*-test | **B** |  confidence interval |

\_\_\_\_\_ I have the lifetimes (in hours) of 12 regular (filament) light bulbs and 17 florescent bulbs, all being used in 110-volt sockets. I want to find out if the florescent bulbs last longer than the filament bulbs.

\_\_\_\_\_ A major national magazine reported that “young men are more comfortable talking about their problems than older men.” Their survey reported that 80 of 129 surveyed 18- to 24-year-old men and 98 of 184 25- to 34-year-old men said they were comfortable talking about their problems. Is the magazine’s interpretation justified by these results?

\_\_\_\_\_  is an irrational number, meaning that the digits after the decimal go on forever, in no discernible pattern. The breakdown of the first 1,000,000 digits after the decimal is as follows:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **0** | 98,222 | **2** | 112,201 | **4** | 95,278 | **6** | 95,923 | **8** | 98,279 |
| **1** | 103,456 | **3** | 93,099 | **5** | 101,005 | **7** | 104,925 | **9** | 97,612 |

Is there evidence that the digits are evenly distributed through the first 1,000,000 digits after the decimal?

\_\_\_\_\_ The mean proportion of seniors who take an AP math class, nationally, is 13.3%. The NISD records show that 623 of the 5,478 seniors graduating this year from the district are taking at least one AP math class. Is there evidence that our seniors are taking AP math classes in a different proportion than the national average?

\_\_\_\_\_ The mean amount of time it takes for a 5th grade student to complete a multiplication tables test has been, historically, 2.35 minutes. In Mrs. Griffith’s 5th grade classes for the past 5 years, the mean amount of time it has taken her kids to complete the same multiplication tables test has been 2 minutes, 28 seconds. Is there evidence that Mrs. Griffith’s kids perform worse than the historical average?

\_\_\_\_\_ Mr. Griffith wanted to know if there was an association between amount of time spent studying for a Calculus exam (in minutes) the night before the exam, and grade earned. He recorded the amount of time each Calculus student studied the previous night for the past 3 exams, and the grade earned, for each test. He found that every extra 5 minutes spent studying likely would result in an extra 3.5 points earned on an exam. Students who did not study at all likely earned a grade of approximately 54.

\_\_\_\_\_ I want to find an interval, with 97% confidence to contain the true proportion of U.S. adults who think that high school math teachers deserve a huge raise (so that they do not have to have an unofficial “retirement fund” that is funded by students).

\_\_\_\_\_ The administrators at WHS took a stratified random sample of freshmen, sophomores, and juniors to determine how many were planning on taking pre-AP or AP math classes next year. The administrators think that, as kids progress through high school, fewer decide to take pre-AP or AP math classes.

\_\_\_\_\_ I want to find an interval, with 98% confidence to contain the true mean speed of drivers on I-410, between the hours of 4:30 P.M. and 6:00 P.M. I will gather data on 232 randomly selected vehicles.

\_\_\_\_\_ A recent article in a local newspaper had an editorial piece about married couples. Specifically, the writer stated that, in his observations, men married women much younger than they were. Mr. Griffith’s AP Statistics class decided to test this observation. The students randomly selected 125 married couples and recorded the ages of the husbands and the ages of the wives. The students started with *H*0:  = 0. That is, the difference in ages was zero. They found a *p*-value of 0.063.

\_\_\_\_\_ Swedish doctors wanted to know if there were an association between the amount of fish men ate and their cholesterol level. The doctors randomly selected the records of 5,225 patients. They recorded the amount of fish eaten (*none, less than 3 ounces per week, more than 3 ounces per week*) and their cholesterol level (*low, medium, high*). They then recorded their findings and performed the appropriate test.

**Which suspect can now be eliminated? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Case File #6: Short Circuits, but No Short Cuts**

The investigation by the SAPD detectives showed that they closely questioned the robotics team members to determine what could cause Flibbergibit to fail. The case files show that there were tests done to determine what could cause Flibbergibit to expire. The following data was gathered:

1. When the stress points of Flibbergibit were compromised, the circuits burned up in 10 out of 167 trials.
2. When subjected to temperatures below 30oF for more than one hour, Flibbergibit’s circuits fried in 21 of the 223 trials.
3. When Flibbergibit’s circuits were exposed to electrical surges, his circuits shorted out in 31 of the 257 trials.

Find the interval, with 90% confidence of capturing the true mean proportion, of the difference in proportion of *failure* between the 3 different combinations of murder devices (stress points, cold, electrical surges).

Use the following pairs. Do the subtraction in this order.

1) Electrical Surges – Stress Points; Confidence interval: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2) Electrical Surges – Temperature; Confidence interval: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3) Temperature – Stress Points Confidence interval: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Eliminate the murder device that is SUBTRACTED within the pair whose confidence interval does not contain zero.**

**Elimination Task #2: Experimental Design and Sampling Methods**

The answers to the multiple-choice questions will give you a clue as to which murder device to eliminate. The correct answers, read in order, will be the clue you are seeking.

\_\_\_\_\_ Random sampling reduces \_\_\_\_\_\_\_\_\_\_\_, while blocking reduces \_\_\_\_\_\_\_\_\_\_\_\_.

1. lurking variables, bias

N) bias, variation

E) replication, placebo effect

S) variation, bias

\_\_\_\_\_ A quality control inspector wants to test the toy being produced today, for proper assembly. He randomly selects boxes from the assembly line and tests all 7 toys in each box. This is an example of:

1. Stratified random sampling
2. SRS
3. Cluster random sampling
4. Systematic sampling with a random start

\_\_\_\_\_ A researcher wants to test the effectiveness of exercise and diet on overweight individuals. He/she has 3 different levels of exercise (low, moderate, high) and 3 different diet plans (low fat, low carbohydrate, low fat& low carbohydrate). The researcher has \_\_\_\_ different treatments.

1. 9
2. 6
3. 3
4. 18

\_\_\_\_\_ If the researcher added a control group to the experiment performed in the previous problem, he/she now has \_\_\_\_\_\_ treatments.

1. 6
2. 18
3. 16
4. 9

\_\_\_\_\_ What is a lurking variable?

1. a variable that kind of hangs around the *x*-axis.
2. The dependent variable’s range.
3. a variable that confuses us.
4. A variable that is unaccounted for, but affects the data.

\_\_\_\_\_ What cannot be determined from a boxplot?

 L) sample size M) shape of distribution N) median O) upper quartile

\_\_\_\_\_ If I’m going to test a new drug that claims to reduce weight, I could effectively block by:

A) Intelligence B) economic level C) political affiliation D) waist size

**Which murder device may now be eliminated? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Case File #7: Location, Location, Location**

Flibbergibit loves going to Fiesta, Texas. In fact, he knows exactly how much time he spends at various places around the amusement park. He always spends exactly 9 hours at Fiesta, Texas, and his time is usually allocated thusly:

* 1. Time on midway – 20%
	2. Time on rides – 40%
	3. Time at shows and attractions – 30%
	4. The rest of the time is spent traveling from place to place, resting his diodes, rehydrating himself, etc.

 The last time he was there, however, his time was spent thusly:

* 1. Time on midway – 1.4 hrs.
	2. Time on rides – 3.0 hrs.
	3. Time at shows and attractions – 4.1 hrs.
	4. Time spent traveling, etc. – 0.5 hrs.

How odd was Flibbergibit’s behavior on his last trip to Fiesta, Texas?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Flibbergibit also likes watching the trains go by, at the tracks near the fabled “haunted railroad tracks” of San Antonio; he considers these mechanical devices as sort of like his ancient and not-so-bright relatives. He usually observes these particular sets of tracks (there are 5 distinct sets of tracks at this location) for a period of exactly 10 hours, at the same time of day. Each set of tracks are expected to handle 20% of the total number of trains coming through. On this particular day, though, Flibbergibit observed, during his 10-hour observation, the following numbers of trains on each track:

|  |  |
| --- | --- |
| **Track #** | **# of Trains** |
| #1 | 41 |
| #2 | 38 |
| #3 | 47 |
| #4 | 39 |
| #5 | 43 |

How different was the expected number of trains than the actual number of trains, for each track?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Run the appropriate test for each set of data (it’s the same test for both situations). **The data that has the lowest *p*-value is least likely to be the site of the robot’s demise, so it can be eliminated.**

If you have done everything properly, you will now know the location of the demise of the robot.

Location:

**Case File #8: The Smoking Gun!**

The following data show the number of nanoliters of water found in various places in Flibbergibit’s body:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Distr.** | **<Q1:** | **Q1:** | **> Q1 <Med:** | **Med:** | **>Med****< Q3:** | **Q3:** | **> Q3:** |
| **Data** | 1, 3, 3, 5 | 5.5 | 6, 7, 8 | 9 (3) | 10, 10 | 11.5 | 13, 21, 23, 24 |

The following data shows the number of volts in each of the various circuits in Flibbergibit’s body from electrical surges:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Distr.** | **<Q1:** | **Q1:** | **> Q1 <Med:** | **Med:** | **>Med****< Q3:** | **Q3:** | **> Q3:** |
| **Data** | 92, 109, 110, 112, 114 | 115 | 116, 117, 117, 119, 121 | 121.5 | 122, 124, 125, 126, 128 | 129 | 130, 131, 133, 133, 136 |

* 1. Creat boxplots for both sets of data.
	2. Find the outliers for both sets of data.

**The device with the outlier farthest from *Q*1 or *Q*3 can be eliminated!**

You should now know the device used:

**Case File #9: He Did It!**

 The final case file shows that the killer must have nerves of steel. One way to test that is to observe the suspects as they gamble, and measure their blood pressure as they make bets of differing denominations. Although this was a simulated experience (Real money wasn’t used. That would be illegal!), it does show us who has the steadiest nerves. **Eliminate the suspect with the lowest *r*-value.**

 Null Zero was observed, and the following data were gathered:

|  |  |
| --- | --- |
| **Amount Bet ($)** | **Diastolic Measure** |
| $5 | 105 |
| $10 | 103 |
| $20 | 105 |
| $50 | 107 |
| $100 | 110 |
| $500 | 108 |
| $1,000 | 111 |
| $2,000 | 108 |
| $5,000 | 115 |
| $10,000 | 117 |

 Ford Persnickety was observed, and the following data were gathered:

|  |  |
| --- | --- |
| **Amount Bet ($)** | **Diastolic Measure** |
| $1 | 101 |
| $5 | 105 |
| $10 | 103 |
| $20 | 103 |
| $50 | 106 |
| $100 | 110 |
| $1,000 | 108 |
| $3,000 | 110 |
| $7,000 | 111 |
| $10,000 | 114 |

You should now know who the culprit is: