AP Statistics – 9.1B	Name: New 2015
Goal: Understanding Power, Type I and Type II Errors	Date:

Statistical Significance: ① The pvalue measures the strength of the evidence against a null hypothesis.
② Alpha(α) IS THE LEVEL OF SIGNIFICANCE. IT IS PREDETERMINED OR USE $\alpha = .05$.

Example "***Tasty Chips***" For his second semester project in AP Statistics, Zenon decided to investigate if students at his school prefer name-brand potato chips to generic potato chips. He randomly selected 50 students and had each student try both types of chips, in random order. Overall, 34 of the 50 students preferred the name-brand chips. Zenon performed a significance test using the hypotheses:

Sample stat $\hat{p}$

$H_0: p = 0.5$ ← population parameter

$H_a: p > 0.5$

SRS: $n = 50$, $\hat{p} = .68$

$P(\hat{p} > .68)$

$P\left(Z > \frac{.68 - .50}{\sqrt{\frac{(.5)(.5)}{50}}}\right) = 2.54$

$= .0055$

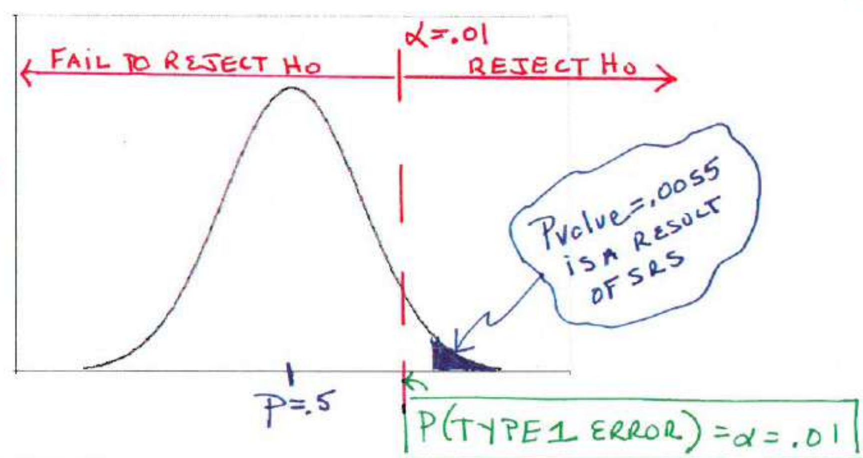
Where: p = ***the true proportion of students at his school that prefer name-brand chips.***
The resulting P-value was 0.0055. ← THIS IS HOW THIS NUMBER WAS CALCULATED

Problem: For each sketch the graph describing the hypothesis and label the reject region, fail to reject region, significance line. Then, what conclusion would you make at each of the following significance levels?

YOU SET α PRIOR TO YOUR ANALYSIS!!

(a) $\boxed{\alpha = 0.01}$

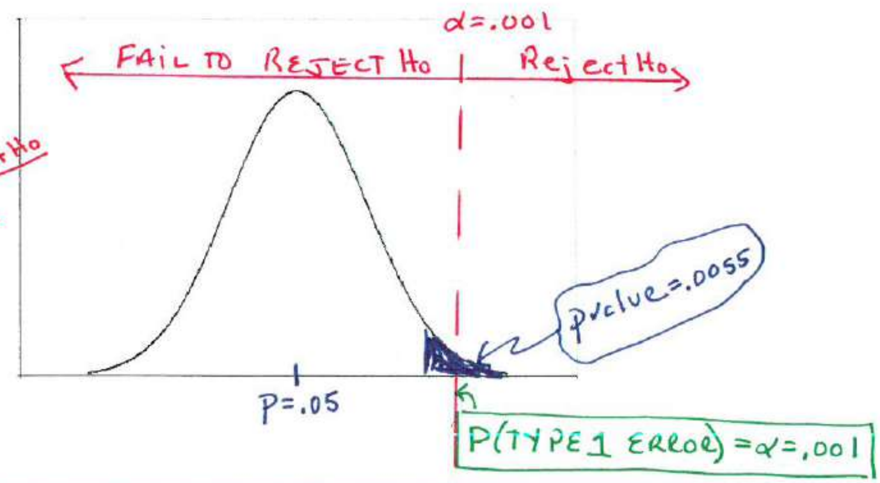
REJECT Ho pvalue < α



$\alpha = .01$ CONCLUSIONS IN CONTEXT
Since the pvalue, .0055, is less than $\alpha = .01$, THE SAMPLE RESULT IS STATISTICALLY SIGNIFICANT AT THE 1% LEVEL. WE HAVE SUFFICIENT EVIDENCE TO REJECT H_o AND CONCLUDE THAT STUDENTS AT ZENON'S SCHOOL PREFER NAME BRAND CHIPS.

(b) $\boxed{\alpha = 0.001}$

FAIL TO Reject Ho pvalue > α



$\alpha = .001$ CONCLUSIONS IN CONTEXT
Since the pvalue, .0055, is greater that $\alpha = .001$, THE SAMPLE RESULT IS NOT STATISTICALLY SIGNIFICANT AT THE .1% LEVEL. WE DO NOT HAVE ENOUGH EVIDENCE AND FAIL TO REJECT H_o AND CAN NOT CONCLUDE THAT STUDENTS AT ZENON'S SCHOOL PREFER NAME BRAND CHIPS.

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II. Type I and Type II Errors

Definition:

If we reject H_0 when H_0 is true, we have committed a Type I error **(FALSE POSITIVE)**

If we fail to reject H_0 when H_0 is false, we have committed a Type II error **(FALSE NEGATIVE)**

→**Fill in the table**: Type I error, Type II error, Power, α, β

TRIAL ANALOGY

Truth about the population

Conclusion based on sample		H_0 true	H_0 false (H_a true)
	Reject H_0	TYPE I ERROR (α) $\boxed{\text{FALSE POSITIVE}}$ "FINDING AN INNOCENT PERSON GUILTY"	CORRECT CONCLUSION (POWER $= 1 - \beta$) "FINDING A GUILTY PERSON GUILTY"
	Fail to reject H_0	CORRECT CONCLUSION "FINDING AN INNOCENT PERSON NOT GUILTY"	TYPE II ERROR (β) $\boxed{\text{FALSE NEGATIVE}}$ "FINDING A GUILTY PERSON NOT GUILTY"

TYPE I ERROR α IS THE LEVEL OF SIGNIFICANCE. $\alpha = P(\text{TYPE I ERROR})$

TYPE I ERROR IS THE PROBABILITY OF REJECTING H_0 WHEN IT IS ACTUALLY TRUE

- TO REDUCE THE RISK OF A TYPE I ERROR, SET α TO A LOWER LEVEL.
  - * DECREASING TYPE I ERROR INCREASES THE RISK OF A TYPE II ERROR.
  - * TYPE I AND TYPE II ERRORS HAVE AN INVERSE RELATIONSHIP

TYPE II ERROR (β) IS THE PROBABILITY OF FAILING TO REJECT A FALSE H_0

- FAILING TO REJECT H_0 MEANS THERE IS INSUFFICIENT EVIDENCE TO REJECT H_0 AND THUS H_0 COULD BE TRUE.

III. FRAPPY

2003 Problem #2

When a law firm represents a group of people in a class action lawsuit and wins that lawsuit, the firm receives a percentage of the group's monetary settlement. That settlement amount is based on the total number of people in the group - the larger the group and the larger the settlement, the more money the firm will receive.

A law firm is trying to decide whether to represent car owners in a class action lawsuit against the manufacturer of a certain make and model for a particular defect. If 5 percent or less of the cars of this make and model have the defect, the firm will not recover its expenses. Therefore, the firm will handle the lawsuit only if it is convinced that more than 5 percent of cars of this make and model have the defect. The firm plans to take a random sample of 1,000 people who bought this car and ask them if they experienced this defect in their cars.

Scoring:

(a) Define the parameter of interest and state the null and alternative hypotheses that the law firm should test.

p = the proportion of all cars of the specific make and model that have the defect

E P I

H_0: $p = .05$

H_A: $p > .05$

(b) In the context of this situation, describe Type I and Type II errors and describe the consequences of each of these for the law firm.

Type I Error: Reject H_0 when H_0 is TRUE.

THAT IS... THE FIRM WILL TAKE THE CASE WHEN THEY SHOULD NOT HAVE

E P I

CONSEQUENCE: THE FIRM WILL NOT RECOVER ITS EXPENSES, RESULTING IN A LOSS TO THE LAW FIRM

TYPE II ERROR: FAIL TO REJECT H_0 WHEN H_0 IS FALSE

E P I

THAT IS... THE FIRM WILL REFUSE TO HANDLE THE SUIT WHEN IT REALLY SHOULD HAVE

CONSEQUENCE: THE LAW FIRM WILL MISS AN OPPORTUNITY TO TAKE THE CASE AND MAKE MONEY.

Total: __ /4

Example ***"Faster fast food?"*** The manager of a fast-food restaurant want to reduce the proportion of drive-through customers who have to wait more than 2 minutes to receive their food once their order is placed. Based on store records, the proportion of customers who had to wait at least 2 minutes was p = 0.63. To reduce this proportion, the manager assigns an additional employee to assist with drive-through orders. During the next month the manager will collect a ndom sample of drive-through times and test the following hypotheses:

$$H_0: p = 0.63$$

$$H_a: p < 0.63$$

where ***p = the true proportion of drive-through customers who have to wait more than 2 minutes after their order is placed to receive their food.***

Problem 1: Describe a Type I and a Type II error in this setting and explain the consequences of each.

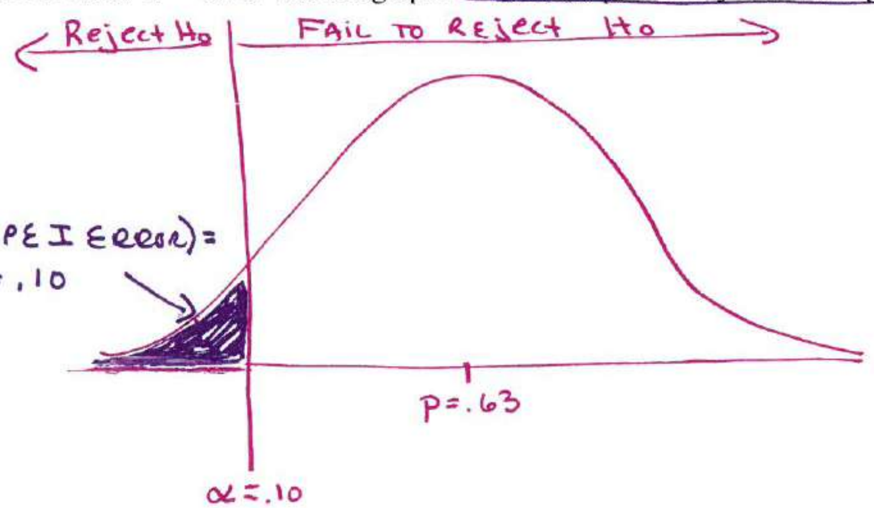
TYPE I ERROR would occur if the manager decides that the true proportion of drive through customers that have to wait at least 2 minutes has been reduced, when in fact it has not been reduced. Reject Ho when p=.63 is TRUE.

• A CONSEQUENCE is that the manager pays for an additional employee that he does NOT need.

Type II ERROR would occur if the manager decides the true proportion of drive through customers that have to wait at least 2 minutes has NOT been reduced, when in fact the time had been reduced. Fail to Reject Ho when p=.63 is FALSE

• A CONSEQUENCE is that the restaurant would NOT have an additional employee helping with the drive through, so they arenot providing faster service when they could.

Problem 2: Suppose that the manager decided to carry out this test using a random sample of 250 orders and a significance level of $\alpha = 0.10$. Make a graph. What is the probability of a making a Type I error?



The probability of a Type I ERROR is 10% which means we reject Ho when Ho is actually true. In this case, a Type I error occurs when the true proportion of customers waiting at least 2 minutes remains p=.63, But we get a value of $\hat{p}$ small enough that the p-value is less than .10.