TOPIC: STEPS IN HYPOTHESIS TESTING

Step 1: Write Hypotheses

HYPOTHESIS TEST			
1) Write Hypotheses	2) Calc Test Stat	3) Get P–Value	4) State Conclusion

◆ Every hypothesis test begins with writing 2 statements based on the problem text.

1) Null Hypothesis – Claim made about a population, "default assumption" or "status quo"

Usually written "H_0: [*parameter*] ___ [*value*]" (e.g. _________)

2) Alternative Hypothesis – Opposing claim you're trying to find evidence for

Usually written "H_a: [*parameter*] ___, ___, or ___ [*value*]" (e.g. _________)

EXAMPLE For each problem, write the null hypothesis and alternative hypothesis.

(A) You're a researcher investigating the average age of students at your university. The enrollment office claims the mean age is 23. You're looking to test if current students are younger than this claimed average.

Parameter: _____

Value: _____

$\boldsymbol{H_0}$: ________________

$\boldsymbol{H_a}$: ________________

(B) A business journal wants to estimate the percentage of companies with female CEOs within the United States. They want to prove that greater than 20% of companies, nationwide, have a female CEO.

Parameter: _____

Value: _____

$\boldsymbol{H_0}$: ________________

$\boldsymbol{H_a}$: ________________

PRACTICE

A popular theme park claims that their weekly attendance is around 100,000. You believe that the weekly attendance is different than this claimed value, so you gather sample data. Write the null and alternative hypotheses.

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PRACTICE A candy manufacturer seeking to minimize the variation in weights of their candies claims to produce candies with a standard deviation less than 0.300 g. Write the null and alternative hypotheses.

EXAMPLE The following statement represents a claim. Use it to write H_0 & H_a: $\mu < 120$

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PRACTICE

Student loan debt has fluctuated over years, with signs indicating that the default rate may be increasing. Write the null and alternative hypotheses if you want to determine if the student loan default rate this year is more than 15%.

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Step 2: Calculate Test Statistic

HYPOTHESIS TEST			
1) Write Hypotheses	2) Calc Test Stat	3) Get P–Value	4) State Conclusion

◆ Recall: We made 2 statements (H_0 & H_a). We use data from a ***sample*** to test H_0, a claim about a ***population***.

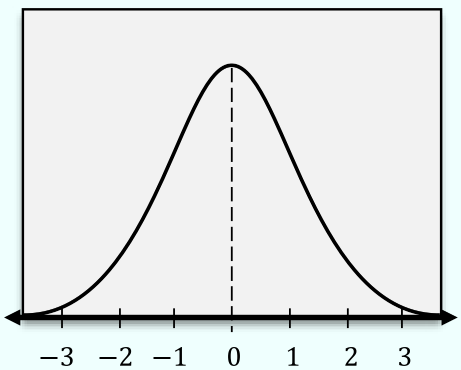
- Convert sample statistics ($\bar{x}, \hat{p}, s$) to ____________ (z, t, X^2), called a **test statistic**, using value from H_0.

Recall

Mean (σ known)	Mean (σ unknown)	Proportion	Variance
$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$	$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$	$z = \frac{\hat{p} - p}{\sqrt{p(1-p)/n}}$	$\chi^2 = \frac{(n-1)s^2}{\sigma^2}$

EXAMPLE

You're a researcher looking to see if students at your university now are younger than students from last year, who had a mean age of 23 years ($H_0: \mu = 23, H_a: \mu < 23$), with a standard deviation $\sigma = 4$ years. You gather data from a sample of $n = 35$ students and find a mean age of $\bar{x} = 22$ years. Determine which test statistic to use & calculate it.



◆ Remember: Test stats (z, t) represent how _____________ the sample data is from the claimed parameter.

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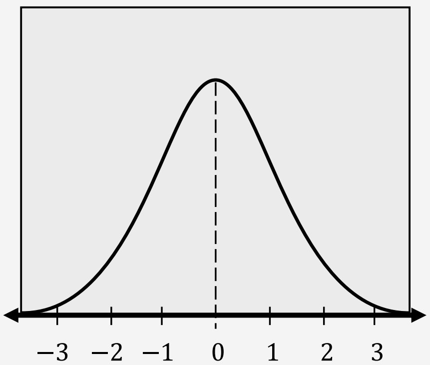
PRACTICE

A survey claimed that 30% of adults prefer electric cars over traditional cars. A car manufacturer believes the true proportion is higher than 30%. To test this, they survey a random sample of 50 adults and find that 19 say they prefer electric cars. Determine which test statistic to use & calculate it.



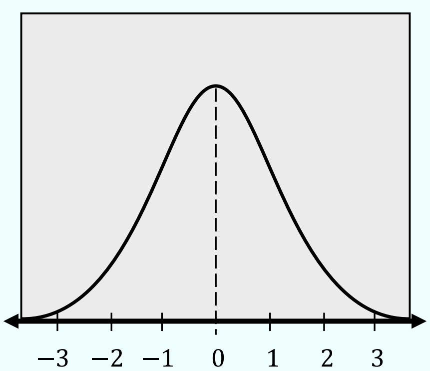
Recall

Mean (σ known)	**Mean (σ unknown)**	**Proportion**	**Variance**
$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$	$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$	$z = \frac{\hat{p} - p}{\sqrt{p(1-p)/n}}$	$\chi^2 = \frac{(n-1)s^2}{\sigma^2}$

EXAMPLE

A school claims that the average score on its math final exam is 75. A teacher believes that the average score is actually lower than 75. To test this, the teacher randomly selects a sample of 15 students and finds the scores shown below. Determine which test statistic to use and calculate it.

$$\mathbf{72, 70, 77, 74, 69, 71, 73, 78, 76, 70, 80, 67, 68, 69, 72}$$



Recall

Mean (σ known)	**Mean (σ unknown)**	**Proportion**	**Variance**
$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$	$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$	$z = \frac{\hat{p} - p}{\sqrt{p(1-p)/n}}$	$\chi^2 = \frac{(n-1)s^2}{\sigma^2}$

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Step 3: Get P–Value

HYPOTHESIS TEST			
1) Write Hypotheses	2) Calc Test Stat	3) Get P–Value	4) State Conclusion

- Recall: Test statistic = score of how *different* sample is from H_0. Now we find how ____________ the sample is.
  - **P–value:** Probability of getting the sample data, assuming H_0 is true, i.e. _________________ test statistic.

EXAMPLE

You're a researcher looking to see how the mean age of students currently in your university has changed from last year, who had a mean age of 23 years old (H_0: $\mu = 23$). To do this, you get a sample of students and calculate a test statistic. In each of the following situations, write H_a. Use z to find the P–Value.

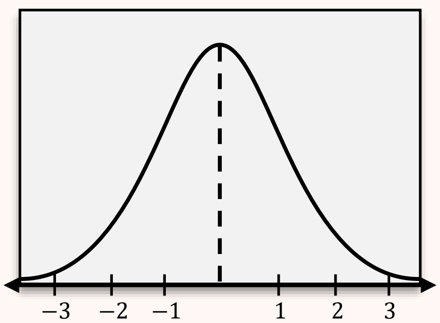
New

Hypothesis Test: P-Values

Left Tail

"Students now are ***younger****…*"

H_a: μ ___ 23; $z = -2.00$

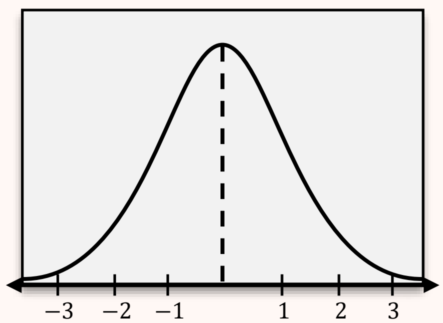


P-value (outside area)
= area ______ of z

Two Tail

"Students now have a ***different*** *mean age…*"

H_a: μ ___ 23; $z = -1.00$

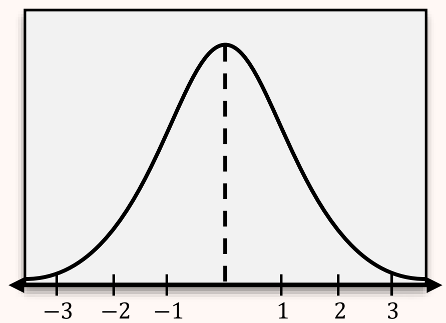


P-value (outside area)
= __ · area _______ z

Right Tail

"Students now are ***older****…*"

H_a: μ ___ 23; $z = 0.8$



P-value (outside area)
= area ______ of z

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PRACTICE Determine whether the hypothesis test is left-tailed, right-tailed, or two-tailed.

(A) Left-tailed

(B) Right-tailed

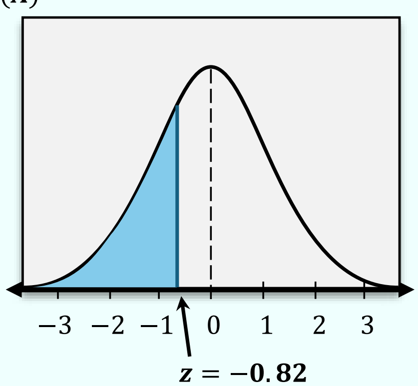
(C) Two-tailed

H_0: $p = 0.4$
H_a: $p \neq 0.4$

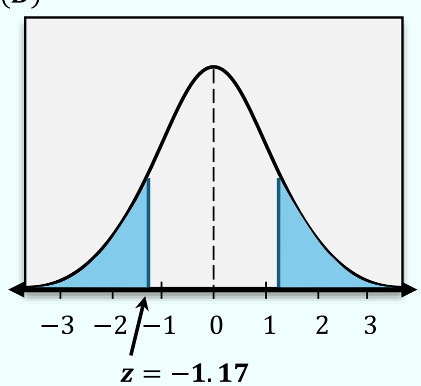
PRACTICE In a certain hypothesis test, $H_0: p = 0.4$, $H_a: p < 0.4$. You collect a sample and calculate a test statistic $z = -1.32$. Find the P-value.

EXAMPLE Match the P-value with the graph that represents the corresponding area: $P = 0.2420$

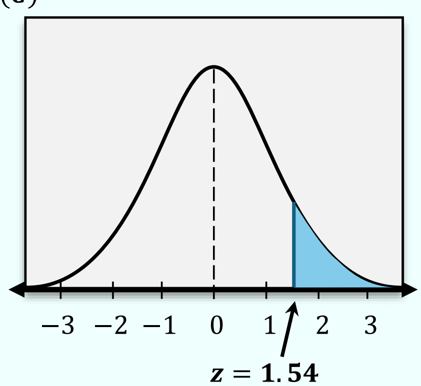
$(\boldsymbol{A})$



$(\boldsymbol{B})$



$(\boldsymbol{C})$



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Step 4: State Conclusion

HYPOTHESIS TEST			
1) Write Hypotheses	2) Calc Test Stat	3) Get P–Value	4) State Conclusion

- Recall: ***P*-value** = Probability of getting sample data, if H_0 is true (low P = unusual sample). *Calculated* in test.
  - Significance Level (α) = ___________ for how unusual sample can be before we reject H_0. *Given* in problem.

  (Commonly $0.10, 0.05, 0.01$*)*

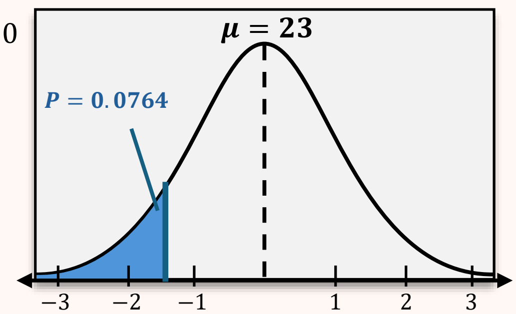
EXAMPLE

You're a researcher looking to see how the mean age of students currently at your university has changed from last year, who had a mean age of 23 years old ($H_0: \mu = 23$). You collect a sample, calculate $z = -1.43$, and get a ***P*–value** of of 0.076. State a conclusion for the hypothesis test using the given levels of significance below.

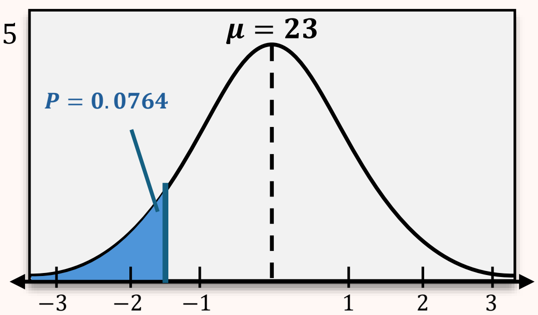
New **Hypothesis Test: Conclusion**

1) Draw graph, compare ***P*–value** to α

(A) $\alpha = 0.10$



(B) $\alpha = 0.05$



2) REJECT or **FAIL TO REJECT**

(A) Because P-val =__________ α = _____,

we ______________________________ H_0.

(B) Because P-val =__________ α = _____,

we ______________________________ H_0.

3) Restate H_a in words

(A) There is _____________ evidence that students at your university are younger than they were 10 years ago.

(B) There is _____________ evidence that students at your university are younger than they were 10 years ago.

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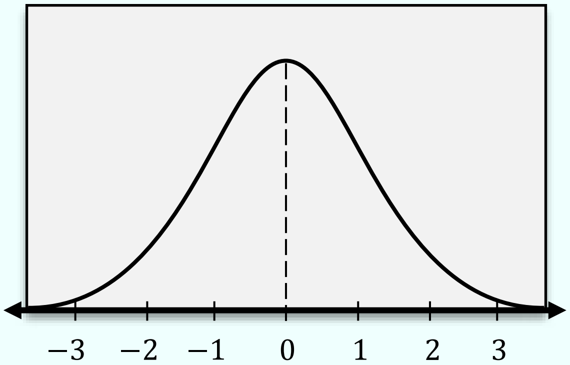
EXAMPLE A college organization claims that more than 10% of students read print newspapers. A hypothesis test results in a P-value of 0.1632. State a conclusion using a significance level of $\alpha = 0.05$.



PRACTICE

A transportation analyst claims that the average commute time in a major city is less than 45 minutes. A hypothesis test is conducted, with a resulting P-value of 0.0084. What would the conclusion be at a significance level $\alpha = .01$?