## TOPIC: HYPOTHESIS TESTS FOR MEAN

### Standard Deviation ($\sigma$) Known

- Recall: To run a hypothesis test 1) Write Hypotheses, 2) Calc. Test Statistic, 3) Find $P$-Value, & 4) State Conclusion.
  - In Step 2, when $\sigma$ is ***known***, we use the ___ test statistic.

**EXAMPLE**

A lighting company advertises their LED bulbs to last on average 25,000 hr. Past data shows the bulbs' lifespans have a normal dist. with $\sigma$ = 1,200 hr. A separate agency suspects the lifespan is actually lower. From a random sample of 36 bulbs, they find $\bar{x}$ = 24,600 hr. Use $\alpha$ = 0.10 to test the claim that the true mean lifespan is 25,000 hr.

**New** — **Hypothesis Tests for Mean ($\sigma$ Known)**

**1) Hyp**

$H_0: \mu =$ ________ $H_a: \mu$ **[ < | > | ≠ ]** ______

**2) Test Stat**

**$\sigma$ Known** $z = \dfrac{\bar{x} - \mu}{\sigma/\sqrt{n}}$

**$\sigma$ Unknown** $t = \dfrac{\bar{x} - \mu}{s/\sqrt{n}}$

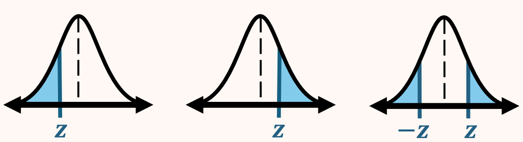
$\bar{x} =$ _____ $\sigma =$ _____ $n =$ _____

$z =$

**3) $P$-Value**

**Area "beyond" $z$**

If $H_a: \mu <$ If $H_a: \mu >$ If $H_a: \mu \neq$




$P$-Value = ______

**4) Conclusion**

Because $P$-value **[ < | > ]** $\alpha$, we **[ REJECT | FAIL TO REJECT ]** $H_0$.
There is **[ ENOUGH | NOT ENOUGH ]** evidence to suggest…

**Criteria**

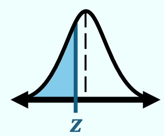
Random Samples? ☐

$X$ is Normal ***OR*** $n > 30$ ☐

**TOPIC: HYPOTHESIS TESTS FOR MEAN**

**EXAMPLE** Perform the hypothesis test using $\sigma = 6$, $n = 36$, and $\alpha = 0.10$. Test the claim that $\mu = 50$ using…

$(\boldsymbol{A})$ Left-Tailed Test: $\bar{x} = 47$




**Recall**

$$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$$

*(σ Known)*

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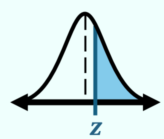
$(\boldsymbol{B})$ Right-Tailed Test: $\bar{x} = 51$




**PRACTICE**

Test the claim about the population mean $\mu$ at the given level of significance. Assume the population is normally distributed. Find the $P$-value and determine whether you should reject or fail to reject the null hypothesis.

Claim: $\mu \neq 1020,\ \ \alpha = 0.01,\ \ \sigma = 85$
Sample: $\bar{x} = 990,\ \ n = 40$

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### EXAMPLE

A company has historically priced one of its best-selling products at \$48.00. A manager suspects that the average price of this product across retail outlets has changed. A random sample of 32 stores showed an average selling price of \$46.90. The population standard deviation is known to be \$3.50. At the $\alpha = 0.05$ significance level, test the claim that the average price is different from \$48.00.

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## EXAMPLE

City officials claim that the average annual salary of all full-time workers in a particular city is $51,000. A local labor expert believes that the average salary has increased since then. A random sample of 18 full-time workers is taken and the results are shown below. The population is approximately normal with a known standard deviation of $4,500. Test this claim using a significance level of $\alpha = 0.05$.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **48,000** | **52,100** | **50,500** | **53,000** | **54,200** | **51,300** | **55,000** | **52,700** | **50,900** |
| **51,800** | **53,100** | **49,500** | **52,300** | **51,100** | **50,700** | **53,200** | **54,000** | **52,400** |

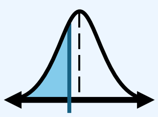
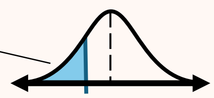
## <u>TOPIC: HYPOTHESIS TESTS FOR MEAN</u>

### <u>Standard Deviation ($\sigma$) Unknown</u>

◆ To run a hypothesis test when $\sigma$ is ***unknown***, use ___ instead of ___ & the ***t*** **distribution** instead of **normal**.

**EXAMPLE**

A tech company claims that the average battery life of their new smartphone model is 12 hr, but you suspect it might actually be less. Test this claim given a sample of 40 phones with mean battery life of 11.4 hr, standard deviation of 1.2 hr & significance level of 0.05.

| | Recall **$\sigma$ Known** | New **Hypothesis Tests for Mean ($\sigma$ Unknown)** |
|---|---|---|
| 1) Hyp | $H_0: \mu = \#$<br>$H_a: \mu < \mid > \mid \neq \#$ | $H_0: \mu =$ _______ $H_a: \mu$ **[ < \| > \| ≠ ]** _______ |
| 2) Test Stat | $z = \dfrac{\bar{x} - \mu}{\sigma/\sqrt{n}}$ | $t = \dfrac{\bar{x} - \mu}{s/\sqrt{n}}$ $\bar{x} =$ _____ $s =$ _____ $n =$ _____<br>$t =$ |
| 3) $P$-Value | <br>$z$ | **Area "beyond" *t***  $t$<br>$df = n - 1 =$ ______<br>$P$-Value $=$ ______ |
| 4) Conclusion | Because $P$-value… | Because $P$-value **[ < \| > ]** $\alpha$, we **[ REJECT \| FAIL TO REJECT ]** $H_0$.<br>There is **[ ENOUGH \| NOT ENOUGH ]** evidence to suggest… |
| Criteria | Random samples? ☐<br>$X$ is normal ***OR*** $n > 30$? ☐ | Random samples? ☐<br>$X$ is normal ***OR*** $n > 30$? ☐ |

## TOPIC: HYPOTHESIS TESTS FOR MEAN

### PRACTICE

Test the claim about the population mean $\mu$ at the given level of significance. Assume the population is normally distributed. Find the $P$-value and determine whether you should reject or fail to reject the null hypothesis.

Claim: $\mu > 52,\ \ \alpha = 0.10$
Sample: $\bar{x} = 53.1,\ \ s = 4.7,\ \ n = 20$

**TOPIC: HYPOTHESIS TESTS FOR MEAN**

## EXAMPLE

A city government claims that the average monthly rent for a one-bedroom apartment in the downtown area is $1,450. A housing advocacy group believes that figure may be outdated and has changed recently. They collect a random sample of 18 apartments finding a sample mean of $1,525 and sample standard deviation of $135. Test the claim using $\alpha = 0.05$.