Hypothesis Testing: Null & Alternative Hypotheses

Statistics Worksheet · Grade 11–12 / Introductory College Stats

Name: _____ Date: _____

Learning Objectives

- Identify and write the null hypothesis using equality notation for a given claim
- Identify and write the alternative hypothesis using the correct inequality symbol based on keyword clues
- Distinguish between one-tailed (left/right) and two-tailed hypothesis tests

Problems

1. A water bottle manufacturer claims that each bottle contains exactly 16 ounces of water. Write the null hypothesis in statistical notation using the population mean.

$H_0 : \mu = 16$

2. A cereal company states that each box contains exactly 18 ounces of cereal. A consumer group believes the boxes contain less than 18 ounces. Write both the null and alternative hypotheses.

$H_0 : \mu = 18 \quad H_a : \mu < 18$

3. A pharmaceutical company claims that exactly 40% of patients respond positively to a new drug. A researcher believes the proportion is different from 40%. Write both the null and alternative hypotheses using population proportion notation.

$H_0 : p = 0.40 \quad H_a : p \neq 0.40$

4. Identify whether each alternative hypothesis represents a left-tailed, right-tailed, or two-tailed test. Match each hypothesis with the correct test type.

Alternative Hypothesis	Test Type
H_a: $\mu < 50$	
H_a: $\mu > 50$	

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Alternative Hypothesis	Test Type
H_a: $\mu \neq 50$	
H_a: $p < 0.30$	
H_a: $p \neq 0.75$	

5. A gym claims that members lose an average of 10 pounds in their first month. A fitness blogger believes members actually lose more than 10 pounds. State the null and alternative hypotheses, then identify the type of test.

$H_0 : \mu = 10 \quad H_a : \mu > 10$

6. A survey states that 65% of teenagers own a smartphone. A school district researcher suspects the true proportion in their district is different from the national figure. A random sample of 200 students is taken. Write the null and alternative hypotheses and identify the parameter of interest.

$H_0 : p = 0.65 \quad H_a : p \neq 0.65$

7. Read the following scenario and answer all parts. A battery company advertises that their batteries last an average of 300 hours. An independent testing lab believes the batteries last fewer than 300 hours. They test a sample of 50 batteries. (a) State H■ and H■. (b) What is the type of test? (c) Who is making the original claim — the null or the alternative?

$H_0 : \mu = 300 \quad H_a : \mu < 300$

8. Determine the correct null and alternative hypotheses for each scenario described in the table.

Scenario	H_0	H_a
A tire brand claims average lifespan is 50,000 miles. An engineer thinks it is less.	H_0: $\mu = 50{,}000$	
A school claims 80% of students graduate. A journalist thinks it is different.	H_0: $p = 0.80$	

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Scenario	H_0	H_a
A coffee shop says each cup has exactly 12 oz. A health inspector thinks it is more.	$H_0: \mu = 12$	

9. A researcher tests whether a new teaching method improves student test scores. Historically, students score an average of 72 points. After using the new method with 35 students, the sample mean is 76 points. State the null and alternative hypotheses, identify the test type, and explain in one sentence what rejecting H■ would mean in context.

$$H_0 : \mu = 72 \quad H_a : \mu > 72$$

10. A national health agency reports that the mean resting heart rate of adults is 72 beats per minute (bpm) with a population standard deviation of 8 bpm. A cardiologist believes that adults who exercise daily have a different mean resting heart rate. She randomly samples 40 adults who exercise daily. (a) Define the parameter and state H■ and H■. (b) Identify the type of test. (c) On the normal curve shown, shade the correct rejection region for a significance level of 0.05. (d) Calculate the z-score if the sample mean is 69 bpm.

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Hypothesis Testing: Null & Alternative Hypotheses — Answer Key

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Answer Key

1. Answer: H■: μ = 16

- The null hypothesis always uses an equality sign (=).
- The claim is that each bottle contains 16 ounces, so the population mean μ equals 16.
- Write: H■: μ = 16

2. Answer: H■: μ = 18 and H■: μ < 18

- The null hypothesis always states the equality based on the company's claim: H■: μ = 18.
- The keyword 'less than' indicates a left-tailed test.
- Write the alternative hypothesis: H■: μ < 18.

3. Answer: H■: p = 0.40 and H■: p ≠ 0.40

- The company's claim gives the null hypothesis: H■: p = 0.40.
- The phrase 'different from' indicates a two-tailed test.
- Write the alternative hypothesis: H■: p ≠ 0.40.

4. Answer: See completed table

Alternative Hypothesis	Test Type
H_a: μ < 50	Left-tailed
H_a: μ > 50	Right-tailed
H_a: μ ≠ 50	Two-tailed
H_a: p < 0.30	Left-tailed
H_a: p ≠ 0.75	Two-tailed

- A '<' symbol in H■ indicates a left-tailed test.
- A '>' symbol in H■ indicates a right-tailed test.
- A '≠' symbol in H■ indicates a two-tailed test.

5. Answer: H■: μ = 10, H■: μ > 10 — Right-tailed test

- The gym's claim becomes the null hypothesis: H■: μ = 10.
- The keyword 'more than' tells us to use the '>' symbol.
- Write: H■: μ > 10. Since '>' is used, this is a right-tailed test.

6. Answer: H■: p = 0.65, H■: p ≠ 0.65; parameter is population proportion p

- The parameter of interest is the population proportion p (proportion of teenagers owning a smartphone).

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- The national survey value forms the null hypothesis: H■: p = 0.65.
- The phrase 'different from' signals a two-tailed test: H■: p ≠ 0.65.

7. Answer: (a) H■: μ = 300, H■: μ < 300; (b) Left-tailed; (c) Null hypothesis

- (a) The company's claim forms H■: μ = 300. The lab's suspicion uses 'fewer than': H■: μ < 300.
- (b) The '<' symbol means this is a left-tailed test.
- (c) The company (the original advertiser) is represented by the null hypothesis H■.

8. Answer: See completed table

Scenario	H_0	H_a
A tire brand claims average lifespan is 50,000 miles. An engineer thinks it is less.	H_0: μ = 50,000	H_a: μ < 50,000
A school claims 80% of students graduate. A journalist thinks it is different.	H_0: p = 0.80	H_a: p ≠ 0.80
A coffee shop says each cup has exactly 12 oz. A health inspector thinks it is more.	H_0: μ = 12	H_a: μ > 12

- Row 1: 'Less than' → left-tailed: H■: μ < 50,000.
- Row 2: 'Different from' → two-tailed: H■: p ≠ 0.80.
- Row 3: 'More than' → right-tailed: H■: μ > 12.

9. Answer: H■: μ = 72, H■: μ > 72; Right-tailed test; Rejecting H■ means there is sufficient evidence that the new method increases average scores above 72.

- The historical average provides the null hypothesis: H■: μ = 72.
- The goal is to test if scores 'improved' (increased), so use '>': H■: μ > 72.
- The '>' symbol confirms a right-tailed test.
- Rejecting H■ provides statistical evidence that the new teaching method significantly raises the average score above 72 points.

10. Answer: (a) μ = mean resting heart rate of daily exercising adults; H■: μ = 72, H■: μ ≠ 72. (b) Two-tailed. (c) Shade both tails beyond z = ±1.96. (d) z ≈ –2.37

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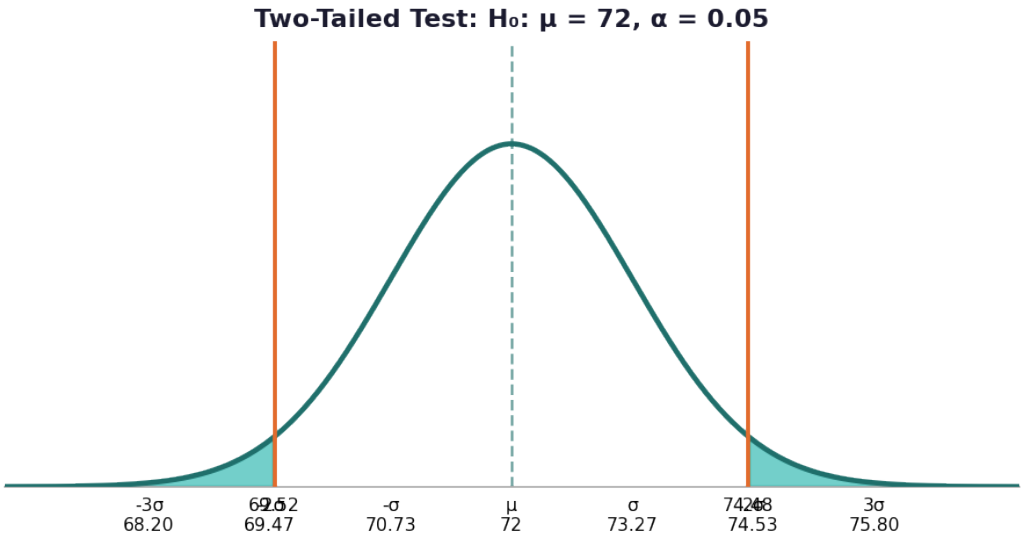

- (a) Parameter: μ = true mean resting heart rate of adults who exercise daily. H■: μ = 72, H■: μ ≠ 72.
- (b) The phrase 'different mean' and the ≠ symbol confirm a two-tailed test.
- (c) For α = 0.05 two-tailed, split α/2 = 0.025 in each tail; critical z-values are ±1.96. Shade both tails.
- (d) Compute: z = (69 – 72) / (8 / √40) = –3 / 1.265 ≈ –2.37. Since |–2.37| > 1.96, we would reject H■.

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