Null and Alternative Hypotheses

If the original claim includes equality **≤, =, or ≥** , it is the **null hypothesis**. If the original claim does **not** include equality (<, ≠, >) then the **null hypothesis** is the complement of the original claim. The **null hypothesis** always includes the **equal** sign. The decision is based on the **null hypothesis**.

Example 1 :

A statistician read that **at least** 77% of the population oppose replacing $1 bills with $1coins. To see if this claim is valid, the statistician selected a sample of 80 people and found that 55 were opposed to replacing the $1 bills.

State the hypotheses and identify the claim.

H_0: $p \geq 0.77$ (claim) This is the null hypothesis since the claim had equality
H_1: $p < 0.77$ This is the alternative hypothesis – the complement.

Example 2 :

YoYo Health Insurance Co. claims that in 2016, the average monthly premium paid for individual health coverage was $283. Suppose you are suspicious that the average, or mean, cost is actually higher.

State the hypotheses and identify the claim.

H_0: $\mu = 283$ (claim) This is the null hypothesis since the claim had equality
H_1: $\mu > 283$ This is the alternative hypothesis

Example 3 :

A local pizza shop advertises “an average delivery time of less than 20 minutes”, but it does not offer a guarantee such as a free pizza. The manager, Guido Marinara wonders if her employees are fulfilling the claim.

State the hypotheses and identify the claim

H_0: $\mu \geq 20$ This is the null hypothesis since it is has equality
H_1: $\mu < 20$ (claim) This is the alternative hypothesis

Hypothesis Testing
Determining H_0 and H_1

Name_____
Class_____**Date**_____

1 - 13 Express the null hypothesis and the alternative hypothesis in symbolic form. Determine which is the claim. Use the correct symbol (μ, p, σ) for the indicated parameter.

1) A researcher claims that the proportion of Americans that have seen a UFO, p, is less than 3 in every one thousand.

A) H_0: $p > 0.003$
H_1: $p \leq 0.003$ claim

B) H_0: $p = 0.003$ claim
H_1: $p > 0.003$

C) H_0: $p \geq 0.003$
H_1: $p < 0.003$ claim

D) H_0: $p < 0.003$ claim
H_1: $p \geq 0.003$

2) A research article in an entomological journal claims that fewer than 7 in ten thousand male fireflies are unable to produce light due to a genetic mutation. Use the parameter p, the true proportion of fireflies unable to produce light.

A) H_0: $p \geq 0.0007$
H_1: $p < 0.0007$ claim

B) H_0: $p = 0.0007$
H_1: $p > 0.0007$ claim

C) H_0: $p > 0.0007$ claim
H_1: $p \leq 0.0007$

D) H_0: $p \neq 0.0007$ claim
H_1: $p \geq 0.0007$

3) Bedazzled Motor Company claims that its new sedan, the Glitteratti , will average better than 26 miles per gallon in the city. Use μ, the true average mileage of the Glitteratti .

A) H_0: $\mu \leq 26$
H_1: $\mu > 26$ claim

B) H_0: $\mu < 26$
H_1: $\mu \geq 26$ claim

C) H_0: $\mu > 26$ claim
H_1: $\mu \leq 26$

D) H_0: $\mu = 26$
H_1: $\mu < 26$ claim

4) The owner of a soccer team claims that the average attendance at games is over 62,900, and he is therefore justified in moving the team to a city with a larger stadium.

A) H_0: $\mu < 62{,}900$
H_1: $\mu \geq 62{,}900$ claim

B) H_0: $\mu = 62{,}900$ claim
H_1: $\mu < 62{,}900$

C) H_0: $\mu > 62{,}900$
H_1: $\mu \leq 62{,}900$ claim

D) H_0: $\mu \leq 62{,}900$
H_1: $\mu > 62{,}900$ claim

5) A UFO researcher claims that more than 4.1 percent of the population have been abducted by Aliens. Use p, to determine the true percentage of the population that have been abducted by Aliens.

A) H_0: $p \leq 4.1\%$
H_1: $p > 4.1\%$ claim

B) H_0: $p < 4.1\%$
H_1: $p \geq 4.1\%$ claim

C) H_0: $p = 4.1\%$ claim
H_1: $p < 4.1\%$

D) H_0: $p > 4.1\%$ claim
H_1: $p \leq 4.1\%$

6) The manufacturer of a refrigeration system for wine produces refrigerators that are supposed to maintain a true mean temperature, μ, of 43°F, ideal for a certain type of French wine. The owner of the Je T'Aime Vin winery does not agree with the refrigerator manufacturer, and claims he can prove that the true mean temperature is incorrect.

A) H_0: $\mu \neq 43°$
H_1: $\mu = 43°$ claim

B) H_0: $\mu \leq 43°$
H_1: $\mu > 43°$ claim

C) H_0: $\mu \geq 43°$ claim
H_1: $\mu < 43°$

D) H_0: $\mu = 43°$ claim
H_1: $\mu \neq 43°$

7) A researcher claims that 62% of voters in Silicon Valley are in favor of free internet for everyone.

A) H_0: $p = 0.62$ claim
H_1: $p \neq 0.62$

B) H_0: $p < 0.62$ claim
H_1: $p \geq 0.62$

C) H_0: $p \geq 0.62$ claim
H_1: $p < 0.62$

D) H_0: $p \neq 0.62$ claim
H_1: $p = 0.62$

8) The principal of a middle school claims that test scores of the seventh-graders at her school vary less than the test scores of seventh-graders at a neighboring school, which have variation described by $\sigma = 14.7$.

A) H_0: $\sigma = 14.7$ claim
H_1: $\sigma \neq 14.7$

B) H_0: $\sigma < 14.7$
H_1: $\sigma > 14.7$ claim

C) H_0: $\sigma > 14.7$
H_1: $\sigma \leq 14.7$ claim

D) H_0: $\sigma < 14.7$ claim
H_1: $\sigma \geq 14.7$

9) Ole Chips and Salsa Company claims that the mean weight of their medium size bag of tortilla chips is at least 14 oz.

A) H_0: $\mu > 14$ claim
H_1: $\mu \leq 14$

B) H_0: $\mu < 14$
H_1: $\mu \geq 14$ claim

C) H_0: $\mu \geq 14$ claim
H_1: $\mu < 14$

D) H_0: $\mu = 14$ claim
H_1: $\mu > 14$

10) An automobile insurance company, Regressive, claims that more than 3.3 percent of the population lie on their applications. Use p, the true percentage of the population that lie on their applications.

A) H_0: $p = 3.3\%$
H_1: $p \neq 3.3\%$ claim

B) H_0: $p < 3.3\%$
H_1: $p \geq 3.3\%$ claim

C) H_0: $p > 3.3\%$ claom
H_1: $p \leq 3.3\%$

D) H_0: $p \leq 3.3\%$
H_1: $p > 3.3\%$ claim

11) A chocolate researcher claims that the proportion of Americans that dislike chocolate, p, is less than 2 in every one thousand.

A) H_0: $p \leq 0.002$ claim
H_1: $p > 0.002$

B) H_0: $p \geq 0.002$
H_1: $p < 0.002$ claim

C) H_0: $p < 0.002$ claim
H_1: $p \geq 0.002$

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12) A coffee company claims that the mean price of an order at one of its airport shops, Starcups is at least $14.

A) H_0: $\mu > 14$ claim
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H_1: $\mu < 14$

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H_1: $\mu \neq 14$ claim

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13) An ice cream sundae researcher claims that the amount of hot fudge pumped out of the automatic hot fudge machine has a standard deviation different from the $\sigma = 3.3$ oz claimed by the manufacturer.

A) H_0: $\sigma \leq 3.3$ oz
H_1: $\sigma > 3.3$ oz claim

B) H_0: $\sigma \geq 3.3$ oz claim
H_1: $\sigma < 3.3$ oz

C) H_0: $\sigma \neq 3.3$ oz claim
H_1: $\sigma = 3.3$ oz

D) H_0: $\sigma = 3.3$ oz
H_1: $\sigma \neq 3.3$ oz claim

14) Which of the following would be an appropriate null hypothesis?
I. The mean of a population is equal to 55.
II. The mean of a sample is equal to 55.
III. The mean of a population is greater than 55.

A) I only
B) III only
C) II only
D) Only I and III are appropriate.

15) Which of the following would be an appropriate null hypothesis?

A) The sample proportion is no less than 0.65.
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Answer Key
INTRO TO HYPOTHESIS TEST

1) C
2) A
3) A
4) D
5) A
6) D
7) A
8) D
9) C
10) D
11) B
12) B
13) D
14) A
15) D
16) B
17) B

Hypothesis Testing
Determining H_0 and H_1

Name_____
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Answer Key
INTRO TO HYPOTHESIS TEST FREE RESPONSE

1) H_0: $p \geq 0.003$
   H_1: $p < 0.003$ claim
2) H_0: $p \geq 0.0007$
   H_1: $p < 0.0007$ claim
3) H_0: $\mu \leq 26$
   H_1: $\mu > 26$ claim
4) H_0: $\mu \leq 62{,}900$
   H_1: $\mu > 62{,}900$ claim
5) H_0: $p \leq 4.1\%$
   H_1: $p > 4.1\%$ claim
6) H_0: $\mu = 43°$ claim
   H_1: $\mu \neq 43°$
7) H_0: $p = 0.62$ claim
   H_1: $p \neq 0.62$
8) H_0: $\sigma < 14.7$ claim
   H_1: $\sigma \geq 14.7$
9) H_0: $\mu \geq 14$ claim
   H_1: $\mu < 14$
10) H_0: $p \leq 3.3\%$
    H_1: $p > 3.3\%$ claim
11) H_0: $p \geq 0.002$
    H_1: $p < 0.002$ claim
12) H_0: $\mu \geq 14$ claim
    H_1: $\mu < 14$
13) H_0: $\sigma = 3.3$ oz
    H_1: $\sigma \neq 3.3$ oz claim
14) A
15) D
16) B
17) B

Null and Alternative Hypotheses

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State the hypotheses and identify the claim.

H_0: $\mu = 283$ (claim) This is the null hypothesis since the claim had equality
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Example 3 :

A local pizza shop advertises “an average delivery time of less than 20 minutes”, but it does not offer a guarantee such as a free pizza. The manager, Guido Marinara wonders if her employees are fulfilling the claim.

State the hypotheses and identify the claim

H_0: $\mu \geq 20$ This is the null hypothesis since it is has equality
H_A: $\mu < 20$ (claim) This is the alternative hypothesis

Hypothesis Testing
Determining H_0 and H_A

Name_____
Class_____**Date**_____

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1) A researcher claims that the proportion of Americans that have seen a UFO, p, is less than 3 in every one thousand.

A) H_O: $p > 0.003$
H_A: $p \leq 0.003$ claim

B) H_O: $p = 0.003$ claim
H_A: $p > 0.003$

C) H_O: $p \geq 0.003$
H_A: $p < 0.003$ claim

D) H_O: $p < 0.003$ claim
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2) A research article in an entomological journal claims that fewer than 7 in ten thousand male fireflies are unable to produce light due to a genetic mutation. Use the parameter p, the true proportion of fireflies unable to produce light.

A) H_O: $p \geq 0.0007$
H_A: $p < 0.0007$ claim

B) H_O: $p = 0.0007$
H_A: $p > 0.0007$ claim

C) H_O: $p > 0.0007$ claim
H_A: $p \leq 0.0007$

D) H_O: $p \neq 0.0007$ claim
H_A: $p \geq 0.0007$

3) Bedazzled Motor Company claims that its new sedan, the Glitteratti , will average better than 26 miles per gallon in the city. Use μ, the true average mileage of the Glitteratti .

A) H_O: $\mu \leq 26$
H_A: $\mu > 26$ claim

B) H_O: $\mu < 26$
H_A: $\mu \geq 26$ claim

C) H_O: $\mu > 26$ claim
H_A: $\mu \leq 26$

D) H_O: $\mu = 26$
H_A: $\mu < 26$ claim

4) The owner of a soccer team claims that the average attendance at games is over 62,900, and he is therefore justified in moving the team to a city with a larger stadium.

A) H_O: $\mu < 62{,}900$
H_A: $\mu \geq 62{,}900$ claim

B) H_O: $\mu = 62{,}900$ claim
H_A: $\mu < 62{,}900$

C) H_O: $\mu > 62{,}900$
H_A: $\mu \leq 62{,}900$ claim

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5) A UFO researcher claims that more than 4.1 percent of the population have been abducted by Aliens. Use p, to determine the true percentage of the population that have been abducted by Aliens.

A) H_O: $p \leq 4.1\%$
H_A: $p > 4.1\%$ claim

B) H_O: $p < 4.1\%$
H_A: $p \geq 4.1\%$ claim

C) H_O: $p = 4.1\%$ claim
H_A: $p < 4.1\%$

D) H_O: $p > 4.1\%$ claim
H_A: $p \leq 4.1\%$

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A) H_O: $\mu \neq 43°$
H_A: $\mu = 43°$ claim

B) H_O: $\mu \leq 43°$
H_A: $\mu > 43°$ claim

C) H_O: $\mu \geq 43°$ claim
H_A: $\mu < 43°$

D) H_O: $\mu = 43°$ claim
H_A: $\mu \neq 43°$

7) A researcher claims that 62% of voters in Silicon Valley are in favor of free internet for everyone.

A) H_O: $p = 0.62$ claim
H_A: $p \neq 0.62$

B) H_O: $p < 0.62$ claim
H_A: $p \geq 0.62$

C) H_O: $p \geq 0.62$ claim
H_A: $p < 0.62$

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A) H_O: $\sigma = 14.7$ claim
H_A: $\sigma \neq 14.7$

B) H_O: $\sigma < 14.7$
H_A: $\sigma > 14.7$ claim

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H_A: $\sigma \leq 14.7$ claim

D) H_O: $\sigma < 14.7$ claim
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A) H_O: $\mu > 14$ claim
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H_A: $\mu \geq 14$ claim

C) H_O: $\mu \geq 14$ claim
H_A: $\mu < 14$

D) H_O: $\mu = 14$ claim
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10) An automobile insurance company, Regressive, claims that more than 3.3 percent of the population lie on their applications. Use p, the true percentage of the population that lie on their applications.

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H_A: $p \neq 3.3\%$ claim

B) H_O: $p < 3.3\%$
H_A: $p \geq 3.3\%$ claim

C) H_O: $p > 3.3\%$ claom
H_A: $p \leq 3.3\%$

D) H_O: $p \leq 3.3\%$
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A) H_O: $p \leq 0.002$ claim
H_A: $p > 0.002$

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H_A: $p < 0.002$ claim

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12) A coffee company claims that the mean price of an order at one of its airport shops, Starcups is at least $14.

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13) An ice cream sundae researcher claims that the amount of hot fudge pumped out of the automatic hot fudge machine has a standard deviation different from the $\sigma = 3.3$ oz claimed by the manufacturer.

A) H_O: $\sigma \leq 3.3$ oz
H_A: $\sigma > 3.3$ oz claim

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14) Which of the following would be an appropriate null hypothesis?
I. The mean of a population is equal to 55.
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Answer Key
INTRO TO HYPOTHESIS TEST

1) C
2) A
3) A
4) D
5) A
6) D
7) A
8) D
9) C
10) D
11) B
12) B
13) D
14) A
15) D
16) B
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Hypothesis Testing
Determining H_0 and H_A

Name_____
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Answer Key
INTRO TO HYPOTHESIS TEST FREE RESPONSE

1) H_0: $p \geq 0.003$

   H_A: $p < 0.003$ claim

2) H_0: $p \geq 0.0007$

   H_A: $p < 0.0007$ claim

3) H_0: $\mu \leq 26$

   H_A: $\mu > 26$ claim

4) H_0: $\mu \leq 62{,}900$

   H_A: $\mu > 62{,}900$ claim

5) H_0: $p \leq 4.1\%$

   H_A: $p > 4.1\%$ claim

6) H_0: $\mu = 43°$ claim H_1: $\mu \neq 43°$

7) H_0: $p = 0.62$ claim H_1: $p \neq 0.62$

8) H_0: $\sigma < 14.7$ claim H_1: $\sigma \geq 14.7$

9) H_0: $\mu \geq 14$ claim H_1: $\mu < 14$

10) H_0: $p \leq 3.3\%$

    H_A: $p > 3.3\%$ claim

11) H_0: $p \geq 0.002$

    H_A: $p < 0.002$ claim

12) H_0: $\mu \geq 14$ claim H_1: $\mu < 14$

13) H_0: $\sigma = 3.3$ oz

    H_A: $\sigma \neq 3.3$ oz claim

14) A
15) D
16) B
17) B