Question 1 : What is a null hypothesis (H_0) and why is it important in hypothesis testing?

➢ Null Hypothesis (H_0):
The null hypothesis is a statement that there is no relationship or no difference between the variables being studied.
Example: There is no effect of a new medicine on patients.

Importance:
The null hypothesis is important because it gives us a starting point for testing. It allows us to check whether the change or effect we see in the data is real or just due to chance.
Without the null hypothesis, we cannot compare our results or decide if the effect we observe is meaningful.

Question 2 : What does the significance level (α) represent in hypothesis testing?

➢ The significance level (α) tells us how much risk we are willing to take of rejecting the null hypothesis when it is actually true, it shows the chance of making a wrong decision.
Common values of α are 0.05, 0.01, and 0.10.
For example, if $\alpha = 0.01$, it means there is a 1% chance that we might say a difference exists even when in reality there is no difference.

Question 3 :Difference Between Type 1 and Type 2 Errors.

➢

Type 1 Error	**Type 2 Error**
1. Rejecting the null hypothesis when it is actually true. 2. Also called a false positive. 3. We think an effect exists but in reality it doesn't. 4. Represented by α (alpha).	1. Failing to reject the null hypothesis when it is actually false. 2. Also called a false negative. 3. We think no effect exists but in reality it does. 4. Represented by β (beta).

Question 4 : Difference Between One-Tailed Test and Two-Tailed Test (With Examples)

➢ **One-Tailed Test**

1. A one-tailed test is used when the alternative hypothesis (H_1) predicts a specific direction of the effect (either increase or decrease).
Hence, it is also called a directional test.

2. It uses greater than (>) or less than (<) signs.
Example:
A company claims that a new battery lasts more than 15 hours on average.
Null Hypothesis (H_0): $\mu \leq 15$
Alternative Hypothesis (H_1): $\mu > 15$
This is right-tailed because it tests for an increase.

➢ **Two-Tailed Test**

1. A two-tailed test is used when the alternative hypothesis (H_1) does not specify a direction.
It only checks whether there is any difference.
Hence, it is called a non-directional test.
2. It uses the not equal to (≠) sign.

Example:
A manager wants to check whether a machine is actually filling exactly 50 candies per bag.
Null Hypothesis (H_0): $\mu = 50$
Alternative Hypothesis (H_1): $\mu \neq 50$

This checks for any increase or decrease.

Question 5 : A company claims that the average time to resolve a customer complaint is 10 minutes. A random sample of 9 complaints gives an average time of 12 minutes and a standard deviation of 3 minutes. At $\alpha = 0.05$, test the claim.

➢ Claim: The average complaint-resolution time is 10 minutes.
Given:

Sample mean ($\bar{x}$) = 12 minutes
Population mean (μ) = 10 minutes
Sample SD (s) = 3 minutes
Sample size (n) = 9

$$Zs = \frac{\mu s - \mu}{\sigma / n}$$

$$Zs = \frac{12 - 10}{3 / \sqrt{9}}$$

$$Zs = \frac{2}{1}$$

According to T table critical value is +/- 2.306
Since, -2.306 < 2.0 < 2.306 , the calculated t-statistic falls within the non-rejection region.

Question 6 : When should you use a Z-test instead of a t-test?

➢ We use a Z-test when the population standard deviation is already known and the sample size is big.
➢ If the population SD is not known and the sample size is small, then we use a t-test.
➢ Z-test is mainly used when the data is normally distributed and we have enough sample size.
➢ So basically, whenever σ is given and the sample size is large, we prefer the Z-test instead of the t-test.

Question 7 :

➢ Sample size n=6
➢ $D2 = \frac{\text{sum } D}{n} = \frac{18}{6} = 3$

Employee	Before (x)	After (Y)	Diff.(D=x-Y)	D-D2	(D-D2)^2
1	50	55	5	5-3=2	4
2	60	65	5	5-3=2	4
3	58	59	1	1-3=-2	4
4	55	58	3	3-3=0	0
5	62	63	1	1-3= -2	4

6	56	59	3	3-3=0	0
Total	341	359	18	0	16

Mean = 18/6=3
Standard deviation of the differences.

$\sqrt{[(D-D2)^2 / n-1]}$

$= \sqrt{(16/6-1)} = \sqrt{(16/5)} = \sqrt{3.2} = 1.789.$

Question 8 :

➢ Expected frequency(E)= $\frac{\text{(Row Total) x(Column Total)}}{\text{Grand Total}}$

(Product A for male) E = $\frac{50 \times 40}{100} = 20$

(Product B for male) E = $\frac{50 \times 60}{100} = 30$

(Product A for female) E = $\frac{50 \times 40}{100} = 20$

(Product B for female) E = $\frac{50 \times 60}{100} = 30$

x^2 = sum of [(O - E)^2/E

Gender	Product	O	E	O-E	(O-E)^2	$\frac{(O-E)^2}{E}$
Male	A	30	20	10	100	100/20=5
Male	B	20	30	-10	100	100/30=3.33
Female	A	10	20	-10	100	100/20=5
Female	B	40	30	10	100	100/30=3.33

X^2 = 5+3.33+5+3.33 = 16.66
df = (2-1) x (2-1) = 1 x1 = 1 df = 1
and α = 0.5 , critical value is 3.841
Since 16.66 > 3.841, we reject the null hypothesis