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①

Q.1) During the 1980's, the general consensus is the about 5% at the nations children's had autism. Some chemical that increase certain chemical in the environment had led to an increase in autism

a) write an appropriate test for this hypothesis, stating what are the neccessary conditions for formating the test.

b) Give an appropriate test for this hypothesis, stating what is this situation.

c) A recent study examined 384 children and found that 46 showed signs of autism perform a test of the hypothesis and state the p-value.

d) what are the conclusions & states how we the p-value.

Step-1 : Establish Null & Alternate hypothesis.

Null hypothesis : 5% of the nation children had autism.

Alternate hypothesis : More than 5% of the nation children had autism.

$$H_0 : \quad p = 0.05$$
$$H_A : \quad p > 0.05$$

* It is a one tailed test since we are going to checked only one end of the Experiment.

Step-2 : Determine the test we are going to perform the Z-test

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(2)

Step-3 :- Set value of alpha (α). Since in this problem the significance value is not given. let by Default assumption,

$$\alpha = 5\%$$
$$\alpha = 0.05$$

Step-4 :- establish the decision rule.
For Z- Critical,
if,
Z- critical < Z Score (Test Score)
we will reject null hypothesis.

For p-values.
if,
p-value < Significance value.
we reject our null hypotheses.

Step-5 :- Gathering Data.
A recent Study examined 347 childrens and found that 46 showed signs of autism. 5% of the nations children had autism.

Step-6 :- Analyze the data.
we Know,

$\boxed{P = 0.05}$, $\boxed{n = 384}$

$$Z\text{- Score} = \frac{\hat{P} - P}{\sqrt{\frac{P \cdot q}{n}}}$$

(3)

Sample proportion,

$$\hat{p} = \frac{46}{384}$$

$$\boxed{\hat{p} = 0.11}$$

$$\boxed{n = 384}$$

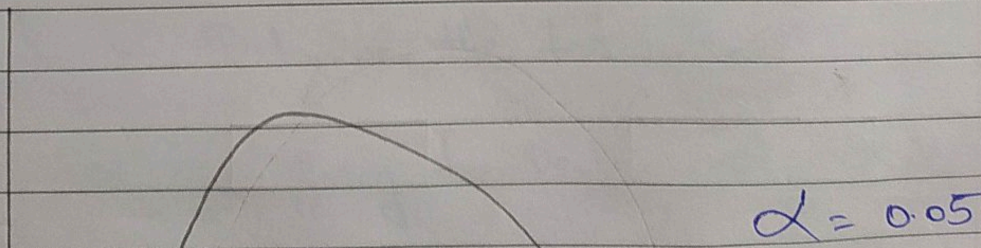
$$\boxed{q = 1 - p}$$

$$\boxed{q = 0.95}$$

$$Z\text{-Score} = \frac{\hat{p} - P}{\sqrt{\frac{P \cdot q}{n}}}$$

$$= \frac{0.11 - 0.05}{\sqrt{\frac{0.05 \times 0.95}{384}}}$$

$$\boxed{Z\text{-Score} = 5.39.}$$



④

Step-7 : Take Statistical Action
using Z- table
we have calculated

$$\boxed{\begin{aligned} Z\text{- Critical} &= 1.64 \\ Z\text{- Score} &= 5.39 \end{aligned}}$$

on the basis of decision rule,

Z- Critical < Z-Score.

1.64 < 5.39

* we will reject Null hypothesis

So,
The More than 5% had autism.
The increase in certain chemical in the environment in autism.

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Q.2) A Company with a fleet of 150 cars found that the Emission Systems of 7 out of the 22 cars tested failed to meet pollution guidelines.
a) Write a hypothesis to test if more than 20% of the entire fleet might be out of compliance.
b) Test the hypothesis based on the binomial distribution and report p-value.
c) Is the test significant at the 10%, 5%, 1% level

* Step - 1 : Establish Null & Alternate hypothesis.

Null hypothesis :- 20% of the car failed to meet population guidelines

Alternate hypothesis : More than 20% of the failed to meets population guidelines.

H_0 :- $p = 0.20$.
H_A : $p > 0.20$.

It is a one tailed test since we are going to check only one end of Experiment.

Step - 2 :- Determine the test

We are going to perform the Z-test

Step - 3 : Set the Significance Value.

Significance Value = 10%.
$\boxed{\alpha = 0.10.}$

Step-4 : Establish Decision rule,

For Z- critical,
Z- critical < Z- Score (Test Score)
we will reject null hypothesis.

For p-value,
If,
p-value < Significance ~~...~~ level.
we will reject our null hypotheses.

Step-5 : Collecting data.

A Company with a fleet of 150 cars found that the emissions type systems of 7 out of the 22 cars tested failed to meet pollution guidelines.

Step-6 : Analysis of data.

For Z- Score

$$Z\text{- Score} = \frac{\hat{P} - P}{\sqrt{\frac{P \cdot q}{n}}}$$

we know that,

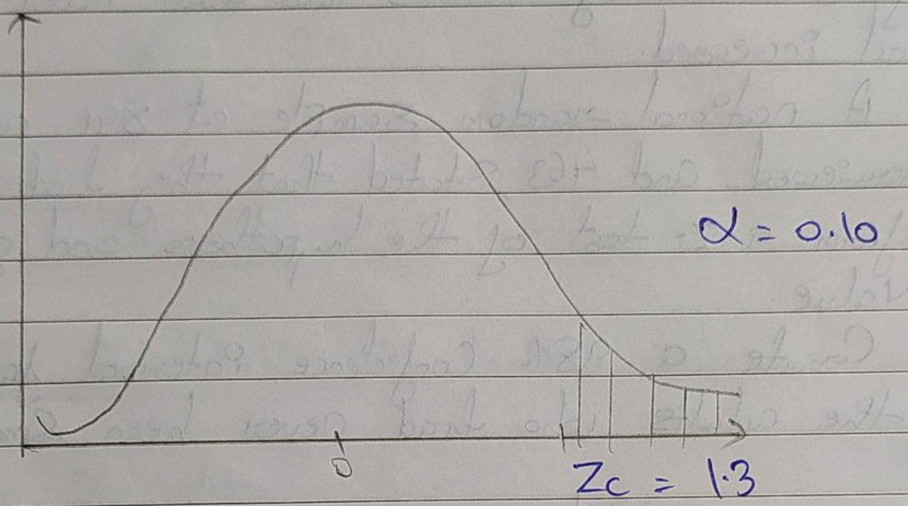
$\boxed{P = 0.20}$ $\boxed{n = 22}$

To Calculate $\hat{P}$,

$\hat{P} = \frac{7}{22}$ $q = 1 - P$ $= \boxed{\hat{P} = 0.31}$

$\boxed{q = 0.80}$

$$Z\text{-}Score = \frac{0.31 - 0.20}{\sqrt{\frac{0.20 \times 0.80}{22}}} = \boxed{Z\text{-}Score = 1.28}$$



By Z-table,

$\boxed{Z_c = 1.3}$

p - Value = $\boxed{1.003}$

Step-7 : Take Statistical action,

For Z-Critical,

Z-Critical > Z-Score

1.3 > 1.28

we will not reject the null hypothesis
we will accept the null hypothesis.

Therefore,

20% of the entire meet of the cars are failed to meet the population guidelines.

Step-8 : Determine business Implications.

So, the 20% at the cars are failed to meet the Population guidelines, that's why we should Improve the cars.

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⑧

Q.3) National Data in the 1960 Showed that about 44% of the adult Population had never Smoked.
a) State a null and alternate to test that the fraction of the 1995 of adults that had never Smoked had increased.
b) A national random sample at 891 adults were interviewed and 463 Stated that they had never Smoked. Perform a Z-test of the hypotheses and given an appropriate p-value.
c) Create a 98% Confidence interval for the proportion of the adults who had never been Smoked.

Step I :- Establish Null & Alternate hypotheses.

Null hypothesis : 44% of the adult population had Never Smoked.

Alternate hypothesis :- More than 44% of the adult population had never Smoked.

$$H_0 : P = 0.44.$$
$$H_A : P > 0.44$$

It is a one-tailed test, Since we are testing only one end of the Experiment

Step 2 :- Determine the test

We are going to Perform the Z-test.

Step 3 :- Set the value of significance level.

Since, confiden level is 98%.
Then,

$\alpha = 2\%$

$\alpha = 0.20$

$\boxed{\alpha = 0.02}$

Step.4 :- Establish the decision rule.

For Z-critical,

If,
Z-critical < Z-test (Test score)
we will reject null hypothesis.

For P-value,

If,
P-values < significance ~~level~~ value
we will reject the null hypotheses.

Step 5 : Gathering the data.

A national random sample of 891 adults were interviewed and 463 stated that they had never smoked.

Step 6 :- Analysis of data.

For Z-score,

$$Z\text{-score} = \frac{\hat{p} - P}{\sqrt{\frac{P \cdot q}{n}}}$$

we know that

$\boxed{P = 0.44}$ $\boxed{n = 891}$

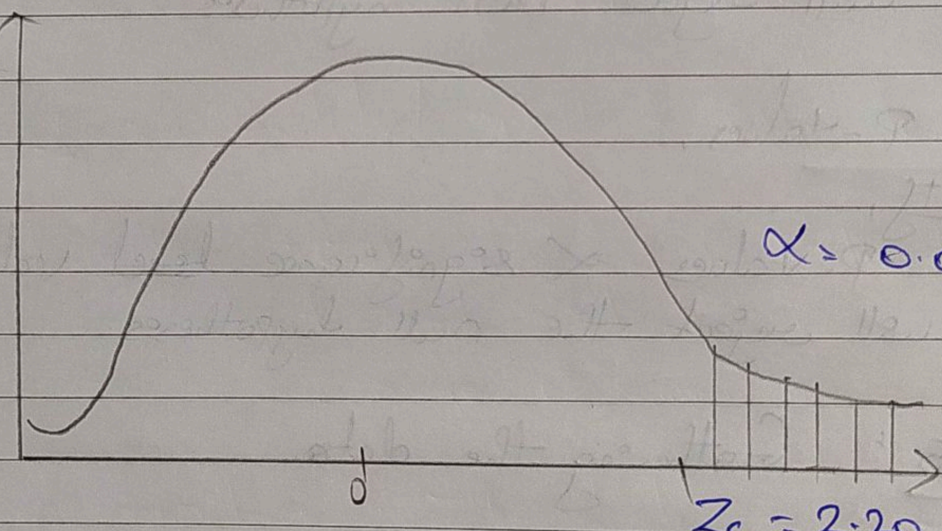
$q = 1 - P$
$= 1 - 0.44$

$\hat{P} = \frac{463}{891}$

$\boxed{q = 0.56}$ $\boxed{\hat{P} = 0.519.}$

$$Z\text{-}Score = \frac{0.519 - 0.44}{\sqrt{\frac{0.44 \times 0.56}{891}}}$$

$\boxed{Z\text{-}Score = 4.75}$



By using Z-table

$\boxed{Z\text{-}Critical = 2.20}$

Step. 7 :- The Statistical Action.

We have Calculated,

$$\boxed{Z\text{-}Score = 4.75}$$

$$\boxed{Z\text{-}Critical = 2.20}$$

On the basis of decision rule,

$$Z\text{-}critical < Z\text{-}Score$$

$$2.20 < 4.75$$

We will reject the null hypothesis.

So,
The more than 44% of the adult population had never Smoked

Step-8

So,
The more than 44% of the adult population never smoked.

Q.4) one of the lenses in your supply is suspected to have a focal length of 9.1 cm. Rather than 9 cm claimed by the manufacturer.
Here's S_1 is the distance from the lens to the object and S_2 is the distance from the lens to the real image of the object
The distances S_1 and S_2 are each independently measured 25 times. The sample mean of the measurement is $\bar{S}_1 = 26.6$ centimeters and $\bar{S}_2 = 13.8$ cm. Respectively: The standard deviation of the measurements is 0.1 cm for S_1 and 0.5 cm for S_2
a) write the appropriate test hypotheses test for this situation.
b) use this to devise a Z-test for the hypotheses and report a p-value the test.

Step 1 : Established Null & Alternate hypothesis.

Null hypotheses :- The distance from the lens to the object and distance from the lens to real image is same.

Alternate hypotheses : The distance from the lens to the object and distance from the lens to real image is not same.

$$H_0 : \mu_A = \mu_B$$

$$H_A : \mu_A \neq \mu_B$$

Step. 2 Determine the test

we are going to perform the Z-test.

Step 3 :- set the significance value.

As the significance value is not given in the problem we are going to take the default significance value.

i.e = $\alpha = 0.05$

Since, it is a two tailed test and we are going to check left & right end of the Experiment

So,

$$\frac{\alpha}{2} = \frac{0.05}{2} = \boxed{0.025}$$

Step 4 : Establish the decision rule.

For critical value

If

Z critical < Z-score

we will reject the null hypothesis.

For p-value.

If,

p-value < significance value

we will reject the null hypothesis.

Step 5 :- Collecting the data.

The distance each S_1 & S_2 are measured independently is 25 times. The Sample mean of the measurement $\bar{S}_1 = 26.6$ cm & $\bar{S}_2 = 13.8$ cm Respectively. The Standard deviation of the measurement is 0.1 cm for S_1 & 0.5 cm for S_2.

Step 6 :- Analysis of data
Since we are going to perform the Z-test for two Sample.

$\boxed{\alpha = 0.05}$

$$\boxed{\frac{\alpha}{2} = 0.025}$$

For distance from the lens to object S_1,

$\bar{S}_1 = 26.6$ cm
$\sigma_1 = 0.1$ cm
$n_1 = 25$

For distance from lens to real image S_2,

$\bar{S}_2 = 13.8$ cm
$\sigma_2 = 0.5$ cm
$n_2 = 25$

For Z-Score,

$$Z\text{-Score} = \frac{\bar{S}_1 - \bar{S}_2}{\sqrt{\frac{(\sigma_1)^2}{n_1} + \frac{(\sigma_2)^2}{n_2}}}$$

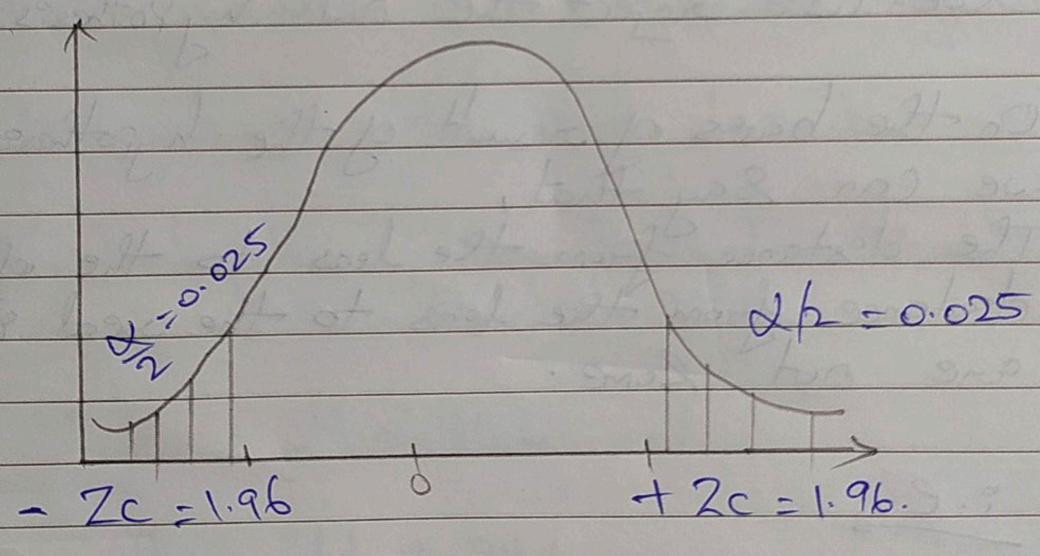
$$= \frac{26.6 - 13.8}{\sqrt{\frac{(0.1)^2}{25} + \frac{(0.5)^2}{25}}}$$

$$= \frac{12.8}{0.102}$$

$$\boxed{\text{Z-Score} = 125.51}$$

Now using Z-table

$$\boxed{\begin{array}{l} \text{Z-critical} = 1.96 \\ \text{P-Value} = 0.0000 \end{array}}$$



<u>Step 7</u> :- Taking statistical action.

on the basis of decision Rule,

For Critical Value,

If $Z_{Critical} < Z\text{-score}$.

$1.96 < 125.51$

we will reject the null hypotheses.

For Critical Value,

If $p\text{-Value} < \text{significance Value}$

$0.0000 < 0.05$

we will reject the null hypothesis.

On the basis of result of the hypothesis test we can say that,
The distance from the lens to the object and distance from the lens to the real image are not same.

<u>i.e</u>

$$\boxed{\mu_A \neq \mu_B}$$

Q.5 The body temperature in degrees fahernheit of 52 randomly chosen healthy adults in measured with the following summary of data.

$$n = 52, \quad \bar{x} = 98.2846, \quad s = 0.6824.$$

a) Are the necessary conditions for constructing a valid interval satisfied

b) Find a 98% confidence interval for the mean body temperature at 98.6 °c fahrenheit and use the information above to the evaluate a test with significance level of $\alpha = 0.02$

Step 1 : Establish Null & Alternate hypothesis.

Null hypothesis : Mean Body temperature is 98.6

Alternate hypothesis - Mean body temperature is not equal to 98.6

$$H_0 : \mu = 98.6$$

$$H_a : \mu \neq 98.6$$

It is two tailed test since we are going to test it on two ends or left & Right end of the test

$$\frac{\alpha}{2} = \frac{0.02}{2} = \boxed{0.01}$$

Step 2 : Determine the test

we are going to perform the t test

Step 3 : Set the significance level.

$\alpha = 0.02$ ...... Given.

Step 4 : Establish decision Rule.

For critical value,

If

t-critical < t-score

we will reject the null hypothesis.

For p-value.

If

p-value < significance level

we will reject the null hypothesis.

Step 5 : Collecting the data

The body temperature in degrees fahrenheit of 52 randomly chosen healthy adults in measured with the following summary of data

$n = 52$, $\bar{x} = 98.2846$, $S = 0.6824$

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Step-6 :- Analysis of data.

Since,
we testing only one random variable and its standard deviation is given.

$$t\text{-score} = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

where, $n = 52$ $\quad$ $DF = n-1$

$\bar{x} = 98.2846$ $\quad$ $= 52-1$

$s = 0.6824$ $\quad$ $DF = 51$

$\mu = 98.6$

$$\therefore\ t\text{-score} = \frac{98.2846 - 98.6}{\frac{0.6824}{\sqrt{52}}}$$

$$\boxed{t\text{-score} = 3.333}$$

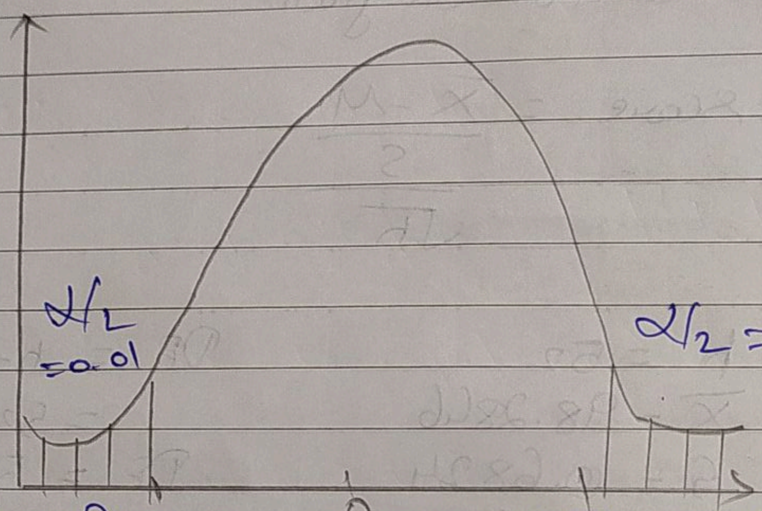
Since it is two tailed test

$$\alpha = \alpha/2 = \frac{0.02}{2}$$

$$\boxed{\alpha = 0.01}, \boxed{DF = 51}$$

Now using t-table,

$\boxed{t\text{-critical} = 2.008}$
$\boxed{\text{P-Values} = 0.0016}$



$-Z_c = 2.008$ $\quad$ $Z_c = +2.008$

<u>Step 7</u> :- Take statistical test

Based on decision rule,
For critical Values.

If,
t-critical < t score
$2.008 < 3.333$
we will reject null hypothesis.

For P-Values
If, P-Value < significance level
$0.0016 < 0.02$
we will reject null hypothesis
So,
The mean body temperature is not Equal to $98.6^\circ F$.

Q.6. Drivers of cars calling for regular gas sometimes premium in the hopes that it will improve gas mileage. Here a rental car company takes 10 randomly chosen car in the its meet and run a tank of gas accordingly to coin toss, run a tank of gas of each type.

Car	1	2	3	4	5	6	7	8	9	10
Regular	16	20	21	22	23	22	27	25	27	28
Premium	19	22	24	24	25	25	26	26	28	32

a) write an appropriate hypothesis test for this situation and state the testing procedure. appropriate to this circumstances.
b) Complete the necessary Summary statistics for the test in part (A)
c) Perform t-test and report the p-value.
d) Compare your result to that of a two sample t-test.

Step I : Establish Null & Alternate hypotheses.

Null hypothesis : There is ~~the~~ no difference between the premium & Regular gas tank in term of mileage.

Alternate hypothesis : There is difference between the mileage of regular and Premium gas tank.

$H_0 :- \mu_A = \mu_B$
$H_A : \mu_A \neq \mu_B$

It is a two tailed test, since we are going to check it on two ends of the experiment.

Step 2 :- Determine the test.

we are going to perform the t-test.

Step 3 :- Set the significance Value.

As the significance value is not given so we take the default value of significance level.

$$\boxed{\alpha = 0.05}$$

Since,
It is a two tailed test

$$\boxed{\alpha/2 = 0.025}$$

Step 4 : Establish the decision rule.

For critical Value.

If,
$t\text{-critical} < t\text{-test}$

We will reject the null hypotheses

For p-value.

If p- value < significance value.
we will reject the null hypothesis.

Step 5 :- Collecting the data.

The Rental car company takes 10 randomly chosen cars in the fleet and runs a tank of gas accordingly to a coin toss sums a tank of gas of each type.

Step 6 :- Analysis of data.

Since it is a t-test for two sample.
Random variable

$$DF = \frac{\left[\frac{S_1^2}{n^1} + \frac{S_2^2}{n^2}\right]^2}{\left[\frac{\left(\frac{S_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{S_2^2}{n_2}\right)^2}{n^2 - 1}\right]}$$

$$t\text{- test} = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n^1} + \frac{S_2^2}{n^2}}}$$

For sample of regular tank,
$\mu_A = \bar{X}_1 = 023.1$
$n = 10$
$S_1 = 3.72$, $\bar{X}_1 - \mu_A = 23.1$

For Sample of Premium tank.

$\overline{X}_2 = \mu_b = 25.1$

$n_2 = 10.$

$\sigma_2 = 3.44.$

$$DF = \frac{\left[\frac{S_1^2}{n_1} + \frac{S_2^2}{n^2}\right]^2}{\left[\frac{\left(\frac{S_1^2}{n_1}\right)^2}{n_1 - 1} \quad \frac{\left(\frac{S_2^2}{n^2}\right)^2}{n_2 - 1}\right]^2}$$

$$= \frac{(1.38 + 1.18)^2}{\frac{(1.38)^2}{9} + \frac{(1.18)^2}{9}}$$

$$= \frac{6.55}{0.36}$$

$$= 18$$

$$\boxed{\therefore DF = 18.}$$

$$t\text{-test} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n^2}}}$$

$$= \frac{23.1 - 25.1}{\sqrt{\frac{(3.72)^2}{10} + \frac{(3.44)^2}{10}}}$$

$t\text{-test} = 1.24$

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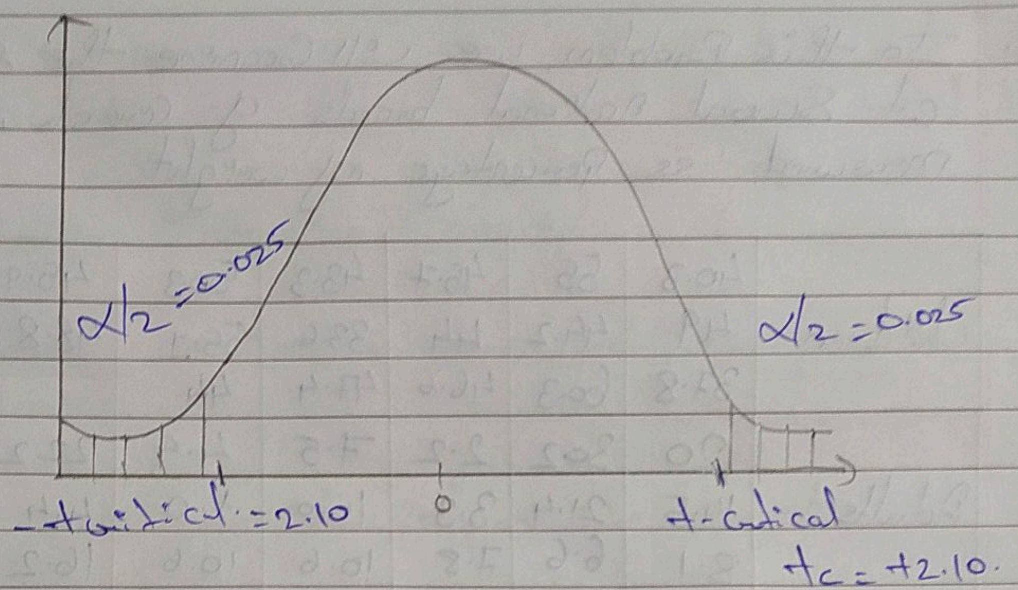

By using t-table,

t-critical $= 2.10$.

$\boxed{P = 0.22}$

Step 7 :- Taking statistical action.

On the basis of decision rule

For t-critical

If
t-critical < t-score
Reject Null hypothesis
t-critical > t-score
$2.10 > 1.24$

we will accept the null hypothesis.
So, on the basis of decision rule we can conclude that there is no difference between the mileage of Regular and Premium tank of the car

$\boxed{\therefore \mu_A = \mu_B}$

Q.7. In this Problem we will examine the Sugar Content of several national brands of cereals, here measured as Percentage of weight

Children	40.3	55	45.7	43.3	50.3	45.9	53.5
	49	44.2	44	33.6	55.1	48.8	50.4
	37.8	60.3	46.6	47.4	44		
Adults	20	30.2	2.2	7.5	4.4	22.2	16.6
	14.5	21.4	3.3	10.0	1.0	4.4	1.3
	8.1	6.6	7.8	10.6	10.6	16.2	14.5
	4.1	15.8	4.1	2.4	3.5	8.5	4.7

a) Give a Summary of two data set.
b) Create Side by Side boxplots and interpret what you see.
c) use R to Create a 95% Confidence interval for the difference in mean Sugar Content and explain your result.

Step 1 : Establish Null & Alternate hypothesis.

Null hypotheses : Sugar content of brand of cereals for children & adult are Same.

Alternate hypotheses : Sugar content of brand of cereals for children and adult are not Same.

$H_0 : \mu_A = \mu_B$
$H_A : \mu_A \neq \mu_B$

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Since we are going to check it on left and right both ends of experiment it is a two-tailed test.

Step 2 :- Determine the test.

Since we are comparing the mean of two samples.

we are going to perform the t-test

Step 3 : Set the significance Value.

As the confidence level is given 95%.
∴ the significance level is 5%.

$$\boxed{\alpha = 5\%}$$

$$\boxed{\alpha = 0.05}$$

Since, it is a two tailed test

$$\frac{\alpha}{2} = \frac{0.05}{2} = \boxed{0.025}$$

Step 4 :- Establish the determine rule.

For critical Value,

If, t-critical < t-test
we will reject null hypothesis.

For p-Values

If p-value < Significance level
we will reject null hypothesis

Step 5 :- collecting the data.

Sugar content at several national brand of cereals where measured as a percentage of weight in question.

~~Step 6~~ :-

Children	40.3	55.0	45.7	43.3	50.3	45.9	53.5
	43.0	44.2	44.0	33.6	55.1	48.8	50.4
	37.8	60.3	46.6	47.4	44.0		
Adults	20.0	30.2	2.2	7.5	4.4	22.2	16.6
	~~8~~ 14.5	21.4	3.3	10.0	1.0	4.4	1.3
	~~15.8~~ 8.1	6.6	10.6	10.6	16.2	14.5	4.1
	~~18.4~~ 15.8	4.1	2.4	3.5	8.5	7.8	4.7
	18.4						

Step. 6 :- Analysis of data.

Since it is a t-test for two sample random variables.

$$DF = \frac{\left[\frac{S_1^2}{n^1} + \frac{S_2^2}{h^2}\right]^2}{\left[\frac{\left(\frac{S_1^2}{h^1}\right)^2}{h-1} + \frac{\left(\frac{S_2^2}{h^2}\right)^2}{h_2-1}\right]}$$

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$$t\text{-test} = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n'} + \frac{S_2^2}{n^2}}}$$

For sample of childrens,

$\bar{X}_1 = \mu_A = 46.8$

$n_1 = 19$

$\bar{S}_1 = 6.41$

For sample of adult,

$\bar{X}_2 = \mu_B = 10.16$

$n_2 = 23$

$\bar{S}_2 = 7.47$

$$DF = \frac{\left[\frac{S_1^2}{n'} + \frac{S_2^2}{n^2}\right]^2}{\left[\frac{\left(\frac{S_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{S_2^2}{n^2}\right)^2}{n_2 - 1}\right]}$$

$$= \frac{(2.16 + 1.92)^2}{\frac{(2.16)^2}{18} \quad \frac{(1.92)^2}{28}}$$

$$= \frac{16.64}{0.38}$$

$$\boxed{DF = 43}$$

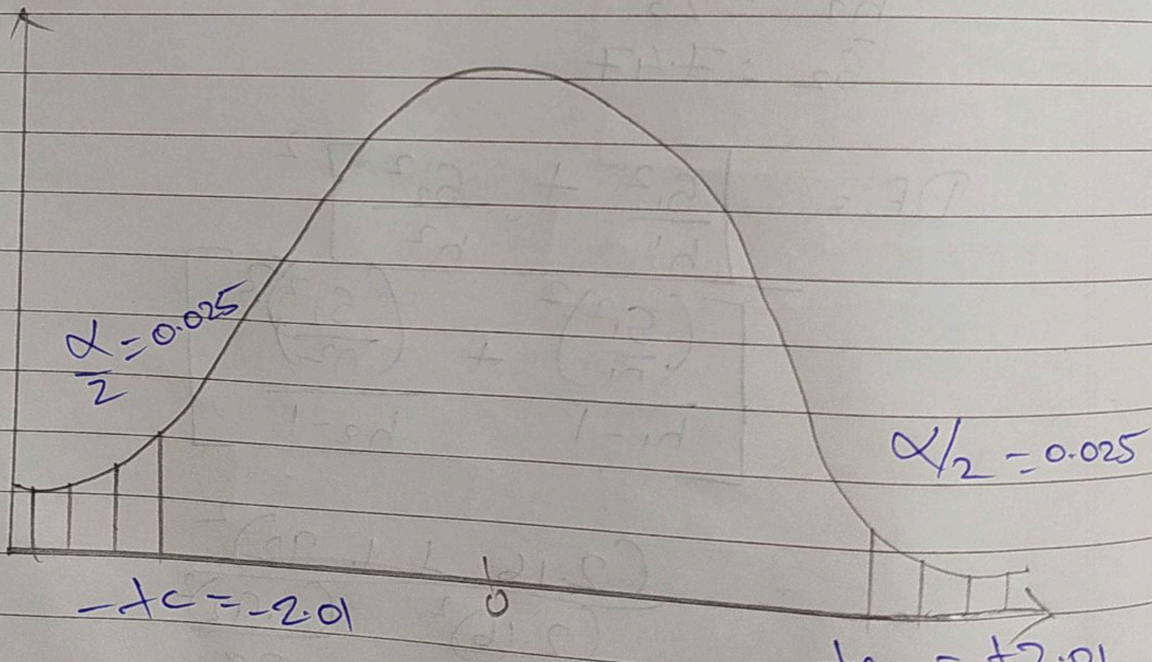
Now,

$$t\text{-test} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$= \frac{6.41 - 7.47}{\sqrt{\frac{(6.41)^2}{19} + \frac{(7.47)^2}{19}}}$$

$$= \frac{36.38}{1.96}$$

$$\boxed{t\text{-test} = 18.10}$$



By using t-table

$\boxed{tc = 2.01}$

$\boxed{P\text{-value} = 0.000}$

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Step 7 : Taking statistical action on the basis of decision rule.

For critical value.

t- critical < t -test.

2.01 < 18.10

we will reject the null hypothesis

For p-values

p-value < significance value.

0.0001 < 0.05

we will reject the null hypothesis.

So, the sugar content in different brand of cereals for children and adult are not same or equal.