

11

CHAPTER

BIOSTATISTICS



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11.1 INTRODUCTION TO BIOSTATISTICS

LONG ANSWER QUESTIONS

Q.5 Define biostatistics. Explain its uses.

(K.B)

Ans:

BIOSTATISTICSDefinition:

Biostatistics is a branch of statistics that applies **statistical methods** to biological sciences.

Importance:

Biostatistics is essential for **designing** biological experiments, **clinical trials**, and **epidemiological** studies.

Uses of Biostatistics:

The major uses of biostatistics include:

1. Designing Experiments and Studies

Biostatistics helps in **planning** and **structuring** experiments to ensure that the **data collected** will be relevant and sufficient to answer the research questions.

Example:

In a clinical trial testing a new **drug**, biostatisticians determine the **sample size** needed to detect a significant effect.

2. Analysing Biological Data

- Biostatistics involves applying statistical techniques to **analyse data**.
- This analysis can uncover **trends**, **correlations**, and **patterns**.

Example:

Analysing the **growth rates** of plants under different environmental conditions can reveal how factors like light and water affect growth.

3. Interpreting Results

After analysing data, biostatistics helps to be in a meaningful way.

Example:

Interpreting the results of a **survey** on the **prevalence of a disease** in a population can guide public health interventions.

4. Predicting Outcomes

Biostatistics can be used to **create models** that **predict future** outcomes based on current data.

Example:

Predicting the spread of an **infectious disease** within a population helps in planning **vaccination campaigns** and **allocating resources**.

5. Public Health and Policy Making

In public health, biostatistics provides **evidence-based insights** that guide policy decisions and health guidelines.

Example:

Statistical analysis of data on **COVID-19** rates can lead to the implementation of COVID-19 vaccination campaign.

Q.6 Give some applications of biostatistics.

(U.B)

Ans:

USES OF BIOSTATISTICS

Some uses of biostatistics are given below:

1. Epidemiology

Epidemiologists use biostatistics to study the **distribution** and **determinants** of health and diseases in populations.

Example:

Analysing data on COVID-19 infection rates, **recovery rates**, and the **effectiveness** of vaccines involves biostatistical methods.

2. Genetics

Biostatistics is used in **genetic research** to analyse the **inheritance** of traits and the association of genetic variations with diseases.

Example:

Genetic studies use biostatistics to identify **genetic markers** linked to diseases like diabetes and cancer.

3. Agriculture

In agricultural research, biostatistics helps in analysing **crop yields**, the effectiveness of **fertilizers**, and the **resistance** of plants to pests and diseases.

Example:

Comparing the **yield** of different wheat varieties under various farming practices involves statistical analysis.

4. Clinical Trials

Biostatistics is crucial in the **design** and **analysis** of clinical trials that test new treatments and drugs.

Example:

Determining whether a new medication is more effective than a **placebo** requires **rigorous statistical testing** to ensure the results are statistically significant.

SHORT ANSWER QUESTIONS

Q.13 Define biostatistics.

(K.B)

Ans:

BIOSTATISTICS**Definition:**

Biostatistics is a branch of statistics that applies **statistical methods** to biological sciences.

Importance:

Biostatistics is essential for **designing** biological experiments, **clinical trials**, and **epidemiological** studies.

Q.14 Enlist some uses of biostatistics.

(K.B)

Ans:

USES OF BIOSTATISTICS

Biostatistics is used for:

- Designing experiments and studies
- Analysing biological data
- Interpreting results
- Predicting outcomes
- Public health and policy making

Q.15 How biostatistics is used in designing experimental studies?

(U.B)

Ans:

BIOSTATISTICS IN EXPERIMENTS**Explanation:**

Biostatistics helps in **planning** and **structuring** experiments to ensure that the **data collected** will be relevant and sufficient to answer the research questions.

Example:

In a clinical trial testing a new **drug**, biostatisticians determine the **sample size** needed to detect a significant effect.

Q.16 How biostatistics helped in public health and policy making?

(U.B)

Ans:

BIOSTATISTICS IN PUBLIC HEALTH**Explanation:**

In public health, biostatistics provides **evidence-based insights** that guide policy decisions and health guidelines.

Example:

Statistical analysis of data on **COVID-19** rates can lead to the implementation of COVID-19 vaccination campaign.

Q.17 Enlist the biological fields where biostatistics can be useful. (K.B)

Ans: USE OF BIOSTATISTICS

Biostatistics can be helpful in the fields of:

- Epidemiology
- Genetics
- Agriculture
- Clinical trials

Q.18 How epidemiologists use biostatistics? (K.B)

Ans: BIOSTATISTICS AND EPIDEMIOLOGY

Epidemiologists use biostatistics to study the **distribution** and **determinants** of health and diseases in populations.

Example:

Analysing data on COVID-19 infection rates, **recovery rates**, and the **effectiveness** of vaccines involves biostatistical methods.

Q.19 What is the use of biostatistics in the field of agriculture? (K.B)

Ans: BIOSTATISTICS AND AGRICULTURE

In agricultural research, biostatistics helps in analysing **crop yields**, the effectiveness of **fertilizers**, and the **resistance** of plants to pests and diseases.

Example:

Comparing the **yield** of different wheat varieties under various farming practices involves statistical analysis.

MULTIPLE CHOICE QUESTIONS

20. What is the primary focus of biostatistics? (K.B)

- | | |
|-------------------------------|--|
| (A) Biological classification | (B) Statistical methods in biological sciences |
| (C) DNA analysis | (D) Environmental studies |

21. Which of the following is NOT a use of biostatistics? (K.B)

- | | |
|-------------------------------|---------------------------------|
| (A) Designing experiments | (B) Interpreting results |
| (C) Analysing biological data | (D) Predicting weather patterns |

22. In a clinical trial, what role does biostatistics play? (K.B)

- (A) Determining the drug's chemical composition
- (B) Determining the sample size
- (C) Manufacturing the drug
- (D) Monitoring side effects

23. What is one of the major applications of biostatistics in genetics? (K.B)

- | | |
|---------------------------------|--------------------------------------|
| (A) Studying crop yields | (B) Observing weather impacts on DNA |
| (C) Identifying genetic markers | (D) Developing vaccines |

24. How does biostatistics contribute to public health? (K.B)

- | | |
|----------------------------------|--------------------------------------|
| (A) By studying ancient fossils | (B) Observing weather impacts on DNA |
| (C) By interpreting genetic data | (D) By making health guidelines |

25. Which branch of science uses biostatistics to study disease distribution in populations? (K.B)

- | | |
|---------------------|-----------------|
| (A) Clinical trials | (B) Genetics |
| (C) Epidemiology | (D) Agriculture |

26. Which type of trials needs vigorous testing and biostatistical analysis? (K.B)

- | | |
|------------------------|-----------------|
| (A) Clinical trials | (B) Genetics |
| (C) Drug manufacturing | (D) Agriculture |

27. What is an example of biostatistics in epidemiology? (K.B)
- (A) Analysing COVID-19 infection rates (B) Observing plant growth patterns
- (C) Studying the inheritance of traits (D) Testing fertilizer effectiveness

11.2 MEAN, MEDIAN, AND MODE

LONG ANSWER QUESTIONS

- Q.1 Define biostatistics. Explain it uses. (K.B)

OR

Discuss the differences between mean, median, and mode. Include examples where each measure is most appropriate to use.

Ans: MEAN, MEDIAN, AND MODE

Introduction:

- The mean, median, and mode are the measures that help **summarize** and **understand** data sets.
- The **mean** provides an **overall average**, the **median** gives the **middle value**, and the **mode** highlights the most **frequent** value.

1. Mean

Definition:

The mean, also known as the **average**, is the sum of all the values in a data set divided by the number of values. It represents the **central value** of a data set.

Formula:

$$\text{Mean} = \frac{\text{Sum of All Data Points}}{\text{Number of Data Points}}$$

Example:

Consider the following data set representing the **heights** (in cm) of five students:
150, 160, 165, 155, 170.

$$\text{Mean} = \frac{150 + 160 + 165 + 155 + 170}{5} = \frac{800}{5} = 160$$

So, the mean height is **160 cm**.

2. Median

Definition:

The median is the **middle value** of a data set when the values are arranged in **ascending** or **descending order**.

Finding the Median:

- If the number of values is **odd**, the median is the middle value.
- If the number of values is **even**, the median is the average of the two middle values.

Steps to Calculate Median:

- Arrange the data in ascending order.
- If the number of values (n) is odd, the median is the value at the position $\frac{n+1}{2}$.
- If the number of values (n) is even, the median is the average of the values at positions $\left(\frac{n}{2}\right)$ and $\left(\frac{n}{2} + 1\right)$.

Example:

Consider the data set: 150, 160, 165, 155, 170.

1. Arrange in ascending order: 150, 155, 160, 165, 170.
2. Number of values (n) = 5 (odd).
3. Median is the value at position $\left(\frac{5+1}{2}\right) = 3$.

So, the median height is 160 cm.

For an even number of values, consider the data set: 150, 160, 165, 155.

1. Arrange in ascending order: 150, 155, 160, 165.
2. Number of values (n) = 4 (even).
3. Median is the average of the values at positions $\left(\frac{4}{2}\right) = 2$ and $\left(\frac{4}{2} + 1\right) = 3$.

$$\text{Median} = \frac{155+160}{2} = \frac{315}{2} = 157.5$$

So, the median height is 157.5 cm.

3. Mode**Definition:**

The mode is the value that appears **most frequently** in a data set. A data set may have one mode, more than one mode, or no mode at all.

Steps to Calculate Mode:

- Count the frequency of each value in the data set.
- The value with the highest frequency is the mode.

Example 1:

Consider the data set: 150, 160, 165, 155, 160.

- Frequencies: 150 (1), 160 (2), 165 (1), 155 (1).
- The value with the highest frequency is 160.

So, the mode of the data set is **160**.

Example 2:

Consider the data set: 150, 160, 160, 155, 155.

- Frequencies: 150 (1), 160 (2), 155 (2).
- The values with the highest frequency are **160** and **155**.

So, the data set is **bimodal** with modes 160 and 155.

Example 3:

Consider the data set: 150, 160, 165, 155, 170.

- Frequencies: 150 (1), 160 (1), 165 (1), 155 (1), 170 (1).
- All values have the same frequency.

So, this data set has **no mode**.

SHORT ANSWER QUESTIONS

Q.1 Define mean.

(K.B)

Ans: MEANDefinition:

The mean, also known as the **average**, is the sum of all the values in a data set divided by the number of values. It represents the **central value** of a data set.

Formula:

$$\text{Mean} = \frac{\text{Sum of All Data Points}}{\text{Number of Data Points}}$$

Q.2 Define median.

(K.B)

Ans: MEDIANDefinition:

The median is the **middle value** of a data set when the values are arranged in **ascending** or **descending order**.

Finding the Median:

- If the number of values is **odd**, the median is the middle value.
- If the number of values is **even**, the median is the average of the two middle values.

Q.3 How median is calculated?

(K.B)

Ans: CALCULATING MEDIANSteps to Calculate Median:

1. Arrange the data in ascending order.
2. If the number of values (n) is odd, the median is the value at the position $\frac{n+1}{2}$.
3. If the number of values (n) is even, the median is the average of the values at positions $\left(\frac{n}{2}\right)$ and $\left(\frac{n}{2} + 1\right)$.

Q.4 Define mode. How it is calculated?

(K.B)

Ans: MODEDefinition:

The mode is the value that appears **most frequently** in a data set. A data set may have one mode, more than one mode, or no mode at all.

Steps to Calculate Mode:

- Count the frequency of each value in the data set.
- The value with the highest frequency is the mode.

Q.5 Calculate the mode for data set: 50, 60, 15, 35, 35, 80.

(A.B)

Ans: MODE

Frequencies: 15(1), 35(2), 50(1), 60(1), 80(1)

Most repeating: 35(2)

So, the mode for this data set is 35.

Q.6 Calculate the mode for data set: 100, 160, 500, 350, 400.

(A.B)

Ans: MODE

Frequencies: 100(1), 160(1), 350(1), 400(1), 500(1)

Repeating: No value is repeating.

So, this data set has no mode.

Q.7 Find the median: 100, 160, 500, 350, 400. (A.B)

Ans: MEDIAN
 Arranging in ascending order: 100, 160, 350, 400, 500
 Number of values (n): 5 (odd)
 Median position: $\left(\frac{5+1}{2}\right) = 3$
 So, the median is 500.

MULTIPLE CHOICE QUESTIONS

1. The purpose of mean is to provide? (K.B)
 (A) Average value (B) Middle value
 (C) Most frequent value (D) Least repeating value
2. The purpose of median is to provide? (K.B)
 (A) Average value (B) Middle value
 (C) Most frequent value (D) Least repeating value
3. The purpose of mode is to provide? (K.B)
 (A) Average value (B) Middle value
 (C) Most frequent value (D) Least repeating value
4. If amir has 50, 40, 42, 26, 82 as prices of a product in different shops. What will be the mean price for that product? (A.B)
 (A) 26 (B) 40
 (C) 48 (D) 50
5. The mode of data set 50, 40, 42, 26, 82 is: (A.B)
 (A) 26 (B) 42
 (C) 50 (D) No mode
6. The median of data set 50, 40, 42, 26, 82 is: (A.B)
 (A) 26 (B) 42
 (C) 50 (D) 82
7. If a data set has 2 modes, then it is called as: (K.B)
 (A) Unimodal (B) Bimodal
 (C) Dimodal (D) Modal set

11.3 BAR CHART

LONG ANSWER QUESTIONS

1. Describe the steps involved in creating a bar chart using Excel. Include a discussion on how to customize the chart for better visualization and interpretation of data. (K.B)

Ans: BAR CHART

Definition:

A bar chart is a **graphical representation** of data using bars of different heights or lengths.

Importance:

- It is used to **compare the quantities** of different categories.
- Bar charts are effective for comparing different categories and **visually** representing the distribution of data.

Steps to Create a Bar Chart:

1. **Gather the data** to be represented in the bar chart.
2. **Arrange the data** into categories and their corresponding values.
3. Draw a **horizontal axis** (x-axis) and a **vertical axis** (y-axis).
4. **Label** the x-axis with the categories and the y-axis with the values.
5. **Determine the scale** for the y-axis based on the range of values in the data set. Divide the axis into equal intervals.

6. For each category, **draw a bar** with a height corresponding to its value. Ensure the bars are of equal width and are spaced evenly.
7. Label each bar with its category name and value.

Example:

Consider the following data representing the number of different species of plants found in a field survey:

Species	Number of Plants
Species A	15
Species B	20
Species C	10
Species D	25
Species E	5

Solution:**1. Collect Data**

The data is already collected in the table above.

2. Organize Data

Data is organized in the table with species and their corresponding number of plants.

3. Draw Axes

Draw the x-axis and y-axis.

4. Label the Axis

Label the x-axis with the species: A, B, C, D, E. Label the y-axis with the values i.e., number of plants.

5. Scale the Axes

The highest value is 25. Use a scale with intervals of 5 i.e., 0, 5, 10, 15, 20, 25.

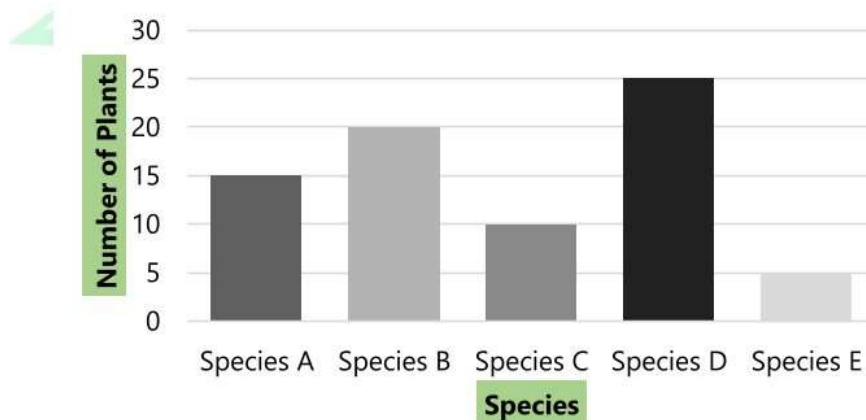
6. Draw Bars

For each species, draw a bar up to the corresponding number of plants.

7. Label the Bars

Label each bar with the species name and its value.

Chart: Number of Plants

**SHORT ANSWER QUESTIONS**

Q.1 What is a bar chart?

Ans:

BAR CHART

(K.B)

Definition:

A bar chart is a **graphical representation** of data using bars of different heights or lengths.

Q.2 Why are bar charts important for data representation? (U.B)

Ans: IMPORTANCE OF BAR CHART

Importance:

- It is used to **compare the quantities** of different categories.
- Bar charts are effective for comparing different categories and **visually** representing the distribution of data.

Q.3 Write down the steps to create bar chart. (K.B)

Ans: STEPS TO CREATE A BAR CHART

Steps:

1. **Gather the data** to be represented in the bar chart.
2. **Arrange the data** into categories and their corresponding values.
3. Draw a **horizontal axis** (x-axis) and a **vertical axis** (y-axis).
4. **Label** the x-axis with the categories and the y-axis with the values.
5. **Determine the scale** for the y-axis based on the range of values in the data set. Divide the axis into equal intervals.
6. For each category, **draw a bar** with a height corresponding to its value. Ensure the bars are of equal width and are spaced evenly.
7. Label each bar with its category name and value.

MULTIPLE CHOICE QUESTIONS

1. **What is a bar chart used for? (K.B)**
 (A) Calculating data values
 (B) Sorting data in ascending order
 (C) Comparing quantities of different categories
 (D) Performing statistical tests
2. **The purpose of mode is to provide? (K.B)**
 (A) Average value
 (B) Middle value
 (C) Most frequent value
 (D) Least repeating value
3. **What is represented on the x-axis of a bar chart? (K.B)**
 (A) Scale intervals
 (B) Categories
 (C) Values
 (D) Bars
4. **What is the first step in creating a bar chart? (K.B)**
 (A) Label the axes
 (B) Draw the bars
 (C) Gather the data
 (D) Determine the scale
5. **How should the bars in a bar chart be spaced? (K.B)**
 (A) Unevenly, based on category size
 (B) Close together with no gaps
 (C) Equally spaced
 (D) Spaced according to the data values
6. **What scale interval should be used if the highest value in a data set is 25? (K.B)**
 (A) 1
 (B) 2
 (C) 5
 (D) 10
7. **What step comes immediately after labeling the axes in a bar chart? (K.B)**
 (A) Determine the scale for the y-axis
 (B) Gather the data
 (C) Draw the bars
 (D) Organize the data into a table

TEXTBOOK EXERCISE

MULTIPLE CHOICE QUESTIONS

47. **What is the primary purpose of biostatistics?**
 (A) To analyse financial data
 (B) To apply statistical methods to biological sciences
 (C) To design engineering models
 (D) To study historical events

48. In biostatistics, which method is used to predict future outcomes based on current data?
(A) Designing experiments (B) Interpreting results
(C) Predicting outcomes (D) Analysing data
49. Which of the following best describes the mean of a data set?
(A) The most frequently occurring value
(B) The middle value when data is ordered
(C) The sum of all values divided by the number of values
(D) The difference between the highest and lowest values
50. If the data set is 5, 8, 12, 15, 20, what is the median?
(A) 8 (B) 12
(C) 15 (D) 20
51. What is the mean of the data set: 7, 8, 9, 10, 11?
(A) 7 (B) 8
(C) 9 (D) 10
52. When the number of values in a data set is even, how is the median calculated?
(A) By choosing the middle value
(B) By taking the average of the two middle values
(C) By selecting the most frequent value
(D) By adding all values and dividing by the total number of values
53. In a data set with values 3, 3, 6, 7, 8, 9, 9, what is the mode?
(A) 3 (B) 6
(C) 7 (D) Both 3 and 9
54. If a data set has no repeated values, what is the mode?
(A) The highest value (B) The average of the data set
(C) There is no mode (D) The median value
55. In a bar chart, what does the height or length of each bar represent?
(A) The total number of categories
(B) The value of the corresponding category
(C) The average of all values
(D) The difference between the highest and lowest values
56. When constructing a bar chart, which axis usually represents the categories?
(A) Vertical axis (y-axis)
(B) Horizontal axis (x-axis)
(C) Both axes equally represent the categories
(D) Neither axis represents the categories

SHORT ANSWER QUESTIONS

Q.24 Define biostatistics.

Ans:

BIOSTATISTICS**Definition:**

Biostatistics is a branch of statistics that applies **statistical methods** to biological sciences.

Importance:

Biostatistics is essential for **designing** biological experiments, **clinical trials**, and **epidemiological** studies.

Q.25 What is the median of a data set?

Ans:

MEDIAN**Definition:**

The median is the **middle value** of a data set when the values are arranged in **ascending** or **descending order**.

Finding the Median:

- If the number of values is **odd**, the median is the middle value.
- If the number of values is **even**, the median is the average of the two middle values.

Q.26 How is the mean calculated?

Ans:

CALCULATING MEAN

The mean value of a data set is calculated by the following formula:

Formula:

$$\text{Mean} = \frac{\text{Sum of All Data Points}}{\text{Number of Data Points}}$$

Example:

Consider the following data set representing the **heights** (in cm) of five students: **150, 160, 165, 155, 170.**

$$\text{Mean} = \frac{150 + 160 + 165 + 155 + 170}{5} = \frac{800}{5} = 160$$

So, the mean height is **160 cm.**

Q.27 What does the height of a bar in a bar chart represent?

Ans:

HEIGHT OF A BAR

Explanation:

The height of a bar in a bar chart represents the value or quantity of the corresponding category.

Q.28 What is the mode of a data set?

Ans:

MODE

Definition:

The mode is the value that appears **most frequently** in a data set. A data set may have one mode, more than one mode, or no mode at all.

Steps to Calculate Mode:

- Count the frequency of each value in the data set.
- The value with the highest frequency is the mode.

EXTENSIVE ANSWER QUESTIONS

Q.12 Explain the importance of biostatistics in the field of public health. Provide examples of how it is used to inform public health decisions.

Ans:

MODE

Explanation:

In public health, biostatistics provides **evidence-based insights** that guide policy decisions and health guidelines.

Example:

1. Epidemiological Studies

Statistical analysis of data on **COVID-19** rates can lead to the implementation of COVID-19 vaccination campaign.

2. Health Forecast

Biostatisticians use historical data to forecast future health trends.

Example:

- Predictive models can identify individuals at high risk for diseases like breast cancer , based on factors such as age and family history.
- This can help in early diagnosis and prevention strategies.

3. Public Health Policy Making

Biostatistical analyses help policymakers understand the potential impact of health problems.

Example:

Studies evaluating the effectiveness of “smoking ending programs” can guide funding decisions and resource allocations.

4. Health Program Evaluation

Biostatistics is used to assess the impact of specific health programs on target populations.

Example:

Analyzing data from an HIV awareness campaign can reveal its effectiveness in increasing testing rates among high-risk groups.

Q.13 Discuss the differences between mean, median, and mode. Include examples where each measure is most appropriate to use.

See Q.No.1 of topic 11.2

Q.14 Describe the steps involved in creating a bar chart using Excel. Include a discussion on how to customize the chart for better visualization and interpretation of data.

See Q.No.1 of topic 11.3

Q.15 Provide a detailed example of how to calculate the mean, median, and mode of a data set. Use the following data set for your calculations: 12, 15, 22, 8, 19, 25, 15.

Ans:

MEAN

Data: 12, 15, 22, 8, 19, 25, 15

Formula:

$$\text{Mean} = \frac{\text{Sum of All Data Points}}{\text{Number of Data Points}}$$

Solution:

$$= \frac{12+15+22+8+19+25+15}{7}$$

$$= 16.57$$

MEDIAN

Data: 12, 15, 22, 8, 19, 25, 15

Solution:

1. Arranged in Ascending order: 8, 12, 15, 15, 19, 22, 25
2. Number of values (n): 7 (odd)
3. Median is the value at position: $\frac{7+1}{2} = 4^{th}$

Answer:

So, the median is 15

MODE

Data: 12, 15, 22, 8, 19, 25, 15

Frequencies: 12(1), 15(2), 22(1), 8(1), 19(1), 25(1)

Answer: The highest frequency is of 15(2). So, the mode of this data set is 15.

Q.16 You are given the following data set, create a bar chart to represent the number of different types of fruits sold at a market in one week:

Apples: 30

Bananas: 45

Oranges: 20

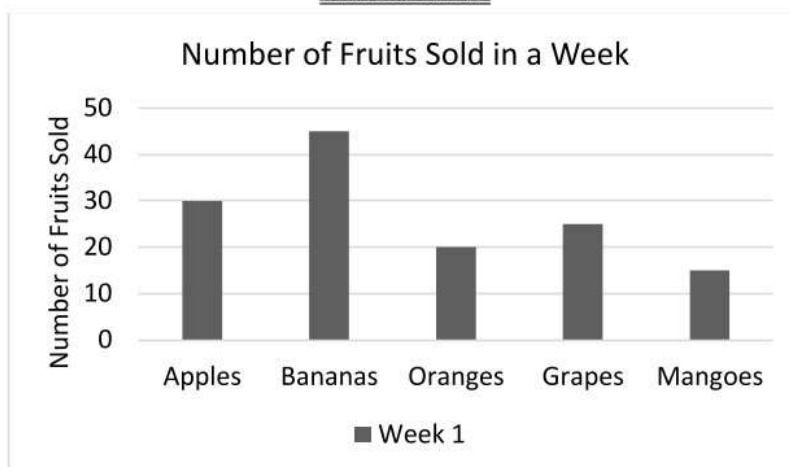
Grapes: 25

Mangoes: 15

Ensure to label the axes and provide a title for the chart.

Ans:

BAR CHART



KIPS ASSIGNMENT

LET'S DRAW AND LABEL



Create a bar chart to represent the following data about the scores of students in a quiz:

Student A: 85

Student B: 90

Student C: 70

Student D: 95

Student E: 80

Include all necessary details, such as labels, scale, and a title.

Answer Key

TOPIC 11.1

1	B	2	D	3	B	4	C	5	D
		6	C	7	A	8	A		

TOPIC 11.2

1	A	2	B	3	C	4	C	5	D
6	B	7	B						

TOPIC 11.3

1	C	2	C	3	B	4	C	5	C
6	C	7	A						

EXERCISE MCQs

1	B	2	C	3	C	4	B	5	C
6	B	7	D	8	C	9	B	10	B