

2

DIAGRAMMATIC AND GRAPHIC REPRESENTATION OF DATA

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2.1 INTRODUCTION

The most important function of the science of Statistics is to present complexity of quantitative data into simple forms and to make them easily intelligible. Classification and tabulation of data are the attempts in this regard. The Statistical data can be presented in the form of diagrams and graphs. In diagrams and graphs, numerical values are shown in pictorial form. Diagrams and graphs help to understand the information in an easy form. The readers, particularly the business executives, like to have the facts presented in diagrams for the purpose of study and comparison.

In the modern age when the commerce and industry are so rapidly growing, the successful advertisers over the world are making good use of this medium for sale promotion activities. The visual method makes the comparison an easy job. Presentation of data by geometric figures is called **Diagrammatic Representation** of data. Similarly presentation of Statistical data by geometrical curves is called **Graphic Representation** of data.

2.2 ADVANTAGES OF DIAGRAMS AND GRAPHS

Diagrams and graphs are very useful. These are the methods of useful aids and appealing to the eye and mind. The important uses of diagrams and graphs are as follows:

(i) Attractive Impression

Beautifully and neatly constructed diagrams are more attractive than simple figures.

(ii) Easy to Understand

Diagrams and graphs make huge data intelligible at a glance.

(iii) Effective Impression

Diagrams and graphs leave more effective and long lasting impression on the mind of reader.

(iv) Helpful in business and Administration

The business men and administrators can draw conclusions after a few minutes study of the diagrams and graphs rather than wasting a lot of time.

(vi) Helpful to Economists

All theoretical economic theories such as law of diminishing utility or law of substitutions can be properly explained with the help of diagrams and graphs. The economic law are easy to understand by diagrams and graphs.

(vii) Useful to All

Diagrams and graphs have universal usefulness. They are useful to social scientists, mathematician, businessmen etc.

2.3 LIMITATIONS OF DIAGRAMS AND GRAPHS

The following are main limitations of diagrams and graphs.

- i. Diagrams and graphs are not the substitutes for the real magnitudes of the quantity they represent.

- ii. It is not possible to show values accurate to a numbers decimal places. Approximate values can be shown by means of diagrams and graphs.
- iii. A common man cannot draw diagrams and graphs but a technical hand can construct a diagram and graph.
- iv. Diagrams and graphs take more time and labour than to construct tables.
- v. Diagrams and graphs are capable of being misused very easily. If a wrong type of diagram is used it can give fallacious conclusion and one should always safeguard of against such types of diagrams and graphs.
- vi. One of the greatest merit of diagrams and graphs is that it facilitates comparison. But when only one diagrams is available, this purpose stands defeated.

2.4 DIAGRAMMATIC REPRESENTATION

Presentation of statistical data by geometrical figures is called **Diagrammatic** representation of data.

2.5 TYPES OF DIAGRAMS

Following are the different types of **diagrammatic representation**.

- i. One Dimensional Diagrams
- ii. Two Dimensional Diagrams
- iii. Three Dimensional Diagrams
- iv. Pie Diagrams
- v. Pictograms
- vi. Cartograms

(I) One Dimensional Diagrams

In one dimensional diagrams only one dimension i.e. length is taken in to account while constructing such diagrams. They consist of Simple Bars, Multiple Bars and Component Bars diagrams or charts.

(II) Two Dimensional Diagrams

In two dimensional diagrams two dimensions i.e. length and breadth is taken into account while constructing such diagrams. These are also called area diagrams because their area is taken in to account while they are constructed. They are of the forms of squares, rectangles, subdivided rectangles and circles etc.

(III) Three Dimensional Diagrams

These diagrams are based on three dimensions i.e. length, breadth and thickness. These are also called volume diagrams, as the volume is taken into account. They are in the form of cubes, blocks and cylinders, whose volumes are proportional to the magnitudes they represent.

(IV) Pie Diagrams

Circular and angular diagrams, e.g. circles whose areas are made proportional to given magnitudes and which may be divided into sectors.

(V) Pictograms

Pictogram represent the figures in the shape of pictures. The size or the number of pictures is in proportion to the given figures.

(VI) Cartograms

Use of maps in the representations of the data is called cartograms.

2.6 ONE DIMENSIONAL DIAGRAMS

2.6.1 Simple Bar Diagrams

A simple bar diagram is used when the data consist of a single component and do not involve much Variation. A bar is merely a thick line whose width, though shown in the diagram, is not taken into consideration. The scale for construction of simple bar diagram should be such as it facilitate the representation of largest bar quite conveniently. There should be sufficient spacing on all sides of diagrams for writing headings, scale, unit etc. For drawing a simple bar diagram, the first step is to arrange the data in ascending or descending order of magnitude, and one horizontal line at the left hand side of the graph paper. Then a proper scale is selected in such a way that the graph may easily accommodate the largest observation. One bar is drawn for one figure. All the bars must be of the same uniform width, separated by equal intervening spaces. Bars may be coloured, lined or dotted, but the colour or lining or dotting should be same in all.

EXAMPLE 2.1

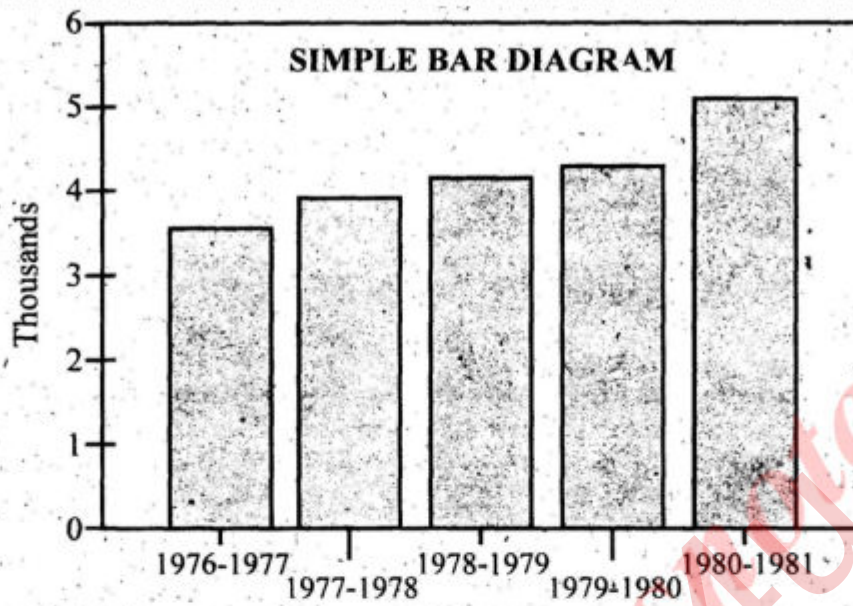
Number of students in a university during the last five years ending 1980- 1981 are given below. Draw a simple Bar diagram.

Year	Number of Students
1976 – 77	3500
1977 – 78	3900
1978 – 79	4200
1979 – 80	4349
1980 – 81	5120

SOLUTION

Diagrammatic representation of the above data in the shape of simple Bar diagram is given below:

Taking the years along the X-axis and the number of students along Y-axis.

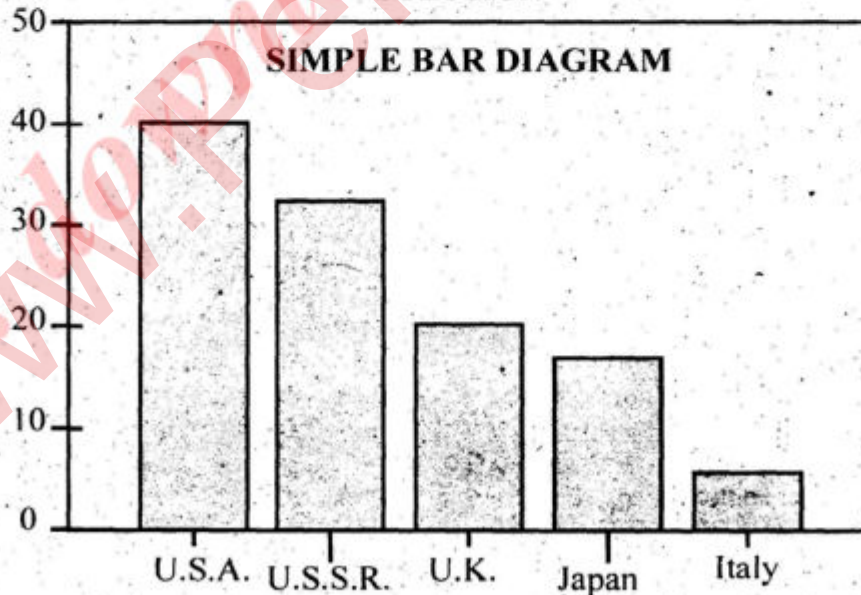


EXAMPLE 2.2

Represent the following data diagrammatically.

Country	Loan from Foreign Countries in Crore of Rupees
U.S.A.	40
U.S.S.R.	32
U.K.	20
Japan	16
Italy	5

SOLUTION



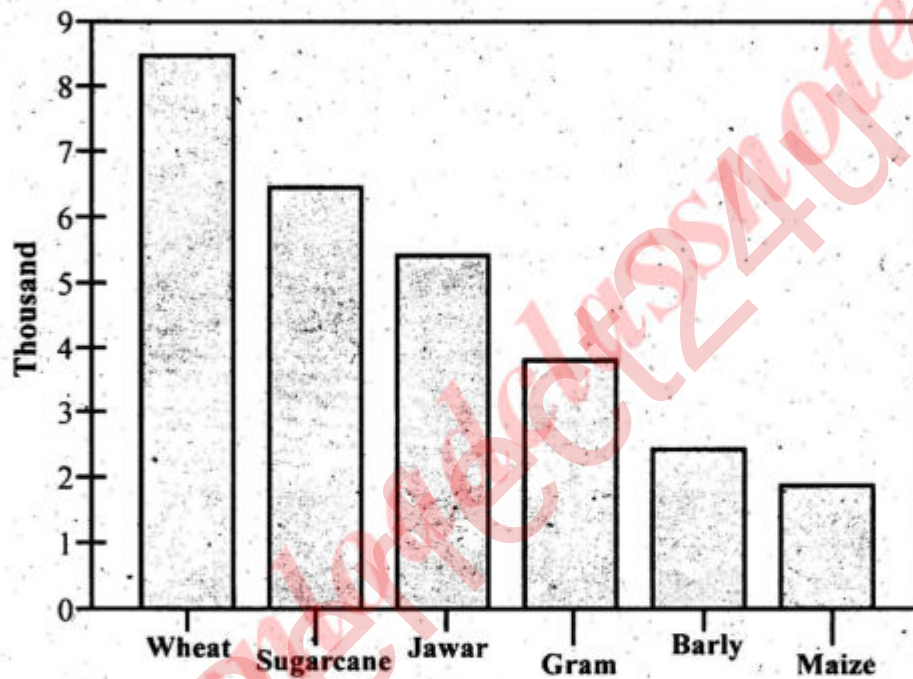
EXAMPLE 2.3

The following table gives the yield of certain food crop in India for 1996-97. Represent them by a suitable diagram.

Crop	: Wheat	Sugar cane	Jawar	Gram	Barley	Maize
Yield in Tons	: 8500	6300	5400	3820	2300	1840

SOLUTION

Yield of Certain Food Crops in India (1996-97)
Simple Bar Diagram



2.6.2 Multiple Bar Diagram

When diagrams in the form of bars is extended to represent two or more sets of interrelated data in one diagram, then more than one bar is used. It is a diagram which supplies more than one information at the same time. Suppose it is required to compare the wheat production of two countries over 15 years. Generally it seems that there will be needed two separate diagrams, each representing the production of a single country over a period of 15 years. For comparison, the two diagrams should be merged in one diagram. For solving this difficulty, a bar representing the wheat production of one country is drawn for a particular year. The bar for the second country, for the same year, is drawn along the first bar and is kept no gap between two bars. The number of male students, female students and number of teachers in a college from year to year is also a practical example which provides us three types of

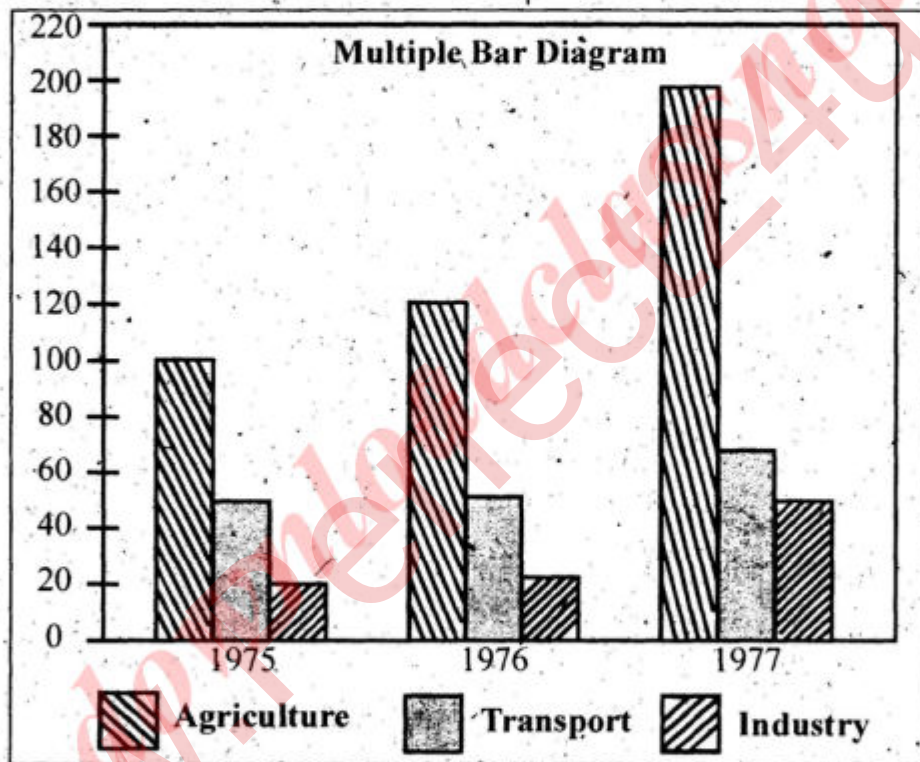
information of the same problem. The different bars drawn should be coloured differently.

EXAMPLE 2.4

Represent the following data by a multiple bar diagram.

Year	Agriculture	Transport	Industry
1975	100	50	20
1976	120	52	23
1977	200	70	50

SOLUTION



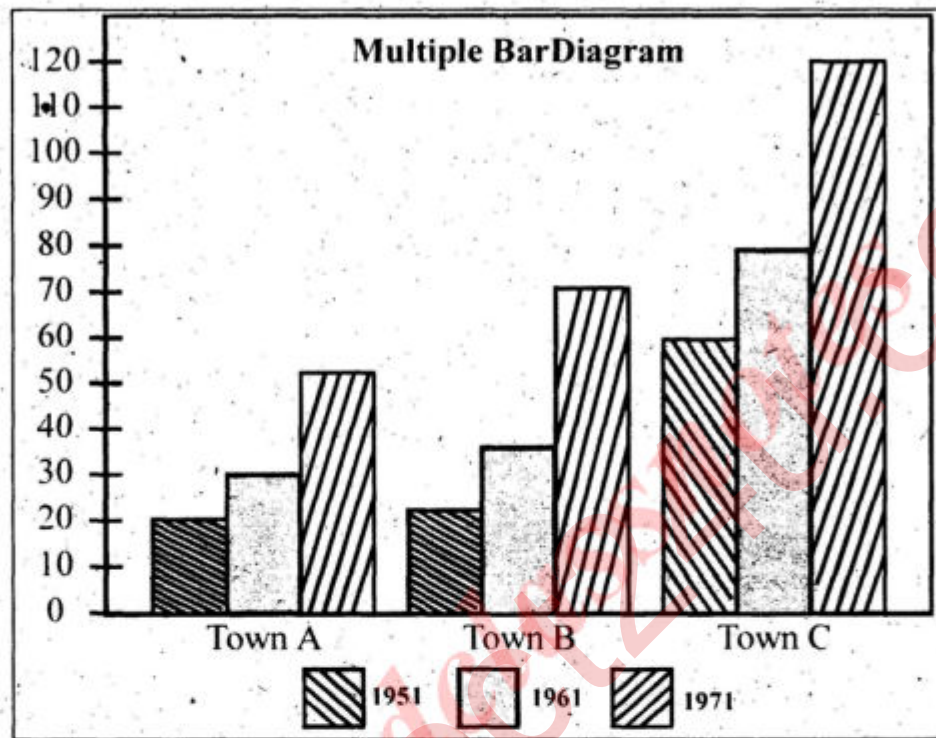
EXAMPLE 2.5

The population of three towns in three census are given below.

Town	Population 1951	Population 1961	Population 1971
A	20,501	31800	50,640
B	25550	35400	70620
C	60660	80140	12050

Represent the above data by a multiple bar diagram

SOLUTION



2.6.3 Subdivided or Component Bar Diagram.

Sub divided bar diagrams are used to present such data which are to be shown in the parts or which are to the total of various sub divisions. In this diagram, bars are drawn with lengths proportional to the ratio of their components. For distribution, the component parts are shaded or coloured or lined differently.

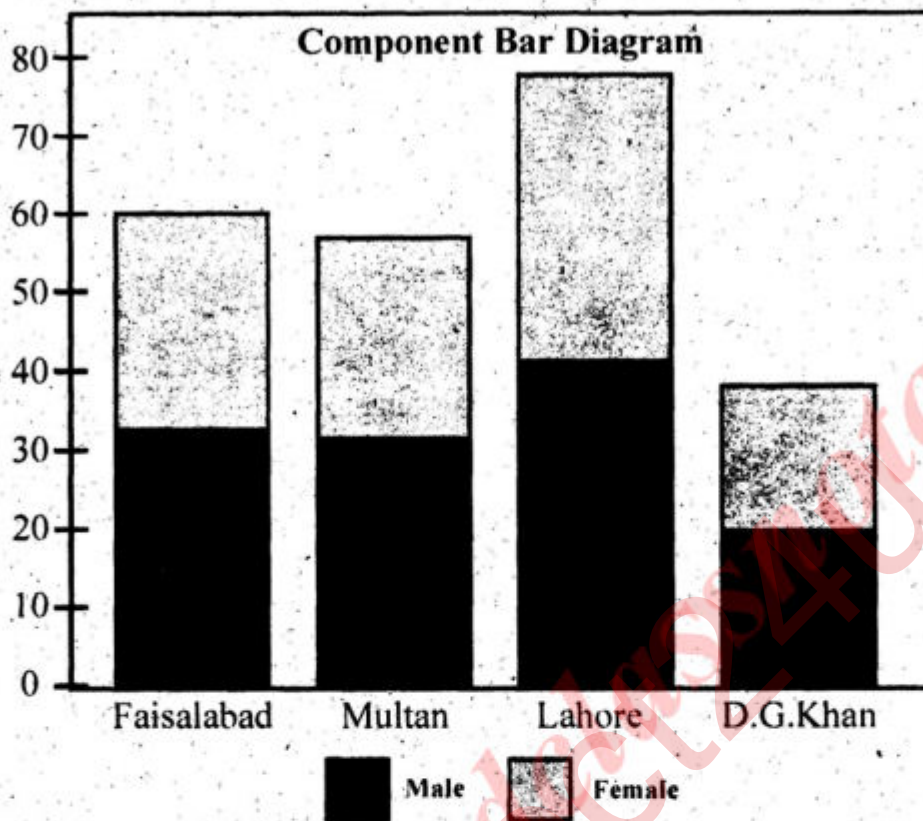
EXAMPLE 2.6

Draw a component bar diagrams for the following data.

Division	Male	Female	Both Sexes
Faisalabad	32	28	60
Multan	31	25	56
Lahore	40	36	76
D.G.Khan	20	18	38

SOLUTION

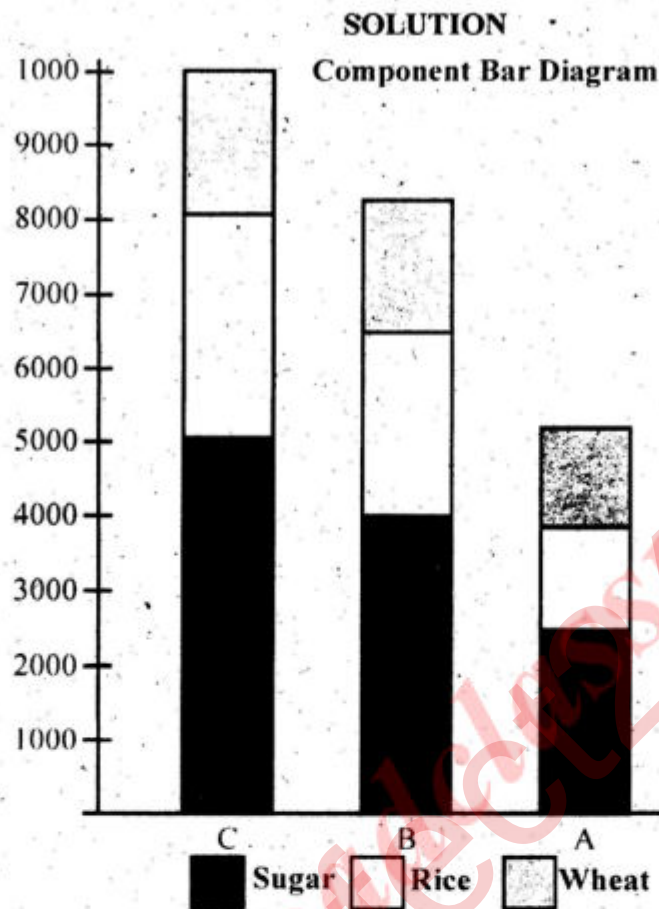
Component Bar Diagram showing population of four division.



EXAMPLE 2.7

Represent the following data by a component bar chart.

Country	Production			Total
	Wheat	Rice	Sugar	
A	2560	1240	1200	5000
B	4000	2500	1500	8000
C	5000	3000	2000	10000



2.7 TWO DIMENSIONAL DIAGRAMS

2.7.1 Rectangles

A rectangle has two dimensions, length and breadth. The area of a rectangle is taken to represent a magnitude. The area of a rectangle is equal to the product of its length and breadth. Both length and breadth of a rectangle are used to represent a quantity by a rectangle. There are two methods to construct rectangles.

- (i) The breadth of the rectangles is kept equal and length is taken to be proportional to the size of the value.
- (ii) The length of the rectangles is kept equal and breadth is taken to be proportional to the value.

If all rectangles have lengths equal to 100 and breadth proportional to the size of the values, then rectangles are called percentage rectangles.

EXAMPLE 2.8

Draw rectangles to represent the profit of four factories given below:

Factory	Profit (Rs. In thousand)
A	50
B	75
C	45
D	60

SOLUTION

The rectangles have been drawn in two ways.

In fig(i) breadth of each rectangle has been taken 10 units and the length of the rectangles for factories A, B, C and D have been taken proportional to 5, 7.5, 4.5 and 6 units respectively.

In fig (ii) the length of all rectangles have been taken as 100 units, but the breadth of the rectangles have been taken in the proportional to 0.5, 0.75, 0.45, 0.60

Fig (i)

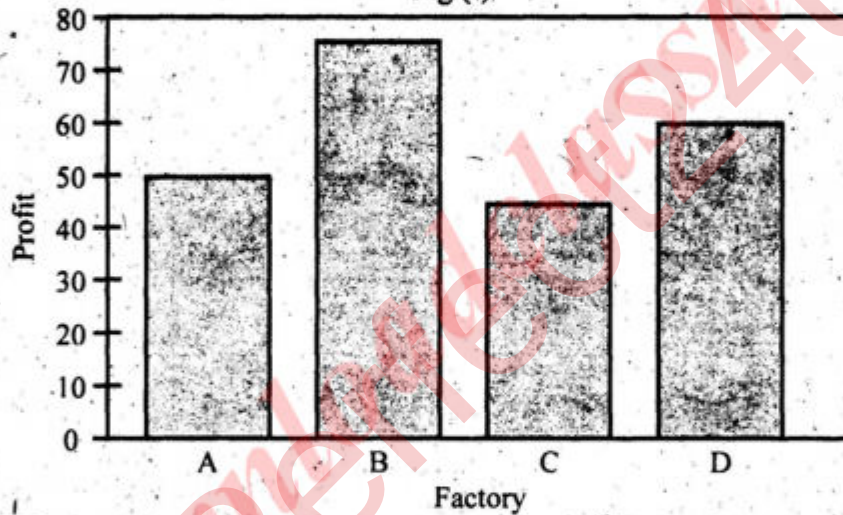
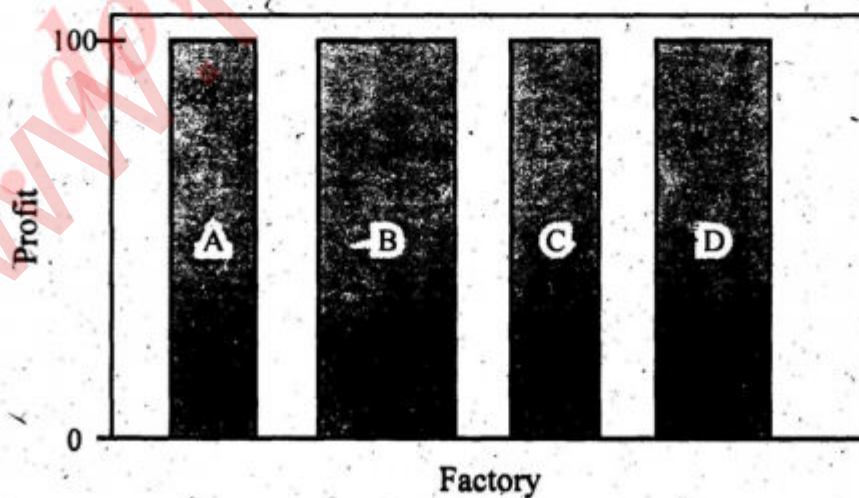


Fig (ii)



2.7.2 Subdivided Rectangles

In an extension of rectangular diagram. Sub divided rectangles are drawn for those data in which the quantities along with their component are to be compared. In this diagram, rectangles are constructed with length equal to 100 units and breadth proportional to the size of the values. First of all percentage rectangles are drawn. The next step is to divide each percentage rectangle into components. These components are expressed as percentages of their totals. Sub divided rectangles are usually constructed to compare the family budgets of different families.

EXAMPLES 2.9

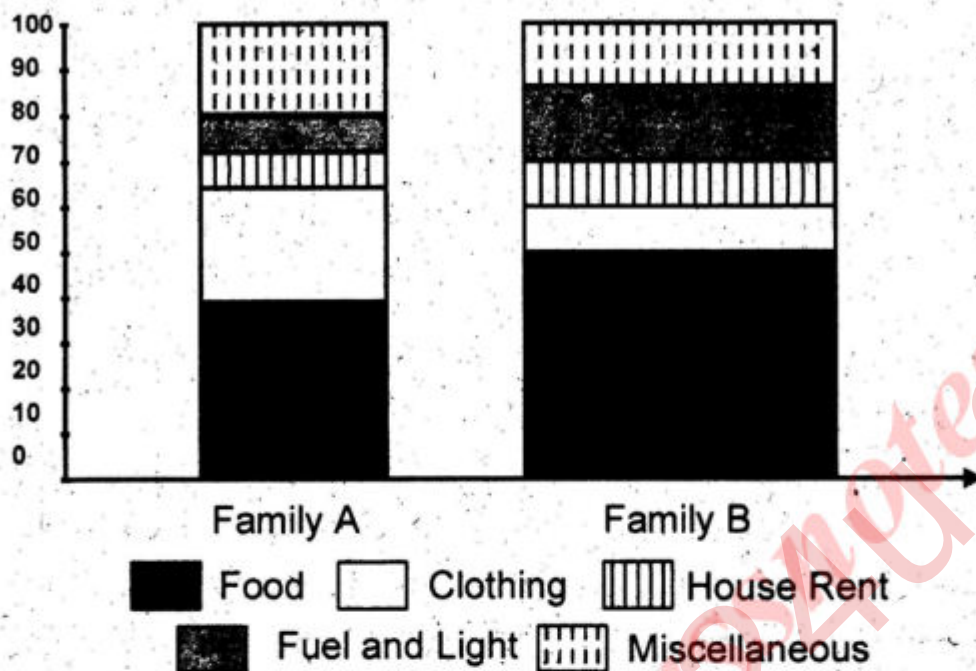
The following table gives details of monthly expenditure of two families. Construct sub-divided rectangles to compare the budgets of two families A and B.

Items of Expenditure	Family A	Family B
Food	32	60
Clothing	20	15
House Rent	8	18
Fuel and light	4	15
Miscellaneous	16	12

SOLUTION

Items of Expenditure	Exp endi ture	Family A Percentage	Cum mulati ve %	Exp endi ture	Family B Percentage	Cum mula tive %
Food	32	$(32/80) \times 100$ =40	40	60	$(60/120) \times 100$ =50	50
Clothing	20	$(20/80) \times 100$ =25	65	15	$(15/120) \times 100$ =12.5	62.5
House Rent	8	$(8/80) \times 100$ =10	75	18	$(18/120) \times 100$ =15	77.5
Fuel and light	4	$(4/80) \times 100$ =5	80	15	$(15/120) \times 100$ =12.5	90.0
Miscellaneous	16	$(16/80) \times 100$ =20	100	12	$(12/120) \times 100$ =10	100
Total	80	100	---	120	100	---

The income are 80 and 120. The following rectangles have length and widths of two are in the ratio of 80 : 120 or 2 : 3.



2.7.3 Squares

When it is needed to compare quantities which bear the ratio 1:12, bar diagrams fail because however small the scale selected be, the height of one bar will have to be made 10 times as greater as that of the other. So one bar will be too tall and other too small. In such cases squares are used. Suppose two quantities 36 and 100 are to be represented by squares, their sides will be in proportion of 36 : 100 or 6 : 10 and not in that of 36 : 100. The side of a square is taken by calculating the square root of the given figures. There are two types of squares simple and subdivided squares.

EXAMPLE 2.10

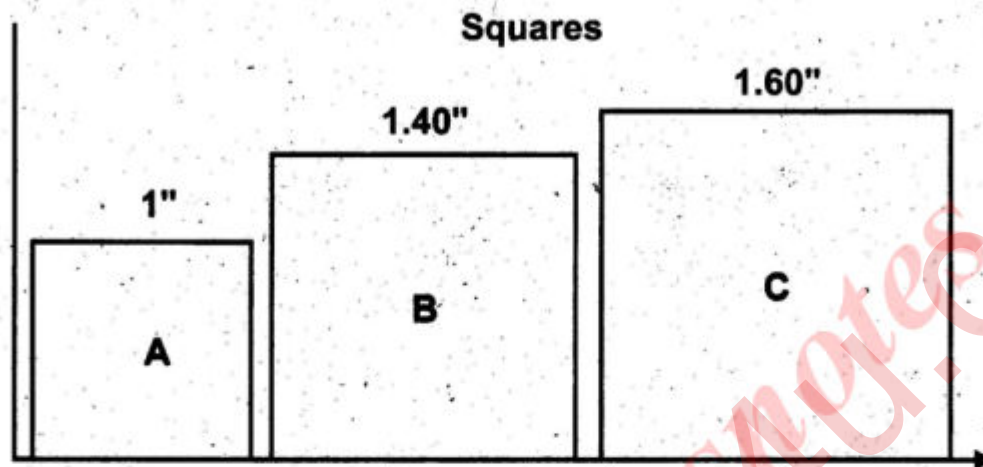
Represent the following information by squares.

Country :	A	B	C
Export (in Rs.) :	2500	4900	6400

SOLUTION

Country	Exports	Square Roots	Side of the squares in inches
A	2500	50	1
B	4900	70.00	1.40
C	6400	80.00	1.60

Column 2 gives the square roots of values given in column 1. Column 3 contains numbers which are obtained by dividing the square root by 50. These numbers given the sides of the squares.



The side of the square, relating to country C, is 1.6". Therefore the area of the square is 2.56 square inches. It represents 6400 rupees. Therefore one square inch represents $6400/2.56 = 2500$

2.7.4 Subdivided Squares

It is an extension of simple squares. Only one simple square is drawn for the totals and its division is made proportionately to the components i.e., a square is divided to show its components.

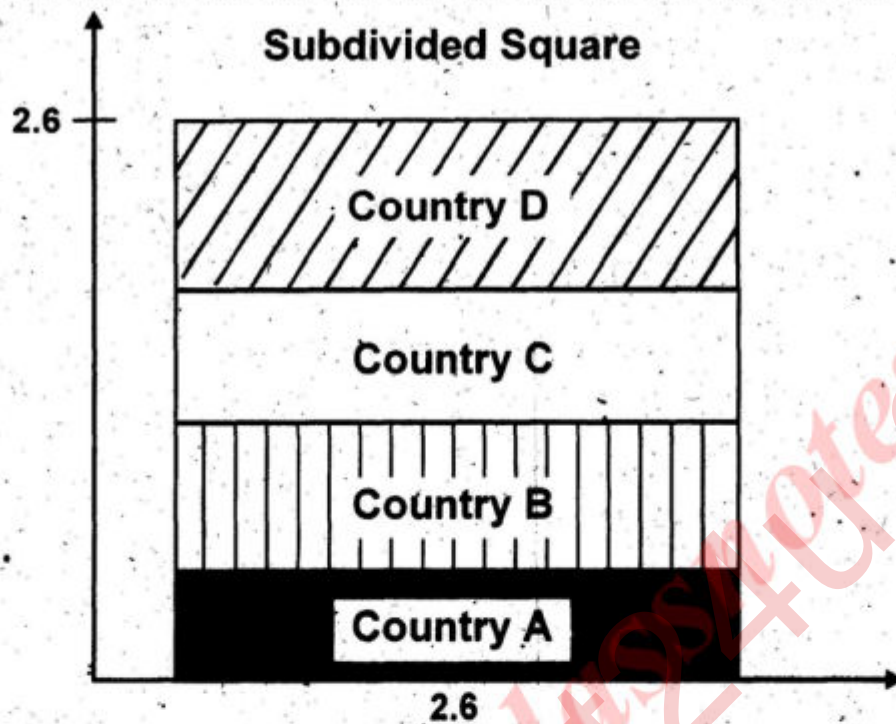
EXAMPLE 2.11

Show the following information by a subdivided square.

Country	A	B	C	D
Exports (in Rs.):	2500	4900	3600	6400

SOLUTION

Country	Exports	Square root	Side of square	Cummutative Length of Side
A	2500	50	0.5	0.5
B	4900	70	0.7	1.2
C	3600	60	0.6	1.8
D	6400	80	0.8	2.6



2.8 THREE DIMENSIONAL DIAGRAMS

Three dimensional diagrams use such figures as cylinders, spheres, cubes, etc., when quantities which have the ratio 1:8:216 are to be compared, then in these cases cubes are drawn. The sides of cubes are equal to the cube-root of the data to be presented. The sides of three cubes respectively 1, 8 and 216 will be $\sqrt[3]{1} = 1$, $\sqrt[3]{8} = 2$ and $\sqrt[3]{216} = 6$ or 1:2:6. Three dimensional diagrams are also called as volume diagrams.

2.9 PIE DIAGRAM

Pie diagrams refer to the presentation of the aggregate given data by a big circle and the various components by sectors inside it. The reason for the popularity of pie diagrams is the easiness and convenience in its construction. There are two types of pie diagrams.

- i. Circles
- ii. Sub divided circles or sector or angular diagram.

2.9.1. Circles

Circles are also used to represent data like squares and rectangles. Circles are more attractive and effective than squares. Therefore, when there is a choice between squares and circles, the circles are generally preferred. Circles are drawn with areas proportional to the quantities to be represented. As the area of a circle is proportional to the square of its radius. Circles are

drawn with radii proportional to the square roots of the quantities. One circle is drawn for each quantity and a uniform space is kept in-between them.

EXAMPLE 2.11

Compare the rice production in the following three countries by a circular diagram.

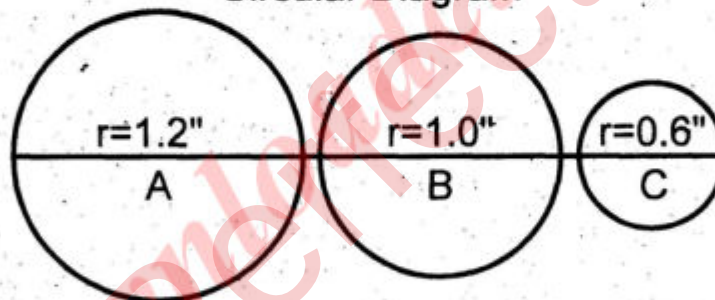
Country	:	A	B	C
Rice Production	:	3600	2500	900
(in thousands of Tons)				

SOLUTION

Country	Production	Square Roots	Radii in inches
A	3600	60	1.2
B	2500	50	1.0
C	900	30	0.6

Column 3 is the square roots of the figures in column 2. These square roots may be taken as the radii of the circles, but since they are too big to be shown in inches or centimeters, they are divided by 50.

Circular Diagram



2.9.2 Subdivided Circles or Sector Diagrams or Angular Diagrams

When the circle is divided into various parts it is known as subdivided circle. For drawing a sector diagram, a circle of appropriate radius is drawn taking the total into account and sectors are made to proportionate to the components. The angle of circle is 360 degrees and it represents the aggregate. It can be subdivided into number of smaller angles whose degrees would be in proportion to the values of the components. Sector wise degree of angles can be calculated through the help of following formula.

$$\text{Angle of Sector} = \frac{360 \times \text{Figure of the sector}}{\text{Aggregate i.e. Total}}$$

EXAMPLE 2.13

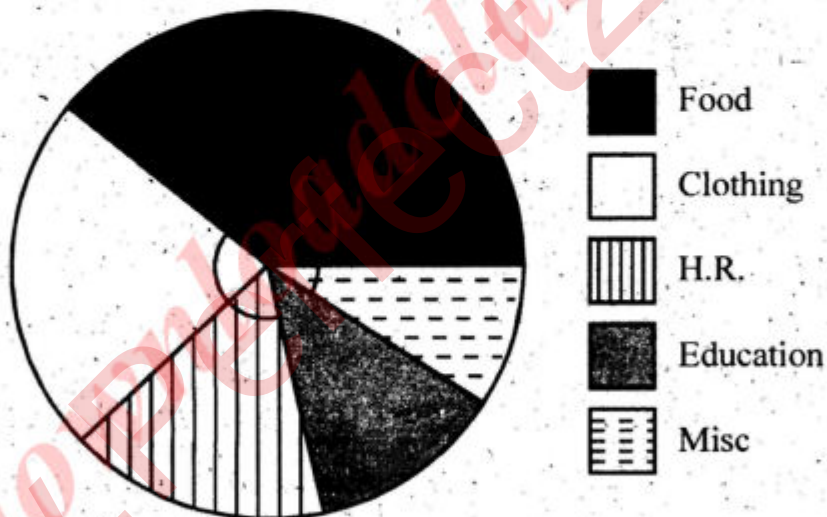
Represent the following information by a pie diagram.

Items	:	Food	Clothing	House rent	Education	Miscellaneous
Expenditure (in Rs.)	:	75	50	30	25	20

SOLUTION

The corresponding angles are computed below:

Items	Expenditure (in Rs.)	Angles of sector (in degrees)	Cumulative angles
Food	75	$(75/200) \times 360 = 135$	135
Clothing	50	$(50/200) \times 360 = 90$	225
House Rent	30	$(30/200) \times 360 = 54$	279
Education	25	$(25/200) \times 360 = 45$	324
Miscellaneous	20	$(20/200) \times 360 = 36$	360
Total	200	360	—



EXAMPLE 2.14

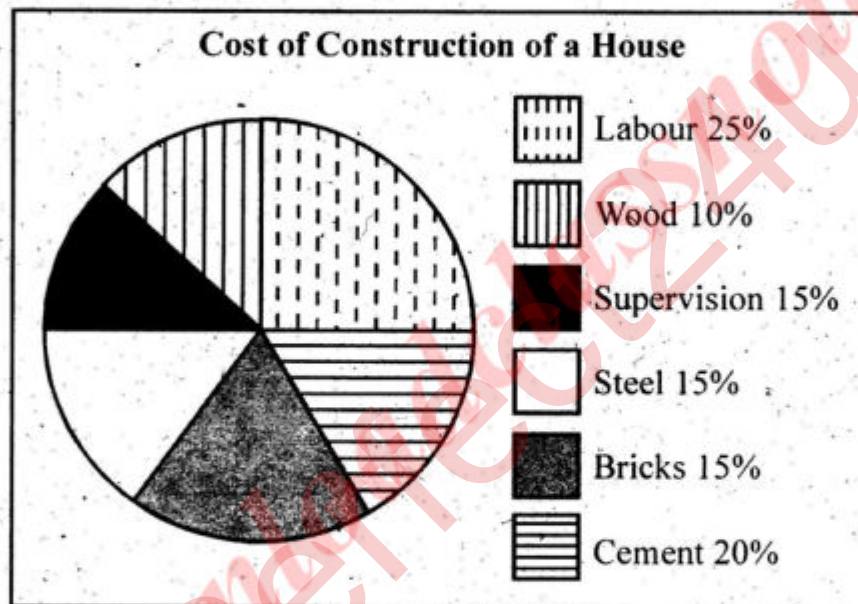
Construct a pie diagram to represent the cost of construction of a house in Lahore.

Items	Expenditure
Labour	2500
Bricks	1500
Cement	2000
Steel	1500
Timber	1000
Supervision	1500

SOLUTION

In constructing a diagram, it is necessary to convert the expenditure into angles of different degrees.

Items	Expenditure	Expenditure in Degrees
Labour	2500	$25 \times 3.6 = 90^\circ$
Bricks	1500	$15 \times 3.6 = 54^\circ$
Cement	2000	$20 \times 3.6 = 72^\circ$
Steel	1500	$15 \times 3.6 = 54^\circ$
Timber	1000	$10 \times 3.6 = 36^\circ$
Supervision	1500	$15 \times 3.6 = 54^\circ$

**2.10 PICTOGRAMS**

When relative values of items are represented by symbols or pictures, it is called pictograms. In pictogram a unit value of the data is represented by a standard symbol or a picture. A part of a symbol or picture is used to represent a quantity which is less than the value of a whole symbol or picture. The symbols or pictures to be used, must be simple and clear. A pictogram is used to compare data in the same way as a simple bar diagram because in this diagram a number of pictures are used to represent the quantity instead of the length of the bars.

2.11 CARTOGRAM

Use of maps in the representation of data is called cartograms. Maps are generally used for the regional representation through statistical data. The distribution of rainfall in various regions of Pakistan and the production of

wheat in the various districts of Pakistan can be shown by maps. So the density of population and census classification are represented on the graph of the country.

2.12 GRAPHS

Presentation of statistical data by geometrical curves is called **Graphic Representation** of data.

A graph shown by means of a curve or straight line is the relationship between two variables; for example, the amount of sales and the period of time when the sales were made, or the relationship between output and cost. One of the variable will be independent and the other dependent variable. Which ever variable is chosen as dependent will depend on the formulation of the problem. For example, the relationship between the number of bushels of wheat per acre and the amount of rainfall can be formulated in two ways. Given the rainfall, wheat is the output per acre, or given the output per acre, what is the rainfall? The first would be the more useful way. The output per acre would depend on the rainfall. The output would be the dependent variable, the rainfall, the independent variable.

2.13 CONSTRUCTION OF GRAPHS

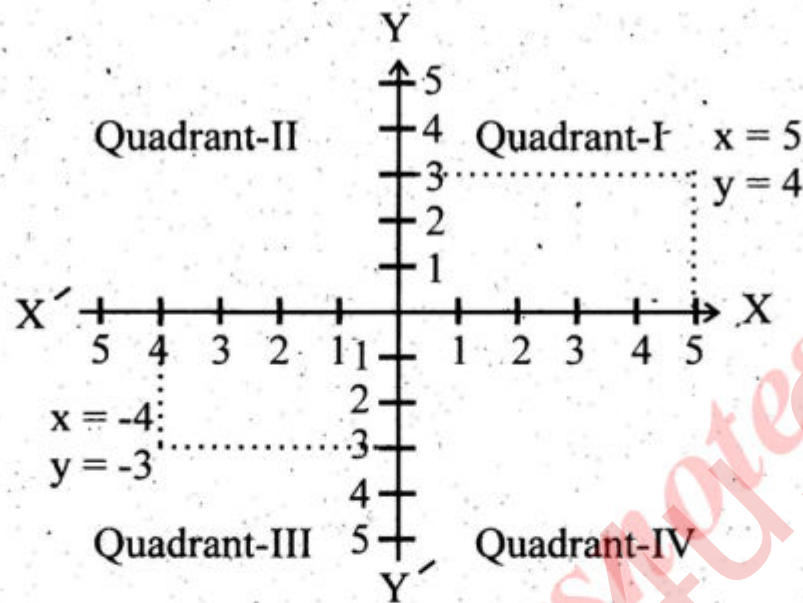
The construction of graph is on two straight lines intersecting each other at right angles. These are known as co-ordinate axes. The horizontal line is called the X-axis or the axis of ordinates. The vertical line is called the Y-axis. The point where they intersect is called the origin and is designated by '0' or zero point of the graph. Usually the frame work of the graph is drawn on squared paper i.e. paper ruled with horizontal and vertical lines intersecting at right angles. It can also be drawn on an ordinary paper if two lines are properly drawn at right angles to each other.

A decision is made that a certain distance of the squared paper should represent a certain unit of measurement. Both these axes will have a scale. The scale can be varied to suit the requirements, namely.

- i. To fit the paper.
- ii. To include all observations.
- iii. To avoid too sharp or too flat a curve.

Having drawn the axes and marked a suitable scale along both axes, next stage is to plot the observations. This is best explained by means of example. Suppose the value of $y = 4$ when the value of $x = 5$ and the value of $y = -3$ when the value of $x = -4$. These two observations are plotted as follows:

The first point is chosen at a distance of 5 from the Y-axis and at a distance of 4 from the X-axis. Similarly the second point is plotted at a position 4 units to the left of 'Y0Y' and 3 units below 'X0X'. See below:



2.14 FALSE BASE LINE

False base line is a method of magnifying the minor fluctuations of a time series. There are certain instances where the dependent variable has got very small differences in values and the smallest value is very distant from the origin. Under these circumstances, if we start our scale from zero on X-axis, the plotted data will be at the top of the graph and will not look attractive. Moreover, the plotted values will show a straight line. For such values we use the technique of "false base line". In such cases vertical scale is broken and some part nearer to origin is shown either by blank space or by Zig Zag line.

2.15 TYPES OF GRAPHS

There are two main classes of graphs:

- i. Graphs of Time Series or Historigram.
- ii. Graphs of Frequency Distributions.

The important graphs of frequency distributions are:

- a) Histogram.
- b) Frequency polygon.
- c) Frequency curve.
- d) Cumulative frequency polygon or ogive.

2.15.1 Graph of the Time Series or Historigram

Graph of the time series or historigram is a curve which shows the changes in value of one or more variables from one period of time to the next. Thus a historigram shows the variations in time series dealing with production, prices, imports, exports, populations, etc. A rectangular co-

ordinate system is used to present time series graphically. Time units are placed on X-axis and the size of the variables are measured on Y-axis. The X-axis is divided into equal parts Y-axis should begin with zero. The scales chosen should be such as would allow the full data to be presented on the graph. To plot the size of an item against a particular date, only a point is placed on the concerning place. Thus when the whole data are plotted, these several points are joined by straight-lines. This will give us a historigram.

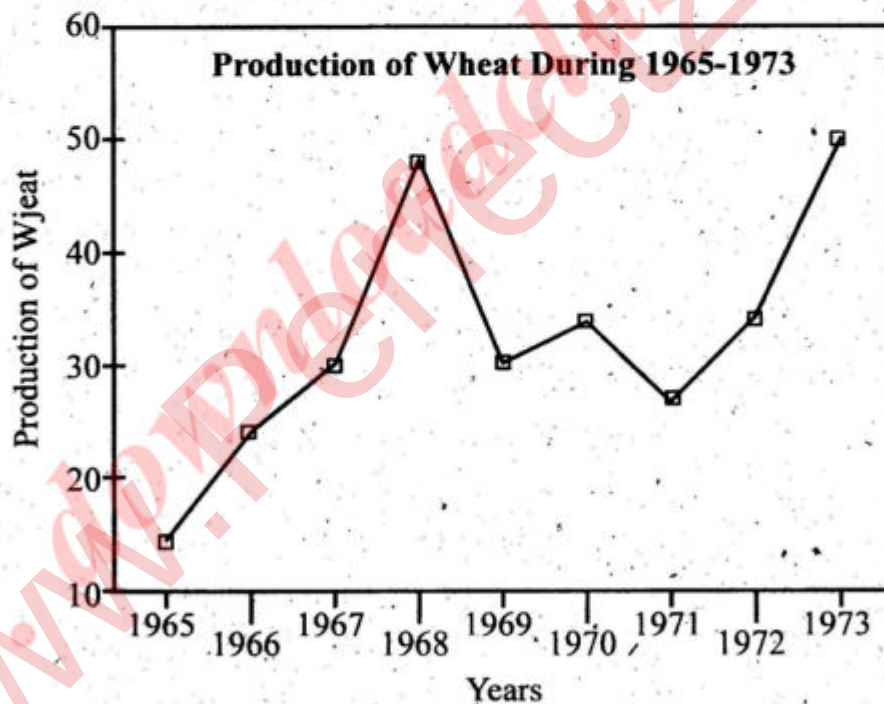
EXAMPLE 2.15

Construct a graph on the basis of the following data.

Year	1965	1966	1967	1968	1969
Production of Wheat (in 10 lakh tons)	15	25	30	48	32
Year	1970	1971	1972	1973	
Production of Wheat (in 10 lakh tons)	35	28	36	50	

SOLUTION

Years are being shown on X-axis and production of wheat on Y-axis.



2.15.2 Graph of Frequency Distribution

Curves are used for graphic representation not only of series such as have been discussed above but also for frequency distribution. Frequency distribution may be discrete or continuous. The graphic method can be used for both the types.

(A) Frequency Graphs for Discrete Series

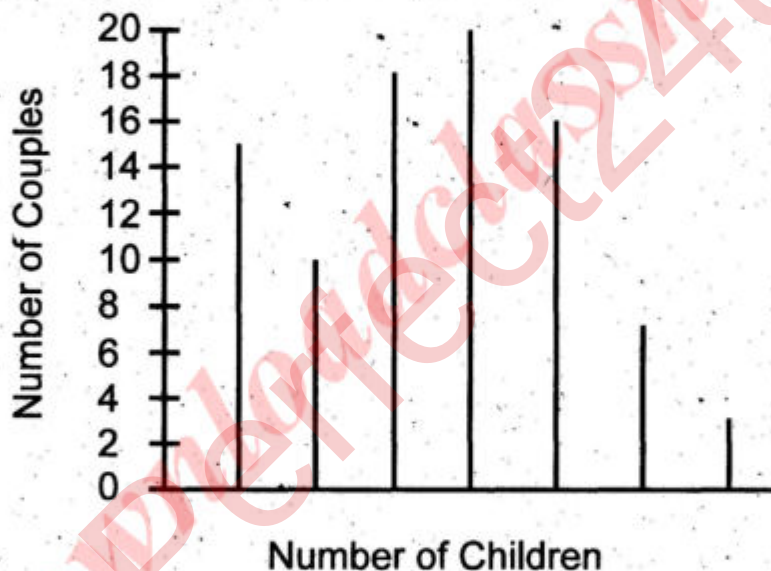
When the frequency distribution is given in discrete series, the simple method of graphic representation is the line or bar. In frequency graph for discrete series the size is taken on the horizontal line (X-axis) and the frequency on the vertical line (Y-axis). The following gives a discrete series which has been graphically represented.

EXAMPLE 2.16

Number of Children	:	1	2	3	4	5	6	7
Number of couples (frequency)	:	15	10	18	20	16	7	3

SOLUTION

Take the No. of children per couple along with X-axis and their corresponding frequencies along Y-axis.

**(B) Histogram or Frequency Graph for Continuous Series**

A histogram consists of a set of adjacent rectangles having bases along X-axis with centres at mid points and areas proportional to class frequencies. If all classes have equal size of class interval, the heights of the rectangles are proportional to the class frequencies and all have the same width. If lengths of class-interval are not equal, then the heights of the rectangles must be adjusted. If a class interval is twice as long as the others, we divide the height of its rectangle by two; if a class interval is three times as long as the other, we divide the height of its rectangle by three and so on.

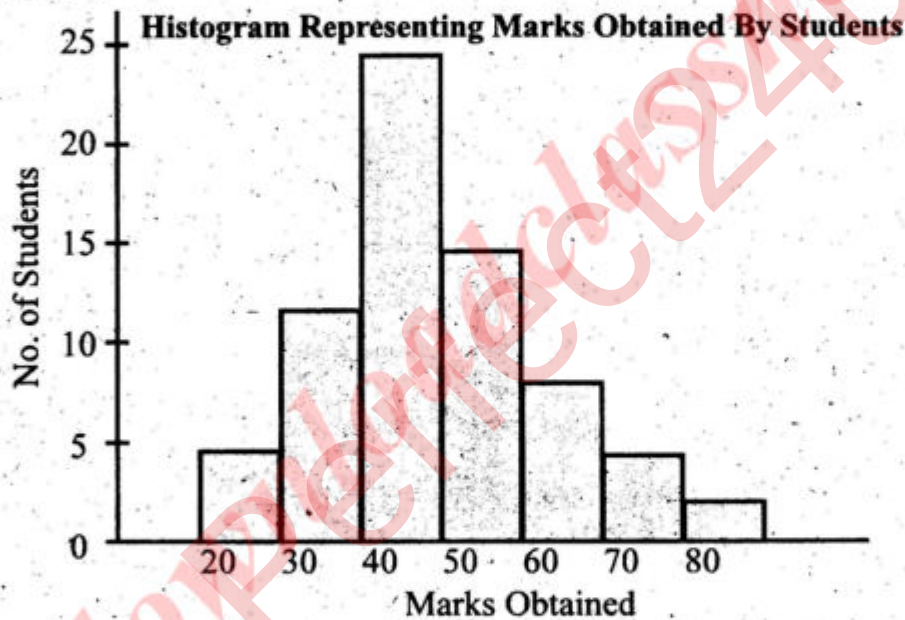
EXAMPLE 2.17

The table given below shows the marks obtained in statistics by a class of 72 students. Construct a histogram.

Marks Obtained	No. of Students
20-30	5
30-40	12
40-50	25
50-60	15
60-70	8
70-80	5
80-90	2

SOLUTION

Take the marks obtained along with X-axis and No. of students along Y-axis.



EXAMPLE 2.18

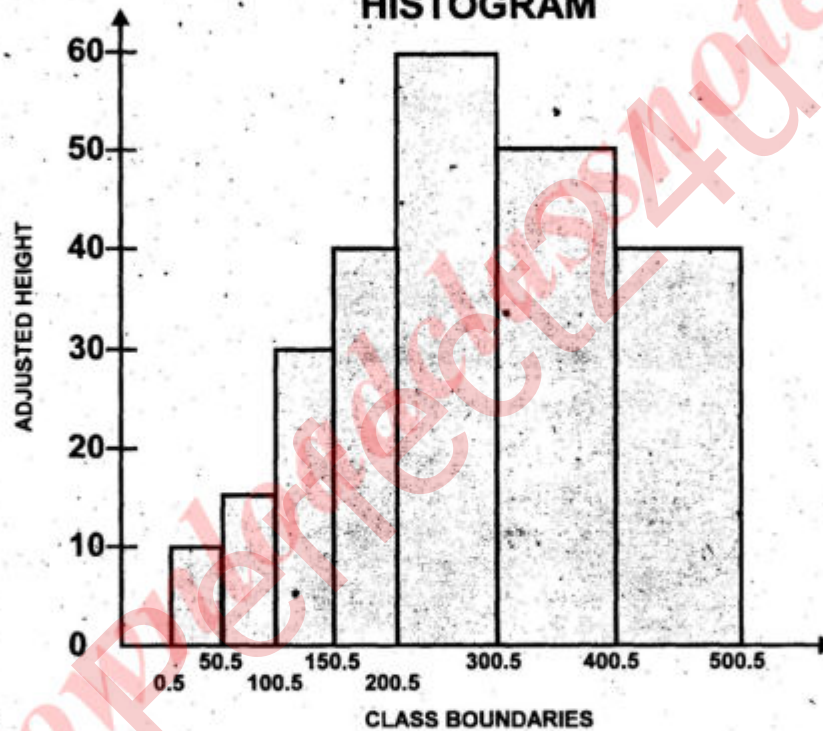
In a saving group, there are 400 members and the number of saving certificates held by them are shown in the following table. Construct a histogram of the distribution of saving certificates.

No. of Certificate	1-50	51-100	101-151	151-200
No. of Members	10	15	30	40
No. of Certificate	201-300	301-400	401-500	
No. of Members	120	100	85	

SOLUTION

No of certificate	No of members	Classes boundaries	Length of class Interval	Adjusted height of rectangle
1-50	10	0.5-50.5	50	$10/1=10$
51-100	15	50.5-100.5	50	$15/1=15$
101-150	30	100.5-150.5	50	$30/1=30$
151-200	40	150.5-200.5	50	$40/1=40$
201-300	120	200.5-300.5	100	$120/2=60$
301-400	100	300.5-400.5	100	$100/2=50$
401-500	85	400.5-500.5	100	$85/2=42.5$

HISTOGRAM



EXAMPLE 2.19

Draw a histogram on the basis of following data.

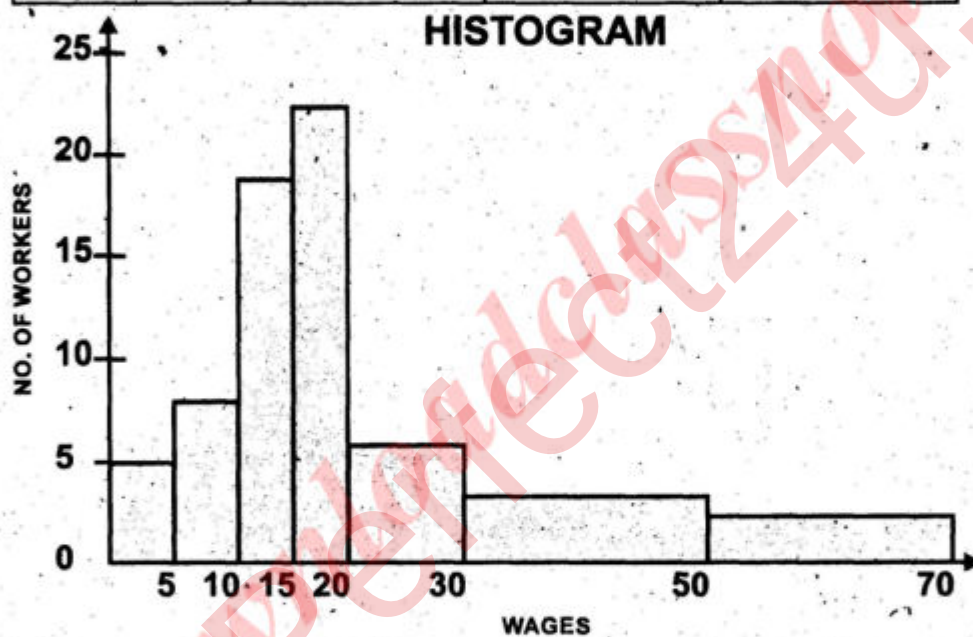
Wages	:	0-5	5-10	10-15	15-20	20-30	30-50	50-70
No. of Workers	:	5	7	19	22	12	12	8

SOLUTION

The class interval in this data is unequal. First, it is 5, then 10 and afterwards for the last two intervals it is 20. In order to make a series with equal class interval of 5, the frequency of class interval 20-30 will be divided by 2 because here the interval is 10 so $(10/2 = 5)$. The reset frequency of this interval would be $12/2=6$. For the class interval 30-50 and 50-70, the frequency of these two classes would be divided by 4 because the interval is

20. The reset frequencies of these classes would be $12/4=3$ and $8/4=2$ respectively.

Wages	No. of Workers	Length of the class interval	Adjusted Frequency
0-5	5	5	5
5-10	7	5	7
10-15	19	5	19
15-20	22	5	22
20-30	12	10	6
30-50	12	20	3
50-70	8	20	2



2.16 FREQUENCY POLYGON

In order to complete the polygon, one extra class is usually added at each end of the distribution, and since these classes have zero frequencies, both ends, if the figures will come down to the horizontal axis. Where there are open or unequal classes, frequency polygon pose the same difficulties as histograms. They cannot be used for distribution with open classes and an appropriate adjustment must be made to account for unequal classes. Frequency polygon can also be obtained by connecting the mid points of the top of the rectangles in the histogram. A frequency polygon is the graphical form of a histogram. Class intervals are marked out along the horizontal axis and values along the vertical axis. The points representing the frequency for each group are then plotted as if the frequency occurred at the mid points of class interval. Then these points are connected by straight lines.

EXAMPLE 2.20

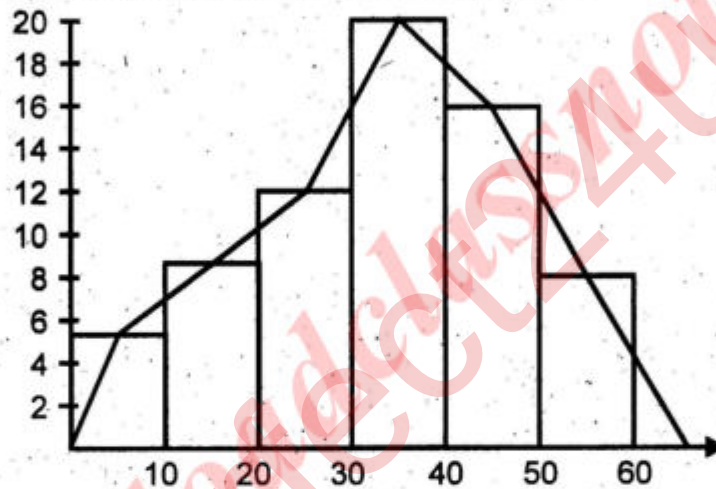
Construct a frequency polygon from the data given below by using

(i) Histogram and (ii) Mid points

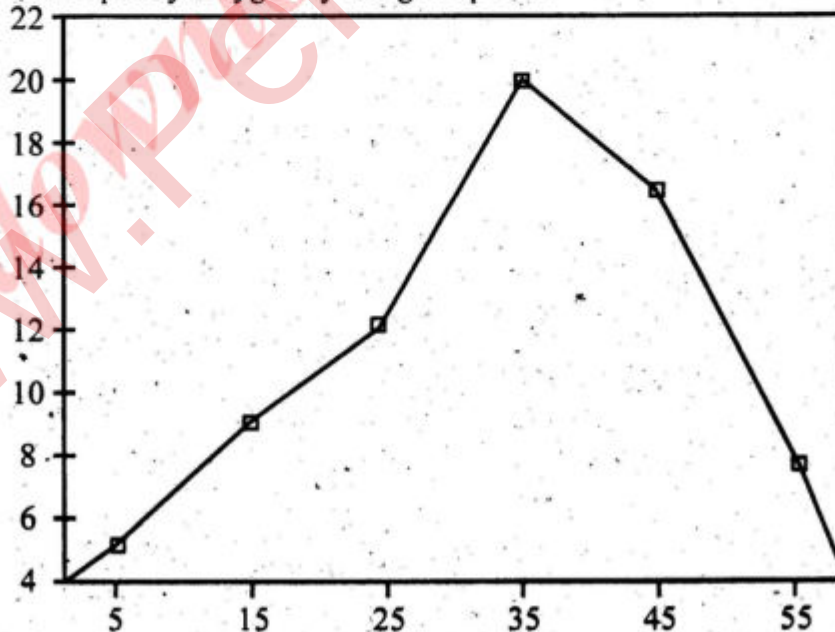
Class Interval	Frequency	Midpoints
0-10	5	5
10-20	9	15
20-30	12	25
30-40	20	35
40-50	16	45
50-60	8	55

SOLUTION

(i) A Frequency Polygon by making the histogram.



(ii) Frequency Polygon by using midpoints.



2.17 FREQUENCY CURVE

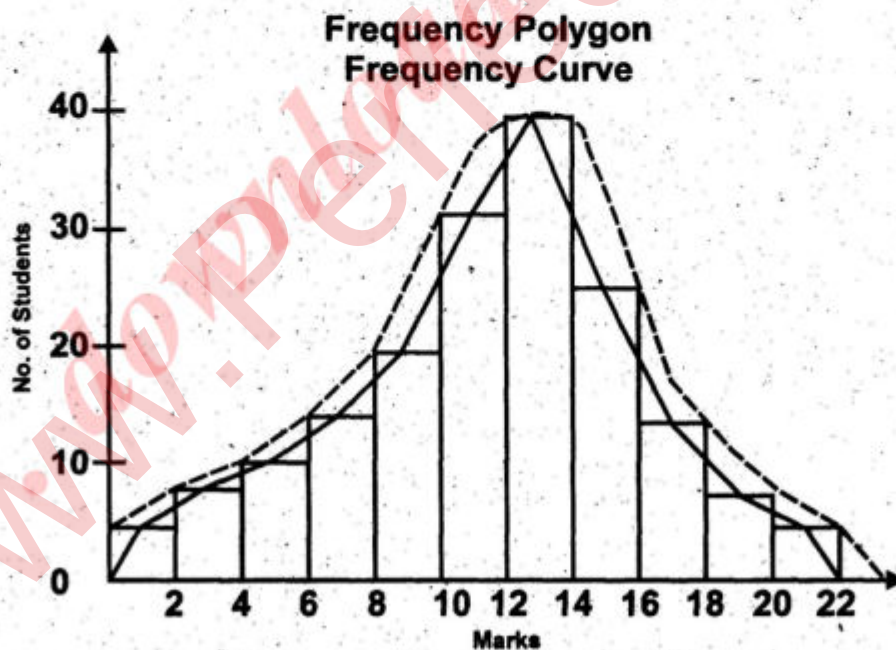
If the frequency polygon is smoothed, the resulting curve is called a frequency curve. To draw the frequency curve it is necessary to draw the polygon. The polygon is then smoothed out, for this reason it is sometimes called a smoothed frequency polygon. It is advisable to draw a frequency curve when the size of the class interval is small, number of classes is large and distribution has continuous variable.

EXAMPLE 2.21

Draw a histogram, frequency polygon and frequency curve of the following distribution.

Marks	No. of Students
0-2	3
2-4	7
4-6	10
6-8	13
8-10	20
10-12	32
12-14	40
14-16	25
16-18	14
18-20	6
20-22	4

SOLUTION

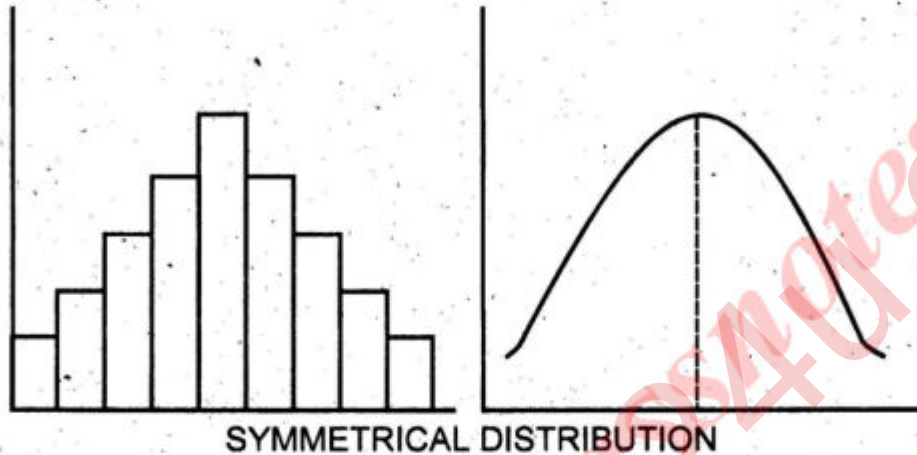


2.17.1 Types of Frequency Curve

The frequency distributions, usually belong to one of the following four types.

(A) A bell Shaped or Symmetrical Distribution

A frequency distribution is said to be symmetrical, if the values of frequency increases up to the middle item and then decreases in the same ratio. The curve can be folded along the central maximum in such a way that the two halves of the curve coincide. This curve is also known as normal curve.

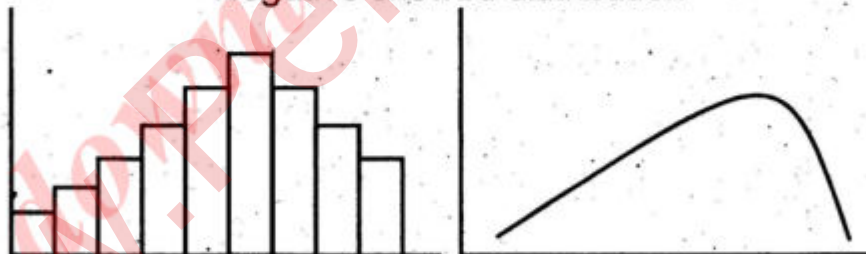


(B) A Skewed or Asymmetrical Distribution

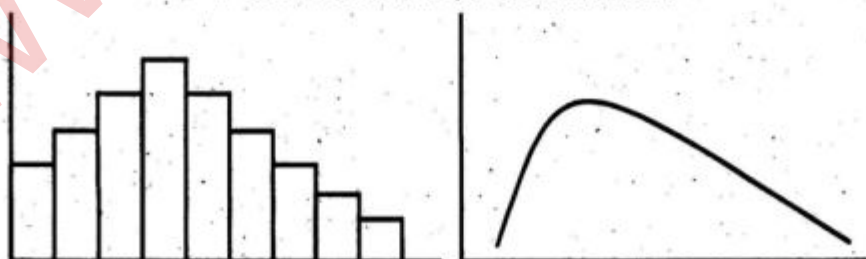
A frequency distribution or curve is said to be skewed or asymmetrical if the distribution or curve has a 'longer tail' at one end or the other. A skewed frequency distribution can be divided into two types.

- i. Positive skewed distribution.
- ii. Negative skewed distribution.

Negative skewed distribution

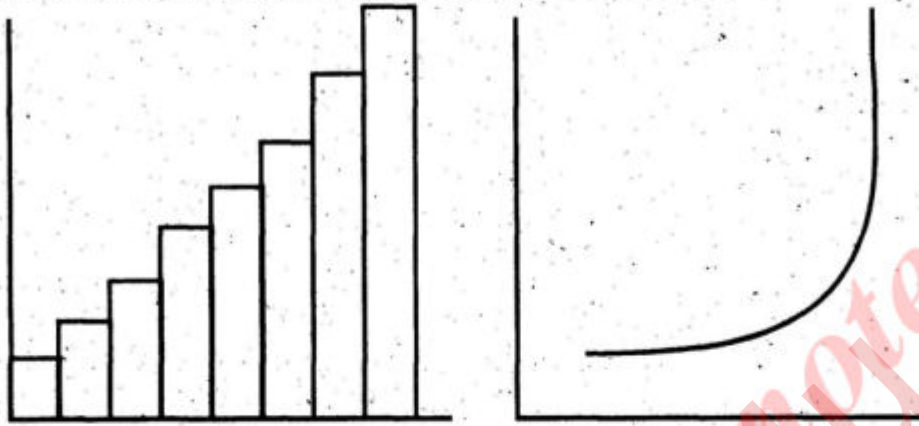


Positive skewed distribution



(C) J-Shaped Distribution

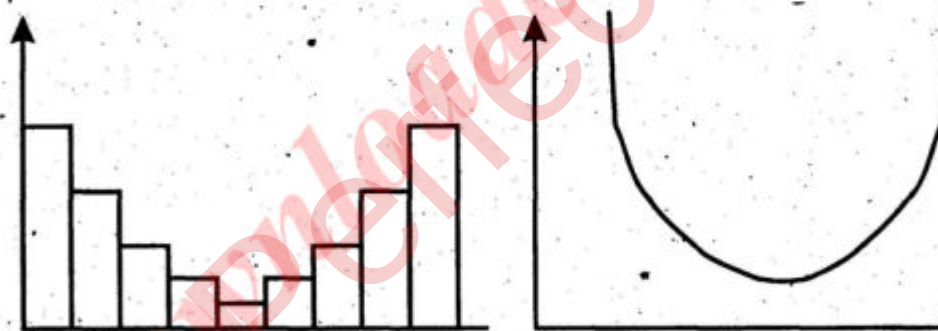
In J-Shaped distribution the frequencies run up to a maximum at one end of the range, having the shape of the letter J or reverse.



J-Shaped Distribution

(D) U-Shaped Distribution

A U-shaped distribution has maximum frequency at both ends and a minimum towards the centre.



U-Shaped Distribution

2.18 COMMULATIVE FREQUENCY POLYGON OR OGIVE

An ogive or cumulative frequency curve is drawn on the basis of cumulative frequency. To construct cumulative frequency curve it is necessary first to form the cumulative frequency table. Then the upper limits of the classes are taken as the X coordinates and the cumulative frequencies as the Y coordinates and the points are plotted. The successive points are joined by means of a straight line. The lowest point is joined by straight line with lowest lower class boundaries and last point with highest upper class boundaries to have a polygon.

There are two methods of drawing a cumulative frequency curve.

- i. The less than method.
- ii. The more than method.

In the "less than method" a frequency distribution is prepared which gives the number of items that are less than a certain size. This gives a series which is cumulated upwards.

In the "more than method" a frequency distribution is prepared that gives the number of items that exceed a certain size. This gives a series that is cumulative downward.

EXAMPLE 2.22

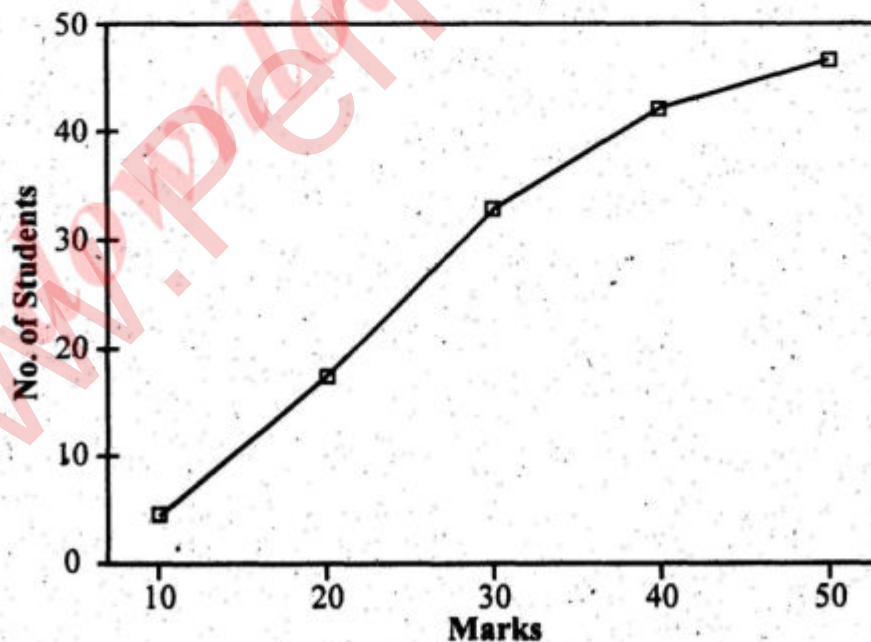
Construct both the ogive curves i.e. 'more than' and 'less than' with the help of following data.

SOLUTION

- (i) Ogive curve with less than method. Then frequency will be adjusted as given below.

Marks	No of Students
Less than 10	5
Less than 20	17
Less than 30	31
Less than 40	41
Less than 50	46

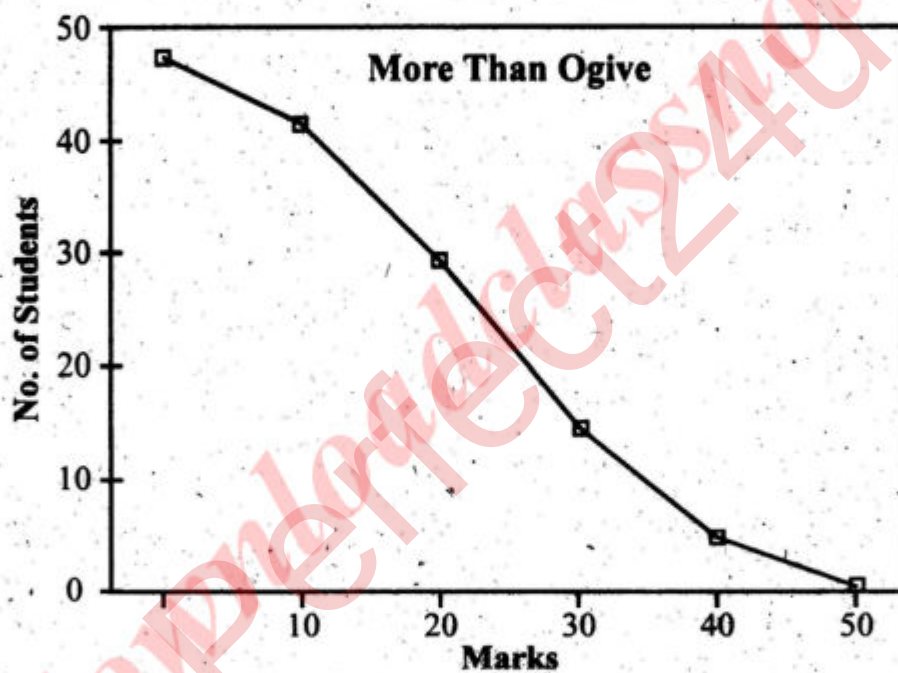
Given below is the less than ogive curve.



(ii) Ogive curve with more than method. The frequency adjustment will be as given below.

Marks	No. of Students
More than 0	46
More than 10	41
More than 20	29
More than 30	15
More than 40	5
More than 50	0

Given below is the ogive curve on the basis of above data.



EXERCISE NO. 2

- 2.1:- Briefly explain the uses of diagrams in presenting statistical data.
- 2.2:- Explain the importance of graphical representation in the presentation of statistical data.
- 2.3:- Describe the advantages and disadvantages of **diagrammatic** representation. Also describe the important types of diagrams.
- 2.4:- Explain the following diagrams
 (i) Simple Bar Diagram (ii) Rectangular Diagram.
 (iii) Multiple Bar Diagram (iv) Sub Divided Bar Diagram
 (v) Sector Diagram (vi) Square Diagram
 (vii) Circle Diagram (viii) Pie Diagram
- 2.5:- State the general rules for a good chart design.
- 2.6:- Draw simple bar chart to represent the production of commodity "A" during year 2000 to 2008.

Year	2000	2001	2002	2003	2004
Product	115	113	110	135	100
Year	2005	2006	2007	2008	
Product	145	190	210	258	

(Faisalabad Board, 2010)

- 2.7:- Represent the following yield per acre data by a Bar diagram.

Year	1940	1941	1942	1943	1944
Yield per acre	5	7	9	6	10
Year	1945	1946	1947	1948	
Yield per acre	12	8	11	12	

- 2.8:- The areas of various continents of the world in millions of squares miles are represented in the following table. Draw a simple Bar diagram.

Continent:	USSR	S. America	N. America	Asia
Area:	7.9	6.9	9.4	10.4

- 2.9:- Draw a Bar diagram for the following data.

Year:	1061	1962	1963	1974	1965
Profit (Rs.):	100000	95000	81500	75500	50000

- 2.10:- The following data relate to the enrollment of students in a college. Represent it by simple bar diagram.

Year:	1986	1987	1988	1989	1990	1991
No. of Student:	1000	1350	1225	1400	1375	1280

- 2.11:- Represent the following information by simple bar chart

Year	2004	2005	2006	2007	2008
Student	1140	1300	1210	1299	1330

(Lahore Board, 2009)

2.12:- The following table shows disability in sample population.

Type of Disability	No of Persons
Blind	13
Deaf and Dumb	26
Crippled	41
Other Handicapped	33

Draw simple bar chart.

(Lahore Board, 2010)

2.13:- Draw simple bar chart of the following time series.

Year	2000	2001	2002	2003	2004	2005
Price (Rs./kg)	205	255	300	275	245	385

(Lahore Board, 2010)

2.14:- The following tables give the birth and death rates per thousand of few countries. Represent this data by multiple bar chart.

Country	Birth Rate	Death Rate
India	33	24
Japan	32	19
Germany	16	10
Egypt	44	24
Australia	20	9
Newzeland	18	8
France	21	16
Russia	38	16

(Faisalabad Board, 2009)

2.15:- The following table gives the birth rates and death rates of a few countries. Represent them by a subdivided bar diagram.

Country	Pakistan	Russia	France	Austral	Egypt	India
Birth rate:	16	38	21	20	44	33
Death rate:	11	16	16	9	24	24

2.16:- Draw a component bar chart for the following data.

(Population in Lakh)

Division	Both Sexes	Male	Female
Peshawar	64	33	31
Rawalpindi	40	21	19
Sargodha	60	32	38
Lahore	65	35	30

(Lahore Board, 2008)

2.17:- Represent the following data by a component bar chart. Production

Name of Country	Wheat	Rice	Sugar :	Total
Pakistan	2560	1220	1220	5000
Iran	4000	2500	1500	8000
Turkey	500	3000	2000	10000

2.18:- Represent the following data by a subdivided bar diagram

Year	Agriculture	Transport	Industry	Total
1960	80	35	20	135
1961	150	70	35	225
1962	200	110	40	350

2.19:- Represent the following data by a multiple chart (in crores)

Source	1975	1976	1977	1978
Agriculture	449	504	503	527
Com and Industry	358	374	362	394
Foreign Trade	157	174	165	184

2.20:- The following table gives the national income of country during various years. Represent by multiple bar diagram.

Source	1980 - 81	1981 - 82	1982 - 83
Agriculture	5500	4900	5000
Mining and industry	1900	1700	2000
Commerce and transport	1900	1780	2100
Other Services	1600	1700	1500

2.21:- Illustrate by a pie diagram, the data expenditure of an average working class family.

Items:	Food	Clothing	Rent	Medical care	Other Items
Expenditure (in Rs.)	95	32	50	23	40

2.22:- The budgets of two families are given below. Represent the data by percentage diagram.

Items of Expenditure	Family A	Family B
Food	160	120
Clothing	80	32
House Rent	60	48
Light and Fuel	20	16
Miscellaneous	80	24
Total	400	240

2.23:- Represent the following data relating to expenditure of Family A and Family B with the help of rectangle diagram.

Items of Expenditure	Family A	Family B
Food	180	110
Clothing	70	50
House Rent	90	60
Fuel and Lighting	35	30
Miscellaneous	75	50
Total	450	300

2.24:- The following gives the details of monthly budgets of two families.

Details	Family A	Family B
Food	50	140
Clothing	30	90
House Rent	20	95
Fuel and Lighting	15	35
Miscellaneous	35	90
Saving	Nil	50
Total	150	500

Represent the above data by a suitable diagram.

2.25:- The following table gives details of monthly expenditure of three families. Represent them by a suitable diagram.

Items of Expenditure	Family A	Family B	Family C
Food	120	250	300
Clothing	20	80	100
H. R.	20	40	80
Education	10	50	70
Miscellaneous	20	80	150

2.26:- The following table gives the details of monthly expenditure of three families A, B, C represent the data by a suitable diagram.

Items of Expenditure	Family A	Family B	Family C
Food Articles	43	87	120
Clothing	18	17	25
Recreation	3	10	12
Education	5	9	15
H. Rent	10	21	17
Miscellaneous	6	15	11

2.27:- Represent the following data relating to the production of wheat of the countries named below by mean of

(i) Rectangles (ii) Squares (iii) Circles

Countries	Production (millions of Quintals)
USSR	289
USA	230
Canda	108
Pakistan	55
India	50

2.28:- Represent the total expenditure on various items of a family by a pie diagram.

Items	Food	Clothing	H. R	Fuel light	Miscellaneous
Expenditure (in Rs.)	50	30	20	15	35

2.29:- (a) Draw a pie diagram for the following data.

Items	Food	Clothing	H. R	Medical Care	Other items
Expenditure	95	32	50	23	40

(b) Represent the following data showing the areas on millions of square miles of the oceans of the world using (i) A Bar diagram (ii) A Pie chart

Ocean:	Pacific	Altantic	India	Antractic	Arctic
Area:	70.8	40.2	30.5	8.0	4.8

2.30:- Describe the graphical methods used in statistics, giving their respective advantages and disadvantages. Also give a list rules for the construction of graph.

2.31:- The following table gives the sales of a certain factory in 7 years. Show this data in a graph.

Years	1910	1911	1912	1913	1914	1915	1916
Sales (Rs.)	120	132	170	162	155	180	170

2.32:- The following table gives the number of cars produced in Germany during the years 1929-46. Draw a suitable graph i.e. Historigram of the series.

Year	1939	1940	1942	1943
No of cars	98	74	68	50
Year	1944	1945	1946	
No of cars	172	245	302	

2.33:- Write short notes on the following:

(i) Histogram (ii) Frequency Polygon and Frequency curve (iii) Ogive

2.34:- Draw the histogram on the bases of following data.

Group	0-5	5-10	10-15	15-20	20-30	30-40
Frequency	5	7	19	22	12	8

(Lahore Board, 2009)

2.35:- Draw histogram from the following frequency distribution.

Classes	50-54	55-59	60-64	65-69
Frequency	3	2	5	3
Classes	70-74	75-79	80-84	85-89
Frequency	7	2	2	1

(Faisalabad Board, 2008)

2.36:- Draw the histogram of the following data.

Groups	100-200	200-300	300-400	400-500	500-600
Frequency	60	80	120	40	20

(Gujranwala Board, 2010)

2.37:- Draw the histogram and polygon of the following data.

Class	2-4	4-6	6-8	8-10	10-12	12-14
Frequency	4	10	15	12	6	2

(Lahore Board, 2008)

2.38:- Draw the frequency polygon for the following data.

Groups	40-50	50-60	60-70	70-80	80-90
Frequency	10	18	22	13	7

(Rawalpindi Board, 2010)

2.39:- The height of college students are given below:

Height	57-59	60-62	63-65	66-68	69-71
Student	8	15	27	18	9

Draw a histogram.

(Sargodha Board, 2010)

2.40:- Draw a histogram and frequency polygon for the following distribution:

Marks:	11-20	21-30	31-40	41-50	51-60	61-70
Students:	3	15	33	52	27	20

2.41:- Draw a histogram, frequency polygon and frequency curve of the following distribution.

Daily Wages:	2-4	4-6	6-8	8-10
No of workers	3	5	8	12
Daily Wages:	10-12	12-14	14-16	16-18
No of workers	15	10	6	2

2.42:- Construct a histogram on the basis of following data.

Marks:	0-10	10-20	20-30	30-40
Frequency	4	10	15	2
Marks:	40-50	50-60	60-70	70-80
Frequency	20	18	8	2

2.43:- Draw the following diagrams for the following data.

(i) Histogram (ii) Frequency polygon (iii) Commulative Frequency curve

Weakly Wages:	20-25	25-30	30-35	35-40
No of Person:	2	4	7	11
Weakly Wages:	40-45	45-50	50-55	55-60
No of Person:	14	9	5	1

2.44:- Construct (i) Histogram (ii) A frequency polygon (iii) An ogive for the following frequency distribution of the height of 100 male students at XYZ university.

Height (inches):	60-62	63-65	66-68	69-71	72-73
No of students	5	18	42	27	8

2

DIAGRAMMATIC AND GRAPHIC REPRESENTATION OF DATA

QUESTION NO. 1

Possible answers are given to each statement. Tick (✓) the correct one.

S#	Questions	Answers			
1)	What is total angle of pie-chart	90°	180°	360°	60°
		(Lahore Board, 2008)			
2)	A statistical table has at least	One part	Two parts	Three parts	Four parts
		(Lahore Board, 2008; Gujranwala Board, 2010)			
3)	A graph of cumulative frequency distribution is called	Histogram	Historigram	Frequency polygon	Ogive
		(Gujranwala Board, 2009; Lahore Board, 2010)			
4)	The data, when plot on graph paper is called	Frequency distribution	Graphic	Ogive	Diagrammatic representation
		(Lahore Board, 2009)			
5)	The graph of time series is called	Pie-chart	Ogive	Histogram	Historigram
		(Lahore Board, 2009; Gujranwala Board 2010)			
6)	Graph of frequency distribution is called	Histogram	Historigram	Pie diagram	Frequency curve
		(Faisalabad Board, 2010)			
7)	Graph of frequency distribution is	Histogram	Bell shaped	J-shaped	Curve
		(Lahore & Gujranwala Boards, 2010)			
8)	An ogive is a	Frequency polygon	Cumulative frequency polygon	Frequency curve	Histogram
		(Lahore Board, 2010)			
9)	Total angles of pie chart are	60°	260°	360°	460°
		(Rawalpindi Board, 2010)			

S#	Questions	Answers			
10)	The data which is plotted on the graph paper is called	Classification	Tabulation	Frequency distribution representation	Graphic representation
(Sargodha Board, 2010)					
11)	Main classes of graphs are (types of graph)	One	Two	Three	Four
(Sargodha Board, 2010)					
12)	In graphic representation data is used:	Individual items	Discrete series	Grouped data	None of these
13)	The data when plot on graph paper it is called:	Frequency distribution	Graphic	Ogive	Diagrammatic representation
14)	Histogram, histogram, frequency polygon, ogive are types of:	Diagrammatic representation	Graphic representation	Two dimensional diagram	None of these
15)	In two dimensional diagrams we use:	Length and breadth	Length	Breadth	Volume
16)	In one dimensional diagrams we draw:	Component bar diagrams	Rectangles	Cubes	Pie Diagram
17)	The main classes of graphs are:	Four	Three	Two	Five
18)	Bar chart has:	Two types	Four types	Six types	Ten types
19)	When we construct histogram, which is to be taken along X-axis:	Class intervals	Mid points	Class boundaries	Class limits
20)	The graph of class boundaries and frequency is:	Bar chart	Ogive	Histogram	None of these
21)	When we connect the mid – points of rectangles in a histogram with lines, we get:	Ogive	Histogram	Frequency polygon	Frequency curve
22)	Which one of the following charts is suitable when two or more different	Simple bar chart	Multiple bar chart	Pie chart	None of these

S#	Questions	Answers			
	variables are presented with total is:				
23)	A set of adjacent rectangles is called:	Ogive	Histogram	Multiple bar diagram	Historigram
24)	A circle in which sectors represent various quantities is called:	Pie chart	Simple bar chart	Multiple bar chart	All above
25)	To show the component parts by sectors, the angle for each sector is obtained by:	$\frac{\text{Component part}}{\text{Total}} \times 90$	$\frac{\text{Component part}}{\text{Total}} \times 180$	$\frac{\text{Component part}}{\text{Total}} \times 270$	$\frac{\text{Component part}}{\text{Total}} \times 360$
26)	The graph of a time series is called:	Histogram	Ogive	Historigram	Pie chart
27)	A graph formed by joining the mid-points of the tops of successive bars in a histogram by straight lines is:	Frequency polygon	Historigram	Ogive	None of these
28)	A graph of a cumulative frequency distribution is called:	Histogram	Historigram	Frequency polygon	Ogive
29)	The data related to import and export of Pakistan should be presented by:	Simple bar diagram	Multiple bar diagram	An ogive	Histogram
30)	The graph of a symmetrical distribution is:	U shaped	J shaped	Bell shaped	None of these
31)	Presentation of statistical data by geometrical curves is called:	Graphs	Diagrams	Both graph & diagram	None of these
32)	Translation of statistical data into	Graphs	Diagrams	Both graph & diagram	None of these

S#	Questions	Answers			
	geometrical figures is called:				

QUESTION NO. 2

Write the short answer to the following questions in the space provided

Q. 1: What is diagrammatic representation?

Ans: Presentation of statistical data by geometrical figures is called diagrammatic representation.

Q. 2: What are the types of diagrams?

Ans: The following are the different types of diagrammatic representation.

- | | |
|----------------------------------|-------------------------------|
| (i) One dimensional diagrams | (ii) Two dimensional diagrams |
| (iii) Three dimensional diagrams | (iv) Pie diagrams |
| (v) Pictograms | (vi) Cartograms |

Q. 3: What is a chart?

(Faisalabad Board, 2008)

Ans: A chart is a device used for presenting a statistical data in a simple, clear and effective manner.

Q. 4: Write any four types of diagrams.

(Faisalabad Board, 2009)

(Sargodha Board, 2010)

Ans: Following are the different types of diagrams

- | | |
|----------------------------------|-------------------------------|
| (i) One dimensional diagrams | (ii) Two dimensional diagrams |
| (iii) Three dimensional diagrams | (iv) Pie diagrams |
| (v) Pictogram | (vi) Cartograms |

Q. 5: Define a simple bar chart.

Ans: A simple bar chart consists of equally spaced vertical or horizontal bars of the same width, having heights proportional to the corresponding numerical values.

Q. 6: Define a multiple bar chart.

Ans: Multiple bar chart is used to represent two or more related sets of data having some common characteristics in a variable value.

Q. 7: Define subdivided or component bar chart.

Ans: The charts used to present the data which are to be shown in the parts are called subdivided or component bar charts.

Q. 8: Define two dimensional diagrams or charts.

Ans: In two dimensional diagrams two dimensions i.e. length and breadth is taken into account. These are called area diagrams.

Q. 9: What are the types of two dimensional diagram.

Ans: Following are the two dimensional diagrams: (i) Squares (ii) Rectangles (iii) Circles.

Q. 10: Define three dimensional diagrams or charts.

Ans: These diagrams are based on three dimensions i.e. length, breadth and thickness. These are called volume diagram.

Q. 11: What are the types of three dimensional diagrams?

Ans: Following are the three dimensional diagrams (i) Cubes (ii) Blocks (iii) Cylinder.

Q. 12: What is a pie diagram or chart?

(Lahore Board, 2008)

(Faisalabad Board, 2008 & 2010)

Ans: Pie chart consists of a circle divided into sectors whose area are proportional to the various parts into which the total quantity is divided.

Q. 13: What is the formula used to obtain the sector wise degree of angles?

Ans: Sector wise degree of angles can be calculated through the help of following formula.

$$\text{Angle of Sector} = \frac{360 \times \text{Figure of the Sector}}{\text{Aggregate i.e. Total}}$$

Q. 14: Define the pictograms.

Ans: When relative values of items are represented by symbols or pictures, it is called pictograms.

Q. 15: Define cartograms.

Ans: The used of maps in the representation of data is called cartograms.

Q. 16: What are the advantages of diagrams?

(Lahore Board, 2010)

Ans: Following are some advantage of diagrams.

- | | |
|--|----------------------------|
| (i) Attractive impression | (ii) Effective impression |
| (iii) Easy to understand | (iv) Helpful to economists |
| (v) Helpful in business and administration | |
| (vi) Helpful to all | |

Q. 17: Define the graph.

Ans: Presentation of statistical data into geometrical curves is called graphic representation of data.

Q. 18: What are main classes of graphs? Or name the types of graphs?

(Lahore Board, 2008)

(Gujranwala Board, 2010)

Ans: There are two main classes of graphs:

- (i) Graphs of time series or histogram
- (ii) Graphs of frequency distributions

Q. 19: What is the histogram?

(Faisalabad Board, 2010)

Ans: Histogram is a curve which shows the changes in the value of one or more variables from one period of time to the next.

Q. 20: What are the important graphs of frequency distributions?

(Lahore Board, 2008, 2009 & 2010

(Gujranwala Board, 2010)

(Sargodha Board, 2010)

Ans: Following are the important graphs of frequency distributions:

- (i) Histogram
- (ii) Frequency polygon
- (iii) Frequency curve
- (iv) Cumulative frequency polygon or ogive

Q. 21: Define Histogram.

(Lahore Board, 2008, 2009 & 2010; Gujranwala & Sargodha Board, 2010)

Ans: A histogram consists of a set of adjacent rectangles having bases along X-axis with centres at mid points and areas proportional to class frequencies.

Q. 22: What is the difference between histogram and historigram.

Ans: Histogram is the graph of frequency distribution where as historigram is the graph of a time series.

Q. 23: Define frequency polygon.

Ans: Frequency polygon is a graph that represent the data by using lines that connect points plotted for the frequencies at the mid points of the classes.

Q. 24: What is meant by frequency curve?

Ans: If the frequency polygon is smoothed, the resulting curve is called a frequency curve.

Q. 25: Define cumulative frequency polygon or ogive.

(Faisalabad Board, 2009)

Ans: An ogive is a graph drawn for the cumulative frequency distribution by joining with straight lines the dots marked above the upper boundaries of classes at heights equal to the cumulative frequencies of respective classes.

Q. 26: What are different methods of representation? Write two names.

(Lahore Board, 2010)

Ans: Following are the two methods of representation.

- (i) Graphical
- (ii) Tabular

Q. 27: For which distribution the graph is bell shaped?

Ans: For symmetrical distribution the graph is bell shaped.

Q. 28: What do you meant by bivariate frequency distribution?

Ans: The constructed frequency distribution, considering two variables at a time is called bivariate frequency distribution.

ANSWERS

QUESTION NO. 1

- | | |
|---|--------------------------------|
| 1) 360° | 2) Four parts |
| 3) Ogive | 4) Diagrammatic representation |
| 5) Historigram | 6) Frequency curve |
| 7) Curve | 8) Cumulative frequency |
| polygon | |
| 9) 360° | 10) Graphic representation |
| 11) Two | 12) Grouped data |
| 13) Diagrammatic representation | 14) Graphic representation |
| 15) Length and breadth | 16) Component bar diagrams |
| 17) Two | 18) Four Types |
| 19) Class Boundaries | 20) Histogram |
| 21) Frequency Polygon | 22) Multiple Bar Diagram |
| 23) Histogram | 24) Pie chart |
| 25) $\frac{\text{Component Part}}{\text{Total}} \times 360^{\circ}$ | 26) Historigram |
| 27) Frequency polygon | 28) Ogive |
| 29) Multiple bar diagram | 30) Bell shaped |
| 31) Graphs | 32) Diagrams |

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