# STATISTICS

# 22 Graphical Representation

In chapter 22 (Understanding I.C.S.E. Mathematics Class IX), we studied about statistical data (raw and grouped), frequency distribution and cumulative frequency distribution etc. We also represented the information contained in a numerical data (frequency distribution) graphically. In this chapter, we shall learn the ways of representing grouped data (both continuous and discontinuous) by histograms and ogives.

## 22.1 HISTOGRAM

*A histogram represents a continuous grouped data and it consists of a set of adjacent rectangles.*

**Procedure to draw a histogram :**

(i) Take the breadth of a rectangle equal to a class size and mark it along $x$-axis, the end points of which correspond to the class limits.

(ii) Take the length of a rectangle equal to the frequency of that class (assuming classes are of equal size) and mark it along $y$-axis.

(iii) Construct rectangles corresponding to each class with the help of steps (i) and (ii).

### Remarks

❒ A histogram consists of a set of adjacent rectangles whose bases are equal to class sizes and heights are equal to class frequencies (assuming classes are of equal size).

❒ The total area of the histogram = sum of areas of all rectangles. In particular, if the class-intervals are of same size (width), then the area of histogram = $Nk$, where $k$ = size of a class and $N$ = sum of frequencies of all classes.

❒ In a histogram, the area of a rectangle represents the frequency of the class. Therefore, if the classes are of unequal size (width) then the heights of rectangles are not equal to the frequencies of the corresponding classes. However, we shall be dealing only with the problems in which class widths are equal.

❒ If the frequency distribution is discontinuous (inclusive), change it to continuous (exclusive) and then construct histogram. See example 4.

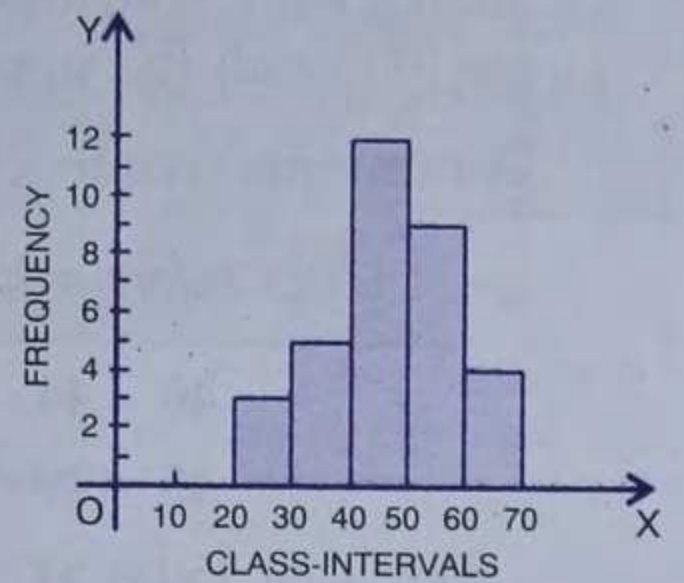**Example 1.** *Draw a histogram to represent the following data :*

| Class-intervals | 20 – 30 | 30 – 40 | 40 – 50 | 50 – 60 | 60 – 70 |
|---|---|---|---|---|---|
| Frequency | 3 | 5 | 12 | 9 | 4 |

**Solution.** *Steps.*

(*i*) Take 1 cm on *x*-axis = 10 units.

(*ii*) Take 1 cm on *y*-axis = 2 frequency.

(*iii*) Construct rectangles corresponding to given data.

The required histogram is shown in the figure given alongside.

**Example 2.** *Draw a histogram for the following data :*

| Height (cm) | 150 – 160 | 160 – 170 | 170 – 180 | 180 – 190 | 190 – 200 |
|---|---|---|---|---|---|
| No. of students | 8 | 3 | 4 | 10 | 2 |

**Solution.** *Steps.*

(*i*) Since the scale on *x*-axis starts at 150, a break (kink or zig-zag curve) is shown near the origin along *x*-axis to indicate that the graph is drawn to scale beginning at 150 and not at the origin itself.

(*ii*) Take 1 cm on *x*-axis = 10 cm (height).

(*iii*) Take 1 cm on *y*-axis = 2 (no. of students).

(*iv*) Construct rectangles corresponding to the given data.

The required histogram is shown in the adjoining diagram.
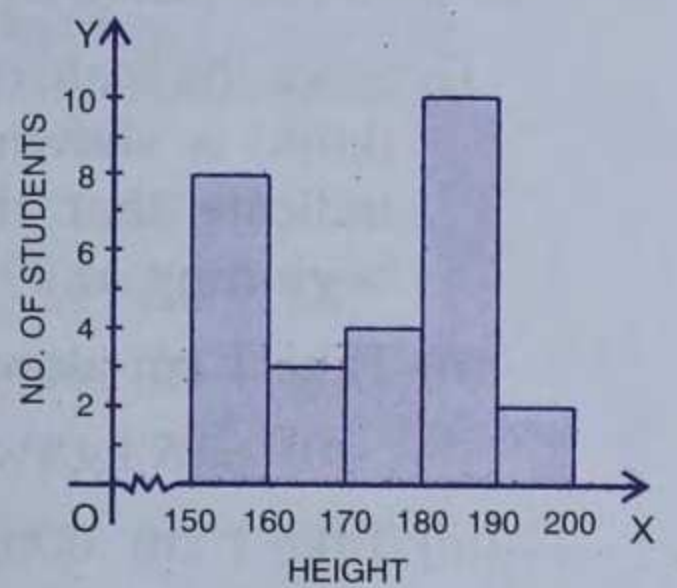
**Example 3.** *Draw a histogram for the following data :*

| Daily pocket money in ₹ | 10 – 20 | 20 – 30 | 30 – 40 | 40 – 50 | 50 – 60 |
|---|---|---|---|---|---|
| No. of students | 11 | 13 | 13 | 9 | 4 |

**Solution.** *To construct histogram :*

(*i*) Take 1 cm along *x*-axis = ₹ 10.

(*ii*) Take 1 cm along *y*-axis = 2 students.

(*iii*) Construct rectangles corresponding to the above continuous frequency distribution table.

The required histogram is shown in the adjoining diagram.
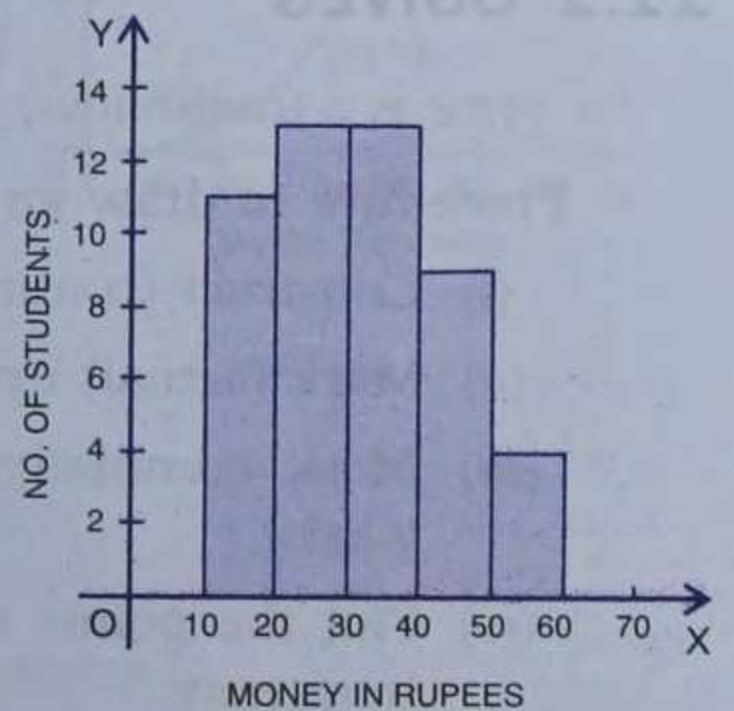
**Example 4.** *Draw a histogram for the following data :*

| Wt. in kg | 40 – 44 | 45 – 49 | 50 – 54 | 55 – 59 | 60 – 64 | 65 – 69 |
|---|---|---|---|---|---|---|
| No. of students | 2 | 8 | 12 | 10 | 6 | 4 |

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**Solution.** The given frequency distribution is discontinuous, to convert it into continuous frequency distribution,

$$\text{adjustment factor} = \frac{\text{lower limit of one class} - \text{upper limit of previous class}}{2}$$

$$= \frac{45 - 44}{2} = \frac{1}{2} = \cdot 5.$$

Subtract the adjustment factor (·5) from all the lower limits and add the adjustment factor (·5) to all the upper limits.

Continuous frequency distribution for the given data is :

| Classes before adjustment | Classes after adjustment | Frequency |
|---|---|---|
| 40 – 44 | 39·5 – 44·5 | 2 |
| 45 – 49 | 44·5 – 49·5 | 8 |
| 50 – 54 | 49·5 – 54·5 | 12 |
| 55 – 59 | 54·5 – 59·5 | 10 |
| 60 – 64 | 59·5 – 64·5 | 6 |
| 65 – 69 | 64·5 – 69·5 | 4 |

*To construct histogram :*

(i) Since the scale on *x*-axis starts at 39·5, a break (kink) is shown near the origin on *x*-axis to indicate that the graph is drawn to scale beginning at 39·5.

(ii) Take 1 cm along *x*-axis
= 5 kg (weight).

(iii) Take 1 cm along *y*-axis
= 2 (no. of students).

(iv) Construct rectangles corresponding to the continuous frequency distribution given in the above table.
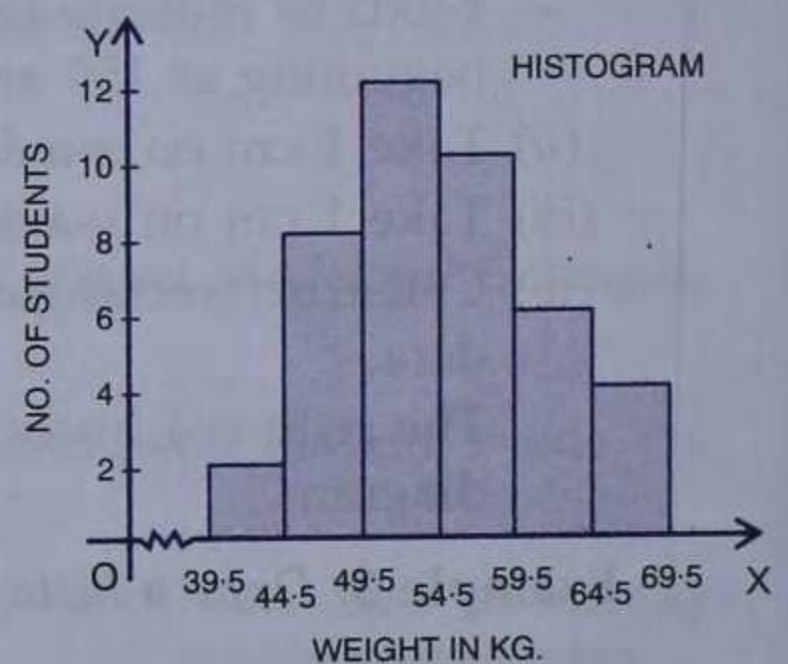


The required histogram is shown in the adjoining figure.

## 22.2 OGIVES

*An ogive is a (continuous) cumulative frequency curve.*

**Procedure to draw an ogive :**

(i) Construct (continuous) cumulative frequency table.

(ii) Mark (actual) upper class limits along *x*-axis.

(iii) Mark cumulative frequency against the respective upper class limit along *y*-axis.

(iv) Plot the points representing upper class limits and the respective cumulative frequency.

(v) Plot the point representing lower limit of the first class on *x*-axis.

(vi) Join these points (of step (iv) and (v)) by a *free hand smooth curve.*
The curve so obtained is the required ogive.

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- ❏ An ogive (cumulative frequency curve) is started from a point on x-axis representing the lower limit of the first class and is terminated at the upper limit of the last class.
- ❏ The ogive obtained by the above process is an *ascending* (or a *rising*) curve and it is called *'less than'* ogive. However, if we accumulate the frequencies from the opposite end of the frequency table we shall obtain a *'more than'* cumulative frequency table instead of *'less than'* table, and can draw an ogive which will be a *descending* graph.

## ILLUSTRATIVE EXAMPLES

**Example 1.** *Draw an ogive for the following frequency distribution :*

| Marks obtained | 50 – 60 | 60 – 70 | 70 – 80 | 80 – 90 | 90 – 100 |
|---|---|---|---|---|---|
| No. of students | 4 | 8 | 12 | 6 | 10 |

**Solution.** *To draw an ogive :*

(i) The cumulative frequency table for the given (continuous) frequency distribution is :

| Marks obtained (class-interval) | No. of students (frequency) | Cumulative frequency |
|---|---|---|
| 50 – 60 | 4 | 4 |
| 60 – 70 | 8 | 12 (4 + 8) |
| 70 – 80 | 12 | 24 (12 + 12) |
| 80 – 90 | 6 | 30 (24 + 6) |
| 90 – 100 | 10 | 40 (30 + 10) |

(ii) Since the scale on x-axis starts at 50, a kink is shown near the origin on x-axis to indicate that the graph is drawn to scale beginning at 50.

(iii) Take 1 cm along x-axis = 10 (marks).

(iv) Take 1 cm along y-axis = 8 (students).

(iv) Plot the points (60, 4), (70, 12), (80, 24), (90, 30) and (100, 40) representing upper class limits and the respective cumulative frequencies.
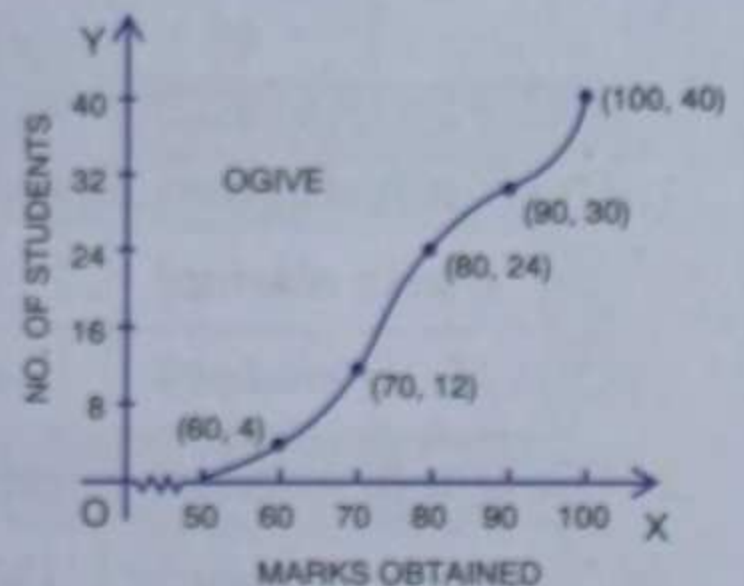
Also plot the point representing lower limit of the first class *i.e.* 50 – 60.

(vi) Join these points by a free hand drawing.

The required ogive is shown in the adjoining figure.

**Example 2.** *100 pupils in a school have heights as tabulated below :*

| Height in cm | 121 – 130 | 131 – 140 | 141 – 150 | 151 – 160 | 161 – 170 | 171 – 180 |
|---|---|---|---|---|---|---|
| No. of pupils | 12 | 16 | 30 | 20 | 14 | 8 |

*Draw the ogive for the above data.*

**Solution.** *To draw an ogive :*

(i) The given frequency distribution is discontinuous, to convert it into continuous distribution,

$$\text{adjustment factor} = \frac{\text{lower limit of one class} - \text{upper limit of previous class}}{2}$$

$$= \frac{131 - 130}{2} = \frac{1}{2} = \cdot 5.$$

Cumulative continuous frequency table for the given data is :

| Classes before adjustment | Classes after adjustment | Frequency | Cumulative Frequency |
|---|---|---|---|
| 121 – 130 | 120·5 – 130·5 | 12 | 12 |
| 131 – 140 | 130·5 – 140·5 | 16 | 28  (12 + 16) |
| 141 – 150 | 140·5 – 150·5 | 30 | 58  (28 + 30) |
| 151 – 160 | 150·5 – 160·5 | 20 | 78  (58 + 20) |
| 161 – 170 | 160·5 – 170·5 | 14 | 92  (78 + 14) |
| 171 – 180 | 170·5 – 180·5 | 8 | 100  (92 + 8) |
| Total | | | 100 |

(ii) Since the scale on *x*-axis starts at 120·5, a kink is shown near the origin on *x*-axis to indicate that the graph is drawn to scale beginning at 120·5.
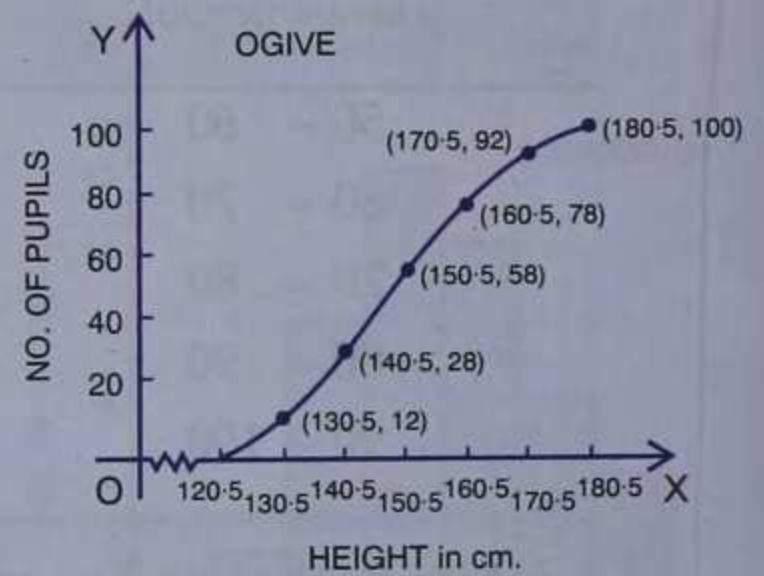
(iii) Take 1 cm along *x*-axis
= 10 cm (height).

(iv) Take 1 cm along *y*-axis
= 20 (pupils).

(v) Plot the points representing upper class limits and the respective cumulative frequencies. Also plot the point representing lower limit of first class *i.e.* 120·5 – 130·5.

(vi) Join these points by a free hand drawing.

The required ogive is shown in the adjoining figure.



# Exercise 22

1. Draw a histogram to represent the following data :

| Marks obtained | 0 – 10 | 10 – 20 | 20 – 30 | 30 – 40 | 40 – 50 | 50 – 60 |
|---|---|---|---|---|---|---|
| No. of students | 4 | 10 | 6 | 8 | 5 | 9 |

2. Draw a histogram to represent the following data :

| Pocket money (in ₹) | 150 – 200 | 200 – 250 | 250 – 300 | 300 – 350 | 350 – 400 |
|---|---|---|---|---|---|
| No. of students | 10 | 5 | 7 | 4 | 3 |

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3. Draw a histogram for the following data :

| Class marks | 12·5 | 17·5 | 22·5 | 27·5 | 32·5 | 37·5 |
|---|---|---|---|---|---|---|
| Frequency | 7 | 12 | 20 | 28 | 8 | 11 |

**Hint**

Classes are 10 – 15, 15 – 20, 20 – 25, 25 – 30, 30 – 35, 35 – 40.

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**4.** Construct a histogram for the following data :

| Weekly earnings (in rupees) | 150 – 165 | 165 – 180 | 180 – 195 | 195 – 210 | 210 – 225 | 225 – 240 |
|---|---|---|---|---|---|---|
| No. of workers | 8 | 14 | 22 | 12 | 15 | 6 |

**5.** In a study of diabetic patients, the following data were obtained :

| Age (in years) | 10 – 20 | 20 – 30 | 30 – 40 | 40 – 50 | 50 – 60 | 60 – 70 | 70 – 80 |
|---|---|---|---|---|---|---|---|
| No. of patients | 3 | 8 | 30 | 36 | 27 | 15 | 6 |

Represent the above data by a histogram.

**6.** Draw a histogram for the following data :

| Wt. in kg | 40 – 44 | 45 – 49 | 50 – 54 | 55 – 59 | 60 – 64 | 65 – 69 |
|---|---|---|---|---|---|---|
| No. of students | 3 | 7 | 12 | 9 | 6 | 4 |

**Hint**

Convert it into continuous distribution.

**7.** Draw an ogive for the following frequency distribution :

| Height (in cm) | 150 – 160 | 160 – 170 | 170 – 180 | 180 – 190 | 190 – 200 |
|---|---|---|---|---|---|
| No. of students | 8 | 3 | 4 | 10 | 2 |

**8.** Draw an ogive for the following data :

| Marks obtained | 24 – 29 | 29 – 34 | 34 – 39 | 39 – 44 | 44 – 49 | 49 – 54 | 54 – 59 |
|---|---|---|---|---|---|---|---|
| No. of students | 1 | 2 | 5 | 6 | 4 | 3 | 2 |

**9.** Draw an ogive for the following data :

| Class-intervals | 1 – 10 | 11 – 20 | 21 – 30 | 31 – 40 | 41 – 50 | 51 – 60 |
|---|---|---|---|---|---|---|
| Frequency | 3 | 5 | 8 | 7 | 6 | 2 |

# CHAPTER TEST

1. Draw a histogram showing marks obtained by the students of a school in a Mathematics paper carrying 100 marks.

| Marks | 0 – 10 | 10 – 20 | 20 – 30 | 30 – 40 | 40 – 50 | 50 – 60 | 60 – 70 |
|-------|--------|---------|---------|---------|---------|---------|---------|
| Students | 4 | 5 | 10 | 8 | 30 | 40 | 60 |

| | | continued | | 70 – 80 | 80 – 90 | 90 – 100 |
|---|---|---|---|---------|---------|----------|
| | | | | 15 | 6 | 3 |

2. In a class of 60 boys, the marks obtained in a monthly test were as under :

| Marks | 14–20 | 20–26 | 26–32 | 32–38 | 38–44 | 44–50 | 50–56 | 56–62 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| No. of Students | 4 | 10 | 9 | 15 | 12 | 5 | 3 | 2 |

Represent the above data by a histogram.

3. Construct a histogram for the following distribution :

| Class-intervals (Marks obtained) | 19–20 | 21–22 | 23–24 | 25–26 | 27–28 | 29–30 |
|----------------------------------|-------|-------|-------|-------|-------|-------|
| No. of Students (frequency) | 3 | 5 | 10 | 10 | 5 | 2 |

4. Draw a cumulative frequency curve for the following distribution :

| Age (in years) | 0–9 | 10–19 | 20–29 | 30–39 | 40–49 | 50–59 | 60–69 |
|----------------|-----|-------|-------|-------|-------|-------|-------|
| No. of patients | 4 | 6 | 7 | 11 | 12 | 8 | 5 |