CHAPTER 14

# Statistics

NCERT FOCUS

## SOLUTIONS

### EXERCISE - 14.1

**1.** We have the following table:

| Number of plants | Number of Houses ($f_i$) | Class mark ($x_i$) | $f_i x_i$ |
|---|---|---|---|
| 0 - 2 | 1 | 1 | 1 |
| 2 - 4 | 2 | 3 | 6 |
| 4 - 6 | 1 | 5 | 5 |
| 6 - 8 | 5 | 7 | 35 |
| 8 - 10 | 6 | 9 | 54 |
| 10 - 12 | 2 | 11 | 22 |
| 12 - 14 | 3 | 13 | 39 |
| Total | $\Sigma f_i = 20$ | | $\Sigma f_i x_i = 162$ |

$\therefore$ Mean, $\bar{x} = \frac{\sum f_i x_i}{\Sigma f_i} = \frac{162}{20} = 8.1$

Thus, mean number of plants per house is 8.1. We have used the direct method because values of $x_i$ and $f_i$ are small.

**2.** Let the assumed mean, $a = 550$

$\because$ Class size, $h = 20$

$\therefore$ $u_i = \frac{x_i - a}{h} = \frac{x_i - 550}{20}$

$\therefore$ We have the following table :

| Class-interval | Frequency ($f_i$) | Class mark ($x_i$) | $u_i = \frac{x_i - 550}{20}$ | $f_i u_i$ |
|---|---|---|---|---|
| 500 - 520 | 12 | 510 | – 2 | – 24 |
| 520 - 540 | 14 | 530 | – 1 | – 14 |
| 540 - 560 | 8 | 550 | 0 | 0 |
| 560 - 580 | 6 | 570 | 1 | 6 |
| 580 - 600 | 10 | 590 | 2 | 20 |
| Total | $\Sigma f_i = 50$ | | | $\Sigma f_i u_i = -12$ |

$\therefore$ Mean, $\bar{x} = a + h \times \left\{\frac{\sum f_i u_i}{\Sigma f_i}\right\}$

$= 550 + 20 \times \left(\frac{-12}{50}\right) = 550 - \frac{24}{5} = 550 - 4.8 = 545.2$

Hence, the mean daily wages of workers is ₹ 545.2.

**3.** Let the assumed mean, $a = 18$

$\because$ Class size, $h = 2$

$\therefore$ $u_i = \frac{x_i - a}{h} = \frac{x_i - 18}{2}$

Now, we have the following table:

| Class-interval | Frequency ($f_i$) | Class mark ($x_i$) | $u_i = \frac{x_i - 18}{2}$ | $f_i u_i$ |
|---|---|---|---|---|
| 11 - 13 | 7 | 12 | – 3 | –21 |
| 13 - 15 | 6 | 14 | – 2 | –12 |
| 15 - 17 | 9 | 16 | – 1 | –9 |
| 17 - 19 | 13 | 18 | 0 | 0 |
| 19 - 21 | $f$ | 20 | 1 | $f$ |
| 21 - 23 | 5 | 22 | 2 | 10 |
| 23 - 25 | 4 | 24 | 3 | 12 |
| Total | $\Sigma f_i = (f + 44)$ | | | $\Sigma f_i u_i = f - 20$ |

$\therefore$ Mean, $\bar{x} = a + h \times \frac{\sum f_i u_i}{\Sigma f_i}$

$\Rightarrow 18 = 18 + 2\left(\frac{f - 20}{f + 44}\right) \Rightarrow 0 = 2\left(\frac{f - 20}{f + 44}\right)$

$\Rightarrow 2(f - 20) = 0 \Rightarrow f = 20$

Thus, missing frequency is 20.

**4.** Let the assumed mean, $a = 75.5$

$\because$ Class size, $h = 3$

$\therefore$ $u_i = \frac{x_i - a}{h} = \frac{x_i - 75.5}{3}$

Now, we have the following table :

| Class-interval | Frequency ($f_i$) | Class mark ($x_i$) | $u_i = \frac{x_i - 75.5}{3}$ | $f_i u_i$ |
|---|---|---|---|---|
| 65 - 68 | 2 | 66.5 | –3 | –6 |
| 68 - 71 | 4 | 69.5 | –2 | –8 |
| 71 - 74 | 3 | 72.5 | –1 | –3 |
| 74 - 77 | 8 | 75.5 | 0 | 0 |
| 77 - 80 | 7 | 78.5 | 1 | 7 |
| 80 - 83 | 4 | 81.5 | 2 | 8 |
| 83 - 86 | 2 | 84.5 | 3 | 6 |
| Total | $\Sigma f_i = 30$ | | | $\sum f_i u_i = 4$ |

$\therefore$ Mean, $\bar{x} = a + h \times \left\{\frac{\sum f_i u_i}{\Sigma f_i}\right\} = 75.5 + 3 \times \frac{4}{30} = 75.5 + \frac{4}{10}$

$= 75.5 + 0.4 = 75.9$

Thus, the mean heartbeats per minute is 75.9.

**5.** Let the assumed mean, $a = 57$

$\therefore$ $d_i = x_i - 57$

Now, we have the following table:

| Number of Mangoes | Frequency ($f_i$) | Class mark ($x_i$) | $d_i = x_i - 57$ | $f_i d_i$ |
|---|---|---|---|---|
| 50 - 52 | 15 | 51 | –6 | –90 |
| 53 - 55 | 110 | 54 | –3 | –330 |
| 56 - 58 | 135 | 57 | 0 | 0 |
| 59 - 61 | 115 | 60 | 3 | 345 |
| 62 - 64 | 25 | 63 | 6 | 150 |
| Total | $\Sigma f_i = 400$ | | | $\Sigma f_i d_i = 75$ |

$\therefore$ Mean, $\bar{x} = a + \frac{\Sigma f_i d_i}{\Sigma f_i} = 57 + \frac{75}{400} = 57 + 0.1875$

$= 57.1875 \approx 57.19$

Thus, the average number of mangoes per box = 57.19.

We choose assumed mean method.

**6.** Let the assumed mean, $a = 225$

And class size, $h = 50$

$\therefore\ u_i = \frac{x_i - a}{h} = \frac{x_i - 225}{50}$

Now, we have the following table:

| Daily expenditure (in ₹) | Frequency ($f_i$) | Class mark ($x_i$) | $u_i = \frac{x_i - 225}{50}$ | $f_i u_i$ |
|---|---|---|---|---|
| 100 - 150 | 4 | 125 | –2 | –8 |
| 150 - 200 | 5 | 175 | –1 | –5 |
| 200 - 250 | 12 | 225 | 0 | 0 |
| 250 - 300 | 2 | 275 | 1 | 2 |
| 300 - 350 | 2 | 325 | 2 | 4 |
| Total | $\Sigma f_i = 25$ | | | $\Sigma f_i u_i = -7$ |

$\therefore$ Mean, $\bar{x} = a + h \times \left(\frac{\Sigma f_i u_i}{\Sigma f_i}\right) = 225 + 50\left(\frac{-7}{25}\right)$

$= 225 + 2(-7) = 225 - 14 = 211$

Thus, the mean daily expenditure on food is ₹ 211.

**7.** Let the assumed mean, $a = 0.14$

Here, class size, $h = 0.04$

$\therefore\ u_i = \frac{x_i - a}{h} = \frac{x_i - 0.14}{0.04}$

$\therefore$ We have the following table:

| Class-intervals | Frequency ($f_i$) | Class mark ($x_i$) | $u_i = \frac{x_i - 0.14}{0.04}$ | $f_i u_i$ |
|---|---|---|---|---|
| 0.00-0.04 | 4 | 0.02 | –3 | –12 |
| 0.04-0.08 | 9 | 0.06 | –2 | –18 |
| 0.08-0.12 | 9 | 0.10 | –1 | –9 |
| 0.12-0.16 | 2 | 0.14 | 0 | 0 |
| 0.16-0.20 | 4 | 0.18 | 1 | 4 |
| 0.20-0.24 | 2 | 0.22 | 2 | 4 |
| Total | $\Sigma f_i = 30$ | | | $\Sigma f_i u_i = -31$ |

$\therefore$ Mean, $\bar{x} = a + h \times \left[\frac{\Sigma f_i u_i}{\Sigma f_i}\right] = 0.14 + 0.04\left[\frac{-31}{30}\right]$

$= 0.14 - 0.041 = 0.099$

$\therefore$ Mean concentration of $SO_2$ in air is 0.099 ppm.

**8.** Using the direct method, we have the following table:

| Number of days | Frequency ($f_i$) | Class mark ($x_i$) | $f_i x_i$ |
|---|---|---|---|
| 0 - 6 | 11 | 3 | 33 |
| 6 - 10 | 10 | 8 | 80 |
| 10 - 14 | 7 | 12 | 84 |
| 14 - 20 | 4 | 17 | 68 |
| 20 - 28 | 4 | 24 | 96 |
| 28 - 38 | 3 | 33 | 99 |
| 38 - 40 | 1 | 39 | 39 |
| Total | $\Sigma f_i = 40$ | | $\Sigma f_i x_i = 499$ |

$\therefore$ Mean, $\bar{x} = \frac{\sum f_i x_i}{\Sigma f_i} = \frac{499}{40} = 12.475$

Thus, mean number of days a student remained absent = 12.48.

**9.** Let assumed mean, $a = 70$

Here, class size, $h = 10$

$\therefore\ u_i = \frac{x_i - a}{h} = \frac{x_i - 70}{10}$

Now, we have the following table:

| Literacy rate (in %) | Frequency ($f_i$) | Class mark ($x_i$) | $u_i = \frac{x_i - 70}{10}$ | $f_i u_i$ |
|---|---|---|---|---|
| 45 - 55 | 3 | 50 | –2 | –6 |
| 55 - 65 | 10 | 60 | –1 | –10 |
| 65 - 75 | 11 | 70 | 0 | 0 |
| 75 - 85 | 8 | 80 | 1 | 8 |
| 85 - 95 | 3 | 90 | 2 | 6 |
| Total | $\Sigma f_i = 35$ | | | $\Sigma f_i u_i = -2$ |

$\therefore$ Mean, $\bar{x} = a + h \times \left[\frac{\Sigma f_i u_i}{\Sigma f_i}\right] = 70 + 10\left[\frac{-2}{35}\right]$

$= 70 + \left[\frac{-4}{7}\right] = \frac{486}{7} = 69.4285 = 69.43$ (approx.)

Thus, the mean literacy rate is 69.43%.

## EXERCISE - 14.2

**1.** Mode : Here, the highest frequency is 23.

The frequency 23 corresponds to the class interval 35-45.

$\therefore$ The modal class is 35-45.

Now, class size, $h = 10$, lower limit, $l = 35$

Frequency of the modal class ($f_1$) = 23

Frequency of the class preceding the modal class ($f_0$) = 21

Frequency of the class succeeding the modal class ($f_2$) = 14

$\therefore$ Mode $= l + \left[\dfrac{f_1 - f_0}{2f_1 - f_0 - f_2}\right] \times h$

$= 35 + \left[\dfrac{23-21}{2\times 23 - 21 - 14}\right]\times 10 = 35 + \left[\dfrac{2}{46-35}\right]\times 10$

$= 35 + \dfrac{20}{11} = 35 + 1.8$ (Approx.) $= 36.8$ years (Approx.)

Mean : Let assumed mean, $a = 40$, $h = 10$

| **Age (in years)** | **Frequency ($f_i$)** | **Class Mark ($x_i$)** | $u_i = \dfrac{x_i - 40}{10}$ | $f_iu_i$ |
|---|---|---|---|---|
| 5 - 15 | 6 | 10 | –3 | –18 |
| 15 - 25 | 11 | 20 | –2 | – 22 |
| 25 - 35 | 21 | 30 | –1 | – 21 |
| 35 - 45 | 23 | 40 | 0 | 0 |
| 45 - 55 | 14 | 50 | 1 | 14 |
| 55 - 65 | 5 | 60 | 2 | 10 |
| Total | $\Sigma f_i = 80$ | | | $\Sigma f_i u_i = -37$ |

$\therefore$ Mean, $\bar{x} = a + h \times \left[\dfrac{\sum f_iu_i}{\Sigma f_i}\right] = 40 + 10\left[\dfrac{-37}{80}\right]$

$= 40 - \dfrac{37}{8} = \dfrac{283}{8} = 35.375$

$\therefore$ Required mean = 35.37 years.

**Interpretation :** The maximum number of patients admitted in the hospital are of age 36.8 years while the average age of patients is 35.37 years.

**2.** Here, the highest frequency = 61

$\because$ The frequency 61 corresponds to class 60 – 80.

$\therefore$ The modal class is 60 – 80.

$\therefore$ We have, $l = 60$, $h = 20$, $f_1 = 61$, $f_0 = 52$, $f_2 = 38$.

$\therefore$ Mode $= l + \left[\dfrac{f_1 - f_0}{2f_1 - f_0 - f_2}\right] \times h$

$= 60 + \left[\dfrac{61-52}{2\times 61 - 52 - 38}\right]\times 20 = 60 + \left[\dfrac{9}{122-90}\right]\times 20$

$= 60 + \dfrac{180}{32} = 60 + \dfrac{45}{8} = 60 + 5.625 = 65.625$ hours.

Thus, the required modal lifetimes of the components is 65.625 hours.

**3.** Mode :

$\because$ The maximum number of families is 40 having their total monthly expenditure in the interval 1500-2000.

$\therefore$ Modal class is 1500-2000

So, $l = 1500$, $h = 500$, $f_1 = 40$, $f_0 = 24$, $f_2 = 33$

$\therefore$ Mode $= l + \left[\dfrac{f_1 - f_0}{2f_1 - f_0 - f_2}\right] \times h$

$= 1500 + \left[\dfrac{40-24}{2\times 40 - 24 - 33}\right]\times 500 = 1500 + \left[\dfrac{16}{80-57}\right]\times 500$

$= 1500 + \dfrac{8000}{23} = 1500 + 347.83 = 1847.83$

Thus, the required modal monthly expenditure of the families is ₹ 1847.83.

Mean: Let assumed mean ($a$) = 3250 and class size, $h = 500$

$\therefore$ We have the following table:

| **Expenditure (in ₹)** | **Number of families ($f_i$)** | **Class mark ($x_i$)** | $u_i = \dfrac{x_i - 3250}{500}$ | $f_iu_i$ |
|---|---|---|---|---|
| 1000 - 1500 | 24 | 1250 | –4 | –96 |
| 1500 - 2000 | 40 | 1750 | –3 | –120 |
| 2000 - 2500 | 33 | 2250 | –2 | –66 |
| 2500 - 3000 | 28 | 2750 | –1 | –28 |
| 3000 - 3500 | 30 | 3250 | 0 | 0 |
| 3500 - 4000 | 22 | 3750 | 1 | 22 |
| 4000 - 4500 | 16 | 4250 | 2 | 32 |
| 4500 - 5000 | 7 | 4750 | 3 | 21 |
| Total | $\Sigma f_i = 200$ | | | $\Sigma f_iu_i = -235$ |

$\therefore \quad \bar{x} = a + h \times \left[\dfrac{\sum f_iu_i}{\Sigma f_i}\right] = 3250 + 500 \times \left[\dfrac{-235}{200}\right]$

$= 3250 - \dfrac{1175}{2} = 3250 - 587.50 = 2662.5$

Thus, the mean monthly expenditure is ₹ 2662.50.

**4.** Mode : Since greatest frequency 10 corresponds to class 30-35.

$\therefore$ Modal Class = 30-35 and $h = 5$, $l = 30$, $f_1 = 10$, $f_0 = 9$, $f_2 = 3$

$\therefore$ Mode $= l + \left[\dfrac{f_1 - f_0}{2f_1 - f_0 - f_2}\right] \times h = 30 + \left[\dfrac{10-9}{2\times 10 - 9 - 3}\right]\times 5$

$= 30 + \dfrac{1}{8}\times 5 = 30 + 0.625 = 30.6$ (Approx.)

Mean : Let the assumed mean, $a = 37.5$ and class size, $h = 5$

$\therefore$ We have the following table:

| **Number of students per teacher** | **Frequency ($f_i$)** | **Class mark ($x_i$)** | $u_i = \dfrac{x_i - 37.5}{5}$ | $f_iu_i$ |
|---|---|---|---|---|
| 15 - 20 | 3 | 17.5 | – 4 | –12 |
| 20 - 25 | 8 | 22.5 | –3 | –24 |
| 25 - 30 | 9 | 27.5 | –2 | –18 |
| 30 - 35 | 10 | 32.5 | –1 | –10 |
| 35 - 40 | 3 | 37.5 | 0 | 0 |
| 40 - 45 | 0 | 42.5 | 1 | 0 |
| 45 - 50 | 0 | 47.5 | 2 | 0 |
| 50 - 55 | 2 | 52.5 | 3 | 6 |
| Total | $\Sigma f_i = 35$ | | | $\Sigma f_iu_i = -58$ |

$\therefore$ Mean, $\bar{x} = a + h \times \left[\dfrac{\sum f_iu_i}{\Sigma f_i}\right]$

$= 37.5 + 5 \times \left[\dfrac{-58}{35}\right] = 37.5 - 8.3 = 29.2.$

**Interpretation :** The maximum teacher-student ratio is 30.6 while average teacher-student ratio is 29.2.

**5.** The class 4000-5000 has the highest frequency *i.e.*, 18

$\therefore$ Modal class = 4000-5000

Also, $h = 1000$, $l = 4000$, $f_1 = 18$, $f_0 = 4$, $f_2 = 9$

$\therefore$ Mode $= l+\left[\dfrac{f_1-f_0}{2f_1-f_0-f_2}\right]\times h$

$= 4000+\left[\dfrac{18-4}{2\times18-4-9}\right]\times1000 = 4000+1000\left[\dfrac{14}{23}\right]$

$= 4000+608.695 = 4608.7$ (Approx.)

Thus, the required mode is 4608.7.

**6.** $\because$ The class 40-50 has the maximum frequency *i.e.*, 20

$\therefore$ Modal class = 40-50

$\therefore$ $l = 40, f_1 = 20, f_0 = 12, f_2 = 11$ and $h = 10$.

$\therefore$ Mode $= l+\left[\dfrac{f_1-f_0}{2f_1-f_0-f_2}\right]\times h$

$= 40+\left[\dfrac{20-12}{2\times20-12-11}\right]\times10 = 40+10\left[\dfrac{8}{40-23}\right]$

$= 40+\dfrac{80}{17} = 40+4.7 = 44.7$

Thus, the required mode is 44.7

## EXERCISE - 14.3

**1.** We have the following table :

| Monthly Consumption (in units) | Number of Consumers ($f_i$) | Cumulative Frequency (*c.f.*) |
|---|---|---|
| 65 - 85 | 4 | 4 |
| 85 - 105 | 5 | 4 + 5 = 9 |
| 105 - 125 | 13 | 9 + 13 = 22 |
| 125 - 145 | 20 | 22 + 20 = 42 |
| 145 - 165 | 14 | 42 + 14 = 56 |
| 165 - 185 | 8 | 56 + 8 = 64 |
| 185 - 205 | 4 | 64 + 4 = 68 |
| Total | $\Sigma f_i = 68$ | |

We have, $n = 68 \Rightarrow \dfrac{n}{2} = \dfrac{68}{2} = 34$

Cumulative frequency just greater than 34 is 42 and corresponding class-interval is 125-145.

$\therefore$ 125-145 is the median class.

So, $l = 125$, $c.f. = 22$, $f = 20$ and $h = 20$

$\therefore$ Median $= l+\left[\dfrac{\frac{n}{2}-c.f.}{f}\right]\times h = 125+\left[\dfrac{34-22}{20}\right]\times20$

$= 125+\dfrac{12}{20}\times20 = 125 + 12 = 137$ units.

Here, $h = 20$

| Class mark ($x_i$) | $f_i$ | $u_i = \dfrac{x_i-135}{h}$ | $f_iu_i$ |
|---|---|---|---|
| 75 | 4 | –3 | –12 |
| 95 | 5 | –2 | –10 |
| 115 | 13 | –1 | –13 |
| 135 = $a$ (let) | 20 | 0 | 0 |
| 155 | 14 | 1 | 14 |
| 175 | 8 | 2 | 16 |
| 195 | 4 | 3 | 12 |
| Total | $\Sigma f_i = 68$ | | $\Sigma f_iu_i = 7$ |

$\therefore$ Mean, $\bar{x} = a+h\times\left\{\dfrac{\sum f_iu_i}{\Sigma f_i}\right\}$

$= 135+20\times\dfrac{7}{68} = 135+2.05 = 137.05$ units.

Now, we find the mode.

$\because$ Class 125-145 has the highest frequency.

$\therefore$ This is the modal class.

So, $h = 20$, $l = 125$, $f_1 = 20$, $f_0 = 13$, $f_2 = 14$

$\therefore$ Mode $= l+\left[\dfrac{f_1-f_0}{2f_1-f_0-f_2}\right]\times h$

$= 125+\left[\dfrac{20-13}{2\times20-13-14}\right]\times20$

$= 125+\dfrac{140}{13} = 125+10.76 = 135.76$ units.

We observe that the three measures are approximately equal.

**2.** Cumulative frequency table for the given data can be drawn as:

| Class-interval | Frequency ($f_i$) | Cumulative frequency (*c.f.*) |
|---|---|---|
| 0 - 10 | 5 | 5 |
| 10 - 20 | $x$ | 5 + $x$ |
| 20 - 30 | 20 | 25 + $x$ |
| 30 - 40 | 15 | 40 + $x$ |
| 40 - 50 | $y$ | 40 + $x$ + $y$ |
| 50 - 60 | 5 | 45 + $x$ + $y$ |
| Total | $\Sigma f_i = 60$ | |

Since, median = 28.5, which lies in the interval 20-30.

$\therefore$ Median class is 20-30.

So, $l = 20$, $h = 10$, $f = 20$, $c.f. = 5 + x$, $n = 60$

$\therefore$ Median $= l+\left[\dfrac{\frac{n}{2}-c.f.}{f}\right]\times h$

$\Rightarrow 28.5 = 20+\left[\dfrac{30-(5+x)}{20}\right]\times10 \Rightarrow 28.5 = 20+\dfrac{25-x}{2}$

$\Rightarrow 57 = 40 + 25 - x \Rightarrow x = 40 + 25 - 57 = 8$ ...(i)

Also, $45 + x + y = 60 \Rightarrow 45 + 8 + y = 60$ (From (i))

$\Rightarrow y = 60 - 45 - 8 = 7$.

Thus, $x = 8$, $y = 7$

**3.** The given table is cumulative frequency distribution. We write the frequency distribution as given below :

| Class-interval | Cumulative frequency (*c.f.*) | Frequency ($f_i$) |
|---|---|---|
| 18 - 20 | 2 | 2 |
| 20 - 25 | 6 | 6 – 2 = 4 |
| 25 - 30 | 24 | 24 – 6 = 18 |
| 30 - 35 | 45 | 45 – 24 = 21 |
| 35 - 40 | 78 | 78 – 45 = 33 |
| 40 - 45 | 89 | 89 – 78 = 11 |
| 45 - 50 | 92 | 92 – 89 = 3 |
| 50 - 55 | 98 | 98 – 92 = 6 |
| 55 - 60 | 100 | 100 – 98 = 2 |

We have, $n = 100 \Rightarrow \frac{n}{2} = \frac{100}{2} = 50$

$\because$ The cumulative frequency just greater than 50 is 78.

$\therefore$ The median class is 35 – 40.

Now, $l$ = 35, $c.f.$ = 45, $f$ = 33 and $h$ = 5

$$\therefore \quad \text{Median} = l + \left[\frac{\frac{n}{2} - c.f.}{f}\right] \times h$$

$$= 35 + \left[\frac{50-45}{33}\right] \times 5$$

$$= 35 + \frac{5}{33} \times 5 = 35 + \frac{25}{33} = 35 + 0.76 = 35.76$$

Thus, the median age = 35.76 years.

**4.** After changing the given table as continuous classes we prepare the cumulative frequency table as follows:

| Length (in mm) | Number of leaves ($f_i$) | Cumulative frequency (c.f.) |
|---|---|---|
| 117.5 - 126.5 | 3 | 3 |
| 126.5 - 135.5 | 5 | 3 + 5 = 8 |
| 135.5 - 144.5 | 9 | 8 + 9 = 17 |
| 144.5 - 153.5 | 12 | 17 + 12 = 29 |
| 153.5 - 162.5 | 5 | 29 + 5 = 34 |
| 162.5 - 171.5 | 4 | 34 + 4 = 38 |
| 171.5 - 180.5 | 2 | 38 + 2 = 40 |
| Total | $\sum f_i = 40$ | |

Here, $n = 40 \Rightarrow \frac{n}{2} = \frac{40}{2} = 20$

The cumulative frequency just greater than 20 is 29 and it corresponds to the class 144.5-153.5.

So, 144.5-153.5 is the median class.

We have, $l$ = 144.5, $f$ = 12, $c.f.$ = 17 and $h$ = 9

$$\therefore \quad \text{Median} = l + \left[\frac{\frac{n}{2} - c.f.}{f}\right] \times h = 144.5 + \left[\frac{20-17}{12}\right] \times 9$$

$$= 144.5 + \frac{3}{12} \times 9 = 144.5 + \frac{9}{4} = 144.5 + 2.25 = 146.75.$$

$\therefore$ Median length of leaves = 146.75 mm.

**5.** To compute the median, let us write the cumulative frequency distribution as given :

| Life time (in hours) | Number of lamps ($f_i$) | Cumulative frequency (c.f.) |
|---|---|---|
| 1500 - 2000 | 14 | 14 |
| 2000 - 2500 | 56 | 14 + 56 = 70 |
| 2500 - 3000 | 60 | 70 + 60 = 130 |
| 3000 - 3500 | 86 | 130 + 86 = 216 |
| 3500 - 4000 | 74 | 216 + 74 = 290 |
| 4000 - 4500 | 62 | 290 + 62 = 352 |
| 4500 - 5000 | 48 | 352 + 48 = 400 |
| Total | $\sum f_i = 400$ | |

Here, $n = 400 \Rightarrow \frac{n}{2} = \frac{400}{2} = 200$

Since, the cumulative frequency just greater than 200 is 216 and corresponding interval is 3000 – 3500.

$\therefore$ The median class is 3000-3500 and so, $l$ = 3000, $c.f.$ = 130, $f$ = 86, $h$ = 500

$$\text{Now, median} = l + \left[\frac{\frac{n}{2} - c.f.}{f}\right] \times h = 3000 + \left[\frac{200-130}{86}\right] \times 500$$

$$= 3000 + \frac{70}{86} \times 500 = 3000 + \frac{35000}{86}$$

= 3000 + 406.98 = 3406.98

Thus, median life = 3406.98 hours.

**6.** Median : The cumulative frequency distribution table is as follows:

| Number of letters | Frequency ($f_i$) | Cumulative Frequency (c.f.) |
|---|---|---|
| 1 - 4 | 6 | 6 |
| 4 - 7 | 30 | 6 + 30 = 36 |
| 7 - 10 | 40 | 36 + 40 = 76 |
| 10 - 13 | 16 | 76 + 16 = 92 |
| 13 - 16 | 4 | 92 + 4 = 96 |
| 16 - 19 | 4 | 96 + 4 = 100 |
| Total | $\sum f_i = 100$ | |

Here, $n = 100 \Rightarrow \frac{n}{2} = \frac{100}{2} = 50.$

Since, the cumulative frequency just greater than 50 is 76 and corresponding interval is 7-10.

$\therefore$ The class 7-10 is the median class.

We have, $l$ = 7, $c.f.$ = 36, $f$ = 40 and $h$ = 3

$$\therefore \quad \text{Median} = l + \left[\frac{\frac{n}{2} - c.f.}{f}\right] \times h = 7 + \left[\frac{50-36}{40}\right] \times 3$$

$$= 7 + \frac{14}{40} \times 3 = 7 + \frac{42}{40} = 7 + 1.05 = 8.05$$

Mean : We have, the following table :

| Class - intervals | Frequency ($f_i$) | Class mark ($x_i$) | $f_i x_i$ |
|---|---|---|---|
| 1 - 4 | 6 | 2.5 | 15 |
| 4 - 7 | 30 | 5.5 | 165 |
| 7 - 10 | 40 | 8.5 | 340 |
| 10 - 13 | 16 | 11.5 | 184 |
| 13 - 16 | 4 | 14.5 | 58 |
| 16 - 19 | 4 | 17.5 | 70 |
| Total | $\sum f_i = 100$ | | $\sum f_i x_i = 832$ |

$$\therefore \quad \text{Mean, } \bar{x} = \frac{\sum f_i x_i}{\sum f_i} = \frac{832}{100} = 8.32$$

Mode : Since the class 7-10 has the maximum frequency.

$\therefore$ The modal class is 7-10.

So, we have $l$ = 7, $h$ = 3, $f_1$ = 40, $f_0$ = 30, $f_2$ = 16

$$\therefore \quad \text{Mode} = l + \left[\frac{f_1 - f_0}{2f_1 - f_0 - f_2}\right] \times h = 7 + \left[\frac{40-30}{2\times40-30-16}\right] \times 3$$

$$= 7 + \left(\frac{10}{34}\right) \times 3 = 7 + \frac{30}{34} = 7 + 0.88 = 7.88$$

**7.** We have cumulative frequency table as follows:

| Weight (in kg) | Frequency ($f_i$) | Cumulative Frequency (c.f.) |
|---|---|---|
| 40 - 45 | 2 | 2 |
| 45 - 50 | 3 | 2 + 3 = 5 |
| 50 - 55 | 8 | 5 + 8 = 13 |
| 55 - 60 | 6 | 13 + 6 = 19 |
| 60 - 65 | 6 | 19 + 6 = 25 |
| 65 - 70 | 3 | 25 + 3 = 28 |
| 70 - 75 | 2 | 28 + 2 = 30 |
| Total | $\sum f_i = 30$ | |

Here, $n = 30 \Rightarrow \frac{n}{2} = \frac{30}{2} = 15$

The cumulative frequency just greater than 15 is 19, which corresponds to the class 55-60. So, median class is 55-60 and we have $l = 55, f = 6, c.f. = 13$ and $h = 5$

$$\therefore \quad \text{Median} = l + \left[\frac{\frac{n}{2} - c.f.}{f}\right] \times h$$

$$= 55 + \left[\frac{15-13}{6}\right] \times 5 = 55 + \frac{2}{6} \times 5$$

$$= 55 + \frac{10}{6} = 55 + 1.67 = 56.67$$

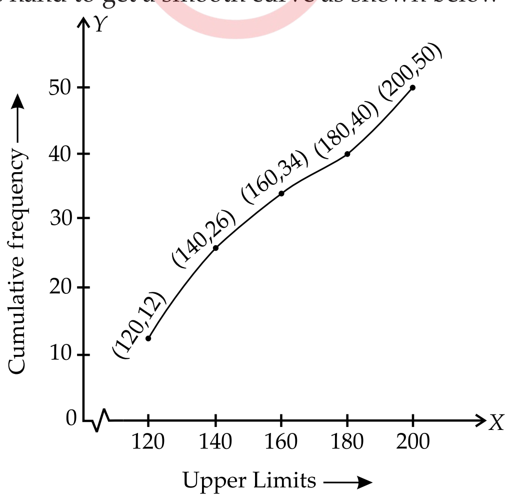
Thus, the required median weight of the students = 56.67 kg.

## EXERCISE - 14.4

**1.** We have the less than type cumulative frequency distribution as follows:

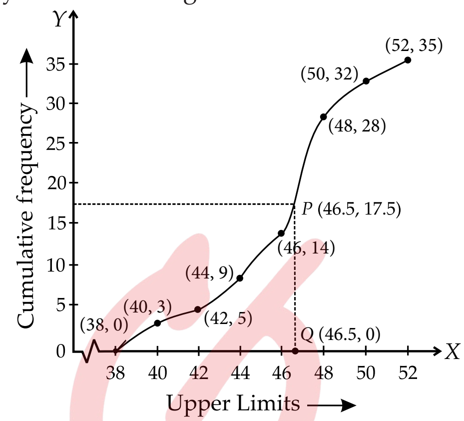
| Daily income (in ₹) | Cumulative frequency |
|---|---|
| Less than 120 | 12 |
| Less than 140 | 12 + 14 = 26 |
| Less than 160 | 26 + 8 = 34 |
| Less than 180 | 34 + 6 = 40 |
| Less than 200 | 40 + 10 = 50 |

Now, we plot the points (120, 12), (140, 26), (160, 34), (180, 40) and (200, 50) on a graph paper and join them by a free hand to get a smooth curve as shown below :




The curve so obtained is called the less than ogive.

**2.** Here, the values 38, 40, 42, 44, 46, 48, 50 and 52 are the upper limits of the respective class-intervals.
We plot the points (38, 0), (40, 3), (42, 5), (44, 9), (46, 14), (48, 28), (50, 32) and (52, 35) on a graph paper and join them by a free hand to get a smooth curve.




The curve so obtained is the less than type ogive.

Now, $n = 35$

$$\Rightarrow \frac{n}{2} = \frac{35}{2} = 17.5$$

Locate the point 17.5 on $y$-axis.
From this point (*i.e.*, from 17.5) we draw a line parallel to the $x$-axis which cuts the curve at $P$. From this point $P$, draw a perpendicular to the $x$-axis, meeting the $x$-axis at $Q$. The point $Q$ represents the median of the data which is 46.5.

**Verification :** To verify the result using the formula, let us make the following table in order to find median using the formula :

| Weight (in kg) | Frequency | Number of students (Cumulative Frequency) |
|---|---|---|
| Below 38 | 0 | 0 |
| 38 – 40 | 3 – 0 = 3 | 3 |
| 40 – 42 | 5 – 3 = 2 | 5 |
| 42 – 44 | 9 – 5 = 4 | 9 |
| 44 – 46 | 14 – 9 = 5 | 14 |
| 46 – 48 | 28 – 14 = 14 | 28 |
| 48 – 50 | 32 – 28 = 4 | 32 |
| 50 – 52 | 35 – 32 = 3 | 35 |

Here, $n = 35 \Rightarrow \frac{n}{2} = \frac{35}{2} = 17.5$

The cumulative frequency just greater than 17.5 is 28 and corresponding interval is 46-48.

$\therefore$ The median class is 46-48.
So, $l = 46, h = 2, f = 14, c.f. = 14$

$$\therefore \text{ Median} = l + \left[\frac{\frac{n}{2} - c.f.}{f}\right] \times h = 46 + \left[\frac{17.5 - 14}{14}\right] \times 2$$

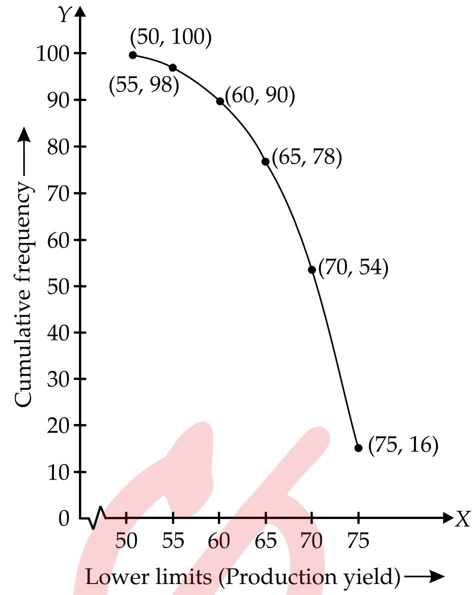
$$= 46 + \frac{3.5}{14} \times 2 = 46 + \frac{1}{2} = 46.5 \text{ kg}$$

Thus, the median = 46.5 kg is verified.

**3.** For more than type distribution, we have:

| Production yield (in kg/ha) | Number of Farms (Cumulative Frequency) |
|---|---|
| More than or equal to 50 | 100 |
| More than or equal to 55 | 100 – 2 = 98 |
| More than or equal to 60 | 98 – 8 = 90 |
| More than or equal to 65 | 90 – 12 = 78 |
| More than or equal to 70 | 78 – 24 = 54 |
| More than or equal to 75 | 54 – 38 = 16 |

Now, we plot the points (50, 100), (55, 98), (60, 90), (65, 78), (70, 54) and (75, 16) and join the points with a free hand to get a smooth curve.




The curve so obtained is the 'more than type ogive'.