EXERCISE 32.1 PAGE NO: 32.6

1. Calculate the mean deviation about the median of the following observation :
(i) 3011, 2780, 3020, 2354, 3541, 4150, 5000
(ii) 38, 70, 48, 34, 42, 55, 63, 46, 54, 44
(iii) 34, 66, 30, 38, 44, 50, 40, 60, 42, 51
(iv) 22, 24, 30, 27, 29, 31, 25, 28, 41, 42
(v) 38, 70, 48, 34, 63, 42, 55, 44, 53, 47
Solution:
(i) 3011, 2780, 3020, 2354, 3541, 4150, 5000
To calculate the Median (M), let us arrange the numbers in ascending order.
Median is the middle number of all the observation.
2354, 2780, 3011, 3020, 3541, 4150, 5000
So, Median = 3020 and n = 7
By using the formula to calculate Mean Deviation,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

x_i	$\lvert d_i\rvert = \lvert x_i - 3020\rvert$
3011	9
2780	240
3020	0
2354	666
3541	521
4150	1130
5000	1980
Total	4546

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/7 × 4546
= 649.42
∴ The Mean Deviation is 649.42.

(ii) 38, 70, 48, 34, 42, 55, 63, 46, 54, 44
To calculate the Median (M), let us arrange the numbers in ascending order.
Median is the middle number of all the observation.
34, 38, 42, 44, 46, 48, 54, 55, 63, 70
Here the Number of observations are Even then Median = (46+48)/2 = 47

Median = 47 and n = 10
By using the formula to calculate Mean Deviation,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

x_i	$\lvert d_i \rvert = \lvert x_i - 47 \rvert$
38	9
70	23
48	1
34	13
42	5
55	8
63	16
46	1
54	7
44	3
Total	86

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 86
= 8.6

∴ The Mean Deviation is 8.6.

(iii) 34, 66, 30, 38, 44, 50, 40, 60, 42, 51
To calculate the Median (M), let us arrange the numbers in ascending order.
Median is the middle number of all the observation.
30, 34, 38, 40, 42, 44, 50, 51, 60, 66
Here the Number of observations are Even then Median = (42+44)/2 = 43
Median = 43 and n = 10
By using the formula to calculate Mean Deviation,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

x_i	$\lvert d_i \rvert = \lvert x_i - 43 \rvert$
30	13
34	9
38	5
40	3
42	1

44	1
50	7
51	8
60	17
66	23
Total	87

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 87

= 8.7

∴ The Mean Deviation is 8.7.

(iv) 22, 24, 30, 27, 29, 31, 25, 28, 41, 42

To calculate the Median (M), let us arrange the numbers in ascending order.

Median is the middle number of all the observation.

22, 24, 25, 27, 28, 29, 30, 31, 41, 42

Here the Number of observations are Even then Median = (28+29)/2 = 28.5

Median = 28.5 and n = 10

By using the formula to calculate Mean Deviation,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

x_i	$\lvert d_i\rvert = \lvert x_i - 28.5\rvert$
22	6.5
24	4.5
30	1.5
27	1.5
29	0.5
31	2.5
25	3.5
28	0.5
41	12.5
42	13.5
Total	47

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 47

= 4.7

∴ The Mean Deviation is 4.7.

(v) 38, 70, 48, 34, 63, 42, 55, 44, 53, 47
To calculate the Median (M), let us arrange the numbers in ascending order.
Median is the middle number of all the observation.
34, 38, 43, 44, 47, 48, 53, 55, 63, 70
Here the Number of observations are Even then Median = (47+48)/2 = 47.5
Median = 47.5 and n = 10
By using the formula to calculate Mean Deviation,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

x_i	$\lvert d_i\rvert = \lvert x_i - 47.5\rvert$
38	9.5
70	22.5
48	0.5
34	13.5
63	15.5
42	5.5
55	7.5
44	3.5
53	5.5
47	0.5
Total	84

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 84
= 8.4
∴ The Mean Deviation is 8.4.

2. Calculate the mean deviation from the mean for the following data :
(i) 4, 7, 8, 9, 10, 12, 13, 17
(ii) 13, 17, 16, 14, 11, 13, 10, 16, 11, 18, 12, 17
(iii) 38, 70, 48, 40, 42, 55, 63, 46, 54, 44
(iv) 36, 72, 46, 42, 60, 45, 53, 46, 51, 49
(v) 57, 64, 43, 67, 49, 59, 44, 47, 61, 59
Solution:
(i) 4, 7, 8, 9, 10, 12, 13, 17

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i – x|$

So, let 'x' be the mean of the given observation.

x = [4 + 7 + 8 + 9 + 10 + 12 + 13 + 17]/8

= 80/8

= 10

Number of observations, 'n' = 8

x_i	$\lvert d_i\rvert = \lvert x_i – 10\rvert$
4	6
7	3
8	2
9	1
10	0
12	2
13	3
17	7
Total	24

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/8 × 24

= 3

∴ The Mean Deviation is 3.

(ii) 13, 17, 16, 14, 11, 13, 10, 16, 11, 18, 12, 17

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i – x|$

So, let 'x' be the mean of the given observation.

x = [13 + 17 + 16 + 14 + 11 + 13 + 10 + 16 + 11 + 18 + 12 + 17]/12

= 168/12

= 14

Number of observations, 'n' = 12

x_i	$\lvert d_i\rvert = \lvert x_i - 14\rvert$
13	1
17	3
16	2
14	0
11	3
13	1
10	4
16	2
11	3
18	4
12	2
17	3
Total	28

$$MD = \frac{1}{n}\sum_{i=1}^{n} |d_i|$$

= 1/12 × 28

= 2.33

∴ The Mean Deviation is 2.33.

(iii) 38, 70, 48, 40, 42, 55, 63, 46, 54, 44

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n} |d_i|$$

Where, $|d_i| = |x_i - x|$

So, let 'x' be the mean of the given observation.

x = [38 + 70 + 48 + 40 + 42 + 55 + 63 + 46 + 54 + 44]/10

= 500/10

= 50

Number of observations, 'n' = 10

x_i	$\lvert d_i\rvert = \lvert x_i - 50\rvert$
38	12
70	20
48	2
40	10
42	8

55	5
63	13
46	4
54	4
44	6
Total	84

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 84

= 8.4

∴ The Mean Deviation is 8.4.

(iv) 36, 72, 46, 42, 60, 45, 53, 46, 51, 49

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i – x|$

So, let 'x' be the mean of the given observation.

x = [36 + 72 + 46 + 42 + 60 + 45 + 53 + 46 + 51 + 49]/10

= 500/10

= 50

Number of observations, 'n' = 10

x_i	$\lvert d_i\rvert = \lvert x_i – 50\rvert$
36	14
72	22
46	4
42	8
60	10
45	5
53	3
46	4
51	1
49	1
Total	72

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 72

= 7.2

∴ The Mean Deviation is 7.2.

(v) 57, 64, 43, 67, 49, 59, 44, 47, 61, 59

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i - x|$

So, let 'x' be the mean of the given observation.

x = [57 + 64 + 43 + 67 + 49 + 59 + 44 + 47 + 61 + 59]/10

= 550/10

= 55

Number of observations, 'n' = 10

x_i	$\lvert d_i\rvert = \lvert x_i - 55\rvert$
57	2
64	9
43	12
67	12
49	6
59	4
44	11
47	8
61	6
59	4
Total	74

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 74

= 7.4

∴ The Mean Deviation is 7.4.

3. Calculate the mean deviation of the following income groups of five and seven

members from their medians:

I Income in ₹	II Income in ₹
4000	3800
4200	4000
4400	4200
4600	4400
4800	4600
	4800
	5800

Solution:

Let us calculate the mean deviation for the first data set.
Since the data is arranged in ascending order,
4000, 4200, 4400, 4600, 4800
Median = 4400
Total observations = 5
We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i – M|$

x_i	$\lvert d_i\rvert = \lvert x_i – 4400\rvert$
4000	400
4200	200
4400	0
4600	200
4800	400
Total	1200

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/5 × 1200
= 240

Let us calculate the mean deviation for the second data set.
Since the data is arranged in ascending order,
3800, 4000, 4200, 4400, 4600, 4800, 5800
Median = 4400

Total observations = 7

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i - M|$

x_i	$|d_i| = |x_i - 4400|$
3800	600
4000	400
4200	200
4400	0
4600	200
4800	400
5800	1400
Total	3200

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/7 × 3200

= 457.14

∴ The Mean Deviation of set 1 is 240 and set 2 is 457.14

4. The lengths (in cm) of 10 rods in a shop are given below:
40.0, 52.3, 55.2, 72.9, 52.8, 79.0, 32.5, 15.2, 27.9, 30.2
(i) Find the mean deviation from the median.
(ii) Find the mean deviation from the mean also.

Solution:

(i) Find the mean deviation from the median

Let us arrange the data in ascending order,

15.2, 27.9, 30.2, 32.5, 40.0, 52.3, 52.8, 55.2, 72.9, 79.0

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i - M|$

The number of observations are Even then Median = (40+52.3)/2 = 46.15

Median = 46.15

Number of observations, ‘n’ = 10

x_i	$\lvert d_i\rvert = \lvert x_i - 46.15\rvert$
40.0	6.15
52.3	6.15
55.2	9.05
72.9	26.75
52.8	6.65
79.0	32.85
32.5	13.65
15.2	30.95
27.9	19.25
30.2	15.95
Total	167.4

$$MD = \frac{1}{n}\sum_{i=1}^{n} |d_i|$$

= 1/10 × 167.4
= 16.74
∴ The Mean Deviation is 16.74.

(ii) Find the mean deviation from the mean also.
We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n} |d_i|$$

Where, $|d_i| = |x_i - x|$
So, let ‘x’ be the mean of the given observation.
x = [40.0 + 52.3 + 55.2 + 72.9 + 52.8 + 79.0 + 32.5 + 15.2 + 27.9 + 30.2]/10
= 458/10
= 45.8
Number of observations, ‘n’ = 10

x_i	$\lvert d_i\rvert = \lvert x_i - 45.8\rvert$
40.0	5.8
52.3	6.5
55.2	9.4
72.9	27.1
52.8	7
79.0	33.2
32.5	13.3

15.2	30.6
27.9	17.9
30.2	15.6
Total	166.4

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 166.4
= 16.64
∴ The Mean Deviation is 16.64

5. In question 1(iii), (iv), (v) find the number of observations lying between $\overline{X} - \text{M.D.}$ and $\overline{X} + \text{M.D.}$, where M.D. is the mean deviation from the mean.

Solution:

(iii) 34, 66, 30, 38, 44, 50, 40, 60, 42, 51

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i - x|$

So, let ‘x’ be the mean of the given observation.

x = [34 + 66 + 30 + 38 + 44 + 50 + 40 + 60 + 42 + 51]/10
= 455/10
= 45.5

Number of observations, ‘n’ = 10

x_i	$\lvert d_i\rvert = \lvert x_i - 45.5\rvert$
34	11.5
66	20.5
30	15.5
38	7.5
44	1.5
50	4.5
40	5.5
60	14.5
42	3.5
51	5.5
Total	90

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 90

= 9

Now

$\overline{X} - M.D.$ = 45.5 - 9 = 36.5

$\overline{X} + M.D.$ = 45.5 + 9 = 54.5

So, There are total 6 observation between $\overline{X} - M.D.$ and $\overline{X} + M.D.$

(iv) 22, 24, 30, 27, 29, 31, 25, 28, 41, 42

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i - x|$

So, let 'x' be the mean of the given observation.

x = [22 + 24 + 30 + 27 + 29 + 31 + 25 + 28 + 41 + 42]/10

= 299/10

= 29.9

Number of observations, 'n' = 10

x_i	$\|d_i\| = \|x_i - 29.9\|$
22	7.9
24	5.9
30	0.1
27	2.9
29	0.9
31	1.1
25	4.9
28	1.9
41	11.1
42	12.1
Total	48.8

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 48.8

= 4.88

Now

$\overline{X} - \text{M.D.} = 29.9 - 4.88 = 25.02$

$\overline{X} + \text{M.D.} = 29.9 + 4.88 = 34.78$

So, There are total 5 observation between $\overline{X} - \text{M.D.}$ and $\overline{X} + \text{M.D.}$

(v) 38, 70, 48, 34, 63, 42, 55, 44, 53, 47

We know that,

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

Where, $|d_i| = |x_i - x|$

So, let 'x' be the mean of the given observation.

x = [38 + 70 + 48 + 34 + 63 + 42 + 55 + 44 + 53 + 47]/10

= 494/10

= 49.4

Number of observations, 'n' = 10

x_i	$\lvert d_i\rvert = \lvert x_i - 49.4\rvert$
38	11.4
70	20.6
48	1.4
34	15.4
63	13.6
42	7.4
55	5.6
44	5.4
53	3.6
47	2.4
Total	86.8

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/10 × 86.8

= 8.68

Now

$\overline{X} - \text{M.D.} = 49.4 - 8.68 = 40.72$

$\overline{X} + \text{M.D.} = 49.4 + 8.68 = 58.08$

So, There are total 6 observation between $\overline{X} - \text{M.D.}$ and $\overline{X} + \text{M.D.}$

EXERCISE 32.2 PAGE NO: 32.11

1. Calculate the mean deviation from the median of the following frequency distribution:

Heights in inches	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**
No. of students	**15**	**20**	**32**	**35**	**35**	**22**	**20**	**10**	**8**

Solution:
To find the mean deviation from the median, firstly let us calculate the median.
We know, Median is the Middle term,
So, Median = 61
Let x_i =Heights in inches
And, f_i = Number of students

x_i	f_i	Cumulative Frequency	$\lvert d_i \rvert = \lvert x_i - M \rvert = \lvert x_i - 61 \rvert$	$f_i \lvert d_i \rvert$
58	15	15	3	45
59	20	35	2	40
60	32	67	1	32
61	35	102	0	0
62	35	137	1	35
63	22	159	2	44
64	20	179	3	60
65	10	189	4	40
66	8	197	5	40
	N = 197			Total = 336

N=197

$$MD = \frac{1}{n}\sum_{i=1}^{n} |d_i|$$

= 1/197 × 336
= 1.70
∴ The mean deviation is 1.70.

2. The number of telephone calls received at an exchange in 245 successive on2-minute intervals is shown in the following frequency distribution:

Number of calls	0	1	2	3	4	5	6	7
Frequency	**14**	**21**	**25**	**43**	**51**	**40**	**39**	**12**

Compute the mean deviation about the median.

Solution:

To find the mean deviation from the median, firstly let us calculate the median.

We know, Median is the even term, (3+5)/2 = 4

So, Median = 8

Let x_i =Number of calls

And, f_i = Frequency

x_i	f_i	Cumulative Frequency	$\lvert d_i\rvert = \lvert x_i - M\rvert = \lvert x_i - 61\rvert$	$f_i \lvert d_i\rvert$
0	14	14	4	56
1	21	35	3	63
2	25	60	2	50
3	43	103	1	43
4	51	154	0	0
5	40	194	1	40
6	39	233	2	78
7	12	245	3	36
				Total = 366
	Total = 245			

N = 245

$$MD = \frac{1}{n}\sum_{i=1}^{n} |d_i|$$

= 1/245 × 336

= 1.49

∴ The mean deviation is 1.49.

3. Calculate the mean deviation about the median of the following frequency distribution:

x_i	5	7	9	11	13	15	17
f_i	**2**	**4**	**6**	**8**	**10**	**12**	**8**

Solution:

To find the mean deviation from the median, firstly let us calculate the median.

We know, N = 50
Median = (50)/2 = 25
So, the median Corresponding to 25 is 13

x_i	f_i	Cumulative Frequency	$\lvert d_i\rvert = \lvert x_i - M\rvert = \lvert x_i - 61\rvert$	$f_i \lvert d_i\rvert$
5	2	2	8	16
7	4	6	6	24
9	6	12	4	24
11	8	20	2	16
13	10	30	0	0
15	12	42	2	24
17	8	50	4	32
	Total = 50			Total = 136

N = 50

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/50 × 136
= 2.72
∴ The mean deviation is 2.72.

4. Find the mean deviation from the mean for the following data:
(i)

x_i	5	7	9	10	12	15
f_i	8	6	2	2	2	6

Solution:
To find the mean deviation from the mean, firstly let us calculate the mean.
By using the formula,

$$Mean = \frac{\sum f_i x_i}{f_i}$$

x_i	f_i	Cumulative Frequency ($x_i f_i$)	$\lvert d_i\rvert = \lvert x_i - Mean\rvert$	$f_i \lvert d_i\rvert$
5	8	40	4	32
7	6	42	2	12
9	2	18	0	0
10	2	20	1	2

12	2	24	3	6
15	6	90	6	36
	Total = 26	Total = 234		Total = 88

$$Mean = \frac{\sum f_i x_i}{f_i}$$

= 234/26

= 9

$$Mean\ deviation = \frac{\sum f_i |d_i|}{f_i}$$

= 88/26

= 3.3

∴ The mean deviation is 3.3

(ii)

x_i	5	10	15	20	25
f_i	**7**	**4**	**6**	**3**	**5**

Solution:

To find the mean deviation from the mean, firstly let us calculate the mean.

By using the formula,

$$Mean = \frac{\sum f_i x_i}{f_i}$$

x_i	f_i	Cumulative Frequency ($x_i f_i$)	$\lvert d_i \rvert = \lvert x_i – Mean \rvert$	$f_i \lvert d_i \rvert$
5	7	35	9	63
10	4	40	4	16
15	6	90	1	6
20	3	60	6	18
25	5	125	11	55
	Total = 25	Total = 350		Total = 158

$$Mean = \frac{\sum f_i x_i}{f_i}$$

= 350/25

= 14

$$Mean\ deviation = \frac{\sum f_i |d_i|}{f_i}$$

= 158/25

= 6.32

∴ The mean deviation is 6.32

(iii)

x_i	**10**	**30**	**50**	**70**	**90**
f_i	**4**	**24**	**28**	**16**	**8**

Solution:

To find the mean deviation from the mean, firstly let us calculate the mean.

By using the formula,

$$Mean = \frac{\sum f_i x_i}{f_i}$$

x_i	f_i	Cumulative Frequency ($x_i f_i$)	$\lvert d_i\rvert = \lvert x_i - \text{Mean}\rvert$	$f_i \lvert d_i\rvert$
10	4	40	40	160
30	24	720	20	480
50	28	1400	0	0
70	16	1120	20	320
90	8	720	40	320
	Total = 80	Total = 4000		Total = 1280

$$Mean = \frac{\sum f_i x_i}{f_i}$$

= 4000/80

= 50

$$Mean\ deviation = \frac{\sum f_i |d_i|}{f_i}$$

= 1280/80

= 16

∴ The mean deviation is 16

5. Find the mean deviation from the median for the following data :

(i)

x_i	15	21	27	30
f_i	3	5	6	7

Solution:

To find the mean deviation from the median, firstly let us calculate the median.

We know, N = 21

Median = (21)/2 = 10.5

So, the median Corresponding to 10.5 is 27

x_i	f_i	Cumulative Frequency	$\|d_i\| = \|x_i – M\|$	$f_i \|d_i\|$
15	3	3	15	45
21	5	8	9	45
27	6	14	3	18
30	7	21	0	0
	Total = 21	Total = 46		Total = 108

N = 21

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/21 × 108

= 5.14

∴ The mean deviation is 5.14

(ii)

x_i	74	89	42	54	91	94	35
f_i	20	12	2	4	5	3	4

Solution:

To find the mean deviation from the median, firstly let us calculate the median.

We know, N = 50

Median = (50)/2 = 25

So, the median Corresponding to 25 is 74

x_i	f_i	Cumulative Frequency	$\|d_i\| = \|x_i – M\|$	$f_i \|d_i\|$
74	20	4	39	156
89	12	6	32	64
42	2	10	20	80

54	4	30	0	0
91	5	42	15	180
94	3	47	17	85
35	4	50	20	60
	Total = 50	Total = 189		Total = 625

N = 50

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/50 × 625

= 12.5

∴ The mean deviation is 12.5

(iii)

Marks obtained	**10**	**11**	**12**	**14**	**15**
No. of students	**2**	**3**	**8**	**3**	**4**

Solution:

To find the mean deviation from the median, firstly let us calculate the median.

We know, N = 20

Median = (20)/2 = 10

So, the median Corresponding to 10 is 12

x_i	f_i	Cumulative Frequency	$\lvert d_i\rvert = \lvert x_i - M\rvert$	$f_i \lvert d_i\rvert$
10	2	2	2	4
11	3	5	1	3
12	8	13	0	0
14	3	16	2	6
15	4	20	3	12
	Total = 20			Total = 25

N = 20

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/20 × 25

= 1.25

∴ The mean deviation is 1.25

EXERCISE 32.3 PAGE NO: 32.16

1. Compute the mean deviation from the median of the following distribution:

Class	**0-10**	**10-20**	**20-30**	**30-40**	**40-50**
Frequency	**5**	**10**	**20**	**5**	**10**

Solution:

To find the mean deviation from the median, firstly let us calculate the median.

Median is the middle term of the X_i,

Here, the middle term is 25

So, Median = 25

Class Interval	x_i	f_i	Cumulative Frequency	$\lvert d_i\rvert = \lvert x_i - M\rvert$	$f_i \lvert d_i\rvert$
0-10	5	5	5	20	100
10-20	15	10	15	10	100
20-30	25	20	35	0	0
30-40	35	5	91	10	50
40-50	45	10	101	20	200
		Total = 50			Total = 450

$$MD = \frac{1}{n}\sum_{i=1}^{n} |d_i|$$

= 1/50 × 450

= 9

∴ The mean deviation is 9

2. Find the mean deviation from the mean for the following data:

(i)

Classes	**0-100**	**100-200**	**200-300**	**300-400**	**400-500**	**500-600**	**600-700**	**700-800**
Frequencies	**4**	**8**	**9**	**10**	**7**	**5**	**4**	**3**

Solution:

To find the mean deviation from the mean, firstly let us calculate the mean.

By using the formula,

$$Mean = \frac{\sum f_i x_i}{f_i}$$

= 17900/50

= 358

Class Interval	x_i	f_i	Cumulative Frequency	$\lvert d_i\rvert = \lvert x_i - M\rvert$	$f_i \lvert d_i\rvert$
0-100	50	4	200	308	1232
100-200	150	8	1200	208	1664
200-300	250	9	2250	108	972
300-400	350	10	3500	8	80
400-500	450	7	3150	92	644
500-600	550	5	2750	192	960
600-700	650	4	2600	292	1168
700-800	750	3	2250	392	1176
		Total = 50	Total = 17900		Total = 7896

N = 50

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/50 × 7896

= 157.92

∴ The mean deviation is 157.92

(ii)

Classes	**95-105**	**105-115**	**115-125**	**125-135**	**135-145**	**145-155**
Frequencies	**9**	**13**	**16**	**26**	**30**	**12**

Solution:

To find the mean deviation from the mean, firstly let us calculate the mean.

By using the formula,

$$Mean = \frac{\sum f_i x_i}{f_i}$$

= 13630/106

= 128.58

Class Interval	x_i	f_i	Cumulative Frequency	$\lvert d_i\rvert = \lvert x_i - M\rvert$	$f_i \lvert d_i\rvert$
95-105	100	9	900	28.58	257.22
105-115	110	13	1430	18.58	241.54
115-125	120	16	1920	8.58	137.28
125-135	130	26	3380	1.42	36.92
135-145	140	30	4200	11.42	342.6

145-155	150	12	1800	21.42	257.04
		N = 106	Total = 13630		Total = 1272.6

N = 106

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/106 × 1272.6

= 12.005

∴ The mean deviation is 12.005

3. Compute mean deviation from mean of the following distribution:

Marks	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**	**80-90**
No. of students	**8**	**10**	**15**	**25**	**20**	**18**	**9**	**5**

Solution:

To find the mean deviation from the mean, firstly let us calculate the mean.

By using the formula,

$$Mean = \frac{\sum f_i x_i}{f_i}$$

= 5390/110

= 49

Class Interval	x_i	f_i	Cumulative Frequency	$\lvert d_i\rvert = \lvert x_i - M\rvert$	$f_i \lvert d_i\rvert$
10-20	15	8	120	34	272
20-30	25	10	250	24	240
30-40	35	15	525	14	210
40-50	45	25	1125	4	100
50-60	55	20	1100	6	120
60-70	65	18	1170	16	288
70-80	75	9	675	26	234
80-90	85	5	425	36	180
		N = 110	Total = 5390		Total = 1644

N = 110

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/110 × 1644

= 14.94

∴ The mean deviation is 14.94

4. The age distribution of 100 life-insurance policy holders is as follows:

Age (on nearest birthday)	**17-19.5**	**20-25.5**	**26-35.5**	**36-40.5**	**41-50.5**	**51-55.5**	**56-60.5**	**61-70.5**
No. of persons	**5**	**16**	**12**	**26**	**14**	**12**	**6**	**5**

Calculate the mean deviation from the median age.

Solution:

To find the mean deviation from the median, firstly let us calculate the median.

N = 96

So, N/2 = 96/2 = 48

The cumulative frequency just greater than 48 is 59, and the corresponding value of x is 38.25

So, Median = 38.25

Class Interval	x_i	f_i	Cumulative Frequency	$\|d_i\| = \|x_i - M\|$	$f_i \|d_i\|$
17-19.5	18.25	5	5	20	100
20-25.5	22.75	16	21	15.5	248
36-35.5	30.75	12	33	7.5	90
36-40.5	38.25	26	59	0	0
41-50.5	45.75	14	73	7.5	105
51-55.5	53.25	12	85	15	180
56-60.5	58.25	6	91	20	120
61-70.5	65.75	5	96	27.5	137.5
		Total = 96			Total = 980.5

N = 96

$$MD = \frac{1}{n}\sum_{i=1}^{n}|d_i|$$

= 1/96 × 980.5

= 10.21

∴ The mean deviation is 10.21

5. Find the mean deviation from the mean and from a median of the following

distribution:

Marks	**0-10**	**10-20**	**20-30**	**30-40**	**40-50**
No. of students	**5**	**8**	**15**	**16**	**6**

Solution:

To find the mean deviation from the median, firstly let us calculate the median.

N = 50

So, N/2 = 50/2 = 25

The cumulative frequency just greater than 25 is 58, and the corresponding value of x is 28

So, Median = 28

By using the formula to calculate Mean,

$$Mean = \frac{\sum f_i x_i}{f_i}$$

= 1350/50

= 27

Class Interval	x_i	f_i	Cumulative Frequency	$\lvert d_i\rvert = \lvert x_i - \text{Median}\rvert$	$f_i \lvert d_i\rvert$	F_iX_i	$\lvert X_i - \text{Mean}\rvert$	$F_i \lvert X_i - \text{Mean}\rvert$
0-10	5	5	5	23	115	25	22	110
10-20	15	8	13	13	104	120	12	96
20-30	25	15	28	3	45	375	2	30
30-40	35	16	44	7	112	560	8	128
40-50	45	6	50	17	102	270	18	108
		N = 50			Total = 478	Total = 1350		Total = 472

Mean deviation from Median = 478/50 = 9.56

And, Mean deviation from Median = 472/50 = 9.44

∴ The Mean Deviation from the median is 9.56 and from mean is 9.44.

EXERCISE 32.4 PAGE NO: 32.28

1. Find the mean, variance and standard deviation for the following data:
(i) 2, 4, 5, 6, 8, 17

Let Mean be,

$$\overline{X} = \frac{2+4+5+6+8+17}{6}$$

$$\overline{X} = \frac{42}{6} = 7$$

X_i	$(x_i-X) = (x_i-7)$	$(x_i-7)^2$
2	-3	25
4	-3	9
5	-2	4
6	-1	1
8	1	1
17	10	100
		$\sum_{1}^{6}(x_i - \bar{X})^2 = 140$

N = 6

Variance (X) = $\frac{1}{n}\sum_{i=1}^{6}(x_i - \overline{X})$
= 140/6
= 23.33

Variance = 23.33

Standard deviation = $\sqrt{\text{Var}(X)}$

$\sigma = \sqrt{23.33}$

Standard deviation = 4.83

(ii) 6, 7, 10, 12, 13, 4, 8, 12

Let Mean be,

$$\overline{X} = \frac{6+7+10+12+13+4+8+12}{8}$$

$$\overline{X} = \frac{72}{8} = 9$$

x_i	$(x_i-X)=(x_i-7)$	$(x_i-7)^2$
6	-3	9
7	-2	4
10	1	1
12	3	9
13	4	16
4	-5	25
12	3	9
		$\sum_1^8 (x_i - \bar{X})^2 = 74$

N = 8

Variance (X) = $\frac{1}{n}\sum_{i=1}^{8}(x_i - \bar{X})$

= 74/8

= 9.25

Variance = 9.25

Standard deviation = $\sqrt{\text{Var(X)}}$

$\sigma = \sqrt{9.25}$

Standard deviation = 3.04

2. The variance of 20 observations is 4. If each observation is multiplied by 2, find the variance of the resulting observations.

Solution:

Let Assume, $x_1, x_2, x_3, \ldots, x_{20}$ be the given observations.

Given: Variance (X) = 5

$X = \frac{1}{n} \times \sum(x_i - \bar{X})^2$

Now, Let $u_1, u_2, \ldots u_{20}$ be the new observation,

When we multiply the new observation by 2, then

$U_i = 2x_i$ (for i=1, 2, 3…, 20) …. (i)

Now,

Mean:

$\bar{U} = \frac{\sum_1^{20} U_i}{n}$

$= \frac{\sum_{i=1}^{20} 2x_i}{20}$

Mean = $2\bar{X}$

Since, $u_i - \bar{U} = 2x_i - 2\bar{X}$

$= 2(x_i - \overline{X})$

Now, $(u_i - \overline{U})^2 = (2(x_i - \overline{X}))$

$4(x_i - \overline{X})^2$

Comparing both the observations

$$\frac{\sum_{20}^{i=1}(u_i - \overline{U})^2}{20} = \frac{\sum_{20}^{i=1} 4(x_i - \overline{X})^2}{20}$$

$$= 4 \times \frac{\sum_{20}^{i=1}(x_i - \overline{X})^2}{20}$$

Variance (U) = 4×Variance (X)

= 4×5

= 20

∴ The variance of new observations is 20.

3. The variance of 15 observations is 4. If each observation is increased by 9, find the variance of the resulting observations.

Solution:

Let Assume, $x_1, x_2, x_3, \ldots, x_{15}$ be the given observations.

Given: Variance (X) = 4

$X = \frac{1}{n} \times \sum(x_i - \overline{X})^2$

Now, Let $u_1, u_2, \ldots u_{20}$ be the new observation,

When new observation increase by 9, then

$U_i = x_i + 9$ (for i=1, 2, 3…, 20) …. (i)

Now,

$$\overline{U} = \frac{1}{n}\sum_{i=1}^{15} u_i$$

$$= \frac{1}{15}\sum_{i=1}^{15}(x_i + 9)$$

$$= \frac{1}{15}\sum_{i=1}^{15} x_i + \frac{9 \times 15}{15}$$

$\overline{U} = 9 + \overline{X}$

$u_i - \overline{U} = (x_i + 9) - (9 + \overline{X})$

$u_i - \overline{U} = x_i - \overline{X}$

$$\frac{\sum_{i=1}^{15}(u_i-\overline{U})^2}{15}=\frac{\sum_{i=1}^{15}4(x_i-\overline{X})^2}{15}$$
$$=\frac{\sum_{i=1}^{15}(u_i-\overline{U})^2}{15}=4$$

Variance (U) = 4

∴ The variance of new observations is 4.

4. The mean of 5 observations is 4.4 and their variance is 8.24. If three of the observations are 1, 2 and 6, find the other two observations.

Solution:

Let x and y be the other two observation. And Mean is 4.4

Let Mean = $\frac{1+2+6+x+y}{5}=4.4$

$\Rightarrow 9+x+y=22$

$x+y=13$ …… (1)

Now, Let Variance (X) is the variance of this observation which is to be 8.24

If $\overline{X}$ is the mean than we get,

$8.24=\frac{1}{5}(1^2+2^2+6^2+x^2+y^2)-(\bar{x})^2$

$8.24=\frac{1}{5}(1^2+2^2+6^2+x^2+y^2)-(4.4)^2$

$8.24=\frac{1}{5}(41+x^2+y^2)-19.36$

$x^2+y^2=97$ …… (2)

$(x+y)^2+(x-y)^2=2(x^2+y^2)$

By substituting the value we get,

$13^2+(x-y)^2=2\times97$

$(x-y)^2=194-169$

$(x-y)^2=25$

$x-y=\pm5$ …… (3)

On solving equations (1) and (3) we get,

$2x=18$

$x=9$ and $y=4$

∴ The other two observations are 9 and 4.

5. The mean and standard deviation of 6 observations are 8 and 4 respectively. If each observation is multiplied by 3, find the new mean and new standard deviation of the resulting observations.

Solution:

Let Assume, $x_1, x_2, x_3, \dots, x_6$ be the given observations.
Given: Variance (X) = 8
N = 6 and $\sigma = 4$ (SD)

$X = \frac{1}{n} \times \sum x_i$

$$8 = \frac{1}{6} \times \sum_{i=1}^{6} x_i$$

Now, Let $u_1, u_2, \dots u_{20}$ be the new observation,
When we multiply the new observation by 3, then
$U_i = 3x_i$ (for i =1, 2, 3…, 6) …… (1)
Now,

$$\bar{U} = \frac{1}{n} \sum_{i=1}^{15} u_i$$

$$= \frac{1}{6} \sum_{i=1}^{6} (3x_i)$$

$$= 3 \times \frac{1}{6} \sum_{i=1}^{6} (x_i)$$

$\bar{U} = 3\bar{X}$

$= 3 \times 8 = 24$

U = 24
So, the Mean of new observation is 24
Now,
Standard Deviation $\sigma_x = 4$
$\sigma_x^2 = \text{Variance X}$
Since, Variance (X) = 16

Variance (U) = $\frac{1}{6} \sum_{i=1}^{6} (3x_i - 3X)$

$= 3^2 \times \frac{1}{6} \times \sum (x_i - X)^2$

$= 9 \times 16$

$\sigma_u^2 = \text{Variance (U)}$
$\sigma_u^2 = 144$
$\sigma = 12$

∴ The mean of new observation is 24 and Standard deviation of new observation is 12.

6. The mean and variance of 8 observations are 9 and 9.25 respectively. If six of the observations are 6, 7, 10, 12, 12 and 13, find the remaining two observations.

Solution:

Let x and y be the other two observation. And Mean is 9

Let Mean = $\frac{6+7+10+12+12+13+x+y}{8} = 9$

$\Rightarrow 60 + x + y = 72$

$x + y = 12$ …… (1)

Now, let Variance (X) be the variance of this observation which is to be 9.25

If $\overline{X}$ is the mean than we get,

$9.25 = \frac{1}{8}(6^2 + 7^2 + 10^2 + 12^2 + 12^2 + 13^2 + x^2 + y^2) - (\bar{x})^2$

$9.25 = \frac{1}{8}(6^2 + 7^2 + 10^2 + 12^2 + 12^2 + 13^2 + x^2 + y^2) - (9)^2$

$642 + x^2 + y^2 = 722$

$x^2 + y^2 = 80$ …. (2)

$(x + y)^2 + (x - y)^2 = 2(x^2 + y^2)$

By substituting the value we get,

$12^2 + (x - y)^2 = 2 \times 80$

$(x - y)^2 = 160 - 144$

$(x - y)^2 = 14$

$X - y = \pm 4$ …… (3)

On solving equations (1) and (3) we get,

$x = 8, 4$ and $y = 4, 8$

∴ The other two observations are 8 and 4.

EXERCISE 32.5 PAGE NO: 32.37

1. Find the standard deviation for the following distribution:

x:	**4.5**	**14.5**	**24.5**	**34.5**	**44.5**	**54.5**	**64.5**
f:	**1**	**5**	**12**	**22**	**17**	**9**	**4**

Solution:

By using the formula for standard deviation:

$SD = \sqrt{Var(X)}$

Mean $= \sum \frac{f_i x_i}{f_i}$

So,

Mean $= \frac{4.5+14.5+24+34.5+44.4+54.5+64.5}{7} = 34.4$

X_i	F_i	$d_i=(x_i-\text{mean})$	$u_i=\frac{x_i-mean}{10}$	f_iu_i	U_i^2	$f_iu_i^2$
4.5	1	-30	-3	-3	9	9
14.5	5	-20	-2	-10	4	20
24	12	-10	-1	-12	1	12
34.5	22	0	0	0	0	0
44.5	17	10	1	17	1	17
54.5	9	20	2	18	4	36
64.5	4	30	3	12	9	36
	$\sum f_i = 70$			$\sum u_i f_i = 22$		$\sum u_i^2 f_i = 130$

Now,

$N = 70, \sum u_i f_i = 22, \sum u_i^2 f_i = 130$

$$Var(X) = h^2\left[\frac{1}{N}\sum_{i=1}^{n} f_i u_i^2 - \left(\frac{1}{N}\sum_{i=1}^{n} u_i f_i\right)^2\right]$$

$$Var(X) = 10^2\left[\frac{1}{70}\times 130 - \left(\frac{1}{70}\times 22\right)^2\right]$$

$$= 100\left[\frac{130}{70} - \left(\frac{22}{70}\right)^2\right]$$

$$= 100\left[\frac{13}{7} - \frac{121}{1225}\right]$$

= 100 [1.857 - 0.0987]

= 100 [1.7583]

Var (X) = 175.83

$$\text{Standard Deviation}, \sigma = \sqrt{\text{Var}(X)}$$
$$= \sqrt{175.83}$$
$$= 13.26$$

∴ The standard deviation is 13.26

2. Table below shows the frequency f with which 'x' alpha particles were radiated from a diskette

x:	0	1	2	3	4	5	6	7	8	9	10	11	12
f:	51	203	383	525	532	408	273	139	43	27	10	4	2

Calculate the mean and variance.

Solution:

By using the formula to find mean,

$$\text{Mean} = \sum \frac{f_i x_i}{x_i}$$
$$= \frac{10078}{2600} = 3.88$$

X_i	F_i	F_iX_i	(X_i-X)	$(X_i-X)^2$	$F_i(X_i-X)^2$
0	51	0	-3.88	15.05	767.55
1	203	203	-2.88	8.29	1682.87
2	383	766	-1.88	3.53	1351.99
3	525	1575	-0.88	0.77	404.25
4	532	2128	0.12	0.014	7.448
5	408	2040	1.12	1.25	510
6	273	1638	2.12	4.49	1225.77
7	139	973	3.12	9.73	1352.47
8	42	344	4.12	16.97	729.71
9	27	243	5.12	26.21	707.67
10	10	100	6.12	37.45	374.5
11	4	44	7.12	50.69	202.76
12	2	24	8.12	65.93	131.86
	N=2600	$\sum f_i x_i = 10078$			$\sum f_i(x_i - \bar{X})^2$=9448.848

Now,

N = 70

$$\text{Variance}(X) = \frac{\sum f_i(x_i - \overline{X})^2}{N}$$

$$\sigma^2 = \frac{9448.848}{2600} = 3.63$$

∴ The mean is 3.88 and variance is 3.63

3. Find the mean, and standard deviation for the following data:
(i)

Year render:	**10**	**20**	**30**	**40**	**50**	**60**
No. of persons (cumulative)	**15**	**32**	**51**	**78**	**97**	**109**

Solution:

By using the formula to find standard deviation:

$SD = \sqrt{Var(X)}$

X_i	F_i	f_i	$u_i = \frac{x_i - mean}{10}$	f_iu_i	U_i^2	$f_iu_i^2$
10	15	15	-2.5	-37.5	6.25	93.75
20	32	17	-1.5	-25.5	2.25	38.25
30	51	19	-0.5	-9.5	0.25	4.75
40	78	27	0.5	13.5	0.25	6.75
50	97	19	1.5	28.5	2.25	42.75
60	109	12	2.5	30	6.25	75
		$\sum f_i = 109$		$\sum u_i f_i = -0.5$		$\sum u_i^2 f_i = 261.2$

Now,

$N = 109, \sum u_i f_i = -0.5, \sum u_i^2 f_i = 261.2$

Mean, $\overline{X} = A + h\left(\frac{\sum u_i f_i}{N}\right)$

$$\overline{X} = 35 + 10\left(\frac{-0.5}{109}\right)$$

$$\overline{X} = 34.96$$

$$Var(X) = h^2\left[\frac{1}{N}\sum_{i=1}^{n} f_i u_i^2 - \left(\frac{1}{N}\sum_{i=1}^{n} u_i f_i\right)^2\right]$$

$$Var(X) = 100\left[\frac{261.25}{109} - \frac{0.25}{11881}\right]$$

$$= 100 \times 2.396$$

Variance = 239.6

Standard Deviation, $\sigma = \sqrt{239.6}$

$= 15.47$ years

∴ The standard deviation is 15.47

(ii)

Marks:	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Frequency:	**1**	**6**	**6**	**8**	**8**	**2**	**2**	**3**	**0**	**2**	**1**	**0**	**0**	**0**	**1**

Solution:

By using the formula to find standard deviation:

$SD = \sqrt{Var(X)}$

x_i	f_i	f_ix_i	$f_ix_i^2$
2	1	2	4
3	6	18	54
4	6	24	96
5	8	40	200
6	8	48	288
7	2	14	98
8	2	16	128
9	3	27	243
10	0	0	0
11	2	22	242
12	1	12	144
13	0	0	0
14	0	0	0
15	0	0	0
16	1	16	256
	N=40	Total=239	Total=1753

Now,

$N = 40, \sum x_i f_i = 239, \sum x_i^2 f_i = 1753$

Mean, $\bar{X} = \left(\frac{\sum x_i f_i}{N}\right)$

$\bar{X} = \frac{239}{40}$

$= 5.975$

$Var(X) = \frac{1753}{40} - (5.97)^2$

Variance $= 8.12$

Standard Deviation, $\sigma = \sqrt{8.12}$

$= 2.85$ years

∴ The standard deviation is 2.85

4. Find the standard deviation for the following data:

(i)

x:	3	8	13	18	23
f:	7	10	15	10	6

Solution:

By using the formula to find standard deviation:

$SD = \sqrt{Var(X)}$

X_i	F_i	F_iX_i	$(x_i - \bar{X})$	$(x_i - \bar{X})^2$	$(x_i - \bar{X})^2 f$
3	7	21	-9.79	95.84	670.88
8	10	80	-4.79	22.94	229.4
13	15	195	0.21	0.04	0.6
18	10	180	5.21	27.14	271.4
23	6	138	10.21	104.24	625.44
	$\sum f_i = 48$	$\sum f_i x_i = 614$			$\sum (x_i - \bar{X})^2 f = 1797.32$

Now, N = 48

$$Var(X) = \frac{\sum(x_i - \bar{X})^2 f}{\sum f_i}$$

$$Var(X) = \frac{1797.32}{48}$$

Variance = 37.44

Standard Deviation, $\sigma = \sqrt{37.44}$

$= 6.12$

$\therefore$ The standard deviation is 6.12

(ii)

x:	2	3	4	5	6	7
f:	4	9	16	14	11	6

Solution:

By using the formula to find standard deviation:

$SD = \sqrt{Var(X)}$

x_i	f_i	f_ix_i	$f_ix_i^2$
2	4	8	16
3	9	27	81
4	16	64	256
5	14	70	350
6	11	66	396
7	6	42	294
	N=60	Total = 277	Total=1393

Now,

$N = 60$, $\sum x_i f_i = 277$, $\sum x_i^2 f_i = 1393$

Mean, $\overline{X} = \left(\frac{\sum x_i f_i}{N}\right)$

$$\overline{X} = \frac{277}{60}$$
$$= 4.62$$

$$Var(X) = \frac{1393}{60} - (4.62)^2$$

Variance $= 1.88$

Standard Deviation, $\sigma = \sqrt{1.88}$

$= 1.37$

$\therefore$ The standard deviation is 1.37

EXERCISE 32.6 PAGE NO: 32.41

1. Calculate the mean and S.D. for the following data:

Expenditure (in ₹):	0-10	10-20	20-30	30-40	40-50
Frequency:	14	13	27	21	15

Solution:

By using the formula to find standard deviation:

$SD = \sqrt{Var(X)}$

Expenditure	Mid Point(X_i)	F_i	F_ix_i	$(x_i - \bar{X})$	$(x_i - \bar{X})^2$	$(x_i - \bar{X})^2 f$
0-10	5	14	70	-21.1	445.21	6233.94
10-20	15	13	195	-11.1	123.21	1601.1
20-30	25	27	675	-1.1	1.21	34.67
30-40	35	21	735	8.9	79.21	1663.41
40-50	45	15	675	18.9	357.21	53.58
		$\sum f_i = 90$	$\sum f_ix_i = 2350$			$\sum (x_i - \bar{X})^2 f = 1797.32$

Now,

Mean, $\bar{X} = \sum \frac{f_i x_i}{f_i}$

$\bar{X} = \frac{2350}{90}$

$= 26.11$

$Var(X) = \frac{14891.9}{90}$

Variance $= 165.47$

Standard Deviation, $\sigma = \sqrt{165.47}$

$= 12.86$

∴ The standard deviation is 12.86

2. Calculate the standard deviation for the following data:

Class:	0-30	30-60	60-90	90-120	120-150	150-180	180-210
Frequency:	9	17	43	82	81	44	24

Solution:

By using the formula to find standard deviation:

$SD = \sqrt{Var(X)}$

Class	F_i	x_i	$u_i=\frac{x_i-mean}{30}$	f_iu_i	U_i^2	$f_iu_i^2$
0-30	9	15	-3	-27	9	81
30-60	17	45	-2	-34	4	68
60-90	43	75	-1	-43	1	43
90-120	82	105	0	0	0	0
120-150	81	135	1	81	1	81
150-180	44	165	2	88	4	176
180-210	24	195	3	72	9	216
		$\sum f_i = 300$		$\sum u_i f_i = 137$		$\sum u_i^2 f_i = 665$

Now,

$N = 300, \sum u_i f_i = 137, \sum u_i^2 f_i = 665$

Mean, $\overline{X} = A + h\left(\frac{\sum u_i f_i}{N}\right)$

$\overline{X} = 105 + 30\left(\frac{137}{300}\right)$

$= 118.7$

$$Var(X) = h^2\left[\frac{1}{N}\sum_{i=1}^{n} f_i u_i^2 - \left(\frac{1}{N}\sum_{i=1}^{n} u_i f_i\right)^2\right]$$

$$Var(X) = \frac{900}{90000}[300 \times 665 - 18769]$$

$$= \frac{1}{100}[199500 - 18769]$$

Variance $= 1807.31$

Standard Deviation, $\sigma = \sqrt{1807.31}$

$= 42.51$

∴ The standard deviation is 42.51

3. Calculate the A.M. and S.D. for the following distribution:

Class:	**0-10**	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**
Frequency:	**18**	**16**	**15**	**12**	**10**	**5**	**2**	**1**

Solution:

By using the formula to find standard deviation:

$$SD = \sqrt{Var(X)}$$

Class	F_i	x_i	$u_i=\frac{x_i - mean}{10}$	f_iu_i	$f_iu_i^2$
0-10	18	5	-3	-54	162
10-20	16	15	-2	-32	64
20-30	15	25	-1	-15	15
30-40	12	35	0	0	0
40-50	10	45	1	10	10
50-60	5	55	2	10	20
60-70	2	65	3	6	18
70-80	1	75	4	4	16
	$\sum f_i = 79$			$\sum u_i f_i = -71$	$\sum u_i^2 f_i = 305$

Now,

$N = 79$, $\sum u_i f_i = -71$, $\sum u_i^2 f_i = 305$

Mean, $\overline{X} = A + h\left(\frac{\sum u_i f_i}{N}\right)$

$$\overline{X} = 35 + 10\left(\frac{-71}{79}\right)$$

$$= 26.01$$

$$Var(X) = h^2\left[\frac{1}{N}\sum_{i=1}^{n} f_i u_i^2 - \left(\frac{1}{N}\sum_{i=1}^{n} u_i f_i\right)^2\right]$$

$$Var(X) = 100\left[\frac{305}{79} - \frac{5041}{6241}\right]$$

Variance = 305.20

Standard Deviation, $\sigma = \sqrt{305.20}$

$= 17.47$

∴ The standard deviation is 17.47

4. A student obtained the mean and standard deviation of 100 observations as 40 and 5.1 respectively. It was later found that one observation was wrongly copied as 50, the correct figure is 40. Find the correct mean and S.D.

Solution:

Given: Uncorrected mean is 40 and corrected SD is 5.1 and N = 100
Here, $\bar{x} = 40, \sigma = 5.1$ and $n = 100$
Then, $\sum x_o = 4000$
The corrected sum of observation, $\sum x_n = 4000 - 50 + 40$

$$\sum x_n = 3990$$

So,

$\overline{x_n} = \frac{\sum x_n}{n}$

= 3990/100

= 39.90

Now,
Given Incorrect SD = 5.1
$\sigma = 5.1$

$$\sum (x_i - \overline{x_o})^2 = 2601$$

$$\sum (x_i - \overline{x_o})^2 = 2601 - 100 + 0.01 = 2501.1$$

Corrected SD, $\sigma_n = \sqrt{\frac{\sum (x_i - \overline{x_o})^2}{n}}$

$$\sigma_n = \sqrt{\frac{2501.01}{100}}$$

= 5

∴ Correct mean is 39.9 and correct SD is 5

5. Calculate the mean, median and standard deviation of the following distribution

Class-interval	**31-35**	**36-40**	**41-45**	**46-50**	**51-55**	**56-60**	**61-65**	**66-70**
Frequency:	**2**	**3**	**8**	**12**	**16**	**5**	**2**	**3**

Solution:

By using the formula to find standard deviation:

$SD = \sqrt{Var(X)}$

Class	F_i	x_i	$u_i=\frac{x_i-mean}{4}$	f_iu_i	$f_iu_i^2$
31-35	2	33	-4	-8	32
36-40	3	38	-3	-9	27
41-45	8	43	-2	-16	32
46-50	12	48	-1	-12	12
51-55	16	53	0	0	0
56-60	5	58	1	5	5
61-65	2	63	2	4	8
66-70	2	68	3	6	18
	$\sum f_i = 50$			$\sum u_if_i = -30$	$\sum u_i^2f_i = 134$

Now,

$N = 50, \sum u_if_i = -30, \sum u_i^2 f_i = 134$

Mean, $\overline{X} = A + h\left(\frac{\sum u_if_i}{N}\right)$

$\overline{X} = 53 + 5\left(-\frac{30}{50}\right)$

$= 50$

$$Var(X) = h^2\left[\frac{1}{N}\sum_{i=1}^{n} f_iu_i^2 - \left(\frac{1}{N}\sum_{i=1}^{n} u_if_i\right)^2\right]$$

$$Var(X) = 25\left[\frac{134}{50} - \frac{9}{25}\right]$$

Variance = 58

Standard Deviation, $\sigma = \sqrt{58}$

$= 7.62$

∴ The standard deviation is 7.62

EXERCISE 32.7 PAGE NO: 32.47

1. Two plants A and B of a factory show the following results about the number of workers and the wages paid to them

	Plant A	Plant B
No. of workers	**5000**	**6000**
Average monthly wages	**₹2500**	**₹2500**
The variance of distribution of wages	**81**	**100**

In which plant A or B is there greater variability in individual wages?
Solution:
Variation of the distribution of wages in plant A (σ^2 =18)
So, Standard deviation of the distribution A (σ – 9)

Similarly, the Variation of the distribution of wages in plant B (σ^2 =100)
So, Standard deviation of the distribution B (σ – 10)

And, Average monthly wages in both the plants is 2500,
Since, the plant with a greater value of SD will have more variability in salary.
∴ Plant B has more variability in individual wages than plant A

2. The means and standard deviations of heights and weights of 50 students in a class are as follows:

	Weights	Heights
Mean	**63.2 kg**	**63.2 inch**
Standard deviation	**5.6 kg**	**11.5 inch**

Which shows more variability, heights or weights?
Solution:

Given: The mean and SD is given of 50 students.
Let us find which shows more variability, height and weight.
By using the formulas,

Coefficient of variations $= \frac{\text{SD}}{\text{Mean}} \times 100$

Coefficient of variations in weights $= \frac{\text{SD}}{\text{Mean}} \times 100$

$$\frac{5.6}{63.2} \times 100 = 8.86$$

The coefficient of variations in weights $= \frac{\text{SD}}{\text{Mean}} \times 100$

$$\frac{11.5}{63.2} \times 100 = 18.19$$

As results clearly show that coefficient of variations in heights is greater than coefficient of variations in weights.
∴ Heights will show more variability than weights

3. The coefficient of variation of two distribution are 60% and 70%, and their standard deviations are 21 and 16 respectively. What is their arithmetic means?
Solution:

Here, the Coefficient of variation for the first distribution is 60
And, Coefficient of variation for the first distribution is 70
SD (σ_1) =21 and SD (σ_2) = 16

We know that, Coefficients of variation $= \frac{\text{SD}}{\text{Mean}} \times 100$
So,
Mean, $\overline{X} = \frac{\text{SD}}{\text{CV}} \times 100$

For first distribution

$$\overline{X} = \frac{21}{60} \times 100$$
$$= 35$$

For the second distribution

$$\overline{X} = \frac{16}{70} \times 100$$
$$= 22.86$$

∴ Means are 35 and 22.86

4. Calculate coefficient of variation from the following data:

Income (in ₹):	1000-1700	1700-2400	2400-3100	3100-3800	3800-4500	4500-5200
No. of families:	12	18	20	25	35	10

Solution:

Let us find the standard deviation of the frequency:

Class	F_i	x_i	$u_i=\frac{x_i-\text{mean}}{700}$	f_iu_i	$f_iu_i^2$
1000-1700	12	1350	-2	-24	48
1700-2400	18	2050	-1	-18	18
2400-3100	20	2750	0	0	0
3100-3800	25	3450	1	25	25
3800-4500	35	4150	2	70	140
4500-5200	10	4850	3	30	90
	$\sum f_i = 120$			$\sum u_if_i = 83$	$\sum u_i^2f_i = 321$

Now,

$N = 120$, $\sum u_i^2 f_i = 321$

Mean, $\overline{X} = A + h\left(\frac{\sum u_i f_i}{N}\right)$

$$\overline{X} = 2750 + 700\left(\frac{83}{120}\right)$$

$= 3234.17$

$$\text{Var}(X) = h^2\left[\frac{1}{N}\sum_{i=1}^{n} f_i u_i^2 - \left(\frac{1}{N}\sum_{i=1}^{n} u_i f_i\right)^2\right]$$

$$\text{Var}(X) = 490000\left[\left(\frac{321}{120}\right) - \left(\frac{83}{120}\right)^2\right]$$

Variance $= 1076332.64$

Standard Deviation, $\sigma = \sqrt{1076332.64}$

$= 1037.47$

Coefficients of variation $= \frac{1037.46}{3234.17} \times 100$

$= 32.08$

∴ The coefficient variation is 32.08

5. An analysis of the weekly wages paid to workers in two firms A and B, belonging to the same industry gives the following results:

	Firm A	**Firm B**
No. of wage earners	**586**	**648**
Average weekly wages	**₹52.5**	**₹47.5**
The variance of the distribution of wages	**100**	**121**

(i) Which firm A or B pays out the larger amount as weekly wages?
(ii) Which firm A or B has greater variability in individual wages?
Solution:

(i) Average weekly wages = $\frac{\text{Total weekly wages}}{\text{No.of workers}}$

Total weekly wages = (Average weekly wages) × (No. of workers)

Total weekly wages of Firm A = 52.5 × 586 = Rs 30765
Total weekly wages of Firm B = 47.5 × 648 = Rs 30780

Firm B pays a larger amount as Firm A

(ii) Here, SD (firm A) 10 and SD (Firm B) = 11
Coefficient variance (Firm A) = $\frac{10}{52.5} \times 100$

$= 19.04$

Coefficient variance (Firm B) = $\frac{11}{47.5} \times 100$
$= 23.15$

∴ Coefficient variance of firm B is greater than that of firm A, Firm B has greater variability in individual wages.

6. The following are some particulars of the distribution of weights of boys and girls in a class:

	Boys	Girls
Number	**100**	**50**
Mean weight	**60 kg**	**45 kg**
Variance	**9**	**4**

Which of the distributions is more variable?

Solution:

Given: SD (Boys) is 3 and SD (girls) = 2

Coefficient variability $= \frac{\text{SD}}{\text{Mean}} \times 100$

Coefficient variance (Boys) $= \frac{3}{60} \times 100$
$= 5$

Coefficient variance (Girls) $= \frac{2}{45} \times 100$
$= 4.4$

$\therefore$ Coefficient variance of Boys is greater than Coefficient variance of girls, and then the distribution of weights of boys is more variable than that of girls.