A-level maths paper 2 - Statistics

This a branch of mathematics dealing with collection, presentation, analysis and interpretation of data

Types of data

(a) Discrete data
Its information collected by counting and usually takes integral values that do not lie within a given range

(b) Continuous data
It is information that takes values within a given range

Discrete or ungrouped data

Terms Used

(i) Mean or average of a sample

It is denoted by $\bar{x}$ and defined as $\bar{x} = \frac{\sum x}{n}$; where x is the variable given and n is the number of variable

If assumed mean (working mean) a is given then

$\bar{x} = A + \frac{\sum d}{n}$; where d = x – A

If the frequency, f, s given then $\bar{x} = \frac{\sum fx}{\sum f}$ or $\bar{x} = A + \frac{\sum fd}{\sum f}$

(ii) **Variance or Var(X)** $= \frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2$

(iii) **Standard deviation** $= \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$

(iv) Mode

This is the value of the distribution that appears most

(v) Median

This is the middle value of the distribution obtained after the values have been arranged either in ascending of descending order.

Median = $\left(\frac{N}{2}\right)^{th}$ value.

Note that the values must be arranged in ascending or descending order

(vi) Range

It is the difference between the largest value and the smallest value.

(vii) Quartiles

A quartile is a value that divides given values into four equal parts

q_1 is the lower quartile and is defined by

$q_1 = \left(\frac{1}{4}N\right)^{th}$ value where N is the sum of all the variables

q_3 is the upper quartile and is defined by

$q_3 = \left(\frac{3}{4}N\right)^{th}$ value where N is the sum of all the variables

Note that the values must be arranged in ascending or descending order

(viii) Percentiles

A percentile is a value that divides given values into 100 pats.

P_{10} is the 10^{th} percentile and is defined as

$P_{10} = \left(\frac{10}{100}N\right)^{th}$ value where N is the sum of all the variables

P_{90} is the 10^{th} percentile and is defined as

$P_{90} = \left(\frac{90}{100}N\right)^{th}$ value where N is the sum of all the variables

Note that the values must be arranged in ascending or descending order

(ix) Deciles

A decile is a value that divides given values into 10 pats.

D_5 is the 5^{th} decile and is defined as

$D_5 = \left(\frac{5}{10}N\right)^{th}$ value where N is the sum of all the variables

Note that the values must be arranged in ascending or descending order

Example 1

Given the following sets of values

2, 1, 3, 4, 5, 6, 7, 8, 9, 10, 3, 4, 6, 8, 9, 6, 3, 2

(a) Form a frequency table of ungrouped data

x	f	fx	cf	x^2	fx^2
1	1	1	1	1	1
2	2	4	3	4	8
3	3	9	6	9	27
4	2	8	8	16	32
5	1	5	9	25	25
6	4	24	13	36	144
7	2	14	15	49	98
8	2	16	17	64	128
9	2	18	19	81	162
10	1	10	20	100	100
	$\sum f = 20$	$\sum fx = 109$			725

(b) Use the table to find the mean and mode

(i) Mean, $\bar{x} = \frac{\sum fx}{\sum f} = \frac{109}{20} = 5.45$

(ii) Standard deviation = $\sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2} = \sqrt{\frac{725}{20} - \left(\frac{109}{20}\right)^2}$ = 2.5588(4D)

(iii) Mode = 6 (the value that appear most

(iv) Find the median value

Median = $\left(\frac{N}{2}\right)^{th}$ value = $\left(\frac{20}{2}\right)^{th}$ = 10th value from cumulative frequency, cf ; median = 6

(v) Range = 10 – 1 = 9

(vi) Lower quartile, q_1 = $\left(\frac{1}{4}N\right)^{th}$ =$\left(\frac{1}{4}x20\right)^{th} = 5^{th}$ value, from cf, q_1 = 3

(vii) Lower quartile, q_3 = $\left(\frac{3}{4}N\right)^{th}$ =$\left(\frac{3}{4}x20\right)^{th} = 15^{th}$ value, from cf, q_3 = 7

(viii) Tenth percentile = $\left(\frac{90}{100}N\right)^{th}$ value where N is the sum of all the variables

$= \left(\frac{90}{100}Nx10\right)^{th} = \left(\frac{90}{100}x20\right)^{th}$ =18th value

From cf, P_{90} =9

Example 2

The ages of eight students in a class are: 12, 13, 14, 15, 12, 17, 12, 13, 16, 12.

Find the;

(a) Form a frequency table of ungrouped data

x	f	cf	fx	x^2	fx^2
12	4	4	48	144	576
13	2	6	26	169	338
14	1	7	14	196	196
15	1	8	15	225	225
16	1	9	16	256	256
17	1	10	17	289	289
	∑f =10		∑fx = 136		$\sum fx^2$=1,880

(b) Use the table to find

a. mean age

mean = $\frac{\sum fx}{\sum f} = \frac{136}{10} = 13.6$

b. variance

Var (X) = $\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2$

= $\frac{1880}{10} - 13.6^2$

= 3.04

c. Standard deviation = $\sqrt{3.04}$ =1.7436(4D)

d. Mode = 12 (most frequent figure)

e. Median = $\left(\frac{10}{5}\right)^{th}$ = 5th value = 13

f. Range = 17 – 12 = 5

g. Lower quartile, q_1 = $\left(\frac{1}{4}N\right)^{th}$ =$\left(\frac{1}{4}x10\right)^{th} = 2.5^{th}$ value, from cf, q_1 = 12

h. Lower quartile, q_3 = $\left(\frac{3}{4}N\right)^{th}$ =$\left(\frac{3}{4}x10\right)^{th} = 7.5^{th}$ value, from cf, q_3 = 15

i. Tenth percentile $= \left(\frac{90}{100}N\right)^{th}$ value where N is the sum of all the variables

$= \left(\frac{90}{100}N\right)^{th} = \left(\frac{90}{100}x20\right)^{th}$ =9th value

From cf, $P_{90} = 16$

Example 3

The frequency distribution table shows the marks of some student from a certain school

x	45	63	65	66	70	72	75	80	88
f	3	5	6	4	6	2	1	2	1

Calculate standard deviation

Solution

x	f	fx	fx^2
45	3	135	6075
63	5	315	19845
65	6	390	25350
66	4	264	17424
70	6	420	29400
72	2	144	10368
75	1	75	5625
80	2	160	12800
88	1	88	7744
	$\sum f$ =30	1991	$\sum fx^2$ =134631

Using assumed mean to get variance and standard deviation

Var (X) = $\frac{\sum fd^2}{\sum f} - \left(\frac{\sum fd}{\sum f}\right)^2$

s.d = $\sqrt{\frac{\sum fd^2}{\sum f} - \left(\frac{\sum fd}{\sum f}\right)^2}$

S.d = $\sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$

= $\sqrt{\frac{134631}{30} - \left(\frac{1991}{30}\right)^2}$

= $\sqrt{\frac{134631}{30} - \left(\frac{1991}{30}\right)^2}$

= $\sqrt{4487.7 - 4404.53}$

= 9.12

Revision exercise 1

1. The data below represents the length of leaves in cm: 4.5 4.4, 6.2, 9.4, 8.2, 12.6, 10.0, 8.8, 3.8 and 13.6. find the;
   (a) Mean
   (b) Standard deviation
2. The concentration in m per litre of a trace element in 7 randomly chosen samples of water from spring wells were: 240.8, 237.3, 236.6, 2333.9 and 232.5. Determine the mean and the variance of the concentration of the trace elements per litre.

3. The table below shows the length of flowers from a certain plant to the nearest 0.5cm.

Length (cm)	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0
Number of flowers	4	9	11	8	10	7	2	3

Find the:

(a) Mean
(b) Mode
(c) The median
(d) Standard deviation

4. The marks scored by 11 students in a test are:52, 61, 78, 49, 47, 79, 54, 58, 62, 73, 72
Find;

(a) Median,
(b) Mean,
(c) Interquartile range
(d) Semi-quartile range

5. The frequency distribution table shows the heights of some students at a certain school

Height	154	155	160	164	171	180
Frequency	4	6	8	5	4	3

Determine the variance and standard deviation of the data using a working mean of 160

6. The table below shows the marks obtained by 20 students in a mathematics test marked out of 20

Marks	10	11	12	13	14	15	16	17	18	19	20
Number of students	1	2	2	2	2	4	2	1	2	1	1

Find:

(a) Mean mark
(b) Standard deviation
(c) 60^{th} percentile
(d) Interquartile range

7. Given the following scores

8, 6, 8, 9, 10, 6, 4, 5, 6, 4, 4, 6, 8, 7, 10, 8, 6, 11, 12, 8

(a) Form a frequency distribution table of ungrouped data.
(b) Find the standard deviation
(c) Calculate semi-quartile range
(d) Determine the range of 45^{th} and 90^{th} percentile.

Solutions to revision exercise 1

1. The data below represents the length of leaves in cm: 4.5 4.4, 6.2, 9.4, 8.2, 12.6, 10.0, 8.8, 3.8 and 13.6. find the;
   (a) Mean
   (b) Standard deviation

   Solution

x	x^2
4.5	20.25
4.4	19.36
6.2	38.44
9.2	84.64
8.2	67.24
12.0	144
10.0	100
8.8	77.44
3.8	14.44
13.6	184.96
$\sum x$ =80.7	$\sum x^2$ =750.77

(a) Mean, $\bar{x} = \frac{\sum x}{n} = \frac{80.7}{10} = 8.07$

(b) s.d = $\sqrt{\frac{\sum x^2}{n} - \bar{x}^2}$ = $\sqrt{\frac{750.77}{10} - (8.07)^2}$ =3.155

2. The concentration in m per litre of a trace element in 7 randomly chosen samples of water from spring wells were: 240.8, 237.3, 236.6, 2333.9 and 232.5. Determine the mean and the variance of the concentration of the trace elements per litre.

   Solution

x	x^2
240.8	57984.64
237.3	56311.29
236.7	56026.89
234.2	54849.64
236.6	55979.56
233.9	54709.21
232.5	54056.25
$\sum x$ =1652	$\sum x^2$ =389917.5

Mean, $\bar{x} = \frac{\sum x}{n} = \frac{1652}{7} = 236$

Var(x) = $\frac{\sum x^2}{n} - \bar{x}^2$

$= \frac{389917.5}{7} - 236^2$

= 55,702.5 – 55,696

= 6.5

3. The table below shows the length of flowers from a certain plant to the nearest 0.5cm.

Length (cm)	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0
Number of flowers	4	9	11	8	10	7	2	3

Find the:
(a) Mean
(b) Mode

(c) The median

(d) Standard deviation

Solution

x	f	fx	fx^2	cf
7.5	4	30	225	4
8.0	9	72	576	13
8.5	11	93.5	794.75	24
9.0	8	72	648	32
9.5	10	95	902.5	42
10.0	7	70	700	49
10.5	2	21	220.5	51
11.0	3	33	363	54
	$\sum f$ =54	$\sum fx$ =486.5	$\sum fx^2$ =4429.75	

(a)Mean = $\frac{\sum fx}{\sum f}$

$= \frac{486.2}{54} = 9.0$

(b) mode = 8.5

(c) Median = $\left(\frac{54}{2}\right)^{th}$ value

= 27th value

From cf the 27th value = 9.0

(d) s.d = $\sqrt{\frac{\sum x^2}{\sum f} - \bar{x}^2}$ = $\sqrt{\frac{4429.75}{54} - \bar{x}^2}$ = 1

4. The marks scored by 11 students in a test are:52, 61, 78, 49, 47, 79, 54, 58, 62, 73, 72
   Find;
   (a) Median
   Arrange values in ascending order
   47, 49, 52, 54, 58, 61, 62, 72,73,78,79
   (a) Median =$middle\ number$ = 6th value = 61
   (b) Mean,
   $\sum x$ = 52+ 61+78 + 49 + 47 + 79 + 54 + 58 + 62 + 73 + 72 =685
   Mean = $\frac{\sum x}{n} = \frac{685}{11}$ = 62.273
   (b) Interquartile range
   $q_1 = \left(\frac{1}{4}\ x\ 11\right)^{th}$ value = 2.75th value = 52
   $q_3 = \left(\frac{3}{4}\ x\ 11\right)^{th}$ value = 8.25th value = 73
   Interquartile range = 73 -52 = 21
   (c) Semi-quartile range = $\frac{Interquartile\ range}{2} = \frac{21}{2} = 10.5$

5. The frequency distribution table shows the heights of some students at a certain school

Height	154	155	160	164	171	180
Frequency	4	6	8	5	4	3

Determine the variance and standard deviation of the data using a working mean of 160

Solution

x	f	d = x - A	fd	fd^2
154	4	-6	-24	144
155	6	-5	-30	150
160	8	0	0	0
164	5	4	20	80
171	4	11	44	484
180	3	20	60	1200
	$\sum f$ =30		$\sum fd$ =70	$\sum fd^2$ =2058

Var (X) = $\frac{\sum fd^2}{\sum f} - \left(\frac{\sum fd}{\sum f}\right)^2$

= $\frac{2058}{30} - \left(\frac{70}{30}\right)^2$

= 63.156

s.d = $\sqrt{Var(x)}$ = $\sqrt{63.156}$ =7.95

6. The table below shows the marks obtained by 20 students in a mathematics test marked out of 20

Marks	10	11	12	13	14	15	16	17	18	19	20
Number of students	1	2	2	2	2	4	2	1	2	1	1

Find:

(a) Mean mark
(b) Standard deviation
(c) 60^{th} percentile
(d) Interquartile range

Solution

x	f	cf	fx	fx^2
10	1	1	10	100
11	2	3	22	242
12	2	5	24	288
13	2	7	26	338
14	2	9	28	392
15	4	13	60	900
16	2	15	32	512
17	1	16	17	289
18	2	18	36	648
19	1	19	19	361
20	1	20	20	400
	$\sum f$ =20		$\sum fx$ =294	$\sum fx^2$ =4470

(a) s.d = $\sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$

= $\sqrt{\frac{4470}{20} - \left(\frac{294}{20}\right)^2}$

= 2.722

(b) 60^{th} percentile

= $\left(\frac{60}{100}\ x\ 20\right)^{th}$ value

= 12^{th} value from cf =15

(d) q_1 = $\left(\frac{1}{4}\ x\ 20\right)^{th}$ value = 5^{th} value from cf = 12

Q_3 = $\left(\frac{3}{4}\ x\ 20\right)^{th}$ value = 15^{th} value from cf = 16

Interquartile range = 16 -12 = 4

7. Given the following scores

8, 6, 8, 9, 10, 6, 4, 5, 6, 4, 4, 6, 8, 7, 10, 8, 6, 11, 12, 8

(a) Form a frequency distribution table of ungrouped data.
(b) Find the standard deviation
(c) Calculate semi-quartile range
(d) Determine the range of 45th and 90th percentile.

Solution

x	f	cf	fx	fx^2
4	3	3	12	48
5	1	4	5	25
6	5	9	30	180
7	1	11	7	49
8	5	16	40	320
9	1	17	9	81
10	2	19	20	200
11	1	20	11	121
12	1	21	12	144
	$\sum f$ =20		$\sum fx$ =146	$\sum fx^2$ =1168

(b) s.d = $\sqrt{\frac{\sum fd^2}{\sum f} - \left(\frac{\sum fd}{\sum f}\right)^2}$

$= \sqrt{\frac{1168}{20} - \left(\frac{146}{20}\right)^2}$ =2.26

(c) $q_1 = \left(\frac{1}{4}\ x\ 20\right)^{th}$ value

= 5th value from cf = 6

$q_3 = \left(\frac{3}{4}\ x\ 20\right)^{th}$ value

= 15th value, from cf = 8

Semi-interquartile range = $\frac{8-6}{2} = 1$

(d) 45th percentile = $\left(\frac{45}{10}\ x\ 20\right)^{th}$ value = 9th value from cf = 6

90th percentile = $\left(\frac{90}{100}\ x\ 20\right)^{th}$ value = 18th value from cf = 10

The range between the 90th percentile and 45th percentile = 10 – 6 = 4

Continuous or grouped data.

This is data whose scores or values are said to be continuous and take interval values

Example

Class	20 – 29	30 – 39	40 – 49	50 – 59	60 – 69	70 – 79	80 - 89
Number of students	4	5	7	3	6	4	1

Terms used

(a) **Class:** these are limits of distribution. In the table above, the classes are: (20 – 29), (30 – 39), (40 – 49), (50 – 59), (60 – 69), (70 – 79), (80 – 89).

(b) **Class mark or mark (x)**

(c) **Frequency (f) =** number of items in a class

This is the mid-point value of the class. It is normally denoted by x. in the table above, the class marks are 24.5, 34.5, 44.5 …..

(d) **Class boundary**

These are continuous class limits. In the above table the first class boundary is (20-0.5) – (29 +0.5). In this case, the lower class boundary is 19.5 and upper class boundary is 29.5

For class interval 2.0 – 2.9, the class boundary is (2.0 -0.05) – (2.9 + 0.05) = 1.95-2.95.

(e) **Class width or class interval**

This is the width of each class boundary.

It is given by;

Class width = upper class boundary – lower class boundary

In the table above, class width = 29.5 – 19.5 = 10

(f) **Mean,** $\overline{\boldsymbol{x}} = \frac{\sum fx}{\sum f}$

(g) **Variance (Var(X) =** $\frac{\sum \boldsymbol{fx^2}}{\sum \boldsymbol{f}} - \left(\frac{\sum fx}{\sum f}\right)^{\mathbf{2}}$

(h) **Standard deviation =** $\sqrt{\mathrm{Var(x)}} = \sqrt{\frac{\sum \boldsymbol{fx^2}}{\sum \boldsymbol{f}} - \left(\frac{\sum fx}{\sum f}\right)^{\mathbf{2}}}$

(i) **Median of grouped data**

Median of grouped data is defined by

Median = $L_b + \left(\frac{\frac{\sum f}{2} - c.f_b}{f}\right) C$

Where L_b = lower class boundary of the median class

C= class width of the median class

(j) **Mode of grouped data**

Mode of grouped data with equal class width is defined as

Mode = Lb + $\left(\frac{\Delta_1}{\Delta_1 + \Delta_2}\right)$ C

Where

Lb = lower class boundary of modal class

C = Class width of the modal class

Δ_1 = Modal frequency (pre-modal frequency)

Δ_2 = Modal frequency (post modal frequency)

(k) Median of grouped data

Median of grouped data is defined by

$$\text{Median} = L_b + \left(\frac{\frac{\sum f}{2} - c.f_b}{f}\right)C$$

Where L_b = lower class boundary of the median class

C= class width of the median class

f = frequency of the median class

$c.f_b$= cumulative frequency before that of the median class

(l) Histogram

This is a graph consisting of vertical bars. It is a graph of frequency against class boundary. The area of the bar is equal to the frequency. Histogram is used to obtain the mode

(m) Percentile

This a value that divides a given distribution into 100 equal parts

The 60th percentile for instance is defined as

$$P60 = L_b + \left(\frac{\frac{60}{100}\sum f - c.f_b}{f}\right)C$$

Where

Lb = lower class boundary of the 60th class

C= class width

F = frequency of the 60th class

$c.f_b$ = cumulative frequency before that one of the 60th class

(n) Quartiles

This a value that divides a given distribution into 4 equal parts

The lower quartile denoted q1 for instance is defined as

$$q1 = L_b + \left(\frac{\frac{1}{4}\sum f - c.f_b}{f}\right)C$$

Where

L_b = lower class boundary of the q_1 class

C= class width

f = frequency of the q_1 class

$c.f_b$ = cumulative frequency before that one of the q_1 class

The upper quartile denoted q_3 for instance is defined as

$$q_3 = L_b + \left(\frac{\frac{1}{4}\sum f - c.f_b}{f}\right)C$$

Where

L_b = lower class boundary of the q_3 class

C= class width

f = frequency of the q_3 class

$c.f_b$ = cumulative frequency before that one of the q_3 class

Interquartile range = $q_3 - q_1$

Semi-interquartile range = $\frac{q_3 - q_1}{2}$

Example 4

The table below shows the weight of 250 students at The Science Foundation College

Weight (kg)	44.0 – 47.9	48.0 – 51.9	52.0 – 55.9	56.0 – 59.9	60.0 – 63.9	64.0 – 67.9	68.0 – 71.9	72.0 – 75.9
Frequency	3	17	50	45	46	57	23	9

Find

(a) Average weight
(b) Standard deviation
(c) Median weight
(d) Modal weight
(e) Draw an Ogive and use it to find
  (i) Upper quartile
  (ii) And 10^{th} percentile
(f) Construct a histogram and use it to determine the mode

Solution

Class	Class boundary	x	f	fx	fx^2	cf
44.0 - 47.9	43.95 - 47.95	45.95	3	137.85	413.55	3
48.0 - 51.9	47.95 - 51.95	49.95	17	849.15	14435.55	20
52.0 - 55.9	51.95 - 55.95	53.95	50	2697.5	134875	70
56.0 -59.9	55.95 - 59.95	57.95	45	2607.75	117348.8	115
60.0 - 63.9	59.95 - 63.95	61.95	46	2849.7	131086.2	161
64.0 - 67.9	63.95 - 67.95	65.95	57	3759.15	214271.6	218
68.0 - 71.9	67.95 - 71.95	69.95	23	1608.85	37003.55	241
72.0 - 75.9	71.95 - 75.95	73.95	9	665.55	5989.95	250
			$\sum f$ =250	$\sum fx$ =15175.5	$\sum fx^2$ =655424.1	

(a) Mean, $\bar{x} = \frac{\sum fx}{\sum f} = \frac{15175.5}{250} = 60.702kg$

(b) Standard

(c) Median = $L_b + \left(\frac{\frac{\sum f}{2} - c.f_b}{f}\right) C$

$\frac{\sum f}{2} = \frac{250}{2} = 125$

Median class boundary is 59.95 - 63.95, f = 46 and C = 4

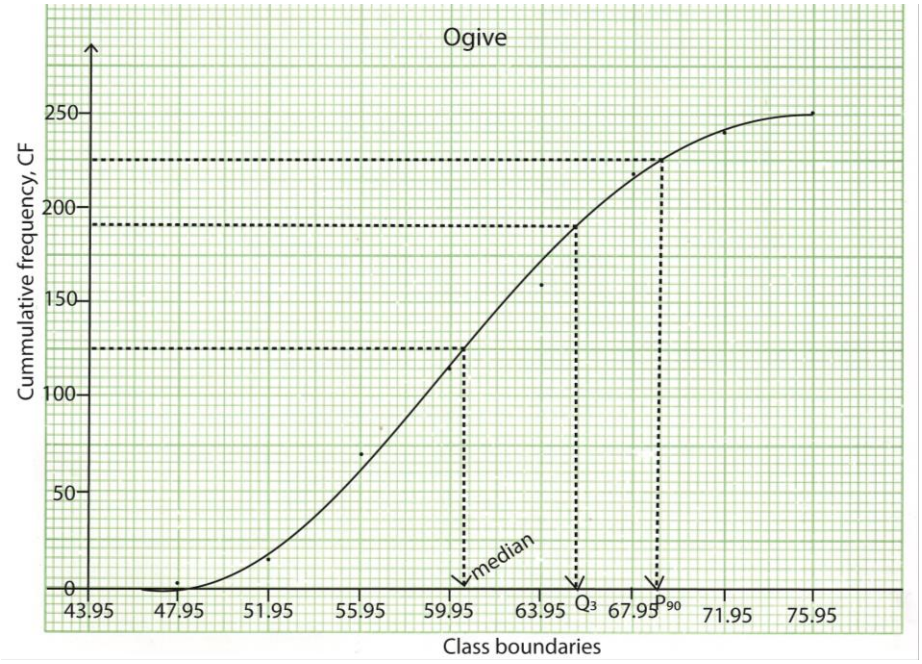
∴ Median = 59.95 + $\left(\frac{125-115}{46}\right) x\ 4$ = 60.82kg

(d) Modal class boundary is 63.95 – 67.95, since 57 is the highest frequency and C = 4

$\Delta_1 = 57 - 46 = 11$ and $\Delta_2 = 57 - 23 = 34$

$Mode = 63.95 + \left(\frac{11}{11+34}\right) x\ 4 = 64.93kg$

(e) Draw an Ogive and use it to find

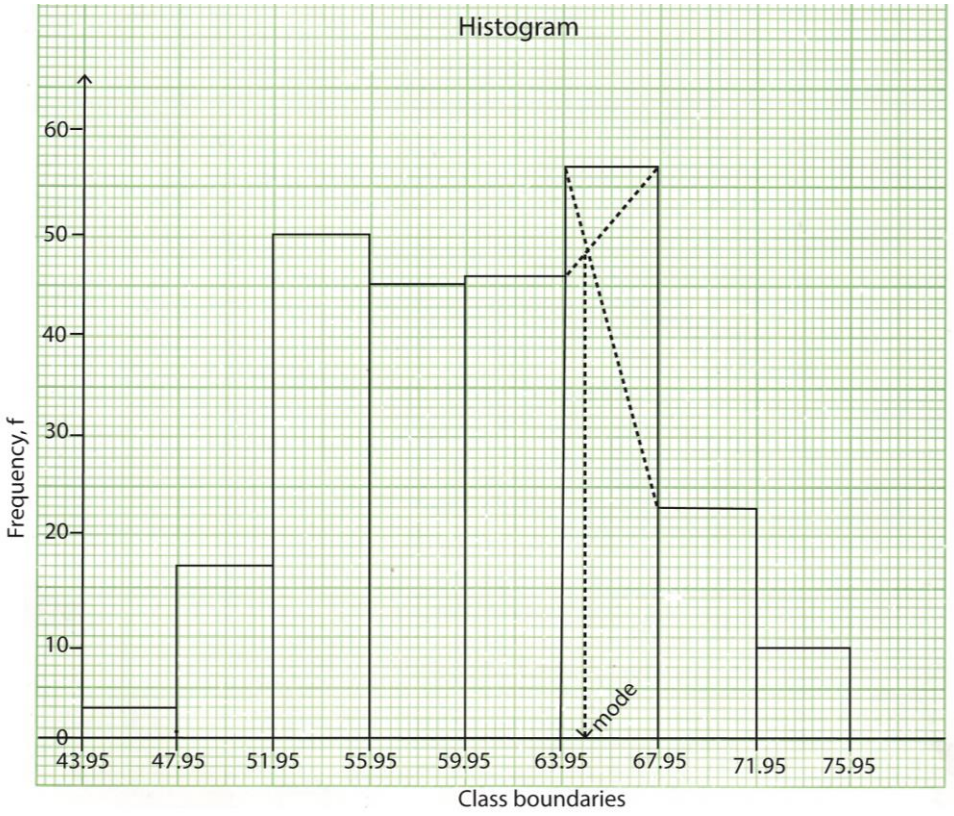


(i) Upper quartile = $\left(\frac{3}{4}x\ 250\right)^{th}$ =187.5th value, from the graph q_3 = 65.55

(ii) Median = $\left(\frac{1}{2}x\ 250\right)^{th}$ =125th value, from the graph, median = 65.55

(iii) 10th percentile= $\left(\frac{90}{10}x\ 250\right)^{th}$ =225th value, from the graph, P90 = 69.15

(f) Construct a histogram and use it to determine the mode



From the graph, the mode =63.95 + 0.8= 64.75

Example 5

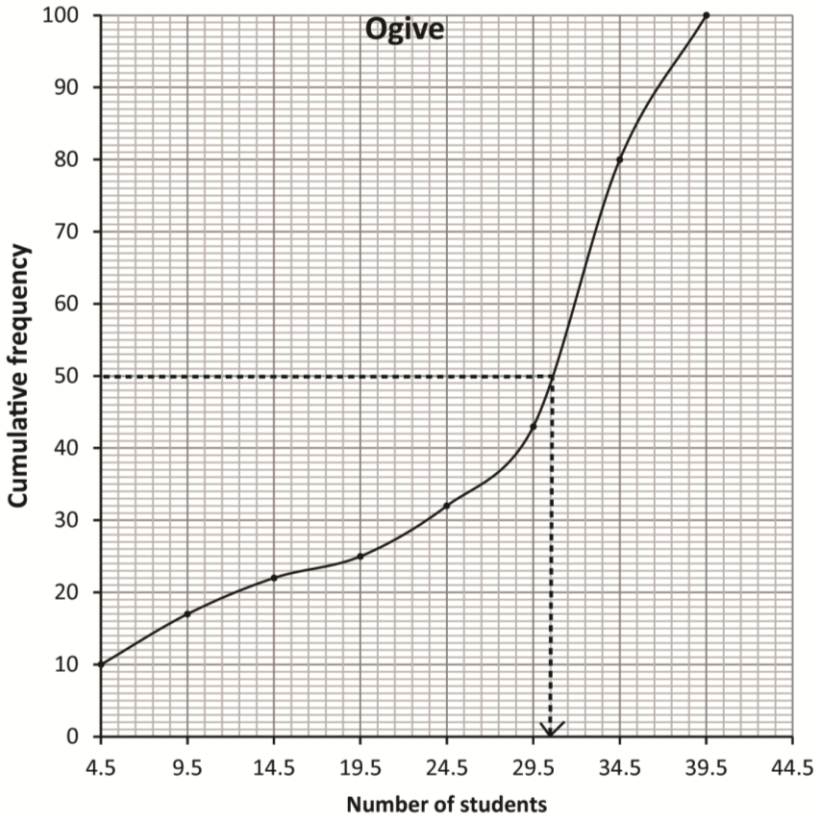
The table below shows the number of students and the mark scored in a test.

MARKS	NUMBER OF STUDENTS
0 – 4	10
5 – 9	7
10 – 14	5
15 – 19	3
20 – 24	7
25 – 29	11
30 – 34	37
35 – 39	20

(a) (i) Draw a cumulative frequency curve (Ogive) for data

MARKS	Class boundaries	NUMBER OF STUDENTS (f)	Cf	x	fx	fx^2
0– 4	0 – 4.5	10	10	2	20	40
5 – 9	4.5 – 9.5	7	17	7	49	343
10 – 14	9.5 – 14.5	5	22	12	60	720
15 – 19	14.5 – 19.5	3	25	17	51	867
20 – 24	19.5 – 24.5	7	32	22	154	3388
25 – 29	24.5 – 29.5	11	43	27	297	019
30 – 34	29.5 – 34.5	37	80	32	1184	37888
35 – 39	34.5 – 39.5	20	100	23	740	27380
		$\sum f = 100$			$\sum fx = 2555$	$\sum fx^2 = 78645$

(i) Use the Ogive to estimate the median mark (06marks)



Note that Cf is plotted against the upper limit of the class

Median $=\left(\frac{N}{2}\right)^{th} = \left(\frac{100}{5}\right)^{th} = 50^{th}$ value= 30.5

(b) Calculate the

(i) Mean mark

Mean = $\frac{\sum fx}{\sum f} = \frac{2555}{100} = 25.55$

(ii) Standard deviation (09 marks)

S.d = $\sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$ = $\sqrt{\frac{78645}{100} - (25.55)^2}$ = 11.56

Example 6

The frequency distribution table below shows the marks of 50 students score in a test

Marks	Number of Students
50 – 52	3
53 – 55	16
56 – 58	14
59 – 61	13
62 – 64	2
65 – 67	2

(a) Calculate the:

Solution

Marks	Class boundaries	Number of Students (f)	fx	Fx^2	CF
50 – 52	49.5 – 52.5	3	153	7803	3
53 – 55	52.5 – 55.5	16	864	46656	19
56 – 58	55.5 – 58.5	14	798	45486	33
59 – 61	58.5 – 61.5	13	780	46800	46
62 – 64	62.5 – 64.5	2	126	7938	48
65 – 67	64.5 - 67.5	2	132	712	50
		50	2853	163395	

(i) Mean mark (04 marks)

Solution

Mean, $\bar{x} = \frac{\sum fx}{\sum f} = \frac{2853}{50} = 57.06$

(ii) Standard deviation. (05 marks)

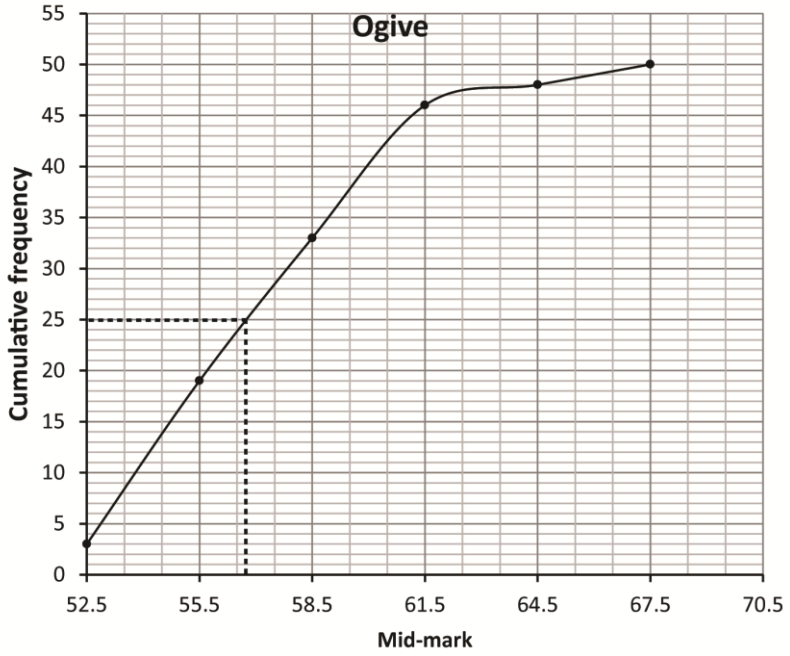
s.d = $\sqrt{\frac{\sum fx^2}{\sum f} - \bar{x}^2}$

= $\sqrt{\frac{163395}{50} - 57.06^2}$

= 12.06

(b) (i) Plot a cumulative frequency curve (Ogive) for the given data. (04 marks)

Note that CF is plotted against the upper limit of each class



(ii) Use the Ogive to estimate the median mark. (02 marks)
56.5

Example 7

The table below shows the age in years of mothers at the time they had their first child.

Age in years	15 -	20 -	25 -	30 -	35 -	40 - 45
Number of mothers	2	14	29	43	33	9

Calculate the modal age of the mothers. (05 marks)

Using the formula

Mode = Li + $\left(\frac{\Delta_1}{\Delta_1+\Delta_2}\right) c$

Modal class (30 – 35)

Δ1 = 43 - 29 = 14

Δ2 = 43 – 33 = 10

Li = 30, Cc = 5

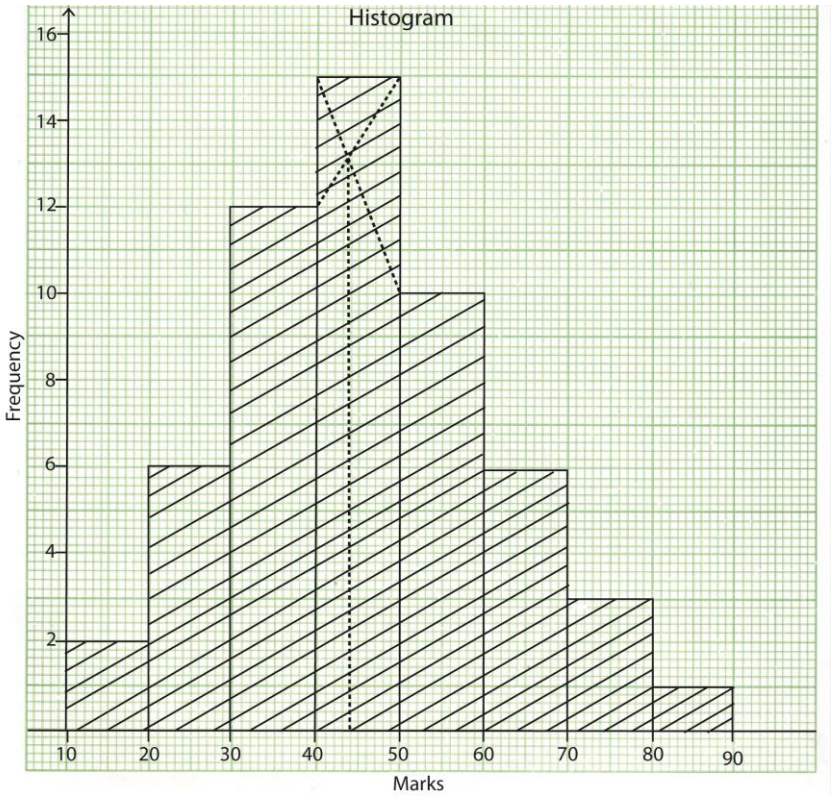
Mode = 30 + 5 $\left(\frac{14}{14+10}\right)$ = 32.92 (2D)

Example 8

The table below shows a frequency distribution of marks scored by s5 students in a test.

Marks	10 -	20 -	30 -	40 -	50 -	60 -	70 -	80 - ≤90
Number of students	2	6	12	15	10	6	3	1

(a) Draw a histogram for the data and use it to estimate the modal mark. (05marks)



From the graph modal mark is 44

(b) Calculate the

Marks	x	f	fx	fx^2
10 - 20	15	2	30	450
20 - 30	25	6	150	3750
30 - 40	35	12	420	14700
40 - 50	45	15	675	30375
50 - 60	55	10	550	30250
60 - 70	65	6	390	25350
70 - 80	75	3	225	16875
80 - 90	85	1	85	7225
		∑f = 55	∑fx=2525	$\sum fx^2$=128975

(i) mean mark

Means, $\bar{x} = \frac{\sum fx}{\sum f} = \frac{2525}{55} = 45.91$

(ii) standard deviation (10marks)

S.D = $\sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2} = \sqrt{\frac{128975}{55} - (45.91)^2}$ = 15.4

Example 9

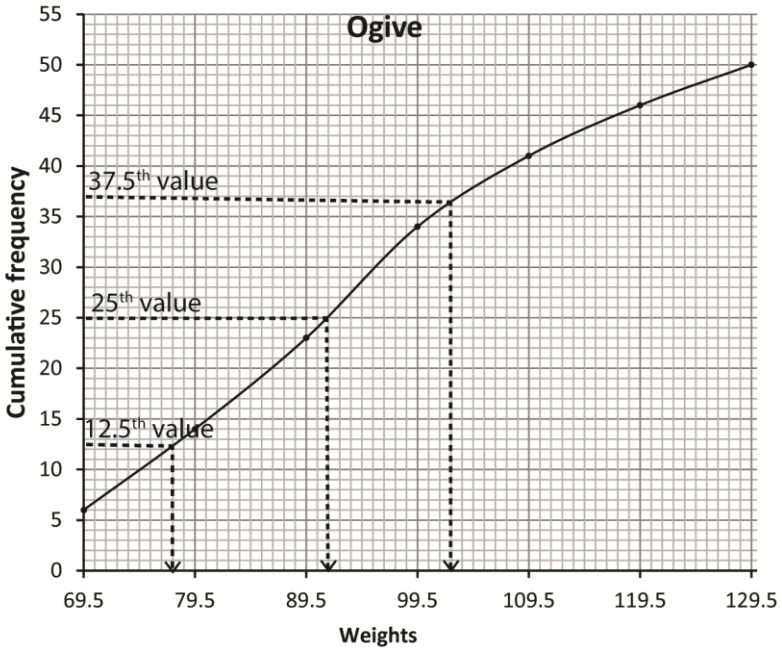
The table below shows the weights in kg of 50 cattle on a farm

60	81	76	68	84	112	76	102	86	67
65	98	107	110	72	99	87	92	76	77
94	102	87	86	73	118	98	120	62	87
65	92	104	116	91	93	78	122	102	92
80	111	73	120	106	123	94	109	80	96

(a) Form a grouped frequency table for the data with classes of equal intervals, starting with the class 60 – 69. (06 marks)

Classes	Class boundaries	Frequency, f	Cumulative frequency, CF
60 – 69	59.5 – 69.5	6	6
70 – 79	69.5 – 79.5	8	14
80 – 89	79.5 – 89.5	9	23
90 – 99	89.5 – 99.5	11	34
100 – 109	99.5 – 109.5	7	41
110 – 119	109.5 – 119.5	5	46
120 – 129	119.5 – 129.5	4	50

(b) Draw a cumulative frequency curve (Ogive) for the given data. (04 marks)



Note that CF is plotted against the upper limit value of the class

(c) Use your Ogive to estimate the;

(i) lower and upper quartile

Lower quartile, $q_1 = \left(\frac{N}{4}\right)^{th} = \left(\frac{50}{4}\right)^{th} = 12.5^{th} value = 69.5 + 8 = 77.5$

(ii) median weight

Median = $\left(\frac{N}{2}\right)^{th} = \left(\frac{50}{2}\right)^{th} = 25^{th} value = 89.5 + 2 = 91.5$

(iii) number of cattle which weigh 118kg and above. (05 marks)

Upper quartile, q_3 = $\left(\frac{3N}{4}\right)^{th} = \left(\frac{3x50}{4}\right)^{th} = 37.5^{th} value = 99.5 + 3 = 102.5$

Example 10

Given the data below

Marks (x)	10-19	20-24	25-34	35-39	40-54	55-64	65-79
Frequency (f)	4	6	7	3	8	6	6

Find the mode

Solution

Class boundary	Class width	f	Frequency density
9.5 - 19.5	10	4	0.4
19.5 - 24.5	5	6	1.2
24.5 - 34.5	10	7	0.7
34.5 - 39.5	5	3	0.6
39.5 - 54.5	15	8	0.53
54.5 - 64.5	10	6	0.6
64.5 - 79.5	15	6	0.4
		$\sum f$ =40	

Mode = $L_b + \left(\frac{\Delta_f . d_1}{\Delta_f . d_1 + \Delta_f . d_2}\right) C$

= $19.5 + \left(\frac{1.2-0.4}{(1.2-0.4)+(1.2-0.7)}\right) x\ 5$

= 22.58

Example 11

The table shows the weights (kg) of 150 patients who visited a certain health centre.

Weight (kg)	0 – 9	10 – 19	20 – 29	30 – 39	40 – 49	50 – 59	60 - 69
Frequency (f	30	16	24	32	28	12	8

Calculate

(a) Mean
(b) Mode
(c) Median

Class	Class boundary	class mark (x)	f	fx	cf
0 - 9	0 - 9.5	4.5	30	135	30
10 - 19	9.5 - 19.5	14.5	16	232	46
20 - 29	19.5 - 29.5	24.5	24	588	70
30 - 39	29.5 -39.5	34.5	32	1104	102
40 - 49	39.5 - 49.5	44.5	28	1246	130
50 - 59	49.5 - 59.5	54.5	12	654	142
60 - 69	59.5 - 69.5	64.5	8	516	150
			$\sum f$ =150	$\sum fx$ =4475	

(a) Mean $\bar{x} = \frac{\sum fx}{\sum f} = \frac{4475}{150}$ = 29.83kg

(b) Mode = $L_b + \left(\frac{\Delta_1}{\Delta_1 + \Delta_2}\right) C$

Modal class boundary is 29.5 – 39.5, since 32 is the highest frequency and C = 10

$\Delta_1 = 32 - 24 = 8$ and $\Delta_2 = 32 - 28 = 4$

$Mode = 29.5 + \left(\frac{8}{8+4}\right) x\ 10 = 36.17kg$

(c) Median = $L_b + \left(\frac{\frac{\sum f}{2} - c.f_b}{f}\right) C$

$\frac{\sum f}{2} = \frac{150}{2} = 75$

Median class boundary is 29.5 -39.5, f = 32 and C = 10

∴ Median = $29.5 + \left(\frac{75-70}{32}\right) x\ 10$ = 30.06kg

Example 12

The table below shows the number of crimes committed by students

Number of crimes	5-<10	10-<20	20-<30	30-<50	50-<100
Number of students	10	15	25	40	26

Calculate the variance and standard deviation for the number of crimes committed

Solution

Number of crime	x	f	fx	fx^2
5-<10	7.5	10	75	562.5
10-<20	15	15	225	3375
20-<30	25	25	625	15625
30-<50	40	40	1600	64000
50-<100	75	25	1875	140625
		$\sum f$ =115	$\sum fx$ =4400	$\sum fx^2$ =224187.5

Var(x) = $\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2 = \frac{224187.5}{115} - \left(\frac{4400}{115}\right)^2 = 485.56$

s.d = $\sqrt{\text{Var(x)}} = \sqrt{485.56} = 22.04$

Example 13

The table below shows the weight of 250 students at a certain day school

Weight (kg)	44.0 – 47.9	48.0 – 51.9	52.0 – 55.9	56.0 – 59.9	60.0 – 63.9	64.0 – 67.9	68.0 – 71.9	72.0 – 75.9
Frequency	3	17	50	45	46	57	23	9

Using assumed mean of 57.95, find

(a) average weight
(b) variance
(c) standard deviation

Solution

weight	x	f	d = x - A	fd	fd^2
43.95-47.95	45.95	3	-12	-36	432
47.95-51.95	49.95	17	-8	-136	1088
51.95-55.95	53.95	50	-4	-200	800
55.95-59.95	57.95	45	0	0	0
59.95-63.95	61.95	46	4	184	736
63.95-67.95	65.95	57	8	456	3648
67.95-71.95	69.95	23	12	276	3312
71.95-75.95	73.95	9	16	144	2304
		$\sum f$ =250		$\sum fd$ =688	$\sum fd^2$ =12320

(a) $\bar{x} = A + \frac{\sum fd}{\sum f} = 57.95 + \frac{688}{250} = 60.702kg$

(b) Var(x) = $\frac{\sum fd^2}{\sum f} - \left(\frac{\sum fd}{\sum f}\right)^2$

$= \frac{12320}{250} - \left(\frac{688}{250}\right)^2 = 41.71kg$

(c) S.d = $\sqrt{Var(x)} = \sqrt{41.71} = 6.46kg$

Example 14

The following table shows the marks obtained by to students in a physics test marked out of 100

Marks (%)	20 -29	30-39	40-49	50-59	60-69	70-79	80-89	90-100
Number of students	4	6	2	5	7	8	5	2

Find

(a) Mean
(b) Standard deviation
(c) Median and mode
(d) Semi-interquartile range
(e) 40^{th} and 85^{th} percentile range

Solution

Class boundary	x	f	fx	fx2	cf
19.5-29.5	24.5	4	98	2401	4
29.5-39.5	34.5	6	207	7141.5	10
39.5-49.5	44.5	2	89	3960.5	12
49.5-59.5	54.5	5	272.5	14851.25	17
59.5-69.5	64.5	7	451.5	29121.75	24
69.5-79.5	74.5	8	596	44402	32
79.5-89.5	84.5	5	422.5	35701.25	37
89.5-99.5	94.5	3	283.5	26790.75	40
		$\sum f$ =40	$\sum fx$ =2420	$\sum fx^2$ =164370	

(i) Mean $\bar{x} = \frac{\sum fx}{\sum f} = \frac{2420}{40} = 60.5\%$

(ii) S.d = $\sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2} = \sqrt{\frac{164370}{40} - \left(\frac{2420}{40}\right)^2}$ = 21.19%

(iii) **Median** = $L_b + \left(\frac{\frac{\sum f}{2} - c.f_b}{f}\right) C$

$\frac{\sum f}{2} = \frac{40}{2} = 20$

Median class boundary is 59.5-69.5, f = 7 and C = 10

∴ Median = $59.5 + \left(\frac{20-17}{7}\right) x\ 10$ = 63.786%

Mode = $L_b + \left(\frac{\Delta_1}{\Delta_1 + \Delta_2}\right) C$

Modal class boundary is 69.5-79.5, since 8 is the highest frequency and C = 10

$\Delta_1 = 8 - 7 = 1$ and $\Delta_2 = 8 - 5 = 3$

$Mode = 69.5 + \left(\frac{1}{1+3}\right) x\ 10 = 72\%$

(iv) $q_1 = L_b + \left(\frac{\frac{1}{4}\sum f - c.f_b}{f}\right) C$

$\frac{\sum f}{4} = \frac{40}{4} = 10$, L_b =29.5, f= 6, C = 10

$q_1 = 29.5 + \left(\frac{10-4}{6}\right) x10 = 39.5$

$q_3 = L_b + \left(\frac{\frac{3}{4}\sum f - c.f_b}{f}\right) C$

$\frac{3\sum f}{4} = \frac{3\ x\ 40}{4} = 30$, L_b =69.5, f= 8, C = 10

$q_1 = 69.5 + \left(\frac{30-24}{8}\right) x10 = 77\%$

Semi-quartile range = $\frac{q_3 - q_1}{2} = \frac{77-39.5}{2} = 18.75\%$

(v) $P_{40} = L_b + \left(\frac{\frac{40}{100}\sum f - c.f_b}{f}\right) C$

$\frac{40\sum f}{100} = \frac{40\ x\ 40}{100} = 16$, L_b =49.5, f= 5, C = 10

$P_{40} = 49.5 + \left(\frac{16-12}{5}\right) x10 = 57.5\%$

(vi) $P_{85} = L_b + \left(\frac{\frac{40}{100}\sum f - c.f_b}{f}\right) C$

$\frac{85\sum f}{100} = \frac{85\ x\ 40}{100} = 34$, L_b = 79.5, f= 5, C = 10

$P_{85} = 79.5 + \left(\frac{34-32}{5}\right) x10 = 83.5\%$

40^{th} and 85^{th} range = 83.5 – 57.5 = 26%

Example 15

Given the information in the table

Class	20-29	30-34	35-44	45-64	65-74	75-84
Frequency	5	5	12	20	10	8

Find

(a) Mean value
(b) Standard deviation
(c) Mode
(d) Median
(e) Interquartile range

(f) 90^{th} percentile

Solution

Class boundary	class width	x	f	f.d	fx	fx^2	cf
19.5-29.5	10	24.5	5	0.5	122.5	3001.25	5
29.5-34.5	5	32	5	1	160	5120	10
34.5-44.5	10	39.5	12	1.2	474	18723	22
44.5-64.5	20	54.5	20	1	1090	59405	42
64.5-74.5	10	69.5	10	1	695	48302.5	52
74.5-84.5	10	79.5	8	0.8	636	50562	60
			$\sum f$ =60		$\sum fx$ =3177.5	$\sum fx^2$ =185113.8	

(a) Mean $\bar{x} = \frac{\sum fx}{\sum f} = \frac{3177.5}{60} = 52.96$

(b) S.d = $\sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2} = \sqrt{\frac{185113.8}{60} - \left(\frac{3177.5}{60}\right)^2}$ = 16.75

(c) Mode = $L_b + \left(\frac{\Delta_f . d_1}{\Delta_f . d_1 + \Delta_f . d_2}\right) C$

=34.5 + $\left(\frac{1.2-1}{(1.2-1)+(1.2-1)}\right) 10$ = 39.5

(d) **Median** = $L_b + \left(\frac{\frac{\sum f}{2} - c.f_b}{f}\right) C$

$\frac{\sum f}{2} = \frac{60}{2} = 30$

Median = 44.5 + $\left(\frac{30-22}{20}\right) x\ 20$ = 552.5

(e) $q_1 = L_b + \left(\frac{\frac{1}{4}\sum f - c.f_b}{f}\right) C$

34.5 + $\left(\frac{\frac{1}{4} x\ 60-10}{20}\right) x\ 10$ = 38.67

$Q_3 = L_b + \left(\frac{\frac{3}{4}\sum f - c.f_b}{f}\right) C$

64.5 + $\left(\frac{\frac{3}{4} x\ 60-42}{10}\right) x\ 10$ = 67.5

Interquartile range = 67.5 – 38.67 = 28.83

(vii) $P_{90} = L_b + \left(\frac{\frac{90}{100}\sum f - c.f_b}{f}\right) C$

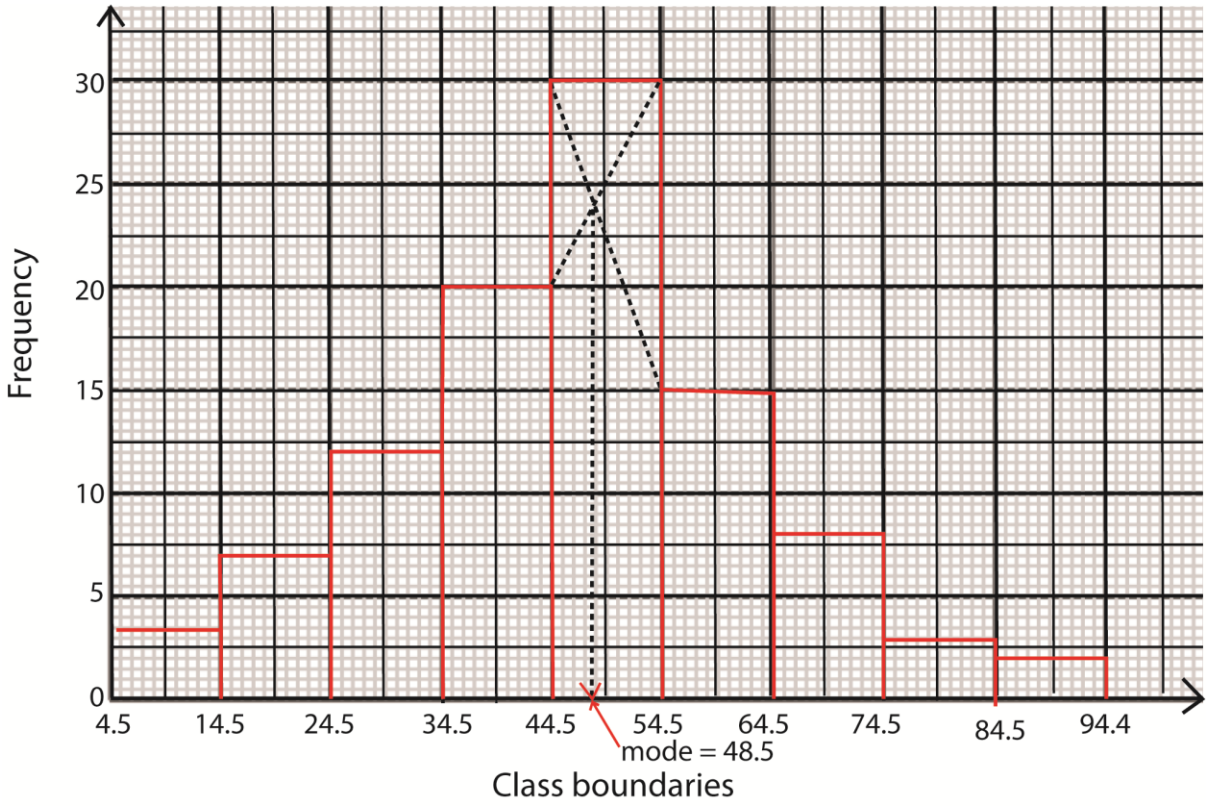
= 74.4 + $\left(\frac{\frac{90}{100}(60)-52}{8}\right) x\ 10$ = 77

Example 17

Given the data below

Marks	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75-85	85-94
Frequency	3	7	12	20	30	15	8	3	2

Draw a histogram and use it to determine the mode



Example 18

Given the data below

Marks	20-29	30-39	40-49	50-59	60-69	70-79
Frequency	4	6	12	8	7	3

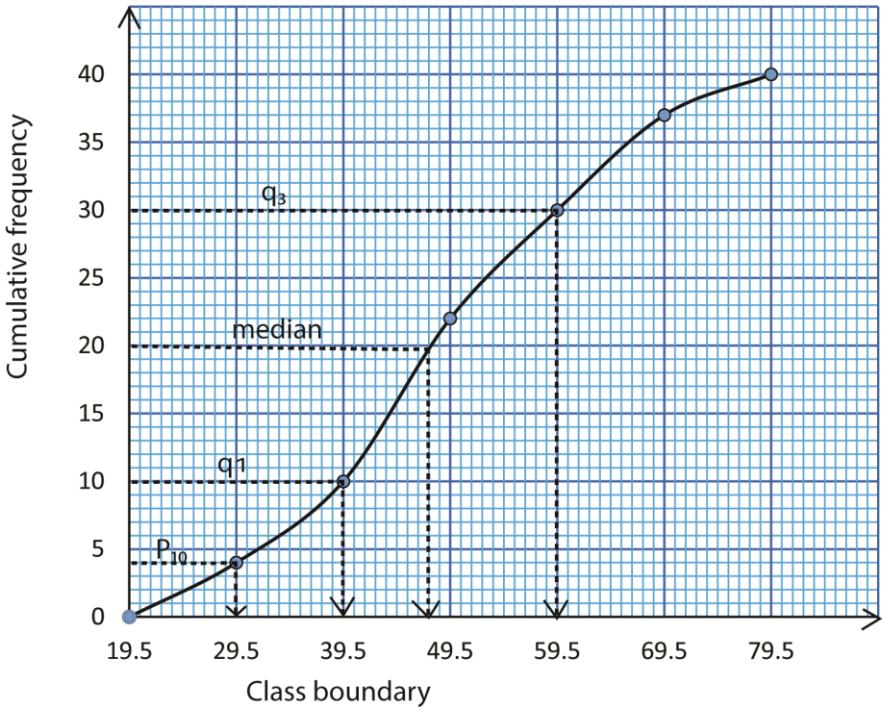
Draw an Orgive and use it to determine

(a) Median
(b) Interquartile range
(c) 10^{th} percentile

Solution

Class boundary	19.5 – 29.5	29.5–39.5	39.5–49.5	49.5 – 59.5	59.5 – 69.5	69.5 – 79.5
cf	4	10	22	30	37	40

An Orgive



(a) The median = $\left(\frac{N}{2}\right)^{th} = \left(\frac{40}{2}\right)^{th}$ = 20th value from the graph = 48.5

(b) $q_1 = \left(\frac{N}{4}\right)^{th} = \left(\frac{40}{4}\right)^{th}$ = 10th value ; from the graph q_1 = 39.5

$q_3 = \left(\frac{3N}{4}\right)^{th} = \left(\frac{3\ x\ 40}{4}\right)^{th}$ = 30th value; from the graph q_3 = 59.5

Interquartile range = 59.5 – 39.5 = 20

(c) $P_{10} = \left(\frac{10N}{100}\right)^{th} = \left(\frac{10\ x\ 40}{100}\right)^{th}$ = 4th value ; from the graph P_{10} = 29.5

Grouped data with unequal class width

(i) Histogram

This is a graph of frequency density against class boundary

Note that frequency density = $\frac{Frequency}{class\ width}$

Orgive

This is a graph of cumulative frequency against the class boundary

Example 19

The data shows the length in centimetres for different calendars produced by a printing press. A cumulative frequency distribution was formed

Length (cm)	<20	<30	<35	<40	<50	<60
Cumulative frequency	4	20	32	42	48	50

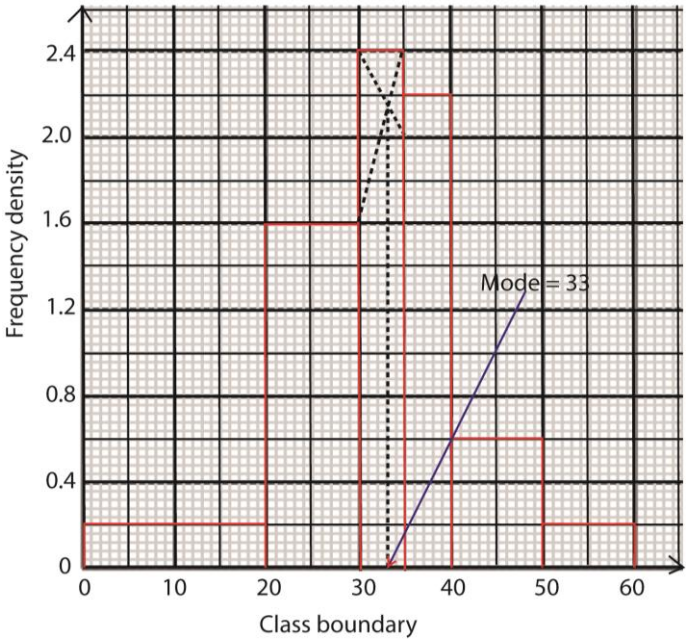
(a) Construct a frequency table.
(b) Find the mean length of the calendars
(c) Draw a histogram and use it to estimate the modal length
(d) Draw an Orgive and use it to estimate the median length.

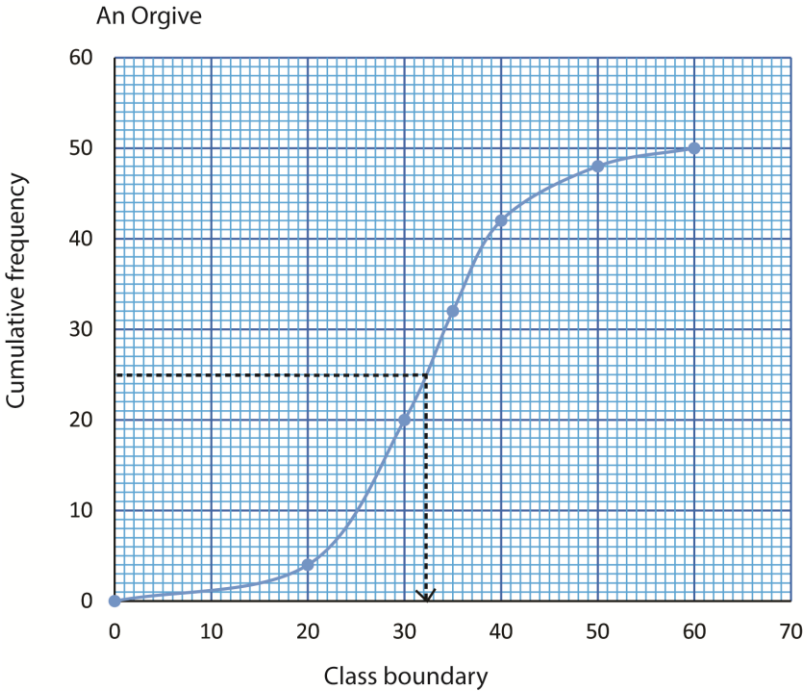
Solution

(a) Frequency table

Class boundary	x	f	fx	class width	frequency density	cf
0 - 20	10	4	40	20	0.2	4
20 - 30	25	16	400	10	1.6	20
30 - 35	32.5	12	390	5	2.4	32
35 - 40	37.5	10	375	5	2	42
40 - 50	45	6	270	10	0.6	48
50-60	55	2	110	10	0.2	50
		$\sum f$50	$\sum fx$ =1585			

(b) Mean $\bar{x} = \frac{\sum fx}{\sum f} = \frac{1585}{50} = 31.7$





Median length is the $\left(\frac{N}{2}\right)^{th} = \left(\frac{50}{2}\right)^{th}$ =25th value, from the graph = 32

Revision Exercise 2 (answers are given in brackets besides the questions)

1. The table below shows cumulative distribution of ages (in years of 400 student

Age(years)	<12	<13	<14	<15	<16	<17	<18	<19
Cumulative frequency	0	27	85	215	320	370	395	400

   (a) Construct a cumulative frequency curve
   (b) Use the curve to estimate
   (i) Median age (Answer 14.9)
   (ii) 20^{th} and 80^{th} percentile range (Ans. 2.1)

2. The table below shows the time taken by students to solve a mathematics problem

Time (mins)	5-9	10-14	15-19	20-24	25-29	30-34
Frequency	5	14	30	17	11	3

   (a) Draw a histogram and use it to estimate the modal time. (ans. 17.3)
   (b) Find the mean and standard deviation of solving the problem (Mean = 18.5mins, s.d = 5.9896 (4D))

3. The frequency distribution table shows the heights of s.6 students measured to the nearest cm;

Height	149-152	153-156	157-160	161-164	165-168	169-172	173-176
Frequency	5	17	20	25	15	6	2

   (a) Calculate
      (i) Mean height (Ans. 160.9cm)
      (ii) Standard deviation (Ans. 5.5873)
   (b) Draw a cumulative frequency curve and use it to estimate the median (Ans. 161cm) and range of height of the middle 60% of the candidates. (Ans. 10cm)

4. The table below the weights of some S.5 students from a certain school

Weight	50-53	54-57	58-61	62-65	66-69	70-73	74-77	78-81
Number of student	3	8	12	18	11	5	2	1

   (a) Calculate
      (i) Mean (63.1kg)
      (ii) Standard deviation of students' weight (6kg)
   (b) Draw a cumulative frequency curve and use it to estimate
      (i) Median weight (63.1kg)
      (ii) Number of students with weight between 58.9kg and 66.7kg (29students

5. The table below is the distribution of weights of a group of animals

Mass (kg)	Frequency
21-25	10
26-30	20
31-35	15
36-40	10
41-50	30
51-60	45
66-74	5

   (a) Draw a cumulative frequency curve to estimate semi-quartile range (24kg)
   (b) Find

(i) Mode (28.8333kg)
(ii) Standard deviation (11.772)

6. The table below shows the amount of money (in thousands of shillings) that was paid out as allowances to participants during a certain workshop

Amount (shs'000s)	110-114	115-119	120-129	130-134	135-144	145-159
Number of participants	13	20	32	17	16	12

(a) Draw a histogram and use it to estimate the modal allowance (shs. 11800)
(b) Calculate the:
(i) Median allowance (shs. 126,375/=)
(ii) Mean allowance (shs. 128,000/=)

7. The table below shows the income of 40 factory workers in millions of shillings per annum

1.0	1.1	1.0	1.2	5.4	1.6	2.0	2.5
2.1	2.2	1.3	1.7	1.8	2.4	3.0	2.2
2.7	3.5	4.0	4.4	3.9	5.0	5.4	5.3
4.4	3.7	3.6	3.9	5.2	5.1	5.7	1.5
1.6	1.9	3.4	4.3	2.6	3.8	5.3	4.0

(a) Form a frequency distribution table with class interval of 0.5millin shillings starting with the lowest limit of 1million shillings
(b) Calculate the
(i) Mean income (shs. 3,175,000)
(ii) Standard deviation (shs. 1,413,992.574)
(c) Draw a histogram to represent the above data. Use it to estimate the modal income
Modal income: (shs. 5, 200,000)

8. The table below shows the mars obtained by students in a physic test

Marks (%)	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	60-69	70-74
Frequency	9	12	10	17	13	25	18	14	8	8

(a) Draw a histogram and use it to estimate the modal mark. (52.5)
(b) Find the
(i) Mean mark (49.4627)
(ii) Standard deviation (12.424)

9. The table below shows the marks obtained in an examination by 200 candidates

Marks(%)	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89
Number of candidates	18	34	58	42	24	10	6	8

(a) Calculate the
(i) Mean mark (40.2%)
(ii) Modal mark (35.5%)
(b) Draw a cumulative frequency curve for the data. Hence estimate the lowest mark for a distinction one if the top 5% of the candidates qualify for the distinction. (75%)

10. A class performed on an experiment to estimate the diameter of a circular object. A sample of five students had the following results in centimetre. 3.13, 3.16, 2.94, 3.33 and 3.0.
Determine the sample;
(i) Mean (3.11)
(ii) Standard deviation (0.1356)(05marks)

11. The times taken for 55 students to have their lunch to the nearest minute are given in the table below

Time (minutes)	3 -4	5-9	10-19	20 – 29	30 – 44
Number of students	2	7	16	21	9

(a) Calculate the mean time for the student to have lunch. (mean=20.65) (04marks)

(b) (i) Draw a histogram for the given data

(ii) Use your histogram to estimate the modal time for the students to have lunch. (08marks) (modal time = 22 minutes)

12. The frequency distribution below shows the age of 240 students admitted to a certain University.

Age (years)	Number of student
18 - < 19	24
19 -< 20	70
20 -< 24	76
24 -< 26	48
26 -< 30	16
30 -< 32	6

(a) Calculate the mean age of the students. (mean =22.1458)(04mark)

(b) (i) Draw a histogram for the given data

(ii) Use the histogram to estimate the modal age (modal age = 19.58) (08mark)

13. The table shows the masses of bolts bought by a carpenter.

Mass (grams)	98	99	100	101	102	103	104
Number of bolts	8	11	14	20	17	6	4

Calculate the:

(a)median mass (101g)

(b) mean mass of the bolt(100.7625g) (05mark

14. The table below shows the marks obtained in a mathematic test by a group of student

marks	5 -<15	15-<25	25-<35	35-<45	45-<55	55-<65	65-<75	75-<100
Number of students	5	7	19	17	7	4	2	3

(a) Construct a cumulative frequency (O give) for the data (05 marks)

(b) Use your Ogive to find the

(i) Range between the 10^{th} and 70^{th} percentiles (26)

(ii) Probability that a student selected at random scored below 50 marks. 0.8125) (07 marks)

15. The table below shows the marks obtained by 100 students in a mathematics test

Marks	20-<40	40-<50	50-<55	55-<60	60-<70	70-<90	90-<100
Number of students	5	15	10	15	25	25	5

(a) Calculate the mean mark (63.125)

(b) Construct a cumulative frequency curve (Ogive) and use it to find the

(i) Median mark (61.5)

(ii) Range of the middle 40% of the mark (15)

Thank You

Dr. Bbosa Science