

Mathematics

Quarter 4- Week 2 Module 2 Solving Measures of Position



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Mathematics 10
Quarter 4 – Week 2 Module 2
Solving Measures of Position

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Region I

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Target

Statistics plays a big role in our everyday life. It keeps us informed about the things that happen around us. Gathered data are being organized and analyzed. Results serve as basis in making decisions and formulate possible course of action to be taken to resolve a particular problem or issue. Various statistical tools are readily available for utilization depending on the treatment that is needed to have an accurate data and statistic. One of these are the measures of position which describe a distribution by dividing it into equal parts and relate a particular value using rank order.

In this module, specific steps in solving for measures of position of ungrouped and grouped data were presented. Measures of position discussed here are quartiles, deciles and percentiles. These are called quantiles, in general. As you deal with set of data, you will be recalling and applying your skills in organizing data in a frequency distribution table which you have learned in the previous years.

In this module, you will learn to:

1. calculate a specified measure of position (e.g. 90th percentile) of a set of data. **(M10SP-IVb-1)**

At the end of this module, you are expected to:

1. organize data in a frequency distribution table; and
2. solve for the quantiles of grouped data.

Let's start! Answer the pre-assessment in a separate sheet of paper and find out how much you already know about the topics included in this module.

PRE-ASSESSMENT

Directions: Choose the letter of the correct answer. Write your answer on a separate sheet of paper. Take note of the items that you were not able to answer correctly and find the right answer as you go through this module.

1. What is the term used to describe the score points that divide a distribution into ten equal parts?
A. decile B. percentile C. quantile D. quartile
2. Which of the following is used to solve for the decile position of ungrouped data?
A. $\frac{k}{2}(n+1)$ B. $\frac{k}{4}(n+1)$ C. $\frac{k}{10}(n+1)$ D. $\frac{k}{100}(n+1)$

For items 3-6, use the given data:

5, 6, 7, 7, 8, 8, 8, 9, 10

3. Where is the 5th decile located?
A. 5th data B. 6th data C. 7th data D. 8th data
4. What is the value of the 5th decile?
A. 5 B. 6 C. 7 D. 8
5. Where is the third quartile located?
A. 7th data B. 7.5th data C. 8th data D. 8.5th data
6. What is the value of the third quartile?
A. 7 B. 7.5 C. 8 D. 8.5

For items 7-8, use the given data:

87, 90, 83, 92, 91, 88, 80, 83, 85, 94, 89, 90, 92, 90

7. Where is the 65th percentile located?
A. 9th data B. 9.25th data C. 9.50th data D. 9.75th data
8. What is the value of the 65th percentile?
A. 89 B. 90 C. 91 D. 92
9. Which of the following is used in solving percentiles of grouped data?
A. $LB + \left[\frac{\frac{kN}{2} + <cf_b}{f} \right] i$ B. $LB + \left[\frac{\frac{kN}{4} + <cf_b}{f} \right] i$
C. $LB + \left[\frac{\frac{kN}{10} + <cf_b}{f} \right] i$ D. $LB + \left[\frac{\frac{kN}{100} + <cf_b}{f} \right] i$

For items 10-15, use the given data:

Class Interval	F	LB	<cf
19-20	2	18.5	30
17-18	5	16.5	28
15-16	10	14.5	23
13-14	8	12.5	13
11-12	4	10.5	5
9-10	1	8.5	1

10. What is the size of each class interval?
A. 2 B. 6 C. 20 D. 30
11. What class interval contains D_8 ?

- | | | | |
|----------|----------|----------|----------|
| A. 13-14 | B. 15-16 | C. 17-18 | D. 19-20 |
|----------|----------|----------|----------|
12. What is the frequency of the D_8 class?
- | | | | |
|------|------|------|-------|
| A. 2 | B. 5 | C. 8 | D. 10 |
|------|------|------|-------|
13. What is the value of D_8 ?
- | | | | |
|---------|---------|---------|---------|
| A. 15.9 | B. 16.9 | C. 17.9 | D. 18.9 |
|---------|---------|---------|---------|
14. What class interval contains P_{20} ?
- | | | | |
|---------|----------|----------|----------|
| A. 9-10 | B. 11-12 | C. 13-14 | D. 15-16 |
|---------|----------|----------|----------|
15. What is the value of P_{20} ?
- | | | | |
|----------|-------|---------|----------|
| A. 12.75 | B. 13 | C. 13.5 | D. 13.75 |
|----------|-------|---------|----------|

Lesson 1

Measures of Position of Ungrouped Data

Different measures of position are also tools in analyzing data based on the location of a single value in relation to other values in the given data set. Some measures that will be discussed in this module are quartiles, deciles and percentiles. Generally, they are called quantiles.



Jumpstart

In this activity, practice your skills in evaluating set of numbers or expressions. This will be of great help as you solve values of quantiles later.

Activity 1: E-value

Evaluate each expression accurately. Write your answers on your answer sheet.

- | | |
|-----------------------------|--|
| 1. $\frac{2}{4}(19 + 1)$ | 6. $\frac{72}{100}(26 + 1)$ |
| 2. $\frac{3}{4}(15 + 1)$ | 7. $\frac{1}{4}(22 + 1)$ |
| 3. $\frac{1}{10}(29 + 1)$ | 8. If $k=2$ and $n=23$, evaluate $\frac{k}{4}(n + 1)$. |
| 4. $\frac{8}{10}(39 + 1)$ | 9. If $k=3$ and $n=9$, evaluate $\frac{k}{10}(n + 1)$ |
| 5. $\frac{40}{100}(39 + 1)$ | 10. If $k=50$ and $n=27$, evaluate $\frac{k}{100}(n + 1)$ |



Discover

Steps in Solving for Quantiles of Ungrouped Data

1. Arrange the data in ascending order.
2. Solve for the quantile position using the following:

$$\text{Quartiles} \\ Q_k = \frac{k}{4}(n + 1)$$

$$\text{Deciles} \\ D_k = \frac{k}{10}(n + 1)$$

$$\text{Percentiles} \\ P_k = \frac{k}{100}(n + 1)$$

where:

k = desired quantile, and;

n = number of data.

3. Determine the quantile value from the given data using the quantile position obtained in step 2.

Steps on Linear Interpolation

If the quantile position solved is a decimal number, interpolation should be performed using the following steps.

1. Determine the possible values using the solved quantile position. Get their difference.
2. Multiply the result in step 1 to the decimal part of the obtained quantile position.
3. Add the result in step 2 to the smaller value from step 1.

Examples

Given the scores of students in an achievement test, solve for the following quantiles:

- a. 3rd quantile,
- b. 2nd decile, and;
- c. 62nd percentile.

Students' scores in an Achievement Test

23, 48, 24, 37, 35, 29, 21, 31, 42, 31, 26, 37, 24, 37, 40, 25, 30, 45, 30

Solutions:

- a. $Q_3 = 3^{\text{rd}}$ quartile

Step 1: Arrange the data in ascending order.

21, 23, 24, 24, 25, 26, 29, 30, 30, 31, 31, 35, 37, 37, 37, 40, 42, 45, 48

Step 2: Solve for the quartile position using $Q_k = \frac{k}{4}(n + 1)$.

Given that:

$$\begin{array}{ll} k = 3 & \text{since } Q_3 \text{ is being solved} \\ n = 19 & \text{there are a total of 19 scores} \end{array}$$

Then by substitution,

$$\begin{aligned} Q_{k_{\text{position}}} &= \frac{k}{4}(n + 1) \\ Q_{3_{\text{position}}} &= \frac{3}{4}(19 + 1) \\ Q_{3_{\text{position}}} &= \frac{3}{4}(20) \\ Q_{3_{\text{position}}} &= \frac{60}{4} \\ \mathbf{Q_{3_{\text{position}}} = 15} \end{aligned}$$

Therefore, the third quartile is located on the 15th data.

Step 3: Determine the Q_3 value from the arranged data in step 1.

The 15th data is 37, thus the value of the 3rd quartile is 37.

$$\mathbf{Q_{3_{\text{value}}} = 37}$$

b. $D_2 = 2^{\text{nd}}$ decile

Step 1: Arrange the data in ascending order.

21, 23, 24, 24, 25, 26, 29, 30, 30, 31, 31, 35, 37, 37, 37, 40, 42, 45, 48

Step 2: Solve for the quartile position using $D_k = \frac{k}{10}(n + 1)$.

Given that:

$$\begin{array}{ll} k = 2 & \text{since } D_2 \text{ is being solved} \\ n = 19 & \text{there are a total of 19 scores} \end{array}$$

Then by substitution,

$$\begin{aligned} D_{k_{\text{position}}} &= \frac{k}{10}(n + 1) \\ D_{2_{\text{position}}} &= \frac{2}{10}(19 + 1) \\ D_{2_{\text{position}}} &= \frac{2}{10}(20) \\ D_{2_{\text{position}}} &= \frac{40}{10} \\ \mathbf{D_{2_{\text{position}}} = 4} \end{aligned}$$

Therefore, the second decile is located on the 4th data.

Step 3: Determine the D_2 value from the arranged data in step 1.

The 4th data is 24, thus the value of the 2nd decile is 24.

$$\mathbf{D_{2_{\text{value}}} = 24}$$

c. $P_{62} = 62^{\text{nd}}$ percentile

Step 1: Arrange the data in ascending order.

21, 23, 24, 24, 25, 26, 29, 30, 30, 31, 31, 35, 37, 37, 37, 40, 42, 45, 48

Step 2: Solve for the quartile position using $P_k = \frac{k}{100}(n + 1)$.

Given that:

$k = 62$ since P_{62} is being solved
 $n = 19$ there are a total of 19 scores

Then by substitution,

$$\begin{aligned}P_{k_{position}} &= \frac{k}{100}(n + 1) \\P_{62_{position}} &= \frac{62}{100}(19 + 1) \\P_{62_{position}} &= \frac{62}{100}(20) \\P_{62} &= \frac{1240}{100} \\P_{62_{position}} &= \mathbf{12.4}\end{aligned}$$

Therefore, the 62nd percentile is located on the 12.4th data.

Step 3: Determine the P_{62} value from the arranged data in step 1.

The percentile position 12.4 is a decimal number; we need to apply linear interpolation.

Steps on Linear Interpolation

1. Determine the possible percentile values, and then get their difference.

The percentile value is located on the 12.4th data; this means it lies between the 12th and the 13th data.

The 12th data is 35 and the 13th data is 37.

Therefore,

$$37 - 35 = \underline{2}$$

2. Multiply the result in step 1 to the decimal part of the obtained percentile position.

$$2 \times 0.4 = 0.8$$

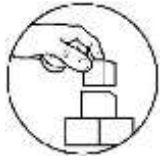
3. Add the result in step 2 to the smaller value from step 1.

$$35 + 0.8 = 35.8$$

Therefore,

$$P_{62_{value}} = \mathbf{35.8}$$

The value of the 62nd percentile is 35.8



Explore

Let's us now apply the skills that you have learned in the previous section by completing the activity given below.

Activity 2: Know Your Position

Solve for the indicated measure of position of each given set of data.

Set A.

Given:

39	35	40	28	26	33	35	32	30	29
22	18	15	25	25	20	21	20	23	

Solve:

- | | | |
|-----------------------|-----------------------|------------------------|
| 1. $Q_{1_{position}}$ | 3. $D_{9_{position}}$ | 5. $P_{30_{position}}$ |
| 2. $Q_{1_{value}}$ | 4. $D_{9_{value}}$ | 6. $P_{30_{value}}$ |

Set B.

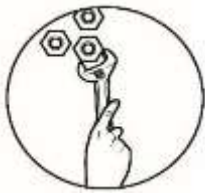
Given:

92	85	89	95	83	93	86	90	97	80	96
----	----	----	----	----	----	----	----	----	----	----

Solve:

- | | |
|-----------------------|------------------------|
| 7. $D_{3_{position}}$ | 9. $P_{85_{position}}$ |
| 8. $D_{3_{value}}$ | 10. $P_{85_{value}}$ |

Were you able to solve accurately for the quantile position and value indicated on the previous activity? If yes, then you are now ready to take a more challenging task provided on the next section.



Deepen

Activity 3: Life's Message

Decode the message below by following these simple steps.

Step 1: Solve for the indicated quantiles in the message box.

Step 2: Look for your computed value in the answer box and determine the word that corresponds to your answer.

Step 3: On the message box, write the word that matched your answer above the given quantile.

Given:

80	86	96	79	97	82	92	87	89
78	90	82	83	87	95	78	87	93

Answer Box:

78	82	96.1	89.35	92.25
down	helping	unless	them	look

79.23	84.8	81.5	96.67	90.6
you're	on	never	up	anybody

Message Box:

Q ₁	Q ₃	D ₁	D ₄	D ₇

D ₉	P ₁₇	P ₂₈	P ₆₅	P ₉₃

What is the hidden message? _____

Lesson 2

Measures of Position for Grouped Data

This lesson will still be presenting how to solve measures of position. But this time, we will be dealing with grouped data.



Jumpstart

Let us have a quick review on organizing data in a frequency distribution table. Below are the common terms you need to recall.

Terms to Remember

- frequency distribution table – a tabular presentation of data that displays frequency of outcomes in a sample
- frequency (f) – the number of occurrences of values in a particular group or interval. The total number of frequency is denoted by N .
- class interval – a subset into which data is grouped
- class size (i) – the size or width of each class interval; the number of data included in a class
- class limits – the highest and lowest data for each class interval
- class boundaries – the halfway points that separate each classes
- upper boundary (UB) – a value that is 0.5 more than the upper limit of a class
- lower boundary (LB) – a value that is 0.5 less than the lower limit of a class
- less than cumulative frequency ($<cf$) – is obtained by adding the frequency of a class and the frequency of the lower classes
- greater than cumulative frequency ($>cf$) – is obtained by adding the frequency of a class and the frequency of the upper classes

Activity 4: Get Organized!

Consider the data on the summative test scores of Grade 10 learners; construct a frequency distribution by completing the table below.

25	20	24	18	29	22	26	24	19	27
28	17	21	23	27	30	25	19	26	27
18	15	25	21	22	18	29	16	14	20

Class Interval	tally	f	UB	LB	<cf	>cf
28-30						
25-27						
22-24						
19-21						
16-18						
13-15						
i=		N=				



Discover

In the previous activity, you were able to recall how to organize data in a frequency distribution table. This tabular presentation of data is needed in solving measures of position of grouped data. It is essential to know each values in the table since these will be used in the formulas to be presented in this section.

Steps in Solving Quantiles of Grouped Data

These are the simple steps you will follow to solve for the quartiles, deciles, and percentiles of grouped data.

1. Set up the frequency distribution table by completing the columns for frequency (f), lower boundary (LB), and less than cumulative frequency ($<cf$), and identify the class size (i) and total number of data (N).
2. Identify the quantile class using the formulas below then determine the class interval that contains the n^{th} data.

Quartiles

$$Q_{k \text{ class}} = \frac{kN}{4}$$

Deciles

$$D_{k \text{ class}} = \frac{kN}{10}$$

Percentiles

$$P_{k \text{ class}} = \frac{kN}{100}$$

3. Identify the values of the following

LB = lower boundary of the quantile class

- N = total frequency
 $<cf_b$ = less than cumulative frequency of the class before the quantile class
 f = frequency of the quantile class
 i = class size
 k = desired quantile

3. Solve for the quantile value by substituting the values in step 2 to the following formulas.

Quartiles	Deciles	Percentiles
$Q_k = LB + \left[\frac{\frac{kN}{4} - <cf_b}{f} \right] i$	$D_k = LB + \left[\frac{\frac{kN}{10} - <cf_b}{f} \right] i$	$P_k = LB + \left[\frac{\frac{kN}{100} - <cf_b}{f} \right] i$

Examples

Given the data on Statistics Test Scores of Grade 10 students; solve for Q_3 , D_5 , and P_{20} .

Class Interval	f	LB	<cf
45-50	6		
39-44	9		
33-38	12		
27-32	10		
21-26	5		
i=	N=		

Solutions:

- A. Solving for Q_3 .

Step 1: Completing the frequency distribution table.

Class Interval	f	LB	<cf
45-50	6	44.5	42
39-44	9	38.5	36
33-38	12	32.5	27
27-32	10	26.5	15
21-26	5	20.5	5
i= 6	N=42		

Step 2: Identify the quartile class.

Since we are solving for Q_3 , we will be using $\frac{kN}{4}$ to solve for the $Q_{3 \text{ class}}$. The desired quartile is 3, therefore $k=3$, and the total number of frequency is 42, then $N=42$.

$$Q_{k \text{ class}} = \frac{kN}{4}$$

$$Q_{3 \text{ class}} = \frac{3(42)}{4} = \frac{126}{4} = 31.5$$

This means we need to find the class interval that contains the 31.5th data.

Class Interval	F	LB	<cf	
45-50	6	44.5	42	37 th -42 nd
39-44	9	38.5	36	28 th -36 th
33-38	12	32.5	27	16 th -27 th
27-32	10	26.5	15	6 th -15 th
21-26	5	20.5	5	1 st -5 th
i= 6	N=42			

In the table, the 31.5th data is on the class interval 39-44. This means that the $Q_{3 \text{ class}}$ is the class interval 39-44.

Step 3: Identify the values of the following: LB, N, cf_b , f , i , and k from the $Q_{3 \text{ class}}$.

$$\begin{aligned} \text{LB} &= 38.5 \\ \text{N} &= 42 \\ <cf_b &= 27 \\ f &= 9 \\ i &= 6 \\ k &= 3 \end{aligned}$$

Step 4: Solve for the Q_3 value.

$$Q_k = LB + \left[\frac{\frac{kN}{4} - <cf_b}{f} \right] i$$

$$Q_3 = 38.5 + \left[\frac{\frac{3(42)}{4} - 27}{9} \right] 6$$

$$Q_3 = 38.5 + \left[\frac{31.5 - 27}{9} \right] 6$$

$$Q_3 = 38.5 + \left[\frac{4.5}{9} \right] 6$$

$$Q_3 = 38.5 + \left[\frac{27}{9} \right]$$

$$Q_3 = 38.5 + 3$$

$$\mathbf{Q_3 = 41.5}$$

Therefore, the value of Q_3 is 41.5.

B. Solving for D_5 .

Step 1: Completing the frequency distribution table.

Class Interval	f	LB	<cf
45-50	6	44.5	42
39-44	9	38.5	36
33-38	12	32.5	27
27-32	10	26.5	15
21-26	5	20.5	5
i= 6	N=42		

Step 2: Identify the decile class.

Since we are solving for D_5 , we will be using $\frac{kN}{10}$ to solve for the D_5 class. The desired decile is 5, therefore $k=5$, and the total number of frequency is 42, then $N=42$.

$$D_{k \text{ class}} = \frac{kN}{10}$$

$$D_{5 \text{ class}} = \frac{5(42)}{10} = \frac{210}{10} = 21$$

This means we need to find the class interval that contains the 21st data.

Class Interval	f	LB	<cf	
45-50	6	44.5	42	37 th -42 nd
39-44	9	38.5	36	28 th -36 th
33-38	12	32.5	27	16 th -27 th
27-32	10	26.5	15	6 th -15 th
21-26	5	20.5	5	1 st -5 th
i= 6	N=42			

In the table, the 21st data is on the class interval 33-36. This means that the D_5 class is the class interval 33-38.

Step 3: Identify the values of the following: LB, N, cf_b , f , i , and k from the D_5 class.

$$\begin{aligned} LB &= 32.5 \\ N &= 42 \\ <cf_b &= 15 \\ f &= 12 \\ i &= 6 \\ k &= 5 \end{aligned}$$

Step 4: Solve for the D_5 value.

$$D_k = LB + \left[\frac{\frac{kN}{10} - <cf_b}{f} \right] i$$

$$D_5 = 32.5 + \left[\frac{\frac{5(42)}{10} - 15}{12} \right] 6$$

$$D_5 = 32.5 + \left[\frac{21 - 15}{12} \right] 6$$

$$D_5 = 32.5 + \left[\frac{6}{12} \right] 6$$

$$D_5 = 32.5 + \left[\frac{36}{12} \right]$$

$$D_5 = 32.5 + 3$$

$$\mathbf{D_5 = 35.5}$$

Therefore, the value of D_5 is 35.5.

C. Solving for P_{20} .

Step 1: Completing the frequency distribution table.

Class Interval	F	LB	<cf
45-50	6	44.5	42
39-44	9	38.5	36
33-38	12	32.5	27
27-32	10	26.5	15
21-26	5	20.5	5
i= 6	N=42		

Step 2: Identify the percentile class.

Since we are solving for P_{20} , we will be using $\frac{kN}{100}$ to solve for the P_{20} class. The desired percentile is 20, therefore $k=20$, and the total number of frequency is 42, then $N=42$.

$$P_{k \text{ class}} = \frac{20(42)}{100}$$

$$P_{20 \text{ class}} = \frac{20(42)}{100} = \frac{840}{100} = 8.4$$

This means we need to find the class interval that contains the 8.4th data.

Class Interval	F	LB	<cf	
45-50	6	44.5	42	37 th -42 nd
39-44	9	38.5	36	28 th -36 th
33-38	12	32.5	27	16 th -27 th
27-32	10	26.5	15	6 th -15 th
21-26	5	20.5	5	1 st -5 th
i= 6	N=42			

In the table, the 8.4th data is on the class interval 27-32. This means that the P_{20} class is the class interval 27-32.

Step 3: Identify the values of the following: LB, N, cf_b , f , i , and k from the P_{20} class.

$$LB = 26.5$$

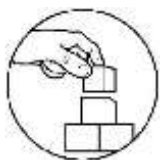
$$N = 42$$

$$\begin{aligned} <cf_b &= 5 \\ f &= 10 \\ i &= 6 \\ k &= 20 \end{aligned}$$

Step 4: Solve for the P_{20} value.

$$\begin{aligned} P_k &= LB + \left[\frac{\frac{kN}{100} - <cf_b}{f} \right] i \\ P_{20} &= 26.5 + \left[\frac{\frac{20(42)}{100} - 5}{10} \right] 6 \\ P_{20} &= 26.5 + \left[\frac{8.4 - 5}{10} \right] 6 \\ P_{20} &= 26.5 + \left[\frac{3.4}{10} \right] 6 \\ P_{20} &= 26.5 + \left[\frac{20.4}{10} \right] \\ P_{20} &= 26.5 + 2.04 \\ P_{20} &= \mathbf{28.54} \end{aligned}$$

Therefore, the value of P_{20} is 28.54.



Explore

Let us apply the skills you have learned on solving measures of position of grouped data in the given activity below.

Activity 5: Table Talk

Use the given table to answer items 1-10.

Class Interval	F	LB	<cf
56-60	2	55.5	40
51-55	5	50.5	38
46-50	9	45.5	33
41-45	16	40.5	24
36-40	8	35.5	8

1. the size of each class interval
2. the class interval containing the Q_2 class

3. the lower boundary of the Q_2 class
4. the Q_2 value
5. the class interval containing D_9 class
6. the frequency of D_9 class
7. the D_9 value
8. the class interval of the P_{72} class
9. the cumulative frequency below the P_{72} class
10. the P_{72} value

You did a great job in answering the activity above. Now, let us continue to enhance your skills in dealing with grouped data.



Deepen

Activity 6: Sum It Up!

The following are the first quarter grades of Grade 10 learners in Mathematics. Use the data and solve for the indicated quantile below.

86	83	95	92	80	92
90	89	85	91	87	88
88	92	84	93	91	86
93	97	81	82	90	89
87	92	90	85	84	86

Class Interval	F	LB	<cf
95-98			
91-94			
87-90			
83-86			
79-82			
i=___	N=___		

1. upper quartile
2. D_3
3. D_8
4. P_{45}
5. P_{98}



Gauge

Assessment: Post-Test

Directions: Find out how much have you learned from the lesson. Choose the letter of the correct answer to the question. Write your answer in a separate sheet of paper.

- What is the term used to describe the scores points that divide a distribution into hundred equal parts?
A. decile B. percentile C. quantile D. quartile
- Which of the following is used to solve for the quartile position of ungrouped data?
A. $\frac{k}{2}(n+1)$ B. $\frac{k}{4}(n+1)$ C. $\frac{k}{10}(n+1)$ D. $\frac{k}{100}(n+1)$

For items 3-6, use the given data:

18 19 20 21 21 23 24 24 26 27 29

- Where is Q_2 located?
A. 3rd data B. 6th data C. 9th data D. 12th data
- What is the value of Q_2 ?
A. 20 B. 23 C. 26 D. 29
- Where is P_{15} located?
A. 1.8th data B. 2nd data C. 2.8th data D. 3rd data
- What is the value of P_{15} ?
A. 18 B. 18.8 C. 19 D. 19.8

For items 7-8, use the given data:

39 35 44 48 49 37 40 43 39 38

- What is the value of D_2 ?
A. 35 B. 35.2 C. 35.4 D. 35.6
- What is the value of P_{85} ?
A. 47 B. 47.35 C. 48 D. 48.35

- Which of the following is used in solving deciles of grouped data?

A. $LB + \left[\frac{\frac{kN}{2} + <cf_b}{f} \right] i$

B. $LB + \left[\frac{\frac{kN}{4} + <cf_b}{f} \right] i$

C. $LB + \left[\frac{\frac{kN}{10} + <cf_b}{f} \right] i$

D. $LB + \left[\frac{\frac{kN}{100} + <cf_b}{f} \right] i$

For items 10-15, use the given data:

Class Interval	F	LB	<cf
93-95	4	92.5	35
90-92	9	89.5	31
87-89	12	86.5	22
84-86	8	83.5	10
81-83	2	80.5	2

10. What is the size of each class interval?
 A. 2 B. 3 C. 35 D. 81
11. What class interval contains D_4 ?
 A. 81-83 B. 84-86 C. 87-89 D. 90-92
12. What is the lower boundary of the D_4 class?
 A. 83.5 B. 86.5 C. 89.5 D. 92.5
13. What is the value of D_4 ?
 A. 86 B. 86.5 C. 87 D. 87.5
14. What class interval contains P_{92} ?
 A. 84-86 B. 87-89 C. 90-92 D. 93-95
15. What is the value of P_{90} ?
 A. 93 B. 93.2 C. 93.4 D. 93.6

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