12-2 Statistics and Parameters

1. **BOOKS** A random sample of 1000 U.S. college students is surveyed about how much money they spend on books per year. Identify the sample and the population for each situation. Then describe the sample statistic and the population parameter.

   **SOLUTION:**
   A sample is a portion of the larger group, the population. A statistic is a measure that describes a characteristic of a sample. A parameter is a measure that describes a characteristic of a population. Parameters are usually estimated values based on the statistics of a carefully chosen random sample.

   The sample is 1000 U.S. college students. The population is all college students in the United States. The sample statistic is the mean of the money spent on books in a year by the sample. The population parameter is the mean of money spent on books by all college students in the United States.

2. **AMUSEMENT PARKS** An amusement park manager kept track of how many bags of cotton candy they sold each hour on a Saturday: \{16, 24, 15, 17, 22, 16, 18, 24, 17, 13, 25, 21\}. Find and interpret the mean absolute deviation.

   **SOLUTION:**
   To find the mean absolute value, first find the mean:

   \[
   \overline{x} = \frac{16 + 24 + 15 + 17 + 22 + 16 + 18 + 24 + 17 + 13 + 25 + 21}{12}
   = 19
   \]

   Then take the sum of the absolute differences between each value and the mean, and divide by the number of values.

   \[
   |16 - 19| = 3 \quad |18 - 19| = 1
   |24 - 19| = 5 \quad |24 - 19| = 5
   |15 - 19| = 4 \quad |17 - 19| = 2
   |17 - 19| = 2 \quad |13 - 19| = 6
   |22 - 19| = 3 \quad |25 - 19| = 6
   |16 - 19| = 3 \quad |21 - 19| = 2
   \]

   \[
   MAD = \frac{3 + 5 + 2 + 3 + 1 + 5 + 2 + 6 + 6 + 2}{12}
   = 3.5
   \]

   The average cotton candy sales per hour were 19 bags. Each hour, on average, the difference from this value was 3.5.

3. **PART-TIME JOBS** Ms. Johnson asks all of the girls on the tennis team how many hours each week they work at part-time jobs: \{10, 12, 0, 6, 9, 15, 12, 10, 11, 20\}. Find and interpret the standard deviation of the data set.

   **SOLUTION:**
   Use a graphing calculator to view statistics for the data set.

   Clear all lists. Select STAT, EDIT to enter the data into L1.

   Select STAT, CALC, 1-Var Stats.

   ![STATS](https://example.com)

   The standard deviation is approximately 4.98.
4. **CCSS MODELING** Mr. Jones recorded the number of pull-ups done by his students. Compare the means and standard deviations of each group.
   Boys: {5, 16, 3, 8, 4, 12, 2, 15, 0, 1, 9, 3} Girls: {2, 4, 0, 3, 5, 4, 6, 1, 3, 8, 3, 4}

**SOLUTION:**
Use a graphing calculator to view statistics for the two sets of data.

Clear all lists. Select STAT, EDIT and enter the data for the boys into L₁. Do the same thing and enter the data for the girls into L₂.

Select STAT, CALC, 1-Var Stats, L₁. This will give the statistics for the boys.

<table>
<thead>
<tr>
<th>1-Var Stats</th>
</tr>
</thead>
<tbody>
<tr>
<td>x̄ = 6.5</td>
</tr>
<tr>
<td>s = 8</td>
</tr>
<tr>
<td>n = 12</td>
</tr>
</tbody>
</table>

Select STAT, CALC, 1-Var Stats, L₂. This will give the statistics for the boys.

<table>
<thead>
<tr>
<th>1-Var Stats</th>
</tr>
</thead>
<tbody>
<tr>
<td>x̄ = 3.583333</td>
</tr>
<tr>
<td>s = 4</td>
</tr>
<tr>
<td>n = 12</td>
</tr>
</tbody>
</table>

On average the boys did 6.5 pull-ups, whereas the girls only completed 3.6 pull-ups. The standard deviation for the boys was 5.2 whereas the girls had a standard deviation of 2.1. The boys had a broader range of the number of pull-ups they could complete whereas the girls were more consistent.

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**Identify the sample and the population for each situation. Then describe the sample statistic and the population parameter.**

5. **POLITICS** A random sample of 1003 Mercy County voters is asked if they would vote for the incumbent for governor. The percent responding yes is calculated.

**SOLUTION:**
A sample is a portion of the larger group, the population. A statistic is a measure that describes a characteristic of a sample. A parameter is a measure that describes a characteristic of a population. Parameters are usually estimated values based on the statistics of a carefully chosen random sample.

sample: 1003 voters in Mercy County; population: all voters in Mercy County; sample statistic: the number of people in the sample who would vote for the incumbent candidate; population parameter: the number of people in the county who would vote for the incumbent candidate

6. **ACTIVITIES** A stratified random sample of high school students from each school in the county was polled about the time spent each week on extracurricular activities.

**SOLUTION:**
A sample is a portion of the larger group, the population. A statistic is a measure that describes a characteristic of a sample. A parameter is a measure that describes a characteristic of a population. Parameters are usually estimated values based on the statistics of a carefully chosen random sample.

sample: stratified random sample from schools in the county; population: all high school students in the county; sample statistic: time spent each week on extracurricular activities by the sample; population parameter: time spent each week on extracurricular activities by all students in the county
7. **MONEY** A stratified random sample of 2500 high school students across the country was asked how much money they spent each month.

**SOLUTION:**
Sample answer: stratified random sample of 2500 students nationwide; population: high school students in the country; sample statistic: how much money the 2500 students spent individually each month; population parameter: how much money all the students in the country spent individually each month.

8. **DVDS** A math teacher asked all of his students to count the number of DVDs they owned. Find and interpret the mean absolute deviation.

**SOLUTION:**
First find the mean of the data.

The sum of the data is 324. There are 18 data values. So the mean is $324 \div 18 = 18$.

Now find the sum of the absolute value of the difference between each value in the data set and the mean.

$$
| 26 - 18 | = 8; | 0 - 18 | = 18; | 2 - 18 | = 16; \\
| 39 - 18 | = 21; | 3 - 18 | = 15; | 0 - 18 | = 18; \\
| 5 - 18 | = 13; | 15 - 18 | = 3; | 11 - 18 | = 7; \\
| 82 - 18 | = 64; | 19 - 18 | = 1; | 1 - 18 | = 17; \\
| 12 - 18 | = 6; | 41 - 18 | = 23; | 19 - 18 | = 1; \\
| 14 - 18 | = 4; | 6 - 18 | = 12; | 29 - 18 | = 11;
$$

The sum of these values is 258.

$258 \div 18 = 14.3$

The mean absolute deviation is 14.3.

This means that the average was 18 and that the majority of the students owned $18 \pm 14.3$ DVDs. Since the mean absolute deviation is so close in value to the average, this means that the data was spread out over a large range of values in comparison to the sample size.

9. **SWIMMING** The owner of a public swimming pool tracked the daily attendance. Find and interpret the mean absolute deviation.

**SOLUTION:**
To find the mean absolute deviation, first find the mean:

$$
\text{Mean} = \frac{86 + 45 + 91 + 104 + 95 + 96 + 103 + 106 + 103 + 103 + 103 + 103 + 103 + 103 + 106 + 106}{18} = 94
$$

The range is the difference between the largest and smallest values.

$18 | = 9; | 104 - 95 | = 9; | 91 - 86 | = 5; | 106 - 96 | = 10; | 103 - 91 | = 12; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8;

$$
| 86 - 95 | = 9; | 45 - 95 | = 50; | 91 - 95 | = 4; | 104 - 95 | = 9; | 95 - 94 | = 1; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8; | 103 - 95 | = 8;
$$

The mean absolute deviation is 14.

On average the daily attendance is only 14 people away from the mean of 94.
10. **CCSS REASONING** Samantha wants to see if she is getting a fair wage for babysitting at $8.50 per hour. She takes a survey of her friends to see what they charge per hour. The results are ($8.00, $8.50, $9.00, $7.50, $15.00, $8.25, $8.75). Find and interpret the standard deviation of the data.

**SOLUTION:**
To find the standard deviation, first find the mean:
\[
\bar{x} = \frac{8.00 + 8.50 + 9.00 + 7.50 + 15.00 + 8.25 + 8.75}{7}
\]
\[
\bar{x} = 9.29
\]

Next calculate the square of the differences and take their sum:
\[
(9.29 - 8.00)^2 = 1.66
\]
\[
(9.29 - 8.50)^2 = 0.62
\]
\[
(9.29 - 9.00)^2 = 0.62
\]
\[
(9.29 - 7.50)^2 = 3.20
\]
\[
(9.29 - 15.00)^2 = 32.60
\]
\[
(9.29 - 8.25)^2 = 1.08
\]
\[
(9.29 - 8.75)^2 = 0.29
\]

The sum of this is 46.15.

Dividing by 7 we get: \[
\frac{46.15}{7} = 6.59
\]

Finally, take the square root: \[
\sqrt{6.59} \approx 2.57
\]

This means that most of Samantha’s friends charge $9.29 ± $2.57 or between $6.72 and $11.86. The outlier of $15.00 skews the data slightly, but Samantha is getting a fair price at $8.50.

11. **ARCHERY** Carla participates in competitive archery. Each competition allows a maximum of 90 points. Carla’s results for the last 8 competitions are {76, 78, 81, 75, 80, 80, 76, 77}. Find and interpret the standard deviation of the data.

**SOLUTION:**
To find the standard deviation, first find the mean:
\[
\bar{x} = \frac{76 + 78 + 81 + 75 + 80 + 80 + 76 + 77}{8}
\]
\[
\bar{x} = 77.875
\]
\[
\bar{x} \approx 78
\]

Next calculate the square of the differences and take their sum:
\[
(\bar{x} - 76)^2 = 3.52
\]
\[
(\bar{x} - 78)^2 = 0.02
\]
\[
(\bar{x} - 81)^2 = 9.77
\]
\[
(\bar{x} - 75)^2 = 8.27
\]
\[
(\bar{x} - 80)^2 = 4.52
\]
\[
(\bar{x} - 80)^2 = 4.52
\]
\[
(\bar{x} - 76)^2 = 3.52
\]
\[
(\bar{x} - 77)^2 = 0.77
\]

The sum of this is 34.875.

Dividing by 8 we get: \[
\frac{34.875}{8} = 4.36
\]

Finally, take the square root: \[
\sqrt{4.36} \approx 2.09
\]

This means that most of Carla scores are $\bar{x} \pm 2.09$ or between 75.8 and 80.0. Carla’s scores are fairly consistent.

12. **BASKETBALL** The coach of the Wildcats basketball team is comparing the number of fouls called against his team with the number called against their rivals, the Trojans. He records the number of fouls called against each team for each game of the season. Compare the means and standard deviations of each set of data.
12-2 Statistics and Parameters

A random sample of 1000 U.S. college students is surveyed about how much money they spend on books per year. The lower quartile is the middle of 106, 118 which is \( \frac{106 + 118}{2} = 112 \). The upper quartile is the middle value of 141, 147 which is \( \frac{141 + 147}{2} = 144 \).

An amusement park was asked to name their favorite store.

To find the range, median, lower quartile, and upper quartile, first arrange the data in ascending order.

SOLUTION:

The range is the difference between the largest and smallest values.
The median is the middle value, or the average of the two middle values if there is an even number of data points.
The lower and upper quartiles are found similarly to the median.

For the amusement park example:

- Range: \( 72 - 10 = 62 \)
- Median: \( \frac{18 + 20}{2} = 19 \)
- Lower Quartile: \( \frac{16 + 18}{2} = 17 \)
- Upper Quartile: \( \frac{22 + 27}{2} = 24.5 \)

The data is quantitative because it is a measure of book spending.

Using a graphing calculator, enter the data into lists L1 and L2. Then select STAT, CALC, 1-Var Stats, L1. This will give the statistics for the Wildcats.

Select STAT, CALC, 1-Var Stats, L2. This will give the statistics for the Trojans.

On average the Wildcats had 11.9 fouls called on them, whereas the Trojans only had 10.1 fouls called on them. The standard deviation for the Wildcats is 2.2 and for the Trojans 2.1.

13. MOVIE RATINGS Two movies were rated by the same group of students. Ratings were from 1 to 10, with 10 being the best.

a. Compare the means and standard deviations of each set of data.

b. Provide an argument for why Movie A would be preferred. Movie B?

SOLUTION:
a. Use a graphing calculator to view statistics for the two sets of data.

Clear all lists. Select STAT, EDIT and enter the data for the Wildcats into L1. Do the same thing and enter the data for the Trojans into L2.

Select STAT, CALC, 1-Var Stats, L1. This will give the statistics for the Wildcats.

Select STAT, CALC, 1-Var Stats, L2. This will give the statistics for the Trojans.
12-2 Statistics and Parameters

Clear all lists. Select STAT, EDIT and enter the data for the Movies A into L₁. Do the same thing and enter the data for the Movie B into L₂.

Select STAT, CALC, 1-Var Stats, L₁. This will give the statistics for the Movie A.

```
1-Var Stats
\[\bar{x} = 7.1875\]
\[\text{Max} = 115\]
\[\text{Min} = 837\]
\[\sum x = 8341662504\]
\[\sigma = 807677999\]
\[n = 16\]
```

Select STAT, CALC, 1-Var Stats, L₂. This will give the statistics for the Movie B.

```
1-Var Stats
\[\bar{x} = 6.75\]
\[\text{Max} = 108\]
\[\text{Min} = 860\]
\[\sum x = 2.955221368\]
\[\sigma = 2.861380786\]
\[n = 16\]
```

The mean for Movie A is 7.2 with a standard deviation of 0.8. The mean for Movie B is 6.75 with a standard deviation of 2.9. On average students liked Movie A better and were more consistent with their ratings. Movie B had on average, lower ratings, but had a greater spread of ratings.

b. Movie A was likely a more pleasing movie to a general audience and received consistently better scores. Movie B had lower scores on average but a larger spread. This means that there were a few people who liked it and a few people who really disliked it. It was probably a genre of movie that only fits a few peoples' taste.

14. PENNIES Mr. Day has another jar of pennies on his desk. There are 30 pennies in this jar. Theo chooses 5 pennies from the jar. Lola chooses 10 pennies, and Peter chooses 20 pennies. Pennies are chosen and replaced.


d. Find the mean absolute deviation for all of the pennies in the jar. Which sample most accurately reflected the population mean? Explain.

**SOLUTION:**

a. First find the mean of the data.

\[
\bar{x} = \frac{1974 + 1975 + 1981 + 1999 + 1992}{5}
\]

\[
= \frac{9921}{5}
\]

\[
\approx 1984
\]

Now find the sum of the absolute value of the difference between each value in the data set and the mean.

\[|1974 - 1984| = 10\]
\[|1975 - 1984| = 9\]
\[|1981 - 1984| = 3\]
\[|1999 - 1984| = 15\]
\[|1992 - 1984| = 8\]

\[10 + 9 + 3 + 15 + 8 = 45\]

Divide the sum by the number of values: \[45 ÷ 5 = 9\]. The mean absolute deviation is approximately 9.0.

d. The mean of the years for Lola's pennies is 2001.

b. The mean of the years for Lola's pennies is 2001.

Find the sum of the absolute value of the difference between each value in the data set and the mean.

\[|2004 - 2001| = 3\]
\[|1999 - 2001| = 2\]
\[|2004 - 2001| = 3\]
\[|2005 - 2001| = 4\]
12-2 Statistics and Parameters

| 1991 – 2001 | = 10
| 2003 – 2001 | = 2
| 2005 – 2001 | = 4
| 2000 – 2001 | = 1
| 2001 – 2001 | = 0
| 1998 – 2001 | = 3

Sum = 32

Divide the sum by the number of values: 32 ÷ 10 = 3.2.
The mean absolute deviation is 3.2

c. Enter the data values into L1 in your calculator. Select STAT, CALC, 1-Var-Stats.

The mean of the years for Peter's pennies is 1998.15. Set L2 equal to the absolute value of L1 minus 1998.15. Then select ENTER.

L2 should now have the absolute value of the difference between the data value and the mean for every value. The sum of L2 divided by the number of values is the mean absolute deviation.

\[
\text{sum}(L2)/20 = 6.42
\]

The mean absolute deviation is 6.42. If we were to use 1998 instead of 1998.15, the mean absolute deviation would be 6.45, which rounds up to 6.5.

d. Follow the same steps in part c. The mean is approximately 1997 and the mean absolute deviation is approximately 7.4; Peter’s sample was the most accurate. The mean year of his sample was 1 year off from the actual mean year.

The mean absolute deviations for the samples went from 9.0 to 3.2 to 6.5 while the mean absolute deviation of the entire data set was 7.4.

The samples that had more pennies were more accurate. Peter's set had the most pennies of the first three sets, and his deviation of 6.5 was the closest to the true deviation of 7.4, so the closer the sample is in size to the population, the more accurately the deviation of the sample reflects the deviation of the population.
15. RUNNING The results of a 5K race are published in the newspaper, but only the times of the top 15 finishers are reported. A random sample of 1000 U.S. college students is surveyed about how much money they spend on books per year. The sample statistic is the mean of the money spent on books in a year by the sample. The population is the total population of U.S. college students. The sample statistic can be applied to the population. A parameter is a measure of a characteristic of a population. A statistic is a measure of a characteristic of a sample. A parameter is a measure of a characteristic of the entire population. A statistic is a measure of a characteristic of a sample. The mean is the sum of all the values divided by the number of values. The standard deviation is the square root of the variance. The variance is the average of the squared differences from the mean. The sample mean is an estimate of the population mean. The sample standard deviation is an estimate of the population standard deviation. Describe a characteristic of a population. Describe a characteristic of a sample. A parameter is a measure of a characteristic of a population. A statistic is a measure of a characteristic of a sample. The mean is the sum of all the values divided by the number of values. The standard deviation is the square root of the variance. The variance is the average of the squared differences from the mean. The sample mean is an estimate of the population mean. The sample standard deviation is an estimate of the population standard deviation. Describe a characteristic of a population. Describe a characteristic of a sample. A parameter is a measure of a characteristic of a population. A statistic is a measure of a characteristic of a sample. The mean is the sum of all the values divided by the number of values. The standard deviation is the square root of the variance. The variance is the average of the squared differences from the mean. The sample mean is an estimate of the population mean. The sample standard deviation is an estimate of the population standard deviation.

SOLUTION:

a. Find the mean and standard deviation of the top 15 finishers. (Convert each time to seconds.)
b. Identify the sample and population.
c. Analyze the sample. Classify the data as qualitative or quantitative and decide if the sample be applied to the population? Explain.

SOLUTION:

a. Use a graphing calculator to view statistics for the data set L1 and calculate the mean and standard deviation.

Enter the data in L1 and calculate the mean and standard deviation.

<table>
<thead>
<tr>
<th>Place</th>
<th>Time (min:s)</th>
<th>Place</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15:56</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>16:06</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>16:11</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>16:21</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>16:26</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

The mean is about 16.9 minutes and the standard deviation is approximately 2.1 minutes.

b. The sample represents part of a larger group. In this case, the population is all of the people who ran the race. The sample represents part of a larger group. In this case, the population is all of the people who ran the race.

c. The data is quantitative because it is a measurement of time.

The sample needs to be random in order to accurately estimate the true mean and standard deviation of the running times for all runners. The sample size should be large enough to be representative of the population. The sample size should be large enough to be representative of the population.

16. CCSS CRITIQUE Jennifer and Megan are determining one way to decrease the size of the standard deviation of a set of data. Is either of them correct? Explain.

SOLUTION:

Consider the formula for standard deviation:

\[ \sigma = \sqrt{\frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \ldots + (x_n - \bar{x})^2}{n}} \]

Jennifer proposes to remove the outliers from the set. This will greatly decrease the numerator, and decrease the denominator by the number of outliers. By decreasing the numerator by a large amount, while decreasing the denominator by only a few, this will result in a much lower standard deviation.

Megan wants to add data values that are equal to the mean. This will not change the numerator since adding values that are equal to the mean will be a difference of 0 from the mean. The denominator, however, will increase by the number of added values. This will result in a lower standard deviation.

Both methods will decrease the standard deviation. However, in practice it is common to look at a set of data without the outliers. Often times equipment can malfunction, or some other event can cause an obscure data point, so it is important to take note of this and look at the data set without this outlier. You never want to simply add data points that are equal to the mean just to get a lower standard deviation.
12-2 Statistics and Parameters

17. **REASONING** Determine whether the statement
   *Two random samples taken from the same population will have the same mean and standard
deviation is sometimes, always, or never true.*
   Explain.

   **SOLUTION:**
   Sometimes; it is possible however, if the samples are
truly random, they would usually not contain identical
elements. Therefore the mean and standard deviation
would differ.

   Consider the population of test scores below.
   90, 95, 85, 90, 100, 100, 95, 90, 80, 100, 85, 90, 75,
   70, 70, 100, 95, 100, 90, 90, 80, 85

   Two random samples of 5 scores could easily contain
identical scores and thus have the same mean and
standard deviation.

18. **OPEN ENDED** Describe a situation in which it
   would be useful to use a sample mean to help
   estimate a population mean. How could you collect a
   random sample?

   **SOLUTION:**
   While the population mean is more accurate, it will
often not be feasible to collect every value in the
population. We should use sample means as
estimates for populations like these. For example, one
cannot contact every eligible voter and get their
opinion on a nationwide election.

   Sample answer: Poll of voters to determine if a
particular presidential candidate is favored to win the
election. Use a stratified random sample to call 100
people throughout the country.

19. **CHALLENGE** Write a set of data with a standard
deviation that is equal to the mean absolute deviation.

   **SOLUTION:**
   Consider the equations for standard deviation and
mean average deviation:

   \[
   \sigma = \sqrt{\frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \ldots + (x_n - \bar{x})^2}{n}}
   \]

   \[
   \text{MAD} = \frac{|x_1 - \bar{x}| + |x_2 - \bar{x}| + \ldots + |x_n - \bar{x}|}{n}
   \]

   For any given set of data, we know that the number
of terms, \(n\), will be the same in both of these
equations. Trying to find further constraints in order
to make these values equal would be difficult unless
we consider the case where both of the values are 0.
This only occurs when every data point is equal to
the mean, and hence when every data point is
equal. Consider the data set of 5, 5, 5, 5, 5, 5, 5. Both
the mean average deviation and standard deviation
are 0.

   **WRITING IN MATH** Compare and contrast
each of the following.

20. **statistics and parameters**

   **SOLUTION:**
   A statistic is a characteristic that is computed on a
sample of the population. A parameter is a
characteristic of the entire population. Sample
answer: To determine the average height of a student
at your high school, you can measure the heights of a
random sample of students at your school. The mean
height of the sample is a statistic; the actual mean
height of the students at your school is a parameter.

21. **standard deviation and mean absolute deviation**

   **SOLUTION:**
   Both are calculated statistical values that show how
each data value deviates from the mean of the data
set. The mean absolute deviation is calculated by
taking the mean of the absolute values of the
differences between each number and the mean of
the data set. To find the standard deviation, you
square each difference and then take the square root
of the mean of the squares.
Consider the following set of data: \{6, 8, 10, 15, 11, 9, 10, 7, 9, 11\}.

There are 10 values.
The sum of the values is 96.
The mean is 96 \div 10 = 9.6.

Mean Absolute Deviation:
\[
\begin{align*}
6 - 9.6 &= 3.6 \\
8 - 9.6 &= 1.6 \\
10 - 9.6 &= 0.4 \\
15 - 9.6 &= 5.4 \\
11 - 9.6 &= 1.4 \\
9 - 9.6 &= 0.6 \\
10 - 9.6 &= 0.4 \\
7 - 9.6 &= 2.6 \\
9 - 9.6 &= 0.6 \\
11 - 9.6 &= 1.4 \\
\end{align*}
\]

Sum = 18
Mean Absolute Deviation = 18 \div 10 = 1.8

Standard Deviation:
\[
\begin{align*}
(6 - 9.6)^2 &= 12.96 \\
(8 - 9.6)^2 &= 2.56 \\
(10 - 9.6)^2 &= 0.16 \\
(15 - 9.6)^2 &= 29.16 \\
(11 - 9.6)^2 &= 1.96 \\
(9 - 9.6)^2 &= 0.36 \\
(10 - 9.6)^2 &= 0.16 \\
(7 - 9.6)^2 &= 6.76 \\
(9 - 9.6)^2 &= 0.36 \\
(11 - 9.6)^2 &= 1.96 \\
\end{align*}
\]

Sum = 56.4
56.4 \div 10 = 5.64
Standard Deviation = \sqrt{5.64} \approx 2.37

22. Melina bought a shirt that was marked 20% off of for $15.75. What was the original price?
A $16.69
B $17.69
C $18.69
D $19.69

\textit{SOLUTION:}
The New Cost = The Original Cost – (The Percentage Off \times The Original Cost)

\[15.75 = x - 0.2x\]
\[15.75 = 0.8x\]
\[19.69 = x\]
The original price of the shirt was $19.69.
The correct choice is D.

23. \textit{SHORT RESPONSE} A group of student ambassadors visited the Capitol building. Twenty students met with the local representative. This was 16% of the students. How many student ambassadors were there altogether?

\textit{SOLUTION:}
Portion of Students = Percentage \times Total Students

\[0.16x = 20\]
\[125 = x\]
There were 125 student ambassadors altogether.
24. The tallest 7 trees in a park have heights in meters of 19, 24, 17, 26, 24, 20, and 18. Find the mean absolute deviation of their heights.

F 3.0
G 3.2
H 3.4
J 21

**SOLUTION:**
To find the mean absolute deviation, first find the mean:
\[ \bar{x} = \frac{19 + 24 + 17 + 26 + 24 + 20 + 18}{7} \]
\[ \approx 21.14 \]

\[ |19 - 21.14| = 2.14 \]
\[ |24 - 21.14| = 2.86 \]
\[ |17 - 21.14| = 4.14 \]
\[ |26 - 21.14| = 4.86 \]
\[ |24 - 21.14| = 2.86 \]
\[ |20 - 21.14| = 1.14 \]
\[ |18 - 21.14| = 3.14 \]

**MAD** = \[ \frac{2.14 + 2.86 + 4.14 + 4.86 + 2.86 + 1.14 + 3.14}{7} \]
\[ = 3.02 \]

The closest value is F, 3.0.

25. It takes 3 hours for a boat to travel 27 miles upstream. The same boat travels 30 miles downstream in 2 hours. Find the speed of the boat.

A 3 mph
B 5 mph
C 12 mph
D 14 mph

**SOLUTION:**
Use distance equals rate times time to find the rates for upstream and downstream.

\[ r \cdot t = d \]
\[ r \cdot 3 = 27 \]
\[ r = 9 \]
\[ r \cdot 2 = 30 \]
\[ r = 15 \]

The rate upstream is 9 mph and the rate downstream is 15 mph. The speed of the boat is the average of these rates because the rate upstream is the speed of the boat against the current while the rate downstream is the speed of the boat with the current.

\[ r + c = 15 \]
\[ r - c = 9 \]
\[ 2r = 24 \]
\[ r = 12 \]

The boat travels at 12 mph.

The correct choice is C.

**Identify each sample as biased or unbiased. Explain your reasoning.**

26. **SHOPPING** Every tenth person walking into the mall is asked to name their favorite store.

**SOLUTION:**
the people are selected randomly and asked about their favorite stores while walking into the mall. This is an unbiased sample. If the people were asked the same question when walking into a particular store, the sample would be biased.
27. **MUSIC** Every fifth person at a rock concert is asked to name their favorite radio station.

**SOLUTION:**
The sample is taken at random, but the question is about their favorite radio station at a rock concert. The majority of the people at the concert already prefer rock music and would likely prefer a rock radio station. This is a biased sample.

**Simplify each expression.**

28. \( \frac{x^2 - 8x + 15}{x^2 + 3x - 18} \)

**SOLUTION:**

\[
\frac{x^2 - 8x + 15}{x^2 + 3x - 18} = \frac{(x - 3)(x - 5)}{(x - 3)(x + 6)} = \frac{x - 5}{x + 6}
\]

29. \( \frac{x^2 - x - 12}{x^2 - 6x + 8} \)

**SOLUTION:**

\[
\frac{x^2 - x - 12}{x^2 - 6x + 8} = \frac{(x - 4)(x + 3)}{(x - 4)(x - 2)} = \frac{x + 3}{x - 2}
\]

30. \( \frac{x^2 - x - 30}{x^2 - 4x - 12} \)

**SOLUTION:**

\[
\frac{x^2 - x - 30}{x^2 - 4x - 12} = \frac{(x - 6)(x + 5)}{(x - 6)(x + 2)} = \frac{x + 5}{x + 2}
\]

31. **SOCCER** The number of members of the local soccer association has increased by 6% every year. As of the beginning of 2010, there were 880 members.

a. Write an equation for the number of members of the association \( t \) years after 2010.

b. If this trend continues, predict how many members the association will have in 2020.

**SOLUTION:**

**SOCCER** The number of members of the local soccer association has increased by 6% every year. As of the beginning of 2010, there were 880 members.

a. Write an equation for the number of members of the association \( t \) years after 2010.

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32. **GEOMETRY** If the side length of a cube is \( s \), the volume is represented by \( s^3 \), and the surface area is represented by \( 6s^2 \).

a. Are the expressions for volume and surface area monomials? Explain.

b. If the side of a cube measures 3 feet, find the volume and surface area.

c. Find a side length \( s \) such that the volume and surface area have the same measure.

d. The volume of a cylinder can be found by \( V = \)


12-2 Statistics and Parameters

\[ \pi r^2 h. \] Suppose you have two cylinders. Each dimension of the second is twice the measure of the first, so \( V = \pi(2r)^2(2h) \). What is the ratio of the volume of the first to the second?

**SOLUTION:**

a. Yes they are monomials, because each is the product of variables and/or a real number.

b. 

\[
\begin{align*}
V &= s^3 \\
&= s^3 \\
&= 27 \text{ cu.ft.} \\
A &= 6s^2 \\
&= 6 \cdot s^2 \\
&= 6 \cdot 9 \\
&= 54 \text{ sq.ft.}
\end{align*}
\]

c. \( s = 6 \text{ units} \)

\[
\begin{align*}
V &= s^3 \\
&= 6^3 \\
&= 216 \text{ cu.ft.} \\
A &= 6s^2 \\
&= 6 \cdot 6^2 \\
&= 6 \cdot 36 \\
&= 216 \text{ sq.ft.}
\end{align*}
\]

d. 

\[
\begin{align*}
\frac{\pi r^2 h}{\pi (2r)^2(2h)} &= \frac{\pi r^2 h}{8\pi r^2 h} \\
&= \frac{(\pi r^2 h)}{8(\pi r^2 h)} \\
&= \frac{1}{8}
\end{align*}
\]

The ratio is 1:8.

Find the range, median, lower quartile, and upper quartile for each set of data.

33. \{15, 23, 36, 15, 19\}

**SOLUTION:**

\{15, 23, 36, 15, 19\}

To find the range, median, lower quartile, and upper quartile, first arrange the data in order.

15, 15, 19, 23, 36

The range is the difference between the largest number and the smallest number: 36 – 15 = 21.

The median is the middle value, or the average between the two middle values: \(\frac{19+23}{2} = \frac{42}{2} = 21\).

The lower and upper quartiles are found similarly to the median except they should divide the lower 25% and upper 75% of values.

The lower quartile is the middle of 15, 15, 19 which is 15.

The upper quartile is the middle value of 23, 36, 46 which is 36.
12-2 Statistics and Parameters

34. \{55, 57, 39, 72, 46, 53, 81\}

**SOLUTION:**
\{55, 57, 39, 72, 46, 53, 81\}

To find the range, median, lower quartile, and upper quartile, first arrange the data in order.

39, 46, 53, 55, 72, 81

The range is the difference between the largest number and the smallest number: 81 – 39 = 42.

The median is the middle value, or the average between the two middle values: 55

The lower and upper quartiles are found similarly to the median except they should divide the lower 25% and upper 75% of values.

The lower quartile is the middle of 39, 46, 53 which is 46.

The upper quartile is the middle value of 57, 72, 81 which is 72.

35. \{21, 25, 19, 18, 22, 16, 27\}

**SOLUTION:**
\{21, 25, 19, 18, 22, 16, 27\}

To find the range, median, lower quartile, and upper quartile, first arrange the data in order.

16, 18, 19, 21, 22, 25, 27

The range is the difference between the largest number and the smallest number: 27 – 16 = 9.

The median is the middle value, or the average between the two middle values: 21

The lower and upper quartiles are found similarly to the median except they should divide the lower 25% and upper 75% of values.

The lower quartile is the middle of 16, 18, 19 which is 18.

The upper quartile is the middle value of 22, 25, 27 which is 25.

36. \{52, 29, 72, 64, 33, 49, 51, 68\}

**SOLUTION:**
\{52, 29, 72, 64, 33, 49, 51, 68\}

To find the range, median, lower quartile, and upper quartile, first arrange the data in order.

29, 33, 49, 51, 52, 64, 68, 72

The range is the difference between the largest number and the smallest number: 72 – 29 = 43.

The median is the middle value, or the average between the two middle values:

\[
\frac{51+52}{2} = \frac{103}{2} = 51.5
\]

The lower and upper quartiles are found similarly to the median except they should divide the lower 25% and upper 75% of values.

The lower quartile is the middle of 33, 49 which is

\[
\frac{33+49}{2} = \frac{82}{2} = 41.
\]

The upper quartile is the middle value of 64, 68 which is

\[
\frac{64+68}{2} = \frac{132}{2} = 66.
\]
37. \{8, 12, 9, 11, 11, 10, 14, 18\}

**SOLUTION:**

\{8, 12, 9, 11, 11, 10, 14, 18\}

To find the range, median, lower quartile, and upper quartile, first arrange the data in order.

8, 9, 10, 11, 11, 12, 14, 18

The range is the difference between the largest number and the smallest number: 18 – 8 = 10.

The median is the middle value, or the average between the two middle values:

\[
\frac{11+11}{2} = 11
\]

The lower and upper quartiles are found similarly to the median except they should divide the lower 25% and upper 75% of values.

The lower quartile is the middle of 9, 10 which is

\[
\frac{9+10}{2} = \frac{19}{2} = 9.5
\]

The upper quartile is the middle value of 12, 14 which is

\[
\frac{12+14}{2} = \frac{26}{2} = 13
\]

38. \{133, 119, 147, 94, 141, 106, 118, 149\}

**SOLUTION:**

\{133, 119, 147, 94, 141, 106, 118, 149\}

To find the range, median, lower quartile, and upper quartile, first arrange the data in order.

94, 106, 118, 119, 133, 141, 147, 149

The range is the difference between the largest number and the smallest number: 149 – 94 = 55.

The median is the middle value, or the average between the two middle values:

\[
\frac{119+133}{2} = \frac{252}{2} = 126
\]

The lower and upper quartiles are found similarly to the median except they should divide the lower 25% and upper 75% of values.

The lower quartile is the middle of 106, 118 which is

\[
\frac{106+118}{2} = \frac{224}{2} = 112
\]

The upper quartile is the middle value of 141, 147 which is

\[
\frac{141+147}{2} = \frac{288}{2} = 144
\]