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# Warm-Up | Using Math to Analyze Data

## Lesson Objectives

By the end of this lesson, you should be able to:

- Use mathematical _____ analysis to analyze data points.
- Explain the difference and relationship between _____ and precision.
- Create _____ and compare data points graphically.

**Science Practice:** Make measurements with accuracy and precision.

## Words to Know

*Fill in this table as you work through the lesson. You may also use the glossary to help you.*

| | |
|---|---|
| accuracy | the closeness of measured values to the accepted _____ |
| bar graph | a graph used to show the _____ of individual measurements or values associated with categories |
| error bar | a visual display of the _____ deviation of a data set on a graph |
| histogram | a type of bar graph that shows the _____ of a value |
| line graph | a graph used to show change in a given _____ when a second variable is changed |
| mean | the _____ of the values in the data set |

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# Warm-Up | Using Math to Analyze Data

W2K

## Words to Know

| | |
|---|---|
| median | the _____ value in the data set |
| mode | the most _____ value in the data set |
| percent error | a _____ way of showing accuracy |
| precision | reliability or reproducibility of a _____ |
| range | the difference between the _____ and minimum values in a data set |
| scatter plot | a graph used to show _____ data points |
| standard deviation | a measure of how tightly data are grouped around the _____ |

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# Instruction | Using Math to Analyze Data

Slide 1

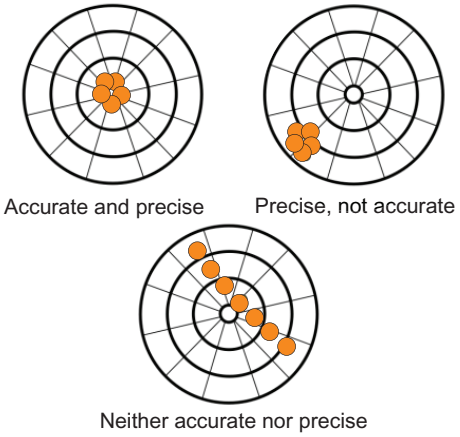
## Lesson Question

Slide 2

## Accuracy vs. Precision

**Accuracy** is the _____ of measured values to the _____ value.

**Precision** is the _____ or reproducibility of a measurement.




Slide 4

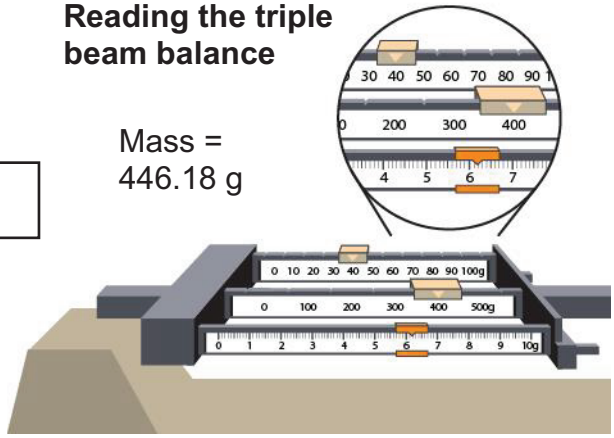
## Precision in Measurement

Any tool has a _____ to its precision.

- Depends on tool used
  - Graduation _____ indicate precision.
- Precision = smallest graduation
- _____ value in measurement = estimate
- Different tools = different precisions

**Reading the triple beam balance**

Mass = 446.18 g



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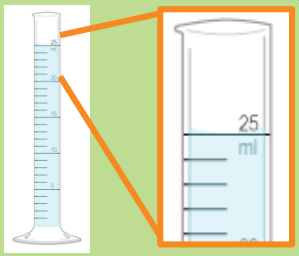
## Determining the Right Tool

**Measuring volume**

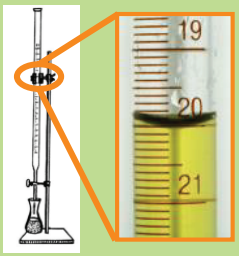



[ ]:
**Graduation marks to 10 mL**




**Graduated cylinder: Graduation marks**

**to** [ ] **mL**




**Buret: Graduation marks to**

**0.1** [ ]

Slide 7

## Percent Error

**Percent error** is a [ ] way of showing accuracy

- An [ ] of accuracy in a measurement
- Higher percent error indicates a less accurate data set
- Must know experimental value and actual or accepted value to calculate percent error

$$\%\text{Error} = \left| \frac{\text{Experimental value} - \text{Accepted value}}{\text{Accepted value}} \right| \times 100$$

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## Calculating Percent Error

- Your average mass = 2.42 g
- Your friend's [ ] mass = 2.51 g
- Actual mass = 2.50 g

$$\%\text{Error (your data)} = \left|\frac{2.42\text{ g} - 2.50\text{ g}}{2.50\text{ g}}\right| \times 100$$

$$= \left|\frac{-0.08\text{ g}}{2.50\text{ g}}\right| \times 100 = \square\ \%$$

$$\%\text{Error (friend's data)} = \left|\frac{2.51\text{ g} - 2.50\text{ g}}{2.50\text{ g}}\right| \times 100$$

$$= \left|\frac{0.01\text{ g}}{2.50\text{ g}}\right| \times 100 = \square\ \%$$

| Sample | Your Mass (g) | Friend's Mass (g) |
|---|---|---|
| 1 | 2.4 | 2.55 |
| 2 | 2.6 | 2.51 |
| 3 | 2.4 | 2.62 |
| 4 | 2.2 | 2.48 |
| 5 | 2.6 | 2.44 |
| 6 | 2.4 | 2.55 |
| 7 | 2.6 | 2.51 |
| 8 | 2.4 | 2.52 |
| 9 | 2.2 | 2.46 |
| 10 | 2.4 | 2.49 |

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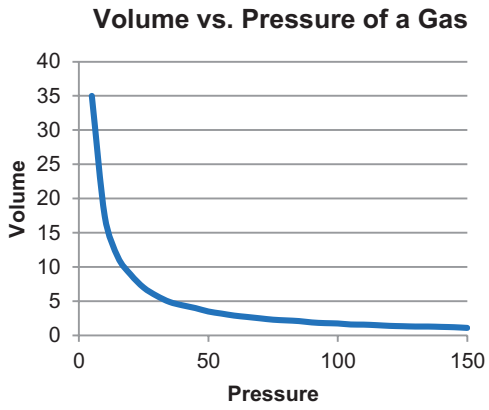
Slide 10

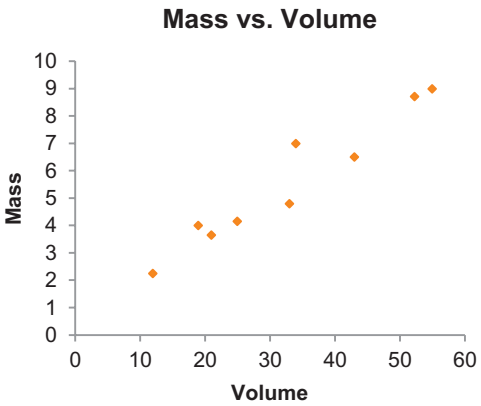
## Common Type of Graphs

A _____ shows change in a given variable when a second _____ is changed.




- Independent variable on *x*-axis
- Dependent variable on *y*-axis
- May include multiple lines
  - One line for each group or sample
- Often used to show change over _____ or response of one variable to another

A _____ shows individual data points.




- Does not imply _____ of one variable on another
- May include multiple data sets
  - Different point style/color for each data set
- Often used to determine mathematical relationship between two variables
- May include _____ line

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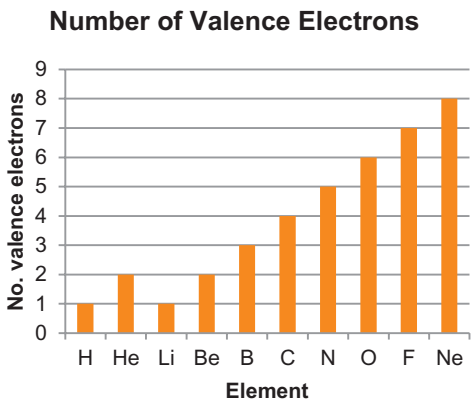
## Common Types of Graphs

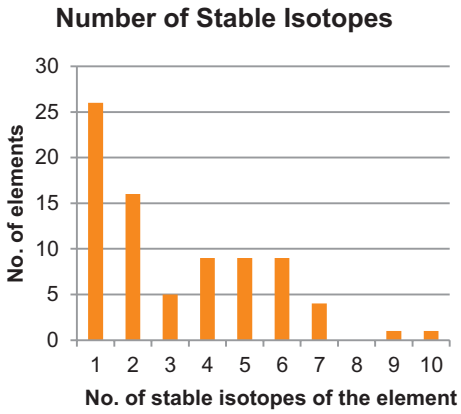
A [ ] shows the magnitude of individual measurements or values associated with categories.

- Can be used for data with only one [ ] value per point
- May include multiple data sets
  - Different bar [ ] for each data set
- Often used to compare categories or magnitudes of data




A [ ] is a type of bar graph that shows the frequency of a value.

- Used to show [ ] of values in a data set
- Often useful in analyses [ ]




**All histograms are bar graphs, but not all bar graphs are histograms!**

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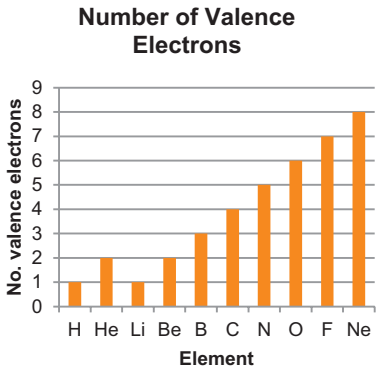
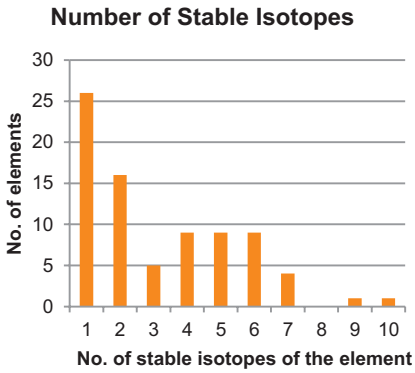
## Bar Graphs vs. Histograms

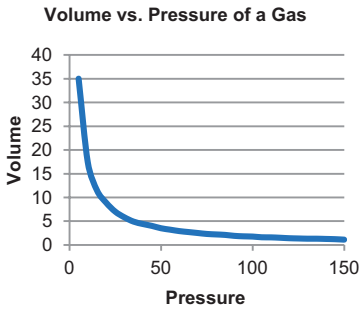


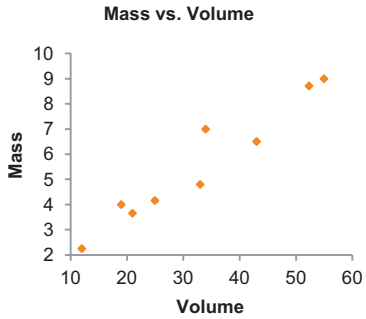




In general, they kind of look the same. But the difference here is this is a _____ on the bar graph.

15

## How to Make a Graph




Important things to remember when building your graph:

- brief descriptive _____
- _____ the axes
- equally spaced numbers
- _____ the x- and y-coordinates for each data point
- Origin may or may not be shown

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## Data Analysis

[ ] often use characteristics of a data set to analyze the data.

- [ ]: The average of the values in the data set
  - [ ] of all values ÷ number of values
- [ ]: The middle value in the data [set]

| Sample | Mass (g) |
|---|---|
| 1 | 2.4 |
| 2 | 2.6 |
| 3 | 2.4 |
| 4 | 2.2 |
| 5 | 2.6 |
| 6 | 2.4 |
| 7 | 2.6 |
| 8 | 2.4 |
| 9 | 2.2 |
| 10 | 2.4 |

Scientists often use [ ] of a data set to analyze the data.

- [ ]: The most common value in the data set
- [ ]: The difference between the maximum and minimum values in a data set

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## Standard Deviation

**Standard deviation** is a [ ] of how tightly data is grouped around the [ ].

- Standard deviation of your data: 0.15
- Standard deviation of your friend's data: 0.05
- Whose data set is more precise? Your friend's data

| Sample | Your Mass (g) | Friend's Mass (g) |
|---|---|---|
| 1 | 2.4 | 2.55 |
| 2 | 2.6 | 2.51 |
| 3 | 2.4 | 2.62 |
| 4 | 2.2 | 2.48 |
| 5 | 2.6 | 2.44 |
| 6 | 2.4 | 2.55 |
| 7 | 2.6 | 2.51 |
| 8 | 2.4 | 2.52 |
| 9 | 2.2 | 2.46 |
| 10 | 2.4 | 2.49 |

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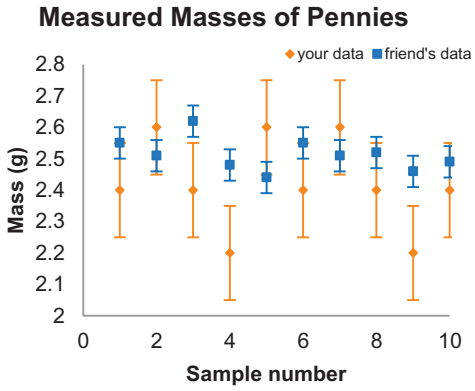
## Error Bars

**Error bars** are a [ ] display of the standard deviation of a data set on a graph.

- Typically one standard [ ] above and below each data point
  - Measured value ($x$) ± standard deviation ($\sigma$)
- Overlap = less [ ] difference
- Can be shown for $x$- and $y$-values
- Smaller error bars = more [ ] data

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# Summary | Using Math to Analyze Data

**Lesson Question**

How do scientists use math to analyze data?

**Answer**

Slide 2

## Accuracy and Precision

Accuracy and precision are terms used to describe measurements.

- Accuracy is the closeness of a measured value to an accepted value.
- Precision is a _____ of the reliability or reproducibility of a measurement.
- Precision also relates to the number of _____ figures a measurement has.
- The precision of a measurement depends on the tool used to make the measurement (especially the decimal place of the units used).
- The accuracy of a measurement is estimated through the calculation of _____ error.

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Slide 2

## Types of Graphs

Graphs provide a visual representation of data that helps us recognize relationships and trends in data.

- Line graphs show the change in one variable (dependent variable) as a result of changing another (independent variable).
- Scatter [ ] show the distribution of individual data points.
- [ ] graphs show the relative magnitude of a measurement across different categories.
- Histograms show the distribution of values within a data set.

## Analyzing Data

A number of statistical tools are used to analyze data in chemistry.

- Mean, median, [ ], and range are some basic characteristics of a data set.
- Standard deviation is a more reliable way to [ ] the precision of a data set.
- Standard deviation can be used to generate error bars on a graph.

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*Use this space to write any questions or thoughts about this lesson.*

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