

## Unit 6, Activity 1, What Does It Mean To Be Accurate?

### What Does It Mean to Be Accurate?

**Accuracy** - How close a measurement is to the accepted “true” value.

Example:

If a 100-gram weight is placed on a scale and the scale reads 100 grams, then it is said to be *accurate*.

Try this experiment with the different scales that are available. Place a 100-gram weight on each of the scales provided.

Place a sticky note on the scales (if any) that are accurate. If none are accurate, which one is most accurate or *closest to the actual value*.

Groups of 4:

Have each student in your group weigh themselves on the bathroom scale provided and record the different measurements.

Student 1	
Student 2	
Student 3	
Student 4	

Is it possible to know if the scale is accurate?

When is it possible to know if the measuring instrument you are using is giving an accurate measurement?

### Accuracy in Time

If you have a watch, record the time at the exact second the teacher prompts you.

Time\_\_\_\_\_

Record the different times on the board.

Which watch is most accurate?

The website <http://www.time.gov> has the official U.S. time, but even its time is accurate to within .7 seconds.

Ask your teacher or another student to check the time on the website at the exact time you and your classmates check your watches to see whose watch is most accurate.

## ***Unit 6, Activity 1, What Does It Mean To Be Accurate?***

If your watch is set with the school bell, how accurate is that time?

Exercises:

Determine if it is possible to get an accurate measure from the information given.

1. Jordan measures a piece of wood to be  $4\frac{1}{2}$  feet long. Is his measurement accurate?
  
2. Jerry bought a 5-pound bag of sugar. When he got home he measured the bag on a scale that he had calibrated with a 5-pound weight. The bag actually weighed 4.75 pounds. Which measurement is more accurate?
  
3. Alex checked the time on his watch at exactly 3:52:04. The time on the world universal website was exactly the same. Is his watch accurate?
  
4. Trevor measured the temperature outside to be 82.67 degrees. Joey also measured the temperature at the same time and got 83.04. Whose measurement is more accurate?
  
5. When is it possible to know if a measurement is accurate?

## Unit 6, Activity 1, What Does It Mean To Be Accurate? with Answers

**Accuracy** - How close a measurement is to the accepted “true” value.

Example:

If a 100-gram weight is placed on a scale and the scale reads 100 grams, then it is said to be **accurate**.

Try this experiment with the different scales that are available. Place a 100-gram weight on each of the scales provided.

Place a sticky note on the scales (if any) that are accurate. If none are accurate, which one is most accurate or **closest to the actual value**.

Groups of 4:

Have each student in your group weigh themselves on the bathroom scale provided and record the different measurements.

Student 1	
Student 2	
Student 3	
Student 4	

Is it possible to know if the scale is accurate? *No, because we do not know our true weight.*

When is it possible to know if the measuring instrument you are using is giving an accurate measurement? *Only when you know the actual true value.*

### Accuracy in Time

If you have a watch, record the time at the exact second the teacher prompts you.

Time\_\_\_\_\_

Record the different times on the board.

The website <http://www.time.gov> has the official U.S. time, but even its time is accurate to within .7 seconds.

Ask your teacher or another student to check the time on the website at the exact time you and your classmates check your watches to see whose watch is most accurate.

If your watch is set with the school bell, how accurate is that time?

## ***Unit 6, Activity 1, What Does It Mean To Be Accurate? with Answers***

Exercises:

Determine if it is possible to get an accurate measure from the information given.

1. Jordan measures a piece of wood to be  $4\frac{1}{2}$  feet long. Is his measurement accurate?

*It is impossible to tell since the actual measurement is not known. His measuring tool may not be accurate.*

2. Jerry bought a 5-pound bag of sugar. When he got home he measured the bag on a scale that he had calibrated with a 5-pound weight. The bag actually weighed 4.75 pounds. Which measurement is more accurate?

*4.75 pounds is more accurate since the scale was calibrated with an actual weight.*

3. Alex checked the time on his watch at exactly 3:52:04. The time on the world universal website was exactly the same. Is his watch accurate?

*Yes, his watch is accurate*

4. Trevor measured the temperature outside to be 82.67 degrees. Joey also measured the temperature at the same time and got 83.04. Whose measurement is more accurate?

*It is impossible to tell who is more accurate since the actual temperature is not known*

5. When is it possible to know if a measurement is accurate?

*It is only possible to tell if a measurement is accurate if the actual value is known.*

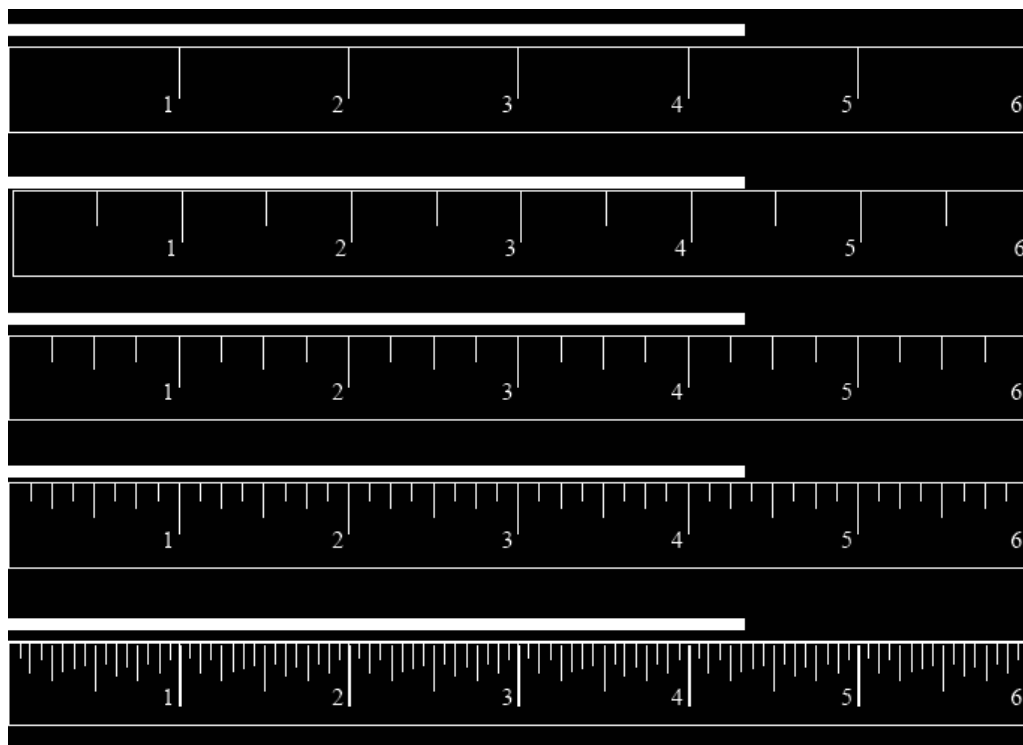
## Unit 6, Activity 2, What is Precision?

### What is Precision?

**Precision of an instrument** – the degree of refinement of a measuring instrument or the number of digits in a reading taken from that measurement

In this activity, we will be focusing on the precision of an instrument.

Look at the different rulers shown below and determine the nearest unit of measure that can be obtained using that ruler.



If you were to measure a toothpick, which ruler would give the most precise measure?

Using the different rulers provided, measure the toothpick.

Ruler 1 \_\_\_\_\_

Ruler 2 \_\_\_\_\_

Ruler 3 \_\_\_\_\_

***Unit 6, Activity 2, What is Precision?***

Ruler 4 \_\_\_\_\_

Which of the measurements is the most precise?

Take your four-sided meter stick and record the measurement of the length of the sheet of paper that you were given. Measure the sheet of paper with each of the four sides and record your measurements below.

Side 1 \_\_\_\_\_

Side 2 \_\_\_\_\_

Side 3 \_\_\_\_\_

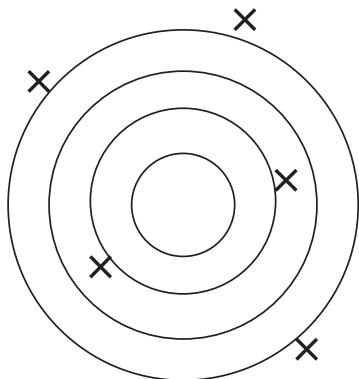
Side 4 \_\_\_\_\_

Record your measurements on the class chart.

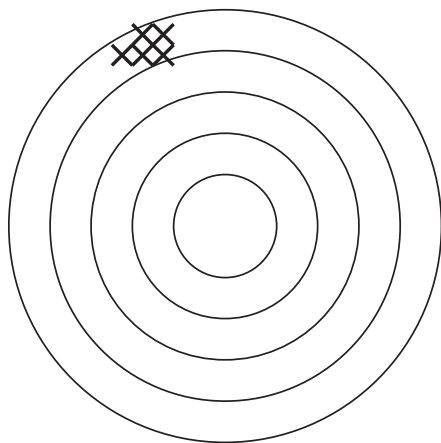
Which side of the meter stick gave the most precise measure of the length of the sheet of paper?

### ***Unit 6, Activity 5, Target***

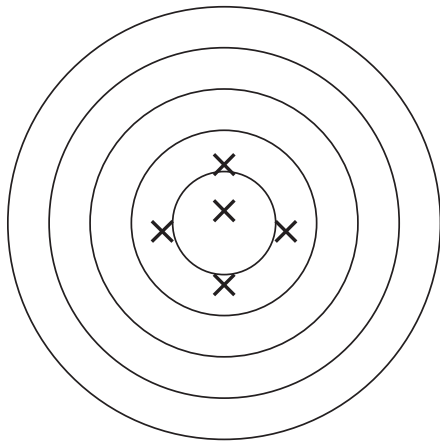
If you were trying to hit a bull's eye (the center of the target) with each of five darts, you might get results such as in the models below. Determine if the results are precise, accurate, neither or both.



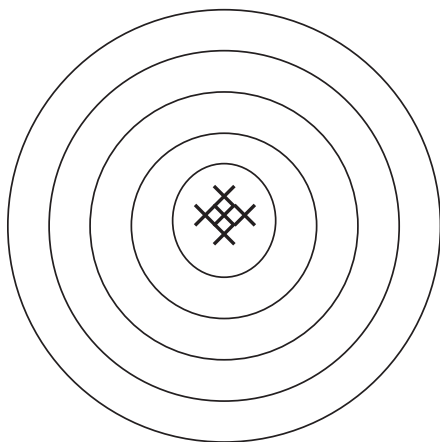
This is a random-like pattern, neither precise nor accurate. The darts are not clustered together and are not near the bull's eye.



This is a precise pattern, but not accurate. The darts are clustered together but did not hit the intended mark.



This is an accurate pattern, but not precise. The darts are not clustered, but their average position is the center of the bull's eye.



This pattern is both precise and accurate. The darts are tightly clustered, and their average position is the center of the bull's eye.

## Unit 6, Activity 5, Precision vs. Accuracy

Directions: Answer the following questions based upon what you know about precision and accuracy. Remember, precision has two aspects to consider...repeatability of the actual measurement and the number of digits in the measurement.

Example 1: Using the table below, answer the following questions. Assume that each data set represents 5 measurements taken from the same object.

- Which of the following sets of data is more precise, based on its range?
- Do you know which data set is more accurate? Explain.

Set A	Set B
14.32	36.56
14.37	36.55
14.33	36.48
14.38	36.53
14.35	36.55

Example 2: The data tables below show measurements that were taken using three different scales. The same standard 100 gram weight was placed on each scale and measured 4 different times by the same reader using the same method each time.

Trial #	Weight on Scale 1	Weight on Scale 2	Weight on Scale 3
1	101.5	100.00	100.10
2	101.5	100.02	100.00
3	101.5	99.99	99.88
4	101.5	99.99	100.02
Average Weight			

- Determine the average weight produced by each scale. Use this average as the actual weight of the 100g mass determined by each scale. Write down the results for each scale used.
- Which scale was the most precise? Explain how you know.
- Which scale was the least precise? Explain how you know.
- Which scale was the most accurate if we consider the true value of the weight to be 100 grams? Explain your answer.

### ***Unit 6, Activity 5, Precision vs. Accuracy***

Example 3: Below is a data table produced by 4 groups of students who were measuring the mass of a paper clip which had a known mass of 1.0004 g.

- Determine the average weight produced by each group's measurements and fill in the results in the table. Use this average as the weight of the paper clip for each group.
- Which of the group's measurements represents a properly accurate and precise measurement of the mass of the paper clip?
- Which of the group's measurements was the least accurate? Explain why.
- Which of the group's measurements had an accurate answer, but not a precise answer? Explain.

Trial #	Group 1 (g)	Group 2 (g)	Group 3 (g)	Group 4 (g)
1	1.01	3.863287	10.13252	2.05
2	1.03	3.754158	10.13258	0.23
3	0.99	3.186357	10.13255	0.75
Average Weight				

## Unit 6, Activity 5, Precision vs. Accuracy with Answers

Directions: Answer the following questions based upon what you know about precision and accuracy. Remember, precision has two aspects to consider...repeatability of the actual measurement and the number of digits in the measurement.

Example 1: Using the table below, answer the following questions. Assume that each data set represents 5 measurements taken from the same object.

Which of the following sets of data is more precise, based on its range?

*(Solution: Data Set A has a range of .06 while Data Set B has a range of .08, thus the more precise data set is Set A. Note that both sets of data were measured to the hundredth...but it is impossible to know hundredth of what since there are no units associated with the measurement.)*

- Do you know which data set is more accurate? Explain.

*(Solution: There is no way of knowing which is more accurate since in both cases there is no indication of the true measure of the object being measured.)*

Set A	Set B
14.32	36.56
14.37	36.55
14.33	36.48
14.38	36.53
14.35	36.55

Example 2: The data tables below show measurements that were taken using three different scales. The same standard 100 gram weight was placed on each scale and measured 4 different times by the same reader using the same method each time.

Trial #	Weight on Scale 1	Weight on Scale 2	Weight on Scale 3
1	101.5	100.00	100.10
2	101.5	100.02	100.00
3	101.5	99.99	99.88
4	101.5	99.99	100.02
Average Weight	101.5g	100.00g	100.00g

- Determine the average weight produced by each scale. Use this average as the actual weight of the 100g mass determined by each scale. Write down the results for each scale used.

- Which scale was the most precise? Explain how you know.

*(Solution: In terms of precision, there are two aspects to consider...if we look at repeatability, then the most precise measurements were made with Scale 1 since the range of values is smaller than in the other scales. In terms of the measurement tool that was used, it would appear that scales 2 and 3 have units to the hundredth of a gram, and so in terms of the measurement device being used, scales 1 and 2 are the most precise.)*

## Unit 6, Activity 5, Precision vs. Accuracy with Answers

- Which scale was the least precise? Explain how you know.  
(Solution: In terms of repeatability, Scale 3 since the range of values is larger. In terms of the measurement tool being used then Scale 1 would be least precise since it is only able to be read to the nearest tenth of a gram as opposed to the nearest hundredth in the other two scales. )
- Which scale was the most accurate if we consider the true value of the weight to be 100 grams? Explain your answer.  
(Solution: If we look at the average weights to be the weight given by each scale, then both Scale 2 and Scale 3 are equally accurate.)

Example 3: Below is a data table produced by 4 groups of students who were measuring the mass of a paper clip which had a known mass of 1.0004 g.

- Determine the average weight produced by each group's measurements and fill in the results in the table. Use this average as the weight of the paper clip for each group.
- Which of the group's measurements represents a properly accurate and precise measurement of the mass of the paper clip?  
(Solution: Both Group 1 and Group 4 had an average weight in line with the true weight of the mass; however, Group 4 did not have a precise measurement—the readings have too wide a range. The average just happened to come out to a value close to the true weight; therefore, only Group 1 data represents both an accurate and precise measurement.)
- Which of the group's measurements was the least accurate? Explain why.  
(Solution: Group 3 had the least accurate answer for the weight of the paper clip since its average value is farthest from the actual value of the paper clip.)
- Which of the group's measurements had an accurate answer, but not a precise answer? Explain.  
(Solution: Group 4 had an accurate weight (if the average is used) but was not precise at all.)

Trial #	Group 1 (g)	Group 2 (g)	Group 3 (g)	Group 4 (g)
1	1.01	3.863287	10.13252	2.05
2	1.03	3.754158	10.13258	0.23
3	0.99	3.186357	10.13255	0.75
Average Weight	1.01	3.601267	10.13255	1.01

## Unit 6, Activity 6, Absolute Error

### Absolute Error

At each measurement station, perform the indicated measurements and answer the questions below.

#### Measurement: Mass

	OBSERVED VALUE	ACCEPTED VALUE	ABSOLUTE ERROR
Scale 1			
Scale 2			
Scale 3			

Which scale is more accurate? \_\_\_\_\_

Why? \_\_\_\_\_

#### Measurement: Volume

	OBSERVED VALUE	ACCEPTED VALUE	ABSOLUTE ERROR
Beaker 1			
Beaker 2			
Measuring Cup			

Which measuring instrument is more accurate? \_\_\_\_\_

Why? \_\_\_\_\_

#### Measurement: Length

	OBSERVED VALUE	ACCEPTED VALUE	ABSOLUTE ERROR
Meter stick			
Ruler 1			
Ruler 2			

Which measuring instrument is more accurate? \_\_\_\_\_

Why? \_\_\_\_\_

## Unit 6, Activity 6, Absolute Error

### Measurement: Time

	OBSERVED VALUE	ACCEPTED VALUE	ABSOLUTE ERROR
Wrist watch			
Calculator			
Cell Phone			

Which measuring instrument is more accurate? \_\_\_\_\_

Why? \_\_\_\_\_

Is it always possible to determine if a measuring instrument is accurate? Why or why not?

Explain how to determine if a measuring instrument is accurate or not.