**Introduction**

**Purpose** To learn various aspects of measurement using the metric system.

**Background Information**

Significant figures are used to insure precise measurements. Have you ever heard the saying: “A chain is only as strong as its weakest link”? This also applies to measurement: a measurement is only as precise as its LEAST precise measurement. For instance, imagine wanting to know the average distance from one location to another and you were given the following measurements: 224 km, 224.0 km and 224.00 km. These numbers represent DIFFERENT precision of measurement.

**Hypothesis**

If the metric system is used to measure various items, a metric progression can be observed which relates to units being a multiple of 10 from each other. The precision can be represented by significant figures.

**Materials** Meter stick Bar Magnet or Pencil Floor tile or Textbook

 Mass Balance 100 ml graduated cylinder Stop Watch

### Procedures

A. Watch the “Metric Measurement” lab video to record observations and data.

<http://somup.com/cY1lIHQbqs>

B. How do you **measure the dimensions** of objects or substances?

1. Determine & label the value of the various lines on the meter stick which correspond to different metric lengths*. Write or type the value of the specific measurement line in the 4 circles provided on the enlarged image below*:

Smallest Lines

10

50

70

90

30

The Entire Meter Stick

\_\_\_

\_\_\_

\_\_\_

\_\_\_\_

C. Use the **metric ruler** for this section to show the metric progression.

1. Measure each item in the chart below, so that the number value BEFORE the metric unit is greater than or equal to 1 AND less than 10. *Estimate to the nearest tenth of that unit*:

|  |  |
| --- | --- |
| **Item to be Measured** | **Number Value with Units** |
| height of bar magnet  |  |
| width of bar magnet |  |
| length of floor tile or textbook |  |
| your height |  |
| length of the driveway |  |

2. Fill in the table values using the equations below it.

|  |  |
| --- | --- |
| Item to be Measured | **Number Value with Units** |
| length of football field (120 yd) |  |
| distance of 2.5 Miles |  |

Football field: 120 yards x 0.9144 m/yard = \_\_\_\_\_\_ m x 1 hm/? m = \_\_\_\_\_\_\_ hm

Distance of 2.5 miles x 1.6 km / mile = \_\_\_\_\_ km

##### Be sure to include UNITS on all of your measurements in this lab

D. Look over your metric UNITS in the two charts on page 1. What is the relationship of all the units as you proceed from the top of the chart to the bottom or from the bottom to the top? [*What is the common multiple in each case*?]

E. How do you **measure the amount of matter** objects or substances occupy?

1. Obtain the mass balance.
2. Measure the mass of the following items to the nearest tenth of a gram:

|  |  |
| --- | --- |
| **Item to be Measured** | **Mass on the Balance** |
| bar magnet |  |
| pen or pencil |  |
| calculator |  |

F. How do you **measure the amount of space** objects or substances take up?

A. Obtain the 100 ml graduated cylinder. Add any amount of water below the 100 ml mark.

B. Observe the **lowest** part of the water in the graduated cylinder as shown in the diagram to the right. This is called the **meniscus**.

1. Determine the volume of water in the graduated cylinder by “reading the meniscus” to the nearest tenth of a milliliter. E.g. 85.3 ml.
2. Repeat steps 4A – 4C for a second measurement.

|  |  |
| --- | --- |
| Volume 1 in Graduated Cylinder | Volume 2 in Graduated Cylinder |
|  |  |

#### Conclusions and Questions

Address the hypothesis:

1. What is the common scientific term for dimensions in measurement?

2. What is the standard unit for dimensions in the metric system?

3. What is the common scientific term for the amount of matter in measurement?

4. What is the standard unit for measuring the amount of matter in the metric system?

5. What is the common scientific term for the amount of space in measurement?

6. What is the standard unit for measuring the amount of space in the metric system?

7. Why do we use significant figures in making measurements?

8. Do you think it is important to be precise in making measurements? Explain by using two examples from daily life.

***9.*** For each of the following measurements, how many significant figures are there and what is the most precise unit for the tool used to determine that measurement?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Measurement | Significant Figures | Precision of Tool |  | Measurement | Significant Figures | Precision of Tool |
| 51.4 liters |  |  |  | 0.0048 meters |  |  |
| 0.03 meters |  |  |  | 3000. km |  |  |
| 5,000,000 g |  |  |  | 79.64 liters |  |  |

 ANSWER KEY

Smallest Lines

The Entire Meter Stick

**mm**

**cm**

10

90

70

30

50

**dm**

**m**

*All measurements in this lab should be to the nearest tenth of the designated unit*:

|  |  |
| --- | --- |
| **Item to be Measured** | **Number Value with Units** |
| height of bar magnet / pencil | 6.0 mm / 6.9 mm |
| width of bar magnet  | 2.5 cm |
| length of floor tile / textbook | 2.9 dm / 2.8 dm |
| your height | 1.8 m |
| length of the driveway | 5.4 Dm |

2. Fill in the table values using the equations below it.

|  |  |
| --- | --- |
| Item to be Measured | **Number Value with Units** |
| length of a football field (120 yds) | 1.1 Hm |
| distance of 2.5 miles | 4.0 km |

Football field: 120 yards x 0.9144 m/yard = **110 m** x 1 hm/100 m = **1.1 hm**

Distance of 2.5 miles x 1.6 km / mile = **4.0 km**

D. What is the relationship of all the units as you proceed from the top of the chart to the bottom or from the bottom to the top? [*What is the common multiple in each case*?]

###### **Multiples of 10 … all metric units are in factors of 10**

E. How do you **measure the amount of matter** objects or substances occupy? **NEAREST 0.1 g**

|  |  |
| --- | --- |
| **Item to be Measured** | **Mass on the Balance** |
| bar magnet | 37.2 g |
| pencil | 4.9 g |
| calculator | 56.4 g |

F. How do you **measure the amount of space** objects or substances take up?

|  |  |
| --- | --- |
| Volume 1 in Graduated Cylinder | Volume 2 in Graduated Cylinder |
| 57.9\* ml | 72.9\* ml |

\*Remember the last significant number (0.9 ml in both cases) is an estimate and may vary.

#### Conclusions

The metric progression of milli, centi, deci, meter, deca, hecta, kilo was observed when measuring the length, width or height of objects.

1. What is the common scientific term for dimensions in measurement?

 ***The scientific term for dimensions in measurement is distance (length).***

2. What is the standard unit for dimensions in the metric system?

 ***The standard metric unit for dimensions in measurement is meters.***

3. What is the common scientific term for the amount of matter in measurement?

***The common scientific term for the amount of matter in a measurement is mass.***

4. What is the standard unit for measuring the amount of matter in the metric system?

***The standard metric unit for measuring the amount of matter is gram or kilogram.***

5. What is the common scientific term for the amount of space in measurement?

***The common scientific term for the amount of space is volume.***

6. What is the standard unit for measuring the amount of space in the metric system?

***The standard metric unit for measuring the amount of space is liter or milliliter.***

7. Why do we use significant figures in making measurements?

* ***Maintain accuracy and precision in measurements***
* ***Use less numbers***

8. Do you think it is important to be precise in making measurements? Explain by using two examples from daily life.

***Of course, it is important to be precise in making measurements.***

***(1) Gas pumps measure gas and the amount of money. We certainly want the devices to be accurate and precise.***

 ***(2) When we purchase food, beverages, etc. we expect to get what we pay for and not less.***

 ***(3) We expect pharmacists to give us the correct drugs in the appropriate combination for our health.***

 ***(4) We want dentists and doctors to be accurate and precision in their diagnoses and their operations.***

***9.*** For each of the following measurements, how many significant figures are there and what is the most precise unit for the tool used to determine that measurement?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Measurement | Significant Figures | Precision of Tool |  | Measurement | Significant Figures | Precision of Tool |
| 51.4 liters | **3** | **L** |  | 0.0048 meters | **2** | **mm** |
| 0.03 meters | **1** | **dm** |  | 3000. km | **4** | **10 km** |
| 5,000,000 g | **1** | **10 Mg** |  | 79.64 liters | **4** | **dL** |

**Remember, the last digit/figure/number in a measurement can be an estimate which is not as “precise”. The second to last digit/figure/number in a measurement can show the graduations on a measuring tool.**

**Errors**

1) not measuring to the nearest tenth of a unit.

2) not showing the metric progression (milli, centi, deci, m/l/g, deca, hecta, kilo).

3) for volume, not reading the meniscus.