**Chapter 1 Notes – Science Skills**

**What is Science? – Section 1.1**

Read Pages 2-6 in order to complete the reading guide and answer the questions.

Science involves asking questions about nature and then finding ways to answer them. This process doesn’t happen by itself – it is driven by the curiosity of scientists.

**Science from Curiosity**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a system of knowledge and the methods you use to find that knowledge. Science Begins with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and often ends with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Curiosity provides questions but is seldom enough to achieve scientific results. Methods such as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ provide ways to find the answers. In some experiments, observations are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or descriptive. In others, they are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or numerical.

* **What is science?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* **What is the basis of science?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Science and Technology**

As scientific knowledge is discovered, it can be applied in ways that improve the lives of people. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the use of knowledge to solve practical problems. While the foal of science is to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ knowledge, the goal of technology is to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ that knowledge.

Science and technology are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Advances in one can lead to advances in the other.

* **How are science and technology related? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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**Branches of Science**

The study of science is divided into social science and natural science. Natural science is generally divided into three branches: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Each of these branches can be further divided.

Physical science covers a broad range of study that focuses on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_. The two main areas of physical science are chemistry and physics. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the study of the composition, structure, properties, and reactions of matter. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the study of matter and energy and the interactions between the two through forces and motion.

***Comprehension Questions***

1. How does the scientific process start and end?

2. Explain the advantages and disadvantages of subdividing science into many different areas.

3. Why do scientists seek to discover new laws of the universe?

Matching

4. \_\_\_\_\_\_science A) study of the origin, history, and structure of Earth

5. \_\_\_\_\_\_technology B) study of the universe beyond Earth

6. \_\_\_\_\_\_chemistry C) system of knowledge and the methods used to find it

7. \_\_\_\_\_\_physics D) study of living things

8. \_\_\_\_\_\_geology E) use of knowledge to solve practical problems

9. \_\_\_\_\_\_astronomy F) study of the composition, structure, properties, and reactions of matter

10.\_\_\_\_\_\_biology G) study of matter and energy and their interactions

**Using a Scientific Approach – Section 1.2**

Read Pages 7-11 in order to complete the reading guide and answer the questions.

**Scientific Methods**

In order to answer questions about the world around them, scientists need to get information. An organized plan for gathering, organizing, and communicating information is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Despite the name, a scientific method can be used by anyone, including \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. All you need is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to use it. The goal of any scientific method is to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or to better understand an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* **What is a scientific method?** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Making Observations***

Scientific investigations often begin with observations. An \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is information that you obtain through your \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Repeatable observations are known as \_\_\_\_\_\_\_\_\_\_\_\_\_\_. For example, when you walk or run in the rain, you get wet. Standing in the rain leaves you much wetter than walking or running in the rain. You might combine these \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ into a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: How does your speed affect how wet you get when you are caught in the rain?

* **What is an observation?** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Forming a Hypothesis***

A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a proposed answer to a question. To answer the question raised by your observation about traveling in the rain, you might guess that the faster your speed, the drier you will stay in the rain. What can you do with your \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_? For a hypothesis to be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, it must be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* **What is a hypothesis?** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Testing a Hypothesis***

Scientists perform \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_ their hypotheses. In an experiment, any factor that can change is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Suppose you do an experiment to test if speed affects how wet you get in the rain. The variables will include your speed, your size, the rate of rainfall, and the amount of water that hits you.

Your hypothesis states that \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, speed, causes a change in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, the amount of water that hits you. The speed with which you walk or run is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variable (***dependent***), or the variable that causes a change in another. The amount of water that you accumulate is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variable (***independent***), or the variable that changes in response to the manipulated variable. To examine the relationship between a manipulated variable and a responding variable, scientists use \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. A controlled experiment is an experiment in which only \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, the manipulated variable, is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ changed at a time. While the responding variable is observed for changes, all other variables are kept \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* **How do you make a controlled experiment?** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Drawing Conclusions***

Based on their data, the scientists concluded that running in the rain keeps you drier than walking – about 40 percent drier, in fact. Now you have scientific \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the hypothesis stated earlier.

What happens if the data do not support the hypothesis? In such a case, a scientist can \_\_\_\_\_\_\_\_\_\_\_ the hypothesis or \_\_\_\_\_\_\_\_\_\_\_\_\_\_ a new one, based on the \_\_\_\_\_\_\_\_\_ from the experiment. A new experiment must then be designed to test the revised or new hypothesis.

***Developing a Theory***

Once a hypothesis has been \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ experiments, scientists can begin to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. A scientific theory is a well-tested \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for a set of observations or experimental results. For example, according to the kinetic theory of matter, all particles of matter are in constant motion. Kinetic theory explains a wide range of observations, such as ice melting or the pressure of a gas.

Theories are never \_\_\_\_\_\_\_\_\_\_\_\_\_. Instead, they become stronger if the facts continue to explain new facts and discoveries, the theory may be revised or a new theory may replace it.

* **What happens if new facts are unexplained by a theory?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Scientific Laws**

After repeated observations or experiments, scientists may arrive at a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_. A scientific law is a statement that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ found in nature. For example, Newton’s law of gravity describes how two objects attract each other by means of a gravitational force. This law has been \_\_\_\_\_\_\_\_\_\_\_\_\_ over and over. However, scientists have yet to agree on a theory that explains how gravity works. A scientific law describes an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ in nature without attempting to \_\_\_\_\_\_\_\_\_\_\_\_\_ it. The explanation of such a pattern is provided by a scientific theory.

* **What is the difference between a scientific theory and a scientific law?\_\_\_\_\_\_\_\_\_\_\_\_**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Scientific Models**

If you have ever been lost in a city, you know that a street map can help you find your location. A street map is a type of model, or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, of an object or event. Scientific models make it easier to understand things that might be too difficult to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_. As long as a model lets you \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ what is supposed to be represented then the model has done its job.

An example of a mental, rather than physical, model might be that comets are like giant snowballs, primarily made of ice. Scientists would \_\_\_\_\_\_\_\_\_\_ this model through \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, experiments, and calculations. Possibly they would even send a space probe – a visit to a comet really is planned! If all of these tests \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the idea that comets are made of ice, then the model of icy comets will continue to be believed.

However, if the data show that this model is wrong, then it must either be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by a new model. If scientists never challenged old models, then nothing new would be learned, and we would still believe what we believed hundreds of years ago. Science works by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The fact that newer models are continually replacing old models is a sign that new \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are continually occurring. As the knowledge that makes up science keeps changing, scientists develop a better and better \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

***Comprehension Questions***

1. What is the goal of scientific methods?

2. Why are scientific models useful?

3. What are three types of variables in a controlled experiment?

4. Does every scientific method begin with an observation? Explain.

Matching

5. \_\_\_\_\_\_scientific method A) statement that summarizes a pattern found in nature

6. \_\_\_\_\_\_observation B) variable that changes in response to the manipulated variable

7. \_\_\_\_\_\_hypothesis C) experiment in which only one variable is deliberately changed

8. \_\_\_\_\_\_manipulated variable D) an organized plan for gathering, organizing, and communicating information

9. \_\_\_\_\_\_responding variable E) the variable that causes a change in another

10.\_\_\_\_\_\_controlled experiment F) representation of an object or event

11.\_\_\_\_\_\_scientific theory G) information you obtain through your senses

12.\_\_\_\_\_\_scientific law H) well tested explanation for a set of observations

13.\_\_\_\_\_\_model I) proposed answer to a question

**Section 1.3 Notes - Measurement**

Read Pages 14 – 20 in order to complete the reading guide and answer the questions.

How old are you? How tall are you? The answers to these questions are measurements. Measurements are important in both science and everyday life. Hardly a day passes without the need for you to measure amounts of money or the passage of time. It would be difficult to imagine doing science without any measurements.

**Using Scientific Notation**

Scientists often work with very large or very small \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. For example, the speed of light is about 300,000,000 meters per second. On the other hand, an average snail has been clocked at a speed of only 0.00086 meter per second.

Instead of having to write out all the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in these numbers, you can use a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_called scientific notation. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a way of expressing a value as the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a number between \_\_\_\_\_ and \_\_\_\_\_\_\_\_ and a power of 10. For example, the number 300,000,000 written in scientific notation is 3.0 x 108. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, 8, tells you that the decimal point is really 8 places to the \_\_\_\_\_\_\_\_\_\_\_ of the 3.

For numbers \_\_\_\_\_\_\_\_\_\_\_\_ than 1 that are in scientific notation, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. For example, the number 0.00086 written in scientific notation is 8.6 x 10-4. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ exponent tells you how many \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ there are to the *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* of the 8.6. Scientific notation makes very large or very small numbers \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to work with.

**SI Units of Measurement**

For a measurement to make sense, it requires both a number and a \_\_\_\_\_\_\_\_\_\_\_\_. For example, if you told one of your friends that you had finished a homework assignment “in five,” what would your friend think? Would it be five minutes or five hours? Maybe it was a long assignment, and you actually meant five days. Or maybe you meant that you wrote five pages. You should always \_\_\_\_\_\_\_\_\_\_\_\_\_\_ measurements in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_ so that their meaning is clear.

Many of the units you are familiar with, such as inches, feet, and degrees Fahrenheit, are not units that are used in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Scientists use a set of measuring units called \_\_\_\_, or the International System of Units. The abbreviation stands for the French name *Systeme International d’Unites*. SI is a revised \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ system, which was originally developed in France in 1791. By adhering to one system of units, scientists can readily \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ one another’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

***Base Units and Derived Units***

SI is built upon \_\_\_\_\_\_\_\_\_\_\_\_\_\_ metric units, known as \_\_\_\_\_\_\_\_\_\_ units, which are listed in the figure below. In SI, the base unit for \_\_\_\_\_\_\_\_\_\_\_\_\_\_, or the straight-line distance between two points, is the \_\_\_\_\_\_\_\_\_\_\_\_\_ (m). The base unit for \_\_\_\_\_\_\_\_\_\_\_\_, or the quantity of matter in an object or sample, is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (kg).

Additional SI units, called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ units, are made from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_ units. The figure below lists some common derived units. For example, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the amount of space taken up by an object. The volume of a rectangular box equals its \_\_\_\_\_\_\_\_\_\_\_\_\_ times its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ times its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Each of these dimensions can be measured in meters, so you can derive the SI unit for volume by multiplying meters by meters by meters, which gives you \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ (m3).

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| ***SI Base Units*** |
| **Quantity** | **Unit** | **Symbol** |
| Length | Meter | M |
| Mass | Kilogram | Kg |
| Temperature | Kelvin | K |
| Time | Second | S |
| Amount of Substance | Mole | mol |
| Electric current | Ampere | A |
| Luminous intensity | Candela | cd |

|  |
| --- |
| ***Derived Units*** |
| **Quantity** | **Unit** | **Symbol** |
| Area | Square meter | M2 |
| Volume | Cubic meter | M3 |
| Density | Kilograms per cubic meter | Kg/m3 |
| Pressure | Pascal (kg/m\*s2) | Pa |
| Energy | Joule (kg\*m2/s2) | J |
| Frequency | Hertz (1/s) | Hz |
| Electric charge | Coulomb (A\*s) | C |

Another quantity that requires a derived unit is density. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the ratio of an object’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_ to its \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

 Density = Mass/Volume

To derive the SI unit for density, you can \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the base unit for \_\_\_\_\_\_\_\_\_\_ by the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ unit for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Dividing kilograms by cubic meters yields the SI unit for density, kilograms per cubic meter (kg/m3).

***Metric Prefixes***

The metric unit for a given quantity is not always a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ one to use. For example, the time it takes for a computer hard drive to read or write data – also known as the seek time – is in the range of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a second. A typical seek time might be 0.009 second. This can be written in a more compact way by using a \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_. A metric prefix indicates how many times a unit should be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by \_\_\_\_\_\_\_.

The figure below shows some common metric prefixes. Using the prefix *milli-* (m), you can write 0.009 second as 9 milliseconds, or 9 ms.

 9 ms = 9/1000 s = 0.009 s

Note that dividing by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the same as multiplying by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Metric prefixes can also make a unit \_\_\_\_\_\_\_\_\_\_\_\_\_\_. For example, a distance of 12,000 meters can also be written as 12 kilometers.

 12 km = 12 x 1000 m = 12,000 m

Metric prefixes turn up in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ units as well. If you work with computers, you probably know that a gigabyte of data refers to 1,000,000,000 bytes. A megapixel is 1,000,000 pixels.

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| --- |
| ***SI Prefixes*** |
| **Prefix** | **Symbol** | **Meaning** | **Multiply Unit by** |
| Giga- | G | Billion (109) | 1,000,000,000 |
| Mega- | M | Million (106) | 1,000,000 |
| Kilo- | k | Thousand (103) | 1,000 |
| Deci- | d | Tenth (10-1) | 0.1 |
| Centi- | c | Hundredth (10-2) | 0.01 |
| Milli- | m | Thousandth (10-3) | 0.001 |
| Micro- | µ | Millionth (10-6) | 0.000001 |
| Nano- | n | Billionth (10-9) | 0.000000001 |

The easiest way \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from one unit of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to another is to use \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. A conversion factor is a \_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ measurements that is used to convert a quantity expressed in one unit to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ unit. Suppose you want to convert the height of Mount Everest, 8848 meters, into kilometers. Based on the prefix *kilo-*, you know that 1 kilometer is 1000 meters. This ratio gives you two possible conversion factors.

 1km/1000m 1000m/1 km

Since you are converting from meters to kilometers, the number should get \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Multiplying by the conversion factor on the left yields a smaller number.

 8848 x (1km/1000m) = 8.848 km

Notice that the meter units \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, leaving you with kilometers (the larger unit).

To convert 8.848 kilometers back into meters, multiply by the conversion factor on the right. Since you are converting from kilometers to meters, the number should get \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

 8.848 km x (1000m/1km) = 8848 m

In this case, the kilometer units cancel, leaving you with meters.

**Limits of Measurement**

Suppose you wanted to measure how much time it takes for you to eat your breakfast. You could use two different clocks – an analog clock and a digital clock. The analog clock displays time to the nearest minute. The digital clock displays time to the nearest second (or one sixtieth of a minute). Which clock would you choose?

***Precision***

The digital clock offers more precision. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a gauge of how \_\_\_\_\_\_\_\_\_\_\_\_\_ a measurement is. According to the analog clock, it might take you 5 minutes to eat your breakfast. Using the digital clock, however, you might measure 5 minutes and 15 seconds, or 5.25 minutes. The second \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ has more significant figures. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are all the\_\_\_\_\_\_\_\_\_\_\_ that are \_\_\_\_\_\_\_\_\_\_\_\_ in a measurement, plus the \_\_\_\_\_\_\_\_\_\_ digit that is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The time recorded as 5.25 minutes has three significant figures. The time recorded as 5 minutes has one significant figure. The \_\_\_\_\_\_\_\_\_\_\_\_ the significant figures, the less \_\_\_\_\_\_\_\_\_\_\_\_\_ the measurement is.

When you make calculations with measurements, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the separate measurements must be correctly \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the final \_\_\_\_\_\_\_\_\_\_\_\_\_. The precision of a calculated answer is\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by the \_\_\_\_\_\_\_\_\_\_ precise measurement used in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. So if the least precise measurement in your calculation has two significant figures, then your calculated answer can have at most two significant figures.

Suppose you measure the mass of a piece of iron to be 34.73 grams on an electronic balance. You then measure the volume to be 4.42 cubic centimeters. What is the density of the iron?

 Density = 34.73g/4.42 cm3 = 7.857466 g/cm3

Your answer should have only \_\_\_\_\_\_\_\_\_\_\_ significant figures because the \_\_\_\_\_\_\_\_\_\_\_\_ precise measurement, the volume, has \_\_\_\_\_\_\_\_\_\_\_\_\_ significant figures. Rounding your answer to three significant figures gives you a density of 7.86 grams per cubic centimeter.

***Accuracy***

Another important quality in a measurement is its accuracy. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a measurement to the \_\_\_\_\_\_\_\_\_\_\_ value of what is being measured. For example, suppose the digital clock is running 15 minutes slow. Although the clock would remain precise to the nearest second, the time displayed would not be accurate.

**Measuring Temperature**

A\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is an instrument that measures \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or how hot an object is.

The two temperature scales that you are probably most familiar with are the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ scale and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ scale. On the Fahrenheit scale, water freezes at 32°F and boils at 212°F at sea level. On the Celsius (or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) scale, water freezes at \_\_\_\_\_\_\_\_\_ and boils at \_\_\_\_\_\_\_\_\_\_\_. A degree Celsius is almost twice as large as a degree Fahrenheit. There is also a difference of 32 degrees between the zero point of the Celsius scale and the zero point of the Fahrenheit scale. You can \_\_\_\_\_\_\_\_\_\_\_\_ from one scale to the other by using one of the following formulas.

 °C = 5/9 (°F – 32.0°) °F = 9/5 (°C) + 32.0°

The SI base unit for temperature is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (K). A temperature of \_\_\_\_\_ K, or 0 kelvin, refers to the \_\_\_\_\_\_\_\_\_\_\_\_\_ possible temperature that can be reached. In degrees Celsius, this temperature is -273.15°C. To \_\_\_\_\_\_\_\_\_\_\_\_\_ between kelvins and degrees Celsius, use the following formula.

 K = °C + 273

The figure below compares some common temperatures expressed in degrees Celsius, degrees Fahrenheit, and kelvins.

|  |
| --- |
| ***Common Temperatures*** |
|  | **Fahrenheight (°F)** | **Celcius (°C)** | **Kelvin (K)** |
| **Water boils** | 212 | 100 | 373 |
| **Human body** | 98.6 | 37 | 310 |
| **Average room** | 68 | 20 | 293 |
| **Water freezes** | 32 | 0 | 273 |

***Comprehension Questions***

1. Why do scientists use scientific notation?
2. What system of units do scientists use for measurements?
3. How does the precision of measurements affect the precision of scientific calculations?
4. List the SI units for mass, length, and temperature.
5. A bulb thermometer gives an indoor temperature reading of 21°C. A digital thermometer in the same room gives a reading of 20.7°C. Which device is more precise? Explain
6. Convert -11°F into degrees Celcius, and then into kelvins.

Matching

7. \_\_\_\_\_\_scientific notation A) the ratio of an object’s mass to its volume

8. \_\_\_\_\_\_length B) ratio of equivalent measurements that is used to convert a quantity expressed in one unit to another unit

9. \_\_\_\_\_\_mass C) way of expressing a value as the product of a number between 1 and 10 and a power of 10

10. \_\_\_\_\_\_volume D) straight-line distance between two points

11. \_\_\_\_\_\_density E) gauge of how exact a measurement is

12.\_\_\_\_\_\_conversion factor F) amount of space taken up by an object

13.\_\_\_\_\_\_precision G) all the digits that are known in a measurement, plus the last digit that is estimated

14.\_\_\_\_\_\_significant figures H) quantity of matter in an object or sample

15.\_\_\_\_\_\_accuracy I) instrument that measures temperature

16.\_\_\_\_\_\_thermometer J) the closeness of a measurement to the actual value of what is being measured