Lesson 1: The Metric System

Ask someone how tall they are and they'll probably tell you in feet and inches.

- This is surprising given that we are a metric country, but it is a traditional way of describing peoples' heights that has stayed with us.
- So why did we switch over to the metric system?

DID YOU KNOW?
The original "foot" was actually defined as the size of the current king's foot! There is evidence that the “yard” was the distance from the nose of King Henry I to his extended fingertip.

Illustration 1: The official "metrication" logo used in Canada in the 70's & 80's.

The metric system started a couple hundred years ago in France.

- It was called "**Le Système International d'Unités**" which is why you sometimes hear it referred to as the **SI** system.
- It grew out of the need to have a standard system that everyone could agree on.
- In 1970 the Canadian government started the “metrication” of Canada. By the early 1980's the majority of Canadian measurements were metric.
- There are three core measurements to the metric system: **length**, **mass**, and **time**.

Length

The standard unit of **length** is the **metre**.

- Notice that it is spelled "metre", not "meter".
  - Many textbooks published in the United States use the "Americanized" spelling with an "er" on the end.
- Originally the distance from the North Pole to the equator divided into little pieces was used as the standard for the metre.
- Then it was switched to a platinum-iridium rod kept at 0°C at the International Bureau of Weights and Measures in Sèvres, France.
- Since even this rod could alter in size over time, we now use the distance that a beam of light will travel in 3.34×10^{-9} s.

Mass

The standard unit of **mass** is the **kilogram**.

- At one time the kilogram was actually defined as the mass of a particular amount of water.
  - 1 kg = 1 litre
- It is now based on a platinum-iridium “slug” kept in Sèvres, France.
- We will also look at another way of defining the kilogram in a later chapter.

Time

The standard unit of **time** is the **second**.

- When the SI system was first created, they defined the second based on how long it took the earth to spin once on its axis! 1 day = 86 400 s.
  - It was felt that this was too inaccurate.

- We now use the frequency given off from electrons jumping energy levels in radioactive isotopes like cesium in atomic clocks to measure time.
- The world bases time on UTC (Universal Coordinated Time).
  - In Alberta we are on Mountain Time
    - UTC –6:00 during Daylight Savings Time
    - UTC –7:00 during the rest of the year
- If you have a shortwave radio, tune in 5000 Hz, 10 000 Hz, or 20 000 Hz to hear the time.

For more information...
...about atomic clocks, and to get the current time, you can visit the U.S. Naval Observatory's Website or the Official U.S. Time Website. Take a "Walk Through Time" at the NIST.

Metric Prefixes

In order to make numbers more "friendly" looking, the metric system sometimes uses **prefixes** in the front of the base units.

- Measuring the distance from Edmonton to Calgary in metres would be silly. Instead we measure it in ***kilo***metres.
- Measuring the size of an atom in metres would be just as bad, so we might use ***pico***metres.

We can use metric prefixes with any measurement in physics.

- If you saw a measurement of 15 cs don't freak out, it's just 15 centiseconds.
  - We don't use stuff like that often, but it is allowed.
- On the back of your data sheet, you'll find a list of the common metric prefixes... notice for example that "kilo" is 1000 or 10^3.
  - You don't need to memorize these since you'll always have a copy of the data sheet handy.
  - Later in this unit when we study **scientific notation** you'll see another alternative that we have.
  - Avoid mixing scientific notation with metric prefixes... it's not considered "polite."

It is very important to always change everything into the most basic units (like metres instead of kilometres) before doing any calculations, since almost all the formulas are based on units without prefixes.

- The exception to this is kilograms, which MUST remain as kilograms in physics!

Example 1:

You have a can of pop that is 355 mL, which means the liquid inside has a mass of 355 g. To convert this into kilograms you divide by 1000.

355 g = 0.355 kg

You are told in a question that something happens for 258 ps. Show this in a way that it could be used in a calculation.

On your data sheet it shows that p means “pico,” which is $\times10^{-12}$

258 ps = 258 $\times10^{-12}$ s

Don’t fool around with moving the decimal, even though this breaks a scientific notation rule!

Base Units vs Derived Units

Warning!
Base vs derived is an idea most people mix up. Make sure you understand what is explained here. It has NOTHING to do with metric prefixes.

Units like **metres**, **kilograms**, and **seconds** are all examples of **base units**.

- They can ***not*** be broken down to simpler parts.
- Other examples of base units are the mole and Kelvin.

Putting metric prefixes in front of a base unit does **NOT** change it from being a base unit.
e.g. writing picoseconds (ps) is still a base unit, it just has a prefix on it.

Sticking some base units together just means you have a bunch of base units.
e.g. metres per second (m/s) is still base units.

Sometimes we need **derived units**. They are a way of shortening up the amount of units you have to write down.

- You already used derived units in Science 10, like Joules, the unit of energy.
- Look at the formula E_p=**m g h**
  - The **base** units on the right would be **kg m/s^2 m**, usually simplified to **kg m^2/s^2**. These are all still base units, even though we are multiplying and dividing them.
- Instead of writing all those base units we just say that the whole mess of them is equal to the **Joule (J)**.
- The unit **Joule** is **derived** from the **base units kg m^2/s^2** of the metric system.

It's just like making something out of Lego blocks. You can arrange the Lego blocks in different ways to derive something different, but it's always made up of the base pieces.