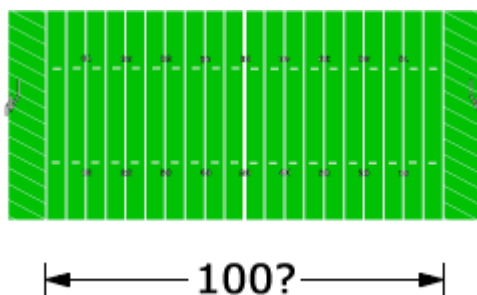


The Measurement of Matter

key concepts:

- A measurement is meaningless unless it has units associated with it.
- The **Système International d'Unités (SI)** was developed as a convenient and uniform system of measurement.
- Some SI units are based on amounts that are too large or small to be useful for chemists, so units derived from SI units are commonly used.



A measurement is meaningless unless it has units associated with it. For example, describing the length of a football field as “100” is insufficient. The length should be given as “100 yards”.

Quantity	Unit	Abbreviation
length	meter	m
mass	kilogram	kg
time	seconds	s
temperature	kelvin	K
chemical amount	mole	mol
electric current	ampere	A
luminous intensity	candela	cd

The Système International d'Unités (SI) was developed as a convenient and uniform system of measurement.

All SI units are built upon seven **base SI units**. These units are the **meter** (length), the **kilogram** (**mass**), the **kelvin** (**temperature**), the **mole** (chemical amount), the **ampere** (**electric current**), and the candela (luminous intensity).

Quantity	Unit	Abbreviation	Basic SI Units
energy	joule	J	$\text{kg}\cdot\text{m}^2\cdot\text{s}^{-2}$
force	newton	N	$\text{kg}\cdot\text{m}\cdot\text{s}^{-2}$
power	watt	W	$\text{kg}\cdot\text{m}^2\cdot\text{s}^{-3}$
pressure	pascal	Pa	$\text{kg}\cdot\text{m}^{-1}\cdot\text{s}^{-2}$
electric charge	coulomb	C	A·s
electric potential difference	volt	V	$\text{kg}\cdot\text{m}^2\cdot\text{s}^{-3}\text{A}^{-1}$

Derived units are units obtained by combining two or more of the base SI units. For example, the **joule** is a unit of **energy** that combines kilograms, meters, and seconds.

Derived units include the joule (energy), the **Newton** (**force**), the **watt** (**power**), the **pascal** (**pressure**), the **coulomb** (electric charge), and the **volt** (electric **potential difference**).

The Measurement of Matter

Factor of 10	Prefix	Abbreviation
10^{12}	tera-	T
10^9	giga-	G
10^6	mega-	M
10^3	kilo-	k
10^2	hecto-	h
10^1	deka-	da
10^{-1}	deci-	d
10^{-2}	centi-	c
10^{-3}	milli-	m
10^{-6}	micro-	μ
10^{-9}	nano-	n
10^{-12}	pico-	p

Greek prefixes are used to modify SI units. For example, one kilometer (km) is equal to 10^3 meters (one thousand meters).

Greek prefixes can be used with any base SI unit except the kelvin. For example, if a very small chemical amount is being measured, it might be given in picomoles (pmol), or 10^{-12} moles (one trillionth of a mole).

Although the base SI unit of mass is the kilogram, Greek prefixes are used to modify grams. For example, one milligram (mg) is equal to 10^{-3} grams (one thousandth of a gram), or one millionth of a kilogram.

Quantity	Units	SI conversion
volume	liter (L)	10^{-3} m^3
mass	gram (g)	10^{-3} kg
temperature	degree Celsius ($^{\circ}\text{C}$)	$\text{K} - 273.15$
pressure	atmosphere (atm)	101,325 Pa

Some SI units are based on amounts that are too large or small to be useful for chemists, so units derived from SI units are commonly used.

The unit commonly used by chemists for **volume** is the **liter** (L), which is equal to 10^{-3} m^3 .

The unit commonly used for mass is the gram (g), which is equal to 10^{-3} kilograms.

A unit commonly used for temperature is the degree **Celsius** ($^{\circ}\text{C}$). To convert from temperature in kelvins to temperature in degrees Celsius, subtract 273.15. However, many calculations in chemistry require that the temperature be in kelvins.

A unit commonly used for pressure is the **atmosphere** (atm), which is equal to 101,325 pascals. The atmospheric pressure at sea level is one atmosphere, making this unit very convenient.