2.6 INTERNATIONAL SYSTEM OF MEASUREMENT—DERIVED UNITS

Not all units are directly measurable, though. **Derived units** cannot be directly measured. Instead, they are calculated from one or more base units or other derived units. These calculations include division and multiplication. The derived units important in chemistry are listed in **Figure 2.6.1**.

Figure 2.6.1

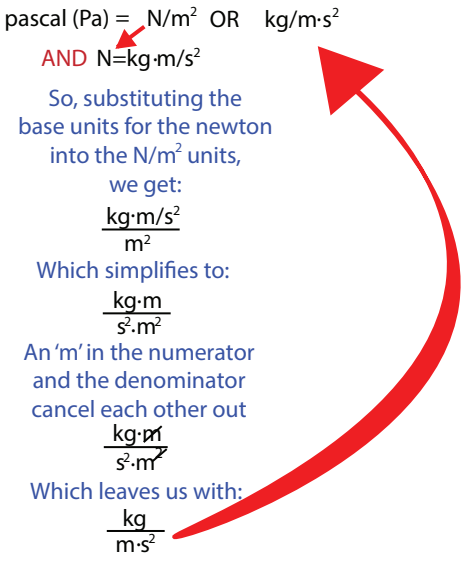
Derived SI Units
There are more derived units than are shown in this table. I just included the ones more relevant to chemistry. The far-right column shows the base units that are represented in the derived value. So, for frequency, Hz, its unit is the "per second" unit so if you measured the frequency of something, let's say of some type of radio wave, and it was 60 Hz, that would be 60 cycles (or waves) per second. Also, for some of the derived units, you will see that they can be written broken down into their base units or as a combination of derived units and/or base units. The unit of force, the newton, N, is represented in base units as "kilogram times meters per second squared"—$kg \cdot m/s^2$. If you look at the unit of pressure, the pascal, Pa, you see that its base units are "kilogram per meter times second squared"—$kg/m \cdot s^2$. This could also be written as N/m^2 because the Newton is expressed as $kg \cdot m/s^2$ so substituting $kg \cdot m/s^2$ in the numerator of N/m^2, we get $kg \cdot m/s^2/m^2$, which can then be rewritten $kg \cdot m/s^2 \cdot m^2$. One of the "m's" cancel each other out and we are left with $kg/s^2 \cdot m$, or $kg/m \cdot s^2$, which is the base units of the pascal. I'll show the work below the diagram for you. We don't do a whole lot of this kind of conversion in chemistry, but it is important to understand how the base units are related to the derived units in this way.

Derived Unit Name	Quantity Name	Abbreviation/ Symbol	Base Units	Mix of Derived and Base Units
frequency	hertz	Hz	s^{-1} or /s ("per second")	
force or weight	newton	N	$kg \cdot m/s^2$	
pressure	pascal	Pa	$kg/m \cdot s^2$	N/m^2
energy/work/heat	joule	J	$kg \cdot m^2/s^2$	$N \cdot m$
electrical charge	coulomb	C	$s \cdot A$	
voltage	volt	V	$kg \cdot m^2/s3 \cdot A$	W/A
resistance	ohm	Ω	$kg \cdot m^2/s^3 \cdot A^2$	V/A
electrical conductance	siemens	S	$s^3 \cdot A^2/kg \cdot m^2$	Ω^{-1}
catalytic activity	katal	kat	mol/s^2	
area	square meter	m^2	m^2	
volume	cubic meter	m^3	m^3	

Updated table

Figure 2.6.2

Conversion of N/m to $kg/m \cdot s^2$ for the Pascal Measurement.
The pascal unit can either be expressed as a base unit of kg/ms^2 or, because the newton is defined as kgm/s^2, it can also be expressed as a mixture of derived units (the newton) and base units. To the right, I show you the calculation of how it can be expressed as either one. I like just using the base units because it doesn't require any type of conversion, but you will see many of the derived units expressed as units of other derived units and base units.



We will be doing some more work on these relationships between the base and derived units, so don't be too worried if you don't totally get it now. Working with the SI units is much easier than working with the American or imperial systems, as we are about to see. For right now, make sure you are familiar with the units, especially the base units, and understand how they generally fit into the derived units.