USEFUL UNITS, CONSTANTS, AND EQUATIONS

Some Basic Units

The Systéme International d'Unités (SI) system of units

length: meter (m)
mass: kilogram (kg)
time: seconds (s)

Other basic units

temperature (T): degrees Kelvin (K), degrees Celsius (C) = K - 273.
Note that a difference of X degrees C is also a difference of X degrees K, but they a given temperature in C and K will differ in absolute value – you will generally use K in this class!
numbers of things: mole (mol) = 6.02×10^{23}, **n** = the number of moles

Some Derived Units

area	square meter (m^2)
volume	cubic meter (m^3)
force	Newton (N), 1 kg m s^{-2}
energy or work	Joule (J), 1 N x m
power	Watt (W), J s^{-1}
pressure, P	Pascal (Pa), 1 N m^{-2}
concentration, [ ]	mol m^{-3}, or molarity, M = mol l^{-1}
density	kg m^{-3}
frequency	hertz (Hz), s^{-1}
voltage, electromotive force	volt (V), 1W/A
specific heat	J kg^{-1} K^{-1}

Exponents and prefixes

Exponents and prefixes are concise ways of expressing numbers. This table contains some of the common prefixes and related exponents and symbols that we will use. Please learn them.

prefix	exponent	symbol	example
nano	10^{-9}	n	nanogram, one billionth of a gram, ng
micro	10^{-6}	μ	micrometer, one millionth meter, **μm**
milli	10^{-3}	m	milliliter, one thousandth of a liter, ml
kilo	10^{3}	k	kilometer, one thousand meters, km
mega	10^{6}	M	mega Pascal, one million Pascals, MPa

The Gas Constant, R - A Very Useful Constant.

1) $R = 8.314\ J\ mol^{-1}\ K^{-1}$, or

2) $R = 8.314\ m^3\ Pa\ mol^{-1}\ K^{-1}$.

R is an empirically derived constant, meaning that it was found to be the constant that made the behavior of gases fully predictable when pressure, volume, or temperature was varied for a given quantity (n) of gas. Do you remember **PV = nRT**? If you isolate R on one side of the equation, you'll see you have R = PV/nT, the same as the second expression for R above.

Study the units in the expressions for R. In both you should see that they are energy (J) per amount (mol) per temperature (K). Remember from class that pressure X volume is an energy term so the second expression for R has the same units as the first, just expressed a bit differently.

We'll see R appearing in lots of other equations, even when gases are not directly involved. It turns out that R also makes these equations "work" under biological conditions of temperature and pressure.

Some other constants and terms

F, Faraday's constant = $9.65 \times 10^4\ J\ V^{-1}\ mol^{-1}$, or 9.65×10^4 coulomb mol^{-1}.

z is valence or charge (e.g. z for $Cl^- = -1$, z for $Ca^{+2} = +2$)

$\mathbf{E_m}$ is membrane potential, V

K is the equilibrium constant of a reaction. K = [products]/[reactants]

$\mathbf{E_o}$,standard oxidation-reduction potential. Units are volts.

$\mathbf{E_o}$' standard oxidation-reduction potential at pH 7.

pH = $-\log [H^+]$; pH 7 means $[H^+] = 10^{-7}$

Density of water, 1 g/cm^3 = 1 g/milliliter. The symbol is **ρ, "rho"**

A note on units and problem solving.

Be sure to write out the units every time you work a problem. Solve it first with units only, then worry about the numbers. If the units lead you where you want to be, the numbers will follow!

Table A3. Values of physical constants.

Quantity	Symbol	Value	Units
Standard temperature	t_o	273.15	K
Standard pressure	p_o	101.325	kPa
Gas constant for an ideal gas	R	8.31441	$J\ mol^{-1}\ k^{-1}$
Avogadros number	N_A	6.022×10^{23}	molecules mol^{-1}
Molar volume of an ideal gas at standard temperature and pressure	V_m	2.241×10^{-2}	$m^3\ mol^{-1}$
Apparent molecular weight of air		28.964×10^{-3}	$kg\ mol^{-1}$
Molecular weight of water		18.016×10^{-3}	$kg\ mol^{-1}$
Molecular weight of carbon dioxide		44.01×10^{-3}	$kg\ mol^{-1}$
Ratio of densities of dry air and water vapor		0.622	dimensionless
Stefan-Boltzman constant	σ	5.6696×10^{-8}	$W\ m^{-2}\ K^{-4}$
Planck's constant	h	6.6262×10^{-34}	J s
Wein's constant		2897	μm K
Velocity of light	c	299.8×10^{-6}	$cm\ s^{-2}$
Gravitational constant	G	6.6720×10^{-11}	$N\ m^2\ kg^{-2}$
Specific heat of dry air at 100 kPa pressure	Cp	1.012×10^3	$J\ kg\ K^{-1}$

Table A4. Conversion Factors.

Pressure	
1 bar	100 kPa
1 atmosphere	101.325 kPa
1 pound per square inch (PSI)	6.89 kPa
1 mm Hg (0°C)	0.13332 kPa
1 mm H_2O (4°C)	9.8064×10^{-2} kPa
Energy	
1 calorie	4.184 J
1 watt hour	3.60×10^{3} J
1 watt s	1 J
1 erg	10^{-7} J
1 dyne cm	10^{-7} J
Power	
1 calorie s^{-1}	4.184 W
1 calorie min^{-1}	6.973×10^{-2} W
1 British thermal unit	1.0544×10^{3} W
1 erg s^{-1}	10^{7} W
1 kg m s^{-1}	.10197 W
Force	
1 dyne	10^{5} N
kilogram force	9.80665 N
pound force	4.44822 N
Flux	
1 calorie cm^{-2} min^{-1}	697 W m^{-2}
1 langley min^{-1}	697 W m^{-2}
1 erg cm^{-2} s^{-1}	10^{-3} W m^{-2}

Table A4 continued.

1 mg CO_2 dm^{-2} $hour^{-1}$	0.631 μmol CO_2 m^{-2} s^{-1}
1 mg CO_2 cm^{-2} s^{-1}	0.227 μmol CO_2 m^{-2} s^{-1}
1 mg CO_2 m^{-2} s^{-1}	22.7 μmol CO_2 m^{-2} s^{-1}
1 mg H_2O m^{-2} s^{-1}	0.055 mmol H_2O m^{-2} s^{-1}
1 g H_2O dm^{-2} $hour^{-1}$	1.542 mmol H_2O m^{-2} s^{-1}
1 kg H_2O m^{-2} $hour^{-1}$	15.42 mmol H_2O m^{-2} s^{-1}
1 μeinstein m^{-2} s^{-1}	1 μmol m^{-2} s^{-1}
Area	
1 square foot	0.09203 m^2
1 square inch	0.6452 x 10^{-3} m^2
1 acre	4046.86 m^2
1 hectare	10,000 m^2
Volume	
1 cubic foot	0.283168 m^3
1 cubic inch	0.16387 x 10^{-4} m^3
1 cubic centimeter	10^{-6} m^3
1 gallon (U.S.)	0.3785 x 10^{-2} m^3
1 gallon (British)	0.4546 x 10^{-2} m^3
Length	
1 inch	2.54 x 10^{-2} m
1 foot	0.3048 m
1 mile (U.S. statute)	1609.344 m

Table A4 continued.

Mass	
1 pound	4.5359×10^{-2} kg
1 ounce	2.834×10^{-2} kg
1 ton (short, 2000 pounds)	907.18 kg
1 ton (metric)	1000 kg