Statistics & Error propagation

$$\mu = \sum_{i=0}^{N\to\infty} \frac{x_i}{N} \qquad \bar{x} = \sum_{i=1}^{N} \frac{x_i}{N}$$

$$\sigma = \sqrt{\lim_{N\to\infty} \frac{\sum_{i=0}^{N} (x_i - \mu)^2}{N}} \qquad s = \sqrt{\frac{\sum_{i=1}^{N} (x_i - \bar{x})^2}{N-1}}$$

$$\mu = \bar{x} \pm z\sigma/\sqrt{N} \qquad \mu = \bar{x} \pm ts/\sqrt{N}$$

$$S_{pool} = \sqrt{\frac{\sum_{i=1}^{Na} (x_{ai} - \bar{x}_a)^2 + \sum_{j=1}^{Nb} (x_{bj} - \bar{x}_b)^2}{Na + Nb - 2}} \quad \text{or} \quad S_{pool} = \sqrt{\frac{(N_a - 1)s_a^{\,2} + (N_b - 1)s_b^{\,2}}{Na + Nb - 2}}$$

$$S_{xx} = \sum_{i=1}^{N} (x_i - \bar{x})^2 \qquad \text{Intercept} = b = \bar{y} - m\bar{x}$$

For the method of External Calibration

$$S_c = \frac{S_r}{m}\sqrt{\frac{1}{M} + \frac{1}{N} + \frac{(\bar{y}_c - \bar{y})^2}{m^2 S_{xx}}}$$

For the method of Standard Additions

$$\left(\frac{S_c}{C_x}\right)^2 = \left(\frac{S_m}{m}\right)^2 + \left(\frac{S_b}{b}\right)^2$$

Propagation of error into a result (x) from variables (p,q,r,y) with standard deviations ($S_{variable}$)		
Addition & subtraction	$x = p + q - r$	$S_x^2 = S_p^2 + S_q^2 + S_r^2$
Multiplication & division	$x = pq/r$	$\left(\frac{S_x}{x}\right)^2 = \left(\frac{S_p}{p}\right)^2 + \left(\frac{S_q}{q}\right)^2 + \left(\frac{S_r}{r}\right)^2$
Exponentiation	$x = p^y$	$\frac{S_x}{x} = y\frac{S_p}{p}$
Logarithm	$x = \log_{10} p$	$S_x = 0.434 \times \frac{S_p}{p}$
Antilogarithm	$x = \text{antilog}_{10} p$	$\frac{S_x}{x} = 2.303 \times S_p$

Optics & Spectrometers

F number $f = \mathrm{F/d}$

Condition for constructive interference $n\lambda = \mathrm{d}(\sin i + \sin r)$

Angular dispersion of a grating $$\frac{dr}{d\lambda} = \frac{n}{d\ \cos r}$$

Linear dispersion $$D = \frac{dy}{d\lambda} = \frac{F dr}{d\lambda}$$

Reciprocal linear dispersion $$D^{-1} = \frac{d\ \cos r}{nF}$$

Effective bandwidth $$\Delta\lambda_{eff} = wD^{-1}$$

Resolving power $$R = \frac{\lambda}{\Delta\lambda} = nN$$

Lens formula $$\frac{1}{f} = \frac{1}{S_1} + \frac{1}{S_2}$$

Snells Law $$\frac{\sin\theta_1}{\sin\theta_2} = \frac{\eta_2}{\eta_1} = \frac{v_1}{v_2}$$

Basic constants of this universe

Constant	Symbol	Value
Speed of light (vacuum)	c	2.99 x 10^{8} m/s
Plank's constant	h	6.626 x 10^{-34} Js
Avogadro's number	N	6.022 x 10^{23} particles/mole
Faraday's constant	F	96485 C/mole
Gas constant	R	8.3145 J/(K mole)
	R	0.0820 L atm / (K mole)
Boltzmann's constant	k	1.3806 x 10^{-23} J/K
Mass of electron (rest)	m_e	9.109 x 10^{-31} kg

Odds & Ends

Transmittance $T = \frac{P}{P_o}$ Percent transmittance $\%T = \frac{P}{P_o} \times 100\%$

Absorbance A = abc

Boltzmann's equation $\frac{N_j}{N_o} = \frac{P_j}{P_o} e^{\frac{-E_j}{kT}}$

Chromatography

M.P. velocity $u = \frac{L}{t_m}$ Analyte velocity $\bar{v} = \frac{L}{t_r}$

$k' = \frac{KVs}{Vm}$ $k' = \frac{tr - tm}{tm}$ $K = \frac{Cs}{Cm}$ $\alpha = \frac{Kb}{Ka} = \frac{k'_b}{k'_a}$

$$\bar{v} = u\frac{CmVm}{CmVm + CsVs} = u\frac{1}{1 + CsVs/CmVm} = u\frac{1}{1 + KVs/Vm} = u\frac{1}{1 + k'}$$

$$N = 5.54\left(\frac{tr}{W_{1/2}}\right)^2 = 16\left(\frac{tr}{W}\right)^2 = 16R_s^2\left(\frac{\alpha}{\alpha - 1}\right)^2\left(\frac{1 + k'_b}{k'_b}\right)^2$$

$$Rs = \frac{k'_b - k'_a}{1 + k'_b} \times \frac{\sqrt{N}}{4}$$

$$tr_b = \frac{NH(1 + k'_b)}{u} = \frac{16R_s^2 H}{u}\left(\frac{\alpha}{\alpha - 1}\right)^2 \frac{(1 + k'_b)^3}{(k'_b)^2}$$

$A = 2\lambda d_p$ $\frac{B}{u} = \frac{2\gamma D_m}{u}$ $C_s u = \frac{fs(k')d_f^2}{D_s}u$ $C_m u = \frac{fm(k')d_p^2}{D_m}u$ $H_{ex} = \frac{\pi r^2}{24D_m}u$

Polarity indices of common liquid chromatography solvents

Fluoroalkanes	-2	Dioxane	4.8
n-hexane	0.1	Methanol	5.1
Toluene	2.4	Acetonitrile	5.8
Ethanol	4.3	Water	10.2

Q_{table}	Level of confidence		
Number of Measurements	90%	95%	99%
3	0.941	0.970	0.994
4	0.765	0.829	0.926
5	0.642	0.710	0.821
6	0.560	0.625	0.740
7	0.507	0.568	0.680
8	0.468	0.526	0.634
9	0.437	0.493	0.598
10	0.412	0.466	0.568
15	0.338	0.384	0.475
20	0.300	0.342	0.425
30	0.260	0.298	0.372

T_{table}					
Confidence interval %	80	90	95	99	99.9
Degrees of freedom					
1	3.078	6.314	12.706	63.656	636.578
2	1.886	2.920	4.303	9.925	31.600
3	1.638	2.353	3.182	5.841	12.924
4	1.533	2.132	2.776	4.604	8.610
5	1.476	2.015	2.571	4.032	6.869
6	1.440	1.943	2.447	3.707	5.959
7	1.415	1.895	2.365	3.499	5.408
8	1.397	1.860	2.306	3.355	5.041
9	1.383	1.833	2.262	3.250	4.781
10	1.372	1.812	2.228	3.169	4.587
11	1.363	1.796	2.201	3.106	4.437
12	1.356	1.782	2.179	3.055	4.318
20	1.325	1.725	2.086	2.845	3.850
∞	1.282	1.646	1.962	2.581	3.300

F_{table} at confidence level = 95%													
		Degrees of freedom of numerator											
		2	3	4	5	6	7	8	9	10	11	12	20
Degrees of freedom of denominator	2	19.000	19.164	19.247	19.296	19.329	19.353	19.371	19.385	19.396	19.405	19.412	19.446
	3	9.552	9.277	9.117	9.013	8.941	8.887	8.845	8.812	8.785	8.763	8.745	8.660
	4	6.944	6.591	6.388	6.256	6.163	6.094	6.041	5.999	5.964	5.936	5.912	5.803
	5	5.786	5.409	5.192	5.050	4.950	4.876	4.818	4.772	4.735	4.704	4.678	4.558
	6	5.143	4.757	4.534	4.387	4.284	4.207	4.147	4.099	4.060	4.027	4.000	3.874
	7	4.737	4.347	4.120	3.972	3.866	3.787	3.726	3.677	3.637	3.603	3.575	3.445
	8	4.459	4.066	3.838	3.688	3.581	3.500	3.438	3.388	3.347	3.313	3.284	3.150
	9	4.256	3.863	3.633	3.482	3.374	3.293	3.230	3.179	3.137	3.102	3.073	2.936
	10	4.103	3.708	3.478	3.326	3.217	3.135	3.072	3.020	2.978	2.943	2.913	2.774
	11	3.982	3.587	3.357	3.204	3.095	3.012	2.948	2.896	2.854	2.818	2.788	2.646
	12	3.885	3.490	3.259	3.106	2.996	2.913	2.849	2.796	2.753	2.717	2.687	2.544
	20	3.493	3.098	2.866	2.711	2.599	2.514	2.447	2.393	2.348	2.310	2.278	2.124