Signal and signal-to-noise ratio of absorption spectrophotometry

Input Data			Calculated Outputs	
Light source				
Blackbody temperature (Tc)	2227	C	Blackbody temperature (Tk)	=Tc+273
Emissivity (emisiv)	0.5		Total radiance (B)	=emisiv*0.0000000000018047*Tk^4
Flicker noise fraction (flicker)	0.00%		Spectral radiance at exw (Blambda)	=emisiv*1.19E+016*exw^-5/(EXP(14380000/(exw*Tk))-1)
			Peak wavelength	=2897000/Tk
			Energy of photon at exw (e)	=6.6261E-034*30000000000*10000000/exw
Monochromator				
Wavelength setting (exw)	400	nm	Slit area (SlitAex)	=Hex*Wex/100
Slit height (Hex)	5	mm	Radiant power input (PhiInEx)	=B*SlitAex*sax
Slit width (Wex)	1	mm	Spectral bandpass (SBex)	=RLDex*Wex
monochromator optics (Tex)	0.5		Radiant power output (PhiOutEx)	=Blambda*Tex*SBex*sax*SlitAex
Solid angle (Sax)	0.024	sr		
Reciprocal linear dispersion (RLDex)	2.8	nm/mm		
Fractional stray light (sl)	0.00%			
Analytical Sample				Sample cell
Molar absorptivity of analyte (a)	1.000	liters/mole-cm	Absorbance at measured wavelength (abs, absRef)	=a*l*c+sa
Path length of cell (l)	1.000	cm	Fraction absorbed (F, Fref)	=1-10^-abs
Molar concentration of analyte (c)	0.001	moles/liter	through sample (PhiAbs, PhiRef)	=PhiOutEx*(1-F)+PhiOutEx*Sl
Solvent absorbance at exw	0			

	Detector (photomultiplier tube)				Sample cell
				Cathode sensitivity (Rlam)	=Klam*1.6E-019/e
	Secondary emission gain per stage (g)	3.21		Radiant power on photocathode (PhiDet, PhiRef)	=PhiAbs
	Quantum efficiency of cathode (Klam)	0.2		photocathodic current (Ic)	=Rlam*PhiDet
	photomultiplier gain (m)	37000		photoanodic current (Ie, Ier)	=m*Rlam*PhiDet
	cathode thermionic emission rate (Rt)	10000	Sec-1	Photon noise rms current (PhotNoise, PhotNoiseRef)	=SQRT(2*1.602E-019*m*(1+1/(g-1))*Ie*deltaf)
	Noise bandwidth (deltaf)	0.5	Sec-1	Themionic anode current (Iat)	=Rt*m*1.602E-019
				Thermionic noise rms current (ThermNoise)	=SQRT(2*1.602E-019*m*(1+1/(g-1))*Iat*deltaf)
				(FlickerNoise, FlickerNoiseRef)	=Flicker*Ie
				Total rms noise (TotNoise, Tot	=SQRT(PhotNoise^2+ThermNoise^2+FlickerNoise^2)
				Intensity signal-to-noise ratio (SNR)	=Ie/TotNoise
				Percent photon noise	=PhotNoise/(PhotNoise+ThermNoise+FlickerNoise)
				Percent thermal noise	=ThermNoise/(PhotNoise+ThermNoise+FlickerNoise)
				Percent flicker noise	=FlickerNoise/(PhotNoise+ThermNoise+FlickerNoise)
				Measured transmittance (Tmeas	=(Ie-Iat)/(Ier-Iat)
				Relative transmittance noise (Tr	=SQRT((TotNoise/Ie)^2+(TotNoiseRef/Ier)^2)
				Measured absorbance (Ameas)	=LOG10(Ier/Ie)
				Relative standard deviation of absorbance	=100*0.434*Tnoise/Ameas
				Absorbance signal-to-noise rati	=1/F43

K					
W/sr/cm2					
W/sr/nm/cm2					
nm					
Joules					
cm2					
watts					
nm					
watts					
Reference cell					
=sa					
=1-10^-absRef					
=PhiOutEx*(1-FRef)+PhiOutEx*Sl	watts				

Reference cell					
=F27	amp/watt				
=PhiRef	watts				
=Rlam*PhiRef	amps				
=m*Rlam*PhiRef	amps				
=SQRT(2*1.602E-019*m*(1+1/(g-1))*Ier*deltaf)	amps				
=Rt*m*1.602E-019	amps				
=SQRT(2*1.602E-019*m*(1+1/(g-1))*Iat*deltaf)	amps				
=Flicker*Ier	amps				
=SQRT(PhotNoiseRef^2+ThermNoise^2+FlickerNoise^2)	amps				
=Ier/TotNoiseRef					
=PhotNoiseRef/(PhotNoiseRef+ThermNoise+FlickerNoiseRef)					
=ThermNoise/(PhotNoiseRef+ThermNoise+FlickerNoiseRef)					
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