Examination

“Material Characterisation – Optical Spectroscopy (Prof. T. Jüstel)”

Date: March 15th, 2012 **Max. 25 Points**

Name, Given name: **Enrolment number:**

Please only use these sheets (you might also use the reverse)!

Task 1) (5 Points)

Fundamentals of Spectroscopy

a) Which kind of fundamental interactions between light and matter are known to you?

b) Please explain the terms “radiometric quantities” and “photometric quantities” !

Task 2) (6 Points)

Luminescence Spectroscopy

a) Sketch the build-up of a typical fluorescence spectrometer and assign all required optical components!

b) Describe the way to record an emission spectrum of a luminescent material, e.g. of $Y_2O_3:Eu^{3+}$ powder, that shows a charge-transfer transition at 230 nm!

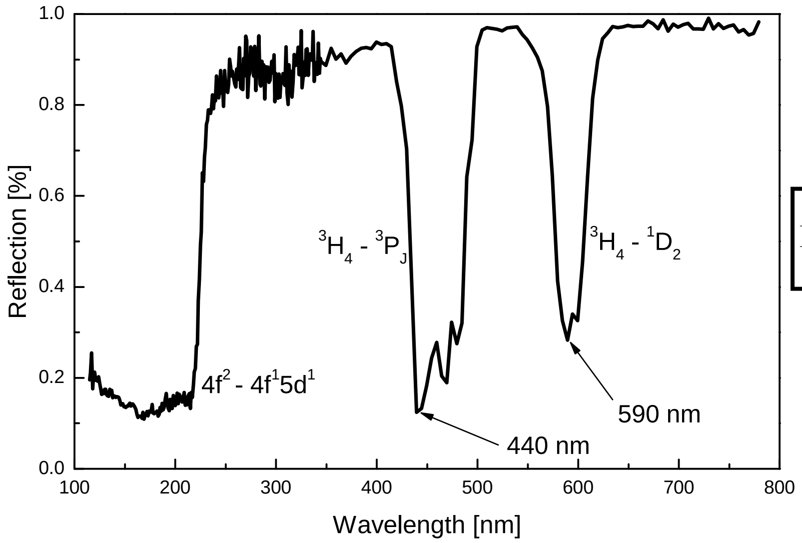
c) Describe the way to record an excitation spectrum of a luminescent material, e.g. of $Y_2O_3:Eu^{3+}$ powder, that shows an emission line at 611 nm!

d) Why is it commonly necessary to correct excitation spectra? Please also describe the process of the correction!

Task 3) **(6 Points)**

Reflection Spectroscopy

A $PrPO_4$ sample with an average particle size of d_{50} = 10 µm exhibits the following reflection spectrum:



$$F(R_\infty) = \frac{A}{S} = \frac{(1-R_\infty)^2}{2 \cdot R_\infty} \sim \frac{\varepsilon \cdot c}{d}$$

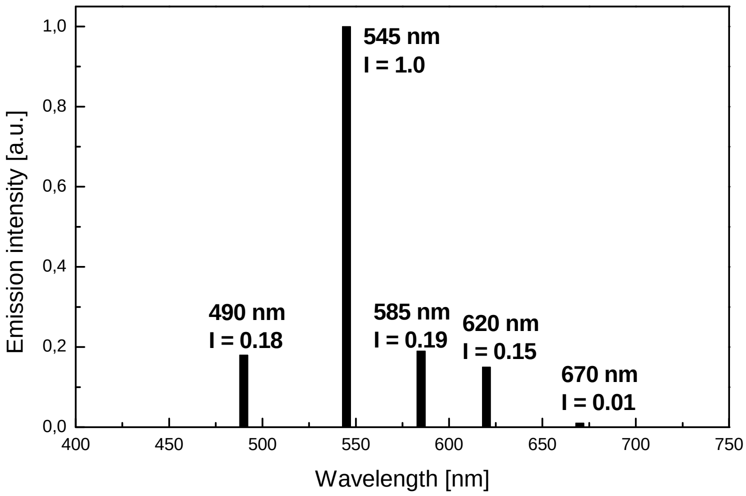
a) Please calculate by taking the R_∞ value and the average particle size into account the absorption constant A in [cm^{-1}] at the wavelengths 440 and 590 nm!

b) Clarify by means of the Kubelka-Munk function, whether completely black or completely white substances may exit!

Task 4) **(4 Points)**

Determination of the Lumen Equivalent

A commercial phosphor sample shows the following simplified emission spectrum upon excitation by 254 nm radiation.



$$\Phi_V = K_{max} \int_{380}^{780} V(\lambda)\Phi_e(\lambda)d\lambda$$

Please calculate the lumen equivalent Φ_V of the phosphor sample by means of the following table (K_{max} = 683 lm/W)!

λ [nm]	V(λ)	λ [nm]	V(λ)	λ [nm]	V(λ)
380	3.90044E-5	520	0.71	660	0.061
385	6.39971E-5	525	0.7932	665	0.04458
390	1.2E-4	530	0.862	670	0.032
395	2.16999E-4	535	0.91485	675	0.0232
400	3.96003E-4	540	0.954	680	0.017
405	6.4E-4	545	0.9803	685	0.01192
410	0.00121	550	0.99495	690	0.00821
415	0.00218	555	1	695	0.00572
420	0.004	560	0.995	700	0.0041
425	0.0073	565	0.9786	705	0.00293
430	0.0116	570	0.952	710	0.00209
435	0.01684	575	0.9154	715	0.00148
440	0.023	580	0.87	720	0.00105
445	0.0298	585	0.8163	725	7.4E-4
450	0.038	590	0.757	730	5.2E-4
455	0.048	595	0.6949	735	3.61098E-4
460	0.06	600	0.631	740	2.49195E-4
465	0.0739	605	0.5668	745	1.71903E-4
470	0.09098	610		750	1.2E-4
475	0.1126	615	0.4412	755	8.48023E-5
480	0.13902	620	0.381	760	6E-5
485	0.1693	625	0.321	765	4.24012E-5
490	0.20802	630	0.265	770	3E-5
495	0.2586	635	0.217	775	2.12006E-5
500	0.323	640	0.175	780	1.49927E-5
505	0.4073	645	0.1382	785	1.06003E-5
510	0.503	650	0.107	790	7.42313E-6
515	0.6082	655	0.0816		

Task 5) **(4 Points)**

Temperature Resolved Spectroscopy

a) Describe the way to record a thermal quenching curve and to determine the temperature $T_{1/2}$, i.e. the temperature, at which the luminescence intensity drops down to 50% relative to the low temperature luminescence intensity!

b) Draw the shape of a typical thermal quenching curve in a respective intensity-temperature diagram!