

Exercises „Incoherent Light Sources“

- 1) Calculate the energy of a photon corresponding to the wavelengths 100, 200, 500 and 1000 nm in the following units!
 - a) cm^{-1}
 - b) J
 - c) eV

- 2) Name the wavelength range for UV radiation (A, B, C), infrared radiation (A, B, C) and visible light!

- 3) Name at least one suitable source and application for the following wavelength range!
 - a) VUV
 - b) UV-C
 - c) UV-B
 - d) UV-A
 - e) NIR

- 4) Which different UV sources do you know?

- 5) Which physical/chemical processes are industrially used to produce light? What other processes do you know?

- 6) Name light sources you know from your daily life and explain the origin of the radiation for each of them!

- 7) What is the difference between radiometric and photometric quantities?

- 8) What is the term $K_{\text{max}} = 683 \text{ lm/W}$ called? What does it mean?

- 9) Describe two photoreceptors of the human eye and their importance for your vision at day and night!

- 10) Describe the spectral sensitivity of the three types of taps in the human eye!

11) Define the term luminance!

12) Define illuminance! What is the recommended illuminance at an indoor workplace?

13) Give the definitions and units of the following quantities!

- a) Intensity
- b) Radiant exposure
- c) Radiant flux
- d) Spectral radiant flux
- e) Luminous flux

14) A room with a base area of 50 m² has to be illuminated with 500 lux. How many fluorescent tubes do you need, if each of them consumes 36 W and possesses a luminous efficiency of 100 lm/W?

15) Sketch the spectral sensitivity curve for the following detectors and explain their shape!

- a) Human eye (photopic, adapted to daylight)
- b) Human eye (scotopic, adapted to the dark)
- c) Facet eye of an insect
- d) Si-photo diode

16) What is meant by additive and subtractive colour mixing? Which technical processes take advantage of these methods?

17) The incident intensity of the radiation emitted by the sun is estimated to 1.35 kW/m² annually (perpendicular to the sun beams). To what values of the radiant power does this add up for the earth ($r = 6378$ km) and the sun (distance: 149.6 Mio. km)? To what extent does the radiant power decrease during a transit of the Venus (distance to the sun: 108.2 Mio. km, radius: 6050 km)?

18) Define the following quantities: light efficiency, energy efficiency, optical and visual efficiency!

19) A light source exhibits an energy efficiency of 40% and emits monochromatic light at 598 nm. Which light efficiency does this light source possess?

- 20) Explain in principle the origin of light in the two basic types of lamps: thermal radiator and discharge lamp! Name main categories and examples!
- 21) How many spectral lines do you need to generate white light? Which wavelengths would be suitable?
- 22) What is defined by the colour-rendering index? Sort the following light sources according to their colour-rendering index, lowest first! Halogen-incandescent lamp, high-pressure sodium lamp, fluorescent tube, low-pressure sodium lamp, Hg-high pressure lamp!
- 23) Describe design, generation of light and the spectrum of an incandescent/halogen lamp!
- 24) What chemical transport reactions do occur in halogen and incandescent lamps?
- 25) What different purposes do halides fulfil in halogen and metal-halide lamps?
- 26) Calculate the wavelengths at which the emission of a black body is maximal for 3000 and 6000 K using Wien's displacement law!
- 27) Which technical measures contribute to increasing the lifetime of an incandescent lamp?
- 28) By which chemical "tricks" can the absorption edge (transmission) of bulb glass be tuned?
- 29) What is meant by atomic and molecular radiators?
- 30) What is the difference between thermal and non-thermal radiation sources?
- 31) What is plasma and what differentiates an isothermal from a non-isothermal plasma?
- 32) Which elements are used as emitting components in gas discharge lamps? Why?

- 33) Explain the built of a fluorescence lamp, how does it work? What is the main emission?
- 34) What is described by the colour temperature of a lamp? Which colour temperature corresponds with the following colour groups: warm-white, neutral-white and daylight-white?
- 35) In fluorescent lamps different shades of white are realised by which principle (explain by spectra)?
- 36) Explain built and origin of light in an Hg-vapour high pressure/metal-halide lamp! Describe the respective spectra!
- 37) What light yields can be achieved by metal-halide/Hg-high pressure lamps? For which purpose are the lamps used?
- 38) Describe built, origin of light and spectrum of a sodium vapour lamp!
- 39) What light yield and colour rendering index do Na-vapour high/low pressure lamps exhibit? What is their respective field of application?
- 40) Calculate the energy efficiency ϵ of a fluorescence lamp driven by a Xe-discharge, taking into consideration the following data: discharge efficiency = 60%, Xe-excimer emission at 172 nm, emission line of (Y,Gd)BO₃:Eu at 595 nm, quantum efficiency of the phosphor at $\lambda_{172} = 85\%$!
- 41) Explain the generation of light in a plasma display!
- 42) Give an equation for the efficiency of the light generation in a plasma display panel! Explain the individual coefficients!

- 43) What effect does a MgO-coating on the front panel glass of a plasma display have? How is such a coating carried out? Give an alternative to the MgO-coating!
- 44) Describe built/spectra of LEDs! How can one derive white light from LEDs (two ways)?
- 45) Explain the recombination process required for the generation of light in a LED!
- 46) How do you assess the efficiency of an LED?
- 47) What is an OLED? Describe two different types!
- 48) Explain the generation of light in an OLED and some typical spectra! Name several possible applications for OLEDs!
- 49) Explain the concept of photochemical water disinfection by elemental reaction schemes!
- 50) Which chemical reactions are triggered by UV-light in the tropo-, strato- and ionosphere?
- 51) Name two prominent photochemical reactions! Which alternative light sources can you think to replace sun light in these reactions?
- 52) Explain a physical process that converts visible light into UV radiation!
- 53) Calculate the energy efficiency ε of an UV-radiation source based on a Xe-excimer discharge (172 nm, discharge efficiency = 70%) and an UV-C phosphor (240 nm, QE = 90%)!

54) Please calculate the light yield of an LED, which comprises a 460 nm emitting LED chip and a 550 nm emitting YAG:Ce ceramic! The electroluminescence yield of the semiconductor is 80%, the package gain (including SS) is 60% and the luminous efficacy LE is 375 lm/W.