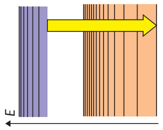


Photoluminescence

luminous colours (fluorescence and phosphorescence)

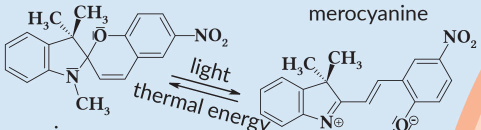
molecular structure and colour | light spectrum and light absorption | electron energy diagram | intermolecular forces (IMFs) | required knowledge

Sek. II

Basic experiment (E1) and analysis assignments (A1-A4) for all groups

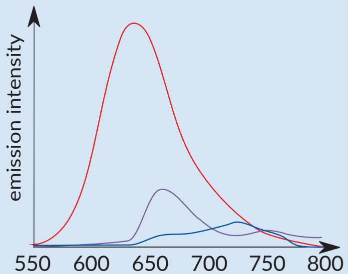
Group S: Luminescence within a solution

E2 Dissolve 5 of mg spiropyrane each in three different test tubes in 5 mL of xylene, acetone, and ethanol, respectively. Irradiate each of the three solutions with the violet LED torch in the dark for one minute. Look at the solutions in the daylight and identify the resulting colours. Note down all your observations.



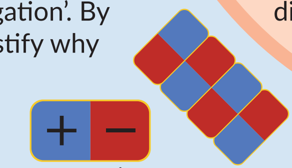
spiropyrane ⇌ merocyanine

S1 Assign the three emission spectra of merocyanine to the three different solvents. Give reasons for your choice.



S2 Draw formulae showing the intermolecular interactions within three different solutions. Name the intermolecular forces between a merocyanine-molecule and the respective solvent molecules.

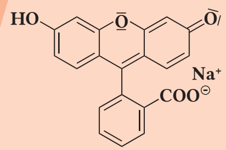
S3 Conduct some research regarding the concept of 'particle aggregation'. By means of your findings, justify why the three solutions show different fluorescence intensities.



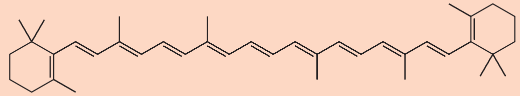
merocyanine

E1 Prepare the following solutions: a) approx. 1 mg of fluorescein sodium salt in 30 mL water, b) approx. 5 mg of aesculin in 30 mL water, and c) dissolve the content of a *β*-carotene capsule in 30 mL n-heptane. Irradiate the solutions in the dark with a violet LED torch and note down your observations.

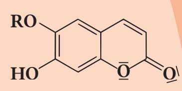
A1



fluorescein sodium salt [Fluoresceine]



β-carotene

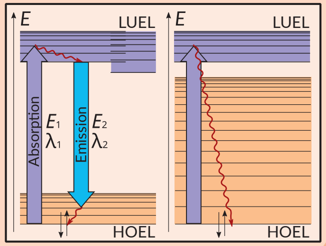


Esculin
R = glucose

Compare the structural features of the three molecules. Then assess to what extent intramolecular rotation and intramolecular vibration are possible within the respective molecule's chromophore.

A2 Conduct some research into the reasons why *β*-carotene does not show any fluorescence while chlorophyll does (refer to the German computer animation 'Ein Fall für Zwei'). Moreover, check to what extent your findings are applicable to your observations in E1.

A3 Compare the two given energy level diagrams and assign them to the *β*-carotene, the aesculin, and the fluorescein molecule. Give reasons for your decisions. *Hint*: The horizontal lines represent the allowed molecular vibrational states within the same energy level.

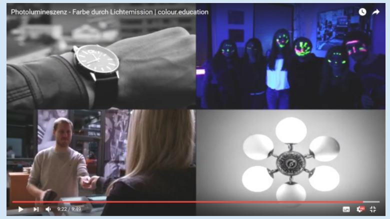


A4 The two following pairs are taken from the above energy level diagram on the left (cf. A3). Fill in the box with either '>' or '<':

E_1 ☐ E_2 $λ_1$ ☐ $λ_2$

Group M: Luminescence within a matrix

E3 Place 5 g tartaric acid each in two test tubes and heat them carefully with the roaring blue flame of a burner. As soon as you observe a highly viscous melt, add a) 1 mg fluorescein, and b) 5 mg esculin. Twist and turn the test tubes so that the melt spreads the inside wall and let it freeze. Then irradiate the samples with the violet LED torch in the dark at different temperatures: i) at room temperature, ii) at approx. 0 °C (use iced water), iii) at approx. 70 °C (use a hot water bath).



M1 Watch the German tutorial "Photolumineszenz". Assign the two luminescent phenomena from **E3** to the technical terms 'fluorescence' and 'phosphorescence' and draw energy level diagrams in explanation of them.

M2 In comparison with the emitted photons during fluorescence, the ones emitted during phosphorescence have undergone a bathochromic shift ('red shift'). Explain this observation by means of your findings in **M1**.

M3 Explain why a cold sample phosphoresces longer than a warm one.

M4 Interpret the function of the tartaric acid in **E3** by referring back to your observations.