Photochemistry and Photophysics Workshops

Fiona Dickinson

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Contents

Welcome

The notes have been prepared in a package called BookDown for RStudio so that the equations are accessible to screen readers. However, by providing the notes as a .html webpage I can also embed short videos to further describe some of the topics. Further you can download the questions (and later the answers, top left of the screen) in a format that suits you (either pdf or epub) to view offline, or change the way this document appears for ease of reading.

Workshops for Photochemistry & Photophysics

The course will use a question first approach and we will learn the material by answering the questions. The questions will be shared here in an accessible format, and this page will be updated weekly.

Version history

The initial commit of this book is dated 25th September 2020.

Chapter 1

Workshop Questions for Week 1

1.1 Short mathematical question - Beer Lambert law

- How far can monochromatic 489 nm light travel through a 0.100 M solution of fluorescein with an extinction coefficient at 489 nm of 92000 M^{-1} cm^{-1} before 90 % of it is absorbed? *(I will use MCQs and UniDoodle to ask this in class)*

1.2 Short conceptual question - molar extinction coefficient

- Modify the molecule in figure 1.1 to increase the molar extinction coefficient (do not worry about what may happen to wavelength).

(I will use UniDoodle's drawing feature to ask this in class)

1.3 Short conceptual question - intensity of colour

- What factors influence the 'intensity of colour' of the following solutions?

(This will be a discussion question - please feel free to raise a hand or write comments in the zoom chat)

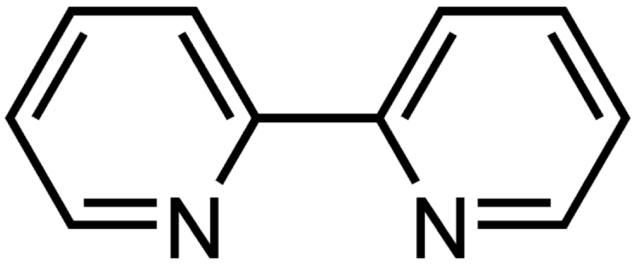

Figure 1.1: The structures of the organic dye methylene blue (left), potassium permanganate (centre) and copper hexa-aqua (right).

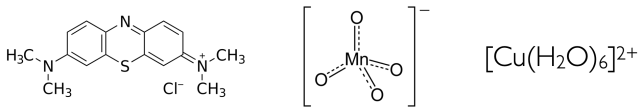

Figure 1.2: The structures of the organic dye methylene blue (left), potassium permanganate (centre) and copper hexa-aqua (right).

Figure 1.3: 1 mM solutions of the organic dye methylene blue (right), potassium permanganate (centre) and copper hexa-aqua (right).

1.4 Short conceptual question - line width

- Why are some spectra very broad (figure 1.4), whereas others have sharp peaks (figure 1.5)?

You will need to look at the x-scale to truley note the difference in the width of these emission spectra.

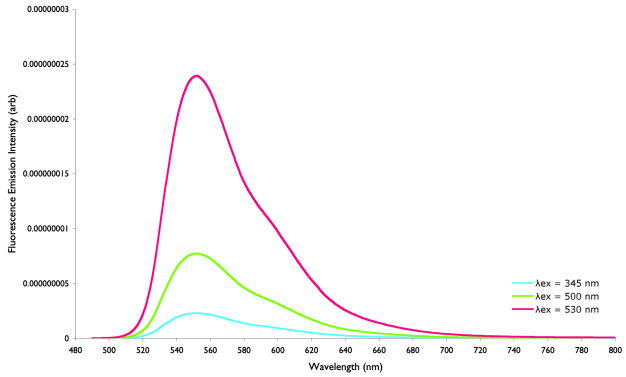

Figure 1.4: The emission spectrum of rhodamine 6G

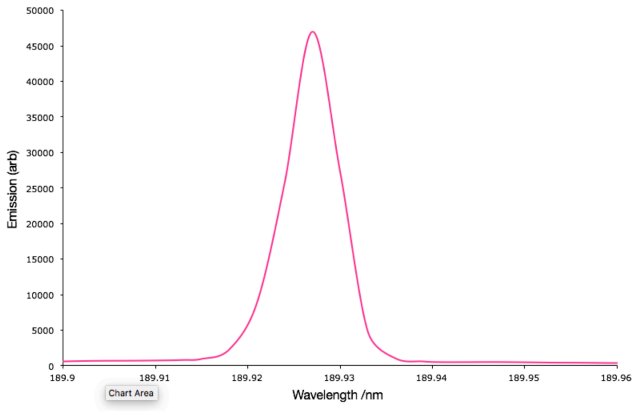

Figure 1.5: The emission spectrum of Sn(II)

(This will be a discussion question - please feel free to raise a hand or write comments in the zoom chat)

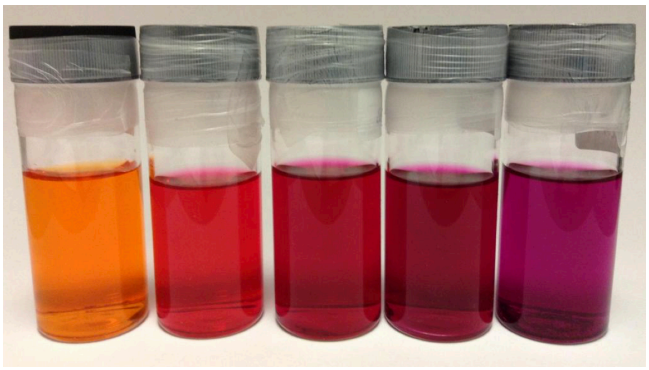

Figure 1.6: Ethidium bromide dissolved in from right; water(orange), methanol, ethanol, propanol and butanol(purple)

1.5 Short conceptual question - the effect of solvation on absorbance

- Why does the observed colour of ethidium bromide depend upon the solvent (figure 1.6))?

Think about the effect of solvation on the energy levels and why those energy levels matter! Remember that if light is transmitted through a solution that is the colour we observe...

(This will be a discussion question - please feel free to raise a hand or write comments in the zoom chat)

1.6 Extended question - Azobenzene

Azobenzene undergoes the following cis-trans isomerisation, the isomerisation occurs in the ps timescale.

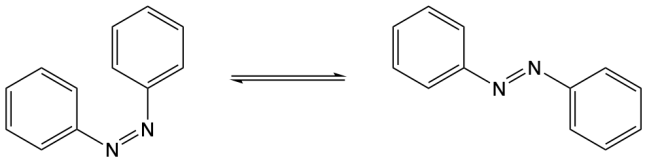

Figure 1.7: The cis-trans isomerisation of azobenzene

- Why would you expect the absorption spectrum of each isomer to be different?
- Suggest why the trans conformation is more stable than the cis isomer.

- Use the following data to predict the proportion of each isomer under 360 nm excitation. Table: The molar extinction coefficient of the two isomers of azobenzene.

	$_{360}$ / M^{-1} cm^{-1}	$_{460}$ / M^{-1} cm^{-1}
trans-azobenzene	22000	4500
cis-azobenzene	2100	5500

- Would there be more or less trans azobenzene at 460 nm? Justify your answer.
- It has been suggested the 360 nm absorption is an $S_0 \rightarrow S_2$ absorption, and the 460 nm band is an $S_0 \rightarrow S_1$ absorption. Suggest which energy levels are involved for each of the two transitions and compare it to stilbene which has a similar structure, but the cis and trans absorptions are 280 & 295 nm respectively.

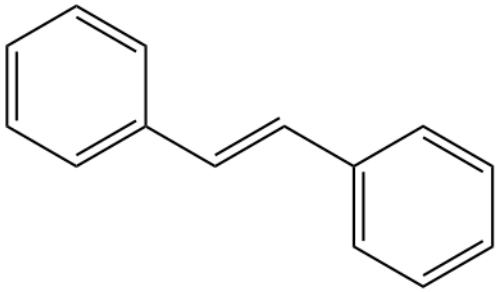

Figure 1.8: The structure of stilbene

(This will be a discussion question - please feel free to raise a hand or write comments in the zoom chat. I don't expect to finish this question but hope to get far enough through that a good attempt can be made at home after the LOIL)