

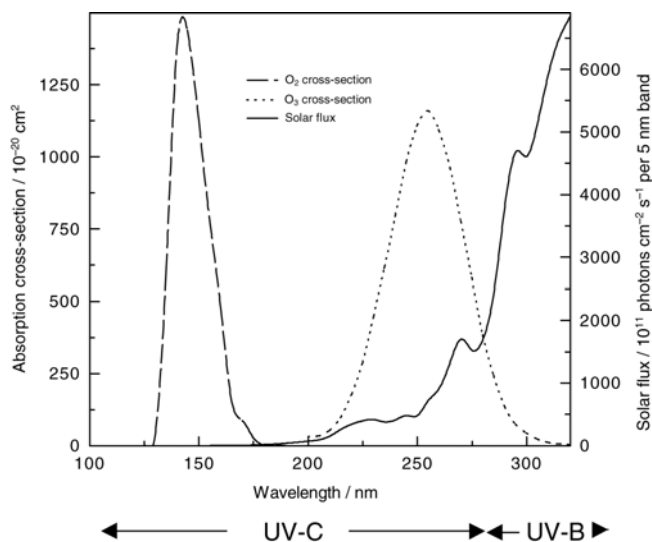
Example Questions involving Photochemistry

1. The energy gap between the triplet ground state and the excited singlet state for molecular oxygen is 90 kJ mol^{-1} . Calculate the wavelength of photons given off if an excited state singlet relaxes to the ground state with the emission of light. What region of the electromagnetic spectrum is this? Is the light emitted fluorescence or phosphorescence?

[Ans: $\lambda = 1330 \text{ nm}$; IR region; Phosphorescence]

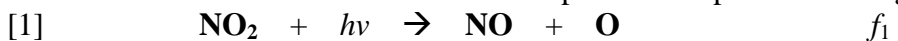
2. The bond dissociation energy of an **O=O** double bond is given in Appendix B3 (text) as 497 kJ mol^{-1} .

- Calculate the maximum wavelength of photons capable of this dissociation.
- Based on the information given in the figure below, (Fig 3.2; text), do you expect photodissociation to actually occur at this wavelength?



[Ans: $\lambda < 241 \text{ nm}$; No, O_2 does not absorb appreciably at $\lambda > 200 \text{ nm}$]

3. Consider the reactions below that correspond to the production of ground level ozone.

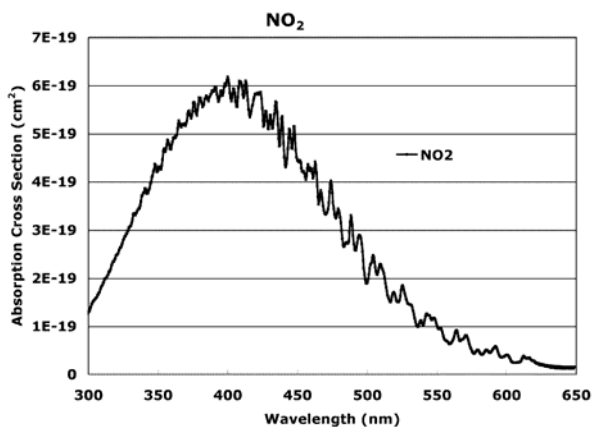


a) Using the values of ΔH_f° in Appendix B2 (text), calculate the maximum wavelength of light that is capable of photodissociating NO_2 .

b) Given the absorption spectrum of NO_2 (below), do you expect this reaction to occur in the troposphere?

c) What colour do you expect for NO_2 to appear?

d) Applying the *steady state approximation* to the $[\text{NO}]$, derive an expression for the steady state $[\text{O}_3]$.



[Ans: $\lambda < 391 \text{ nm}$; Yes, NO_2 has a strong absorption in the 300 – 500 nm and there plenty of UV-a photons in the troposphere to carry out this reaction; absorbs blue, \therefore appears orange-brown; $[\text{O}_3] = f_1[\text{NO}_2]/k_3[\text{NO}]$]