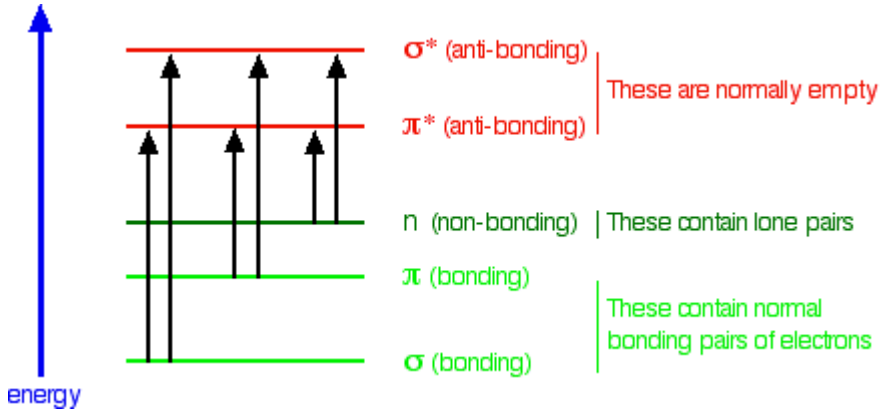
UV-VISIBLE SPECTROSCOPY – SPECTRA

1. When light passes through a compound some wavelengths are absorbed because their energy is used to promote an electron into a higher energy orbital. The diagram from the Chemguide page shows the electron jumps which are possible.



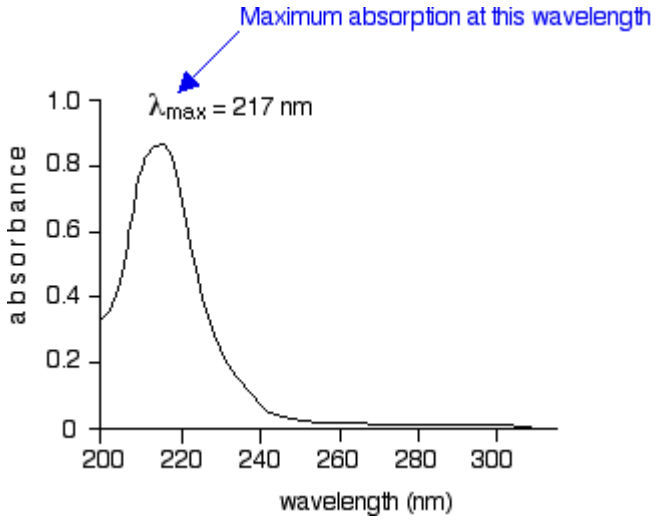
a) Which jump needs the highest energy?

b) Which jump absorbs light of the highest frequency? Explain your answer.

c) Which jump absorbs light of the highest wavelength? Explain your answer.

d) The three longest jumps aren't useful in UV-visible spectrometry. Explain why.

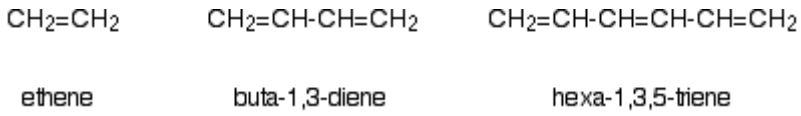
e) The spectrum for buta-1,3-diene, $CH_2=CH-CH=CH_2$, looks like this:



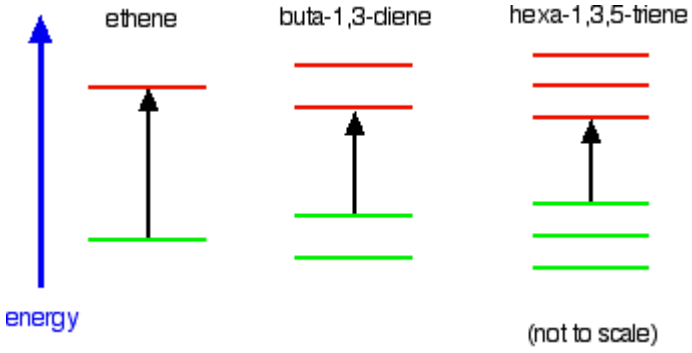
What sort of jump is responsible for the peak? Explain your answer.

f) Ethanal, CH_3CHO, produces two peaks involving jumps from the pi electrons in the C=O double bond and from a lone pair on the oxygen. The peaks are at 180 and 290 nm. Which jump produces which peak? Explain your answer by reference to the first diagram on this page.

2. The Chemguide page has these bits of information:



molecule	wavelength of maximum absorption (nm)
ethene	171
buta-1,3-diene	217
hexa-1,3,5-triene	258

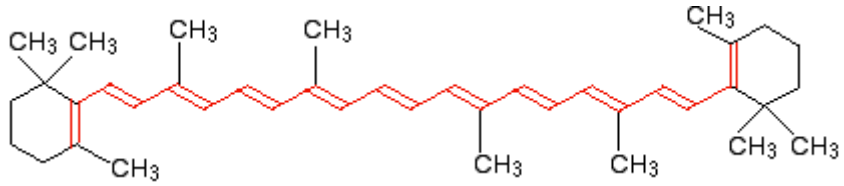


a) The green lines in the energy diagram represent pi bonding orbitals, and the red ones pi anti-bonding orbitals. Why are there more of each of these as you go from ethene to buta-1,3-diene to hexa-1,3,5-triene?

b) Explain the relationship between these diagrams and the figures in the table.

Questions continue . . .

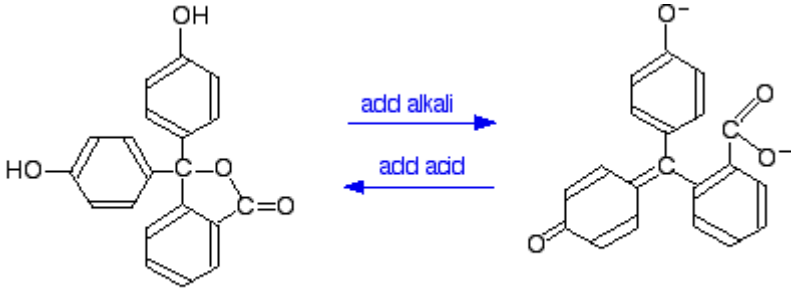
3. Beta-carotene has the following structure. The red parts are all conjugated double bonds.



Beta-carotene absorbs strongly throughout the UV, and has strong absorptions in the visible region between 400 and 500 nm, peaking at about 470 nm. Use this table to explain why beta-carotene is orange.

colour region	wavelength (nm)
violet	380 - 435
blue	435 - 500
cyan	500 - 520
green	520 - 565
yellow	565 - 590
orange	590 - 625
red	625 - 740

4. a) Phenolphthalein exists in two forms depending on the pH of the solution:



Redraw these structures showing the extent of the delocalisation in each one in red.

b) Use your diagrams to explain why adding the alkali shifts the colour from colourless to magenta.

c) Methyl orange exists in two forms, one yellow (with a maximum peak in its spectrum at about 440 nm) and the other red (with maximum peak at about 520 nm).

(i) Explain briefly why the two forms are the colours they are.

(ii) Which of these forms has the greater amount of delocalisation?