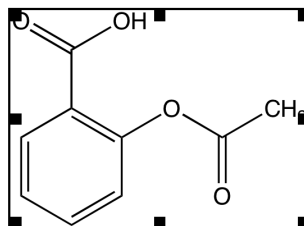


January 2009

(a) (i) Aspirin (acetylsalicylic acid), is a weak acid with the chemical structure shown below. Explain, with appropriate chemical structures, why pH-dependent spectral changes are observed in the UV-visible spectra of aqueous solutions of this drug.

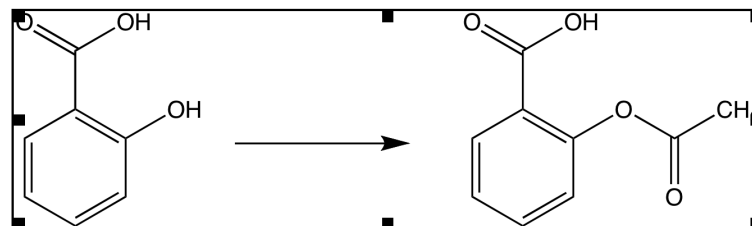


[15 marks]

(ii) Describe two methods which could be used in the UV-visible determination of aqueous solutions of acetylsalicylic acid which would overcome this problem.

[25 marks]

(b) Acetylsalicylic acid can be prepared from salicylic acid according to the reaction shown below. Explain the major differences you would expect to observe in the infrared spectra of salicylic acid and acetylsalicylic acid.

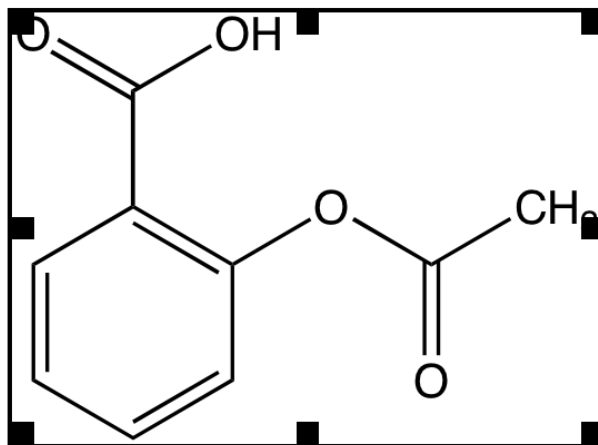


[20 marks]

(c) A pharmaceutical preparation contains two compounds, A and B, which absorb UV-visible radiation. The absorbance maxima and extinction coefficients at those maxima in ethanol are given below. A sample of the preparation is dissolved in ethanol and the resulting solution has absorbance values of 1.458 and 1.261 at 254 nm and 319 nm respectively using a cuvette of pathlength 1 cm. Deduce the concentrations of A and B in this solution, assuming A and B do not interact and obey the Beer-Lambert law.

	Compound A	Compound B
ϵ at 254nm / $\text{mol}^{-1}\text{dm}^3\text{cm}^{-1}$	8400	990

(a) (i) Aspirin (acetylsalicylic acid) , is a weak acid with the chemical structure shown below. Explain, with appropriate chemical structures, why pH-dependent spectral changes are observed in the UV-visible spectra of aqueous solutions of this drug.



[15 marks]

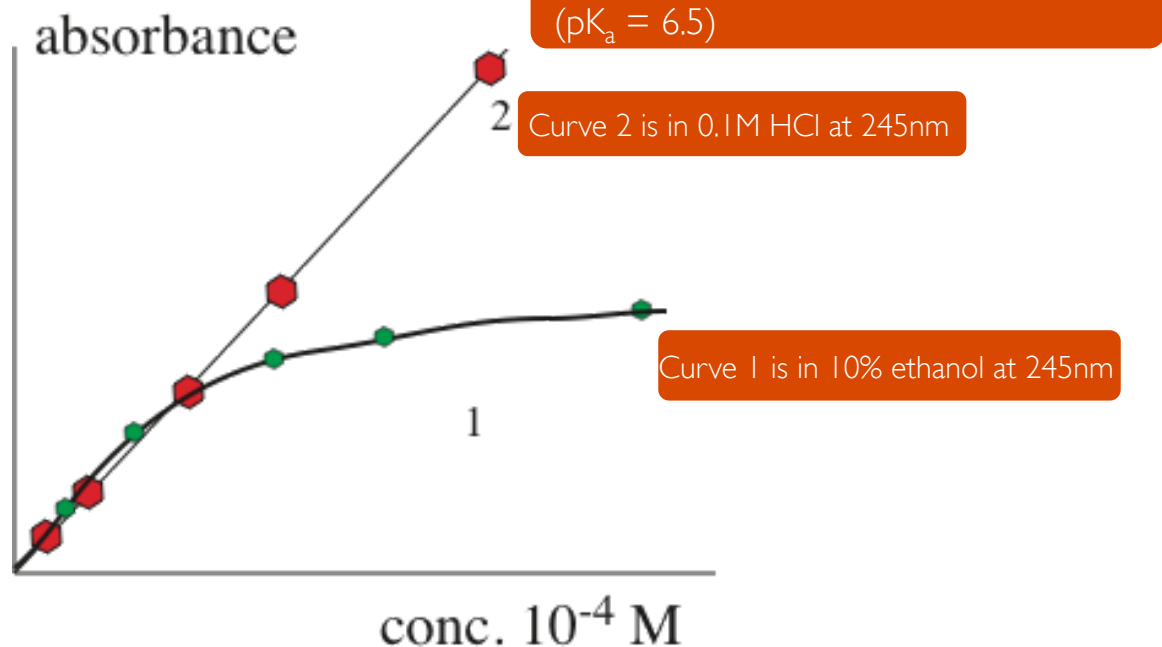
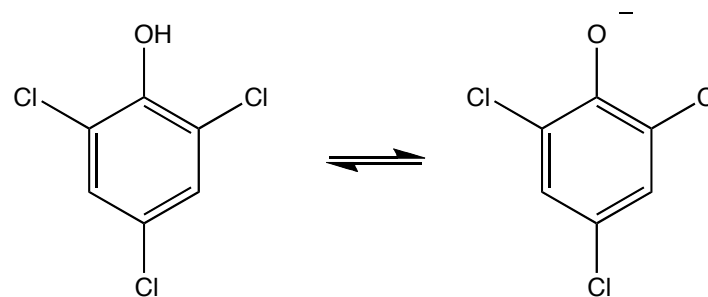
(ii) Describe two methods which could be used in the UV-visible determination of aqueous solutions of acetylsalicylic acid which would overcome this problem.

[25 marks]

Deviations from the Beer Lambert law

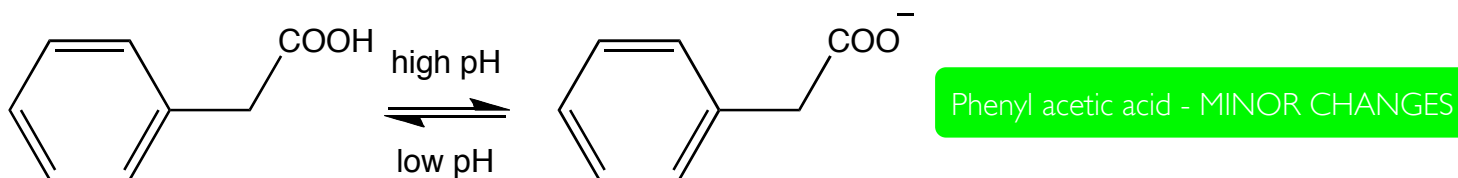
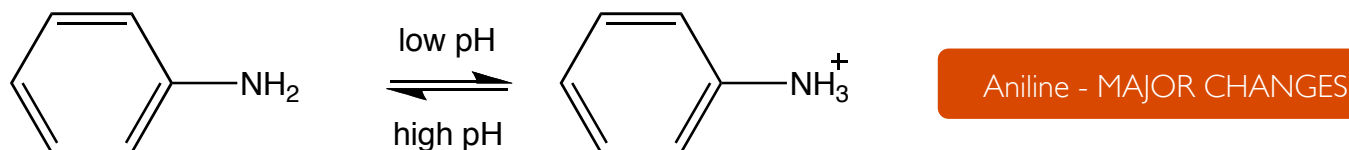
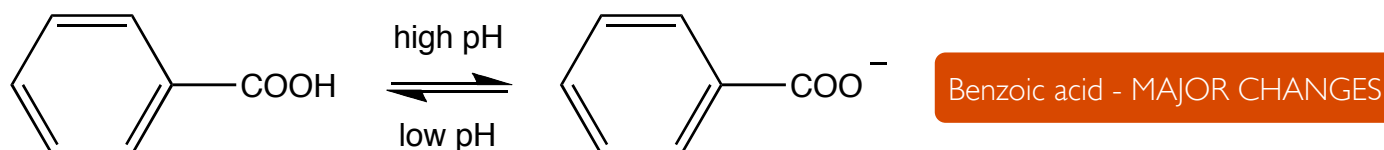
- Protonation/deprotonation can be suppressed by carrying out analysis in

- strongly acidic
- strongly basic
- buffered media



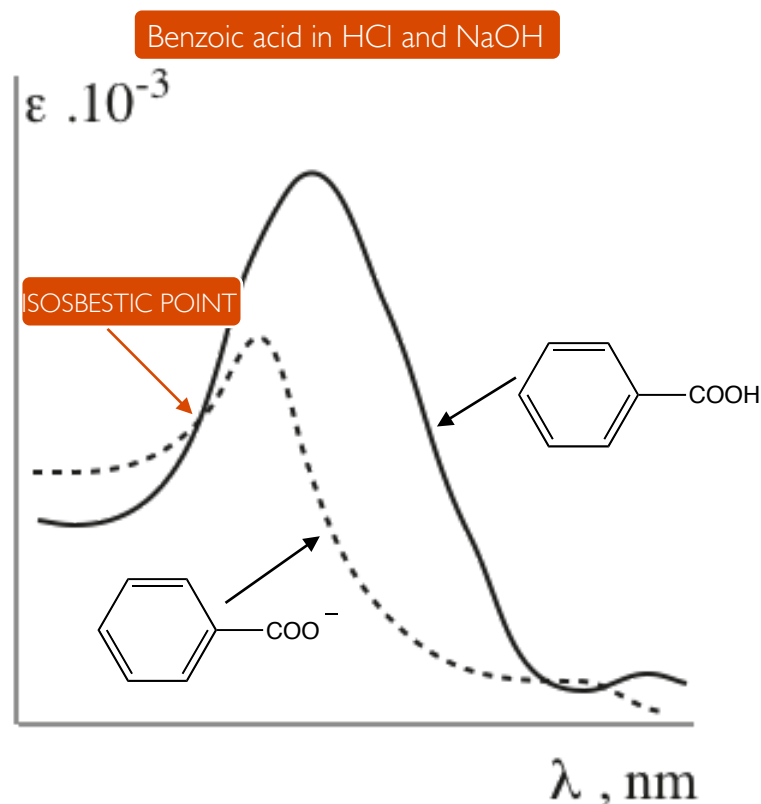
Effect of pH on spectra

- If a compound has an ionisable group which contributes n or π electrons to the chromophore (*i.e.* is an auxochrome), spectra of the two forms will be profoundly different
- The pH at which one form dominates over the other depends on the pK_a of the compound



Effect of pH on spectra

- If buffers and strongly acidic/alkaline media cannot be used, there is an alternative
- For spectra run at different pH values, there is a wavelength where the absorbances of both ionised and unionised forms is the same



- Absorbance at the **isosbestic point or wavelength** does not depend on pH of the solution
- Reliable measurements at this λ can be made without buffers or pH control
- As the isosbestic point is often not close to λ_{\max} , sensitivity may be lowered

(c) A pharmaceutical preparation contains two compounds, A and B, which absorb UV-visible radiation. The absorbance maxima and extinction coefficients at those maxima in ethanol are given below. A sample of the preparation is dissolved in ethanol and the resulting solution has absorbance values of 1.458 and 1.261 at 254 nm and 319 nm respectively using a cuvette of pathlength 1 cm. Deduce the concentrations of A and B in this solution, assuming A and B do not interact and obey the Beer-Lambert law.

	Compound A	Compound B
ϵ at 254nm / mol ⁻¹ dm ³ cm ⁻¹	8400	990
ϵ at 319nm / mol ⁻¹ dm ³ cm ⁻¹	140	6200

[40 marks]

Equations will be constructed using the assumption that the absorbances of the two components in the mixture are additive. Two equations should be given with concentrations of A and B as unknowns. They should be solved simultaneously to give concentration of A = $1.50 \times 10^{-4} \text{ mol dm}^{-3}$ and concentration of B = $2.00 \times 10^{-3} \text{ mol dm}^{-3}$.

A_{mix} (at λ) = Sum of contributing absorbances

A_{mix} (at λ) = Absorbance due to A + that due to B

A_{mix} (at λ) = $\epsilon_{A\lambda} \cdot c_A \cdot l$ (due to A) + $\epsilon_{B\lambda} \cdot c_B \cdot l$ due to B

$$1.458 = 8400 C_A + 990 C_B$$

$$1.261 = 140 C_A + 6200 C_B$$

Multiply the top equation by (6200/990)

$$9.131 = 52606 C_A + 6200 C_B$$

Subtract the 2nd equation from this

$$7.870 = 52466 C_A$$

$$C_A = 1.50 \times 10^{-4} \text{M}$$

Substituting this into either the 1st or 2nd equations gives

$$1.458 = (8400 \times 1.50 \times 10^{-4}) + 990 C_B$$

$$\text{So } 990 C_B = 1.458 - (8400 \times 1.50 \times 10^{-4})$$

$$C_B = 2.00 \times 10^{-4} \text{M}$$