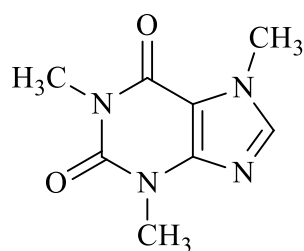


- Shown below is the structure of caffeine.



caffeine

Marks
5

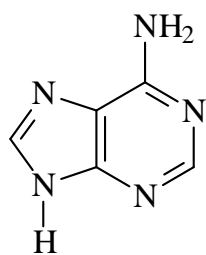
Draw the structure of a 10 π -electron aromatic resonance contributor to the structure of caffeine.

Only one of the nitrogen atoms in caffeine is basic. Indicate which of the nitrogen atoms is basic and explain why it is basic and why the others are not.

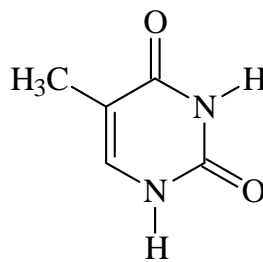
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Marks
4

- Adenine and thymine have the structures shown below.



adenine

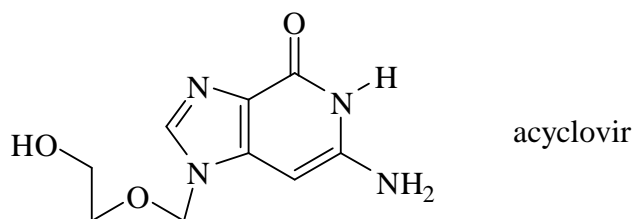


thymine

Draw a tautomer of the shown structure of adenine.

In DNA, adenine forms a “base pair” with thymine. Explain what is meant by “base pair” and indicate the point(s) of interaction between adenine and thymine.

- Acyclovir is an analogue of the nucleoside guanosine, and is used clinically as an antiviral agent.

Marks
4

Hydrolysis of acyclovir gives the nucleic base guanine, a diol and a carbonyl compound. Give the structures of guanine, a tautomer of guanine, and the diol and carbonyl compounds formed.

guanine	tautomer of guanine
the diol	the carbonyl compound

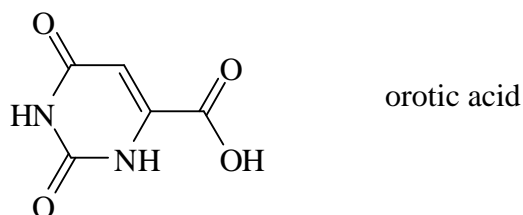
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4

- Lithium salts, especially lithium carbonate, are commonly used in the treatment of bipolar disorder. Write the net ionic equation for the reaction which occurs between lithium carbonate and hydrochloric acid in the stomach.

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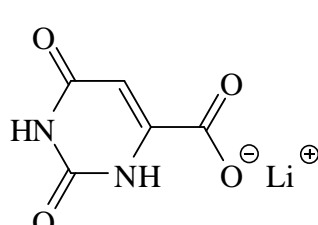
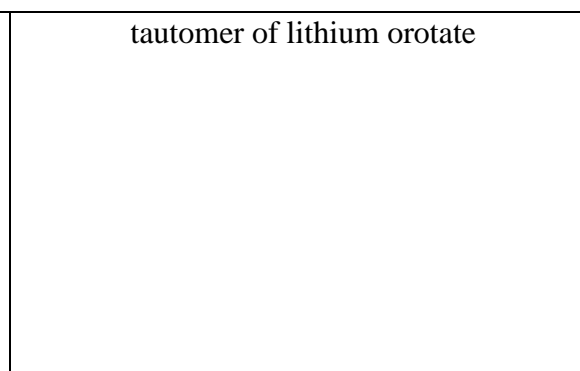
Lithium orotate (as a monohydrate salt, $\text{LiC}_5\text{H}_3\text{N}_2\text{O}_4 \cdot \text{H}_2\text{O}$) is a controversial alternative formulation sold in some health food stores. The orotate ion is the conjugate base of orotic acid, whose structure is shown below.



Like the carbonate, lithium orotate is taken orally. Using an equation, comment on any differences between the form in which lithium is bioavailable from these two lithium salts.

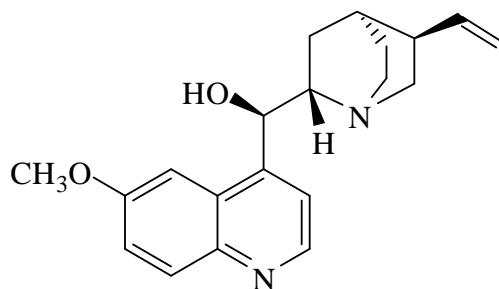
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Like three of the bases found in DNA and RNA, orotic acid is a derivative of pyrimidine. Also like those bases, orotic acid and its salts have tautomers. Draw the structural formula of a tautomer of lithium orotate.

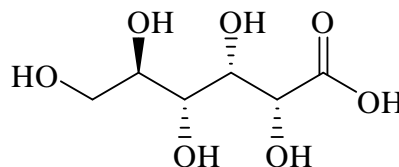
lithium orotate	tautomer of lithium orotate
	

Marks
4

- Quinine has long been used for the treatment of malaria. For an intramuscular injection, quinine is reacted with gluconic acid. Structures and molar masses for these substances are shown below.



quinine
molar mass $324.41 \text{ g mol}^{-1}$



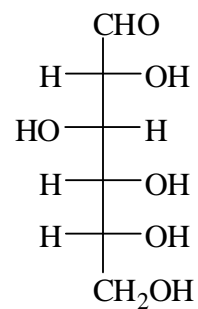
gluconic acid
molar mass $196.16 \text{ g mol}^{-1}$

Quinine and gluconic acid can undergo an acid-base reaction to form a salt, or a condensation reaction to form an ester. One molecule of each substance is required for the transformation, and a 160.0 mg dose of quinine gluconate is equivalent to a 100.0 mg dose of quinine. By determining the molar mass of the product formed, or otherwise, determine whether the product formed is an ester or a salt.

Suggest two reasons why it might be important to know whether quinine gluconate is a salt or an ester.

THIS QUESTION CONTINUES ON THE NEXT PAGE.

Gluconic acid is formed in biological systems by the oxidation of glucose, which can exist as both an open-chain form and as cyclic forms. The Fischer projection for the open-chain form of D-glucose is shown on the right. Illustrate the formation of the cyclic forms of glucose, and discuss whether gluconic acid can form similar cyclic forms.

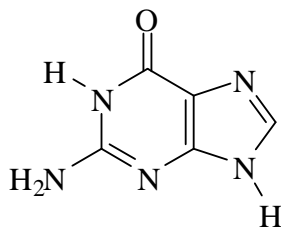


Marks
3

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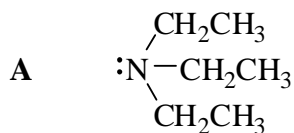
- The nucleic base guanine is drawn below as a keto tautomer. Draw two other tautomers of guanine.

Marks
2

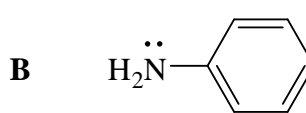


- The pK_b 's of two nitrogen-containing compounds are given below. Explain the difference in basicity of these two compounds.

3



$$pK_b = 2.99$$



$$pK_b = 9.37$$