• In a standard acid-base titration, 25.00 mL of 0.1043 M NaOH solution was found to react exactly with 28.45 mL of an HCl solution of unknown concentration. What is the pH of the unknown HCl solution at 25 °C?	**3**
pH =	

Marks 7

- Glycine, NH_2CH_2COOH, is the simplest of all naturally occurring amino acids. The pK_a of the acid group is 2.35 and the pK_a associated with the amino group is 9.78. Draw a structure that indicates the charges on the molecule at the physiological pH of 7.4.

Use your structure to illustrate the concept of resonance.

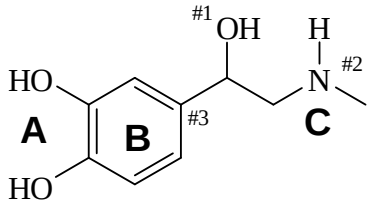
What are the hybridisation states and geometries of the two carbon atoms and the nitrogen atom in glycine?

Propionic acid, CH_3CH_2COOH, has a melting point of –20.7 °C while glycine has a melting point of 292 °C. Suggest a reason why these two molecules have such different melting points.

• Explain the terms '*weak*' and '*strong*' and the terms '*dilute*' and '*concentrated*' in the context of acids and bases.	**Marks 2**

Marks 4

- The molecular structure of adrenaline (epinephrine), a hormone involved in the "fight or flight" response, is shown below.



List the types of intermolecular interactions that each of the following sites on adrenaline would be involved in if dissolved in water.

A
B
C

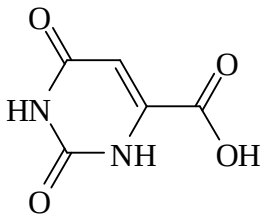
Pharmaceuticals with amine groups are frequently supplied as their "hydrochloride salts". Draw the structure that would result if adrenaline were reacted with one equivalent of HCl. What **additional** intermolecular forces would be present if this form of adrenaline were dissolved in water?

The pK_b of N-1 is 10.88 and the pK_b of N-2 is 5.98. Draw the structure of the predominant form of nicotine that exists in the human body at pH 7.4. **3**

Marks 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.

Lithium orotate (as a monohydrate salt, $LiC_5H_3N_2O_4 \cdot H_2O$) 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.



orotic acid

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.

Marks 5

- Glycine, NH_2CH_2COOH, the simplest of all naturally occurring amino acids, has a melting point of 292 °C. The pK_a of the acid group is 2.35 and the pK_a associated with the amino group is 9.78. Draw a structure that indicates the charges on the molecule at the physiological pH of 7.4.

Describe the hybridisation of the two carbon atoms and the nitrogen atom in glycine and the geometry of the atoms surrounding these three atoms.

Glycine has an unusually high melting point for a small molecule. Suggest a reason for this.

Marks 5

- Consider the following equation.

$$HBrO(aq) + NH_3(aq) \rightleftharpoons BrO^-(aq) + NH_4^+(aq)$$

Name all of the species in this equation.

HBrO	
BrO^-	
NH_3	
NH_4^+	

Complete the following table by giving the correct pK_a or pK_b value where it can be calculated. Mark with a cross (✕) those cells for which insufficient data have been given to calculate a value.

Species	HBrO	NH_3	BrO^-	NH_4^+
pK_a of acid	8.64			
pK_b of base		4.76		

Determine on which side (left or right hand side) the equilibrium for the reaction above will lie. Provide a brief rationale for your answer.