CHEM1102 Worksheet 8 – Answers to Critical Thinking Questions

The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Model 1: pH

1.

pH	0.50	1.50	2.50	3.50	4.50	5.50	5.75
$[H_3O^+(aq)]$	3.2×10^{-1}	3.2×10^{-2}	3.2×10^{-3}	3.2×10^{-4}	3.2×10^{-5}	3.2×10^{-6}	1.8×10^{-6}

2. The part of the pH value *before* the decimal point affects the exponent (i.e. the position of the decimal point).
3. The part of the pH value *after* the decimal point affects the coefficient (i.e. the numerical value).

Model 2: Strong and Weak Acids

1. The major species present are $H_3O^+(aq)$, $Cl^-(aq)$ and $H_2O(l)$. There is essentially no "HCl(aq)".
2. The major species present are $CH_3COOH(aq)$ and $H_2O(l)$. The percentage ionization is very small and there is *very* little $H_3O^+(aq)$, $CH_3COO^-(aq)$.
3. $CH_3COO^-(aq)$ is the *dominant* species only at high pH.
4. $CH_3COOH(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CH_3COO^-(aq)$ $\qquad K_a = \dfrac{[H_3O^+(aq)][CH_3COO^-(aq)]}{[CH_3COOH(aq)]}$
5. The *major* species present are $CH_3NH_2(aq)$ and $H_2O(l)$.
6. $CH_3NH_3^+(aq)$ is the *dominant* species only at low pH.
7. (a) Aspirin is absorbed in the stomach. In the intestine, it is deprotonated.
   (b) Amphetamine is absorbed in the intestine. In the stomach, it is protonated.

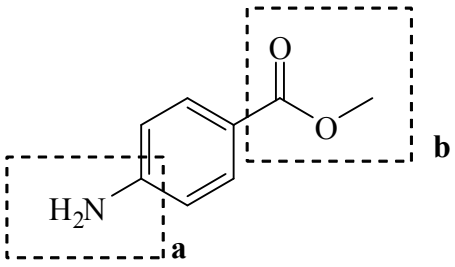
Model 3: Conjugate Pairs

1. (a) OH^- (b) H_3O^+
2. (a) CH_3COO^- (b) NH_3 (c) CH_3NH_2
3. (a) H_3S^+ (b) H_2S (c) HS^-

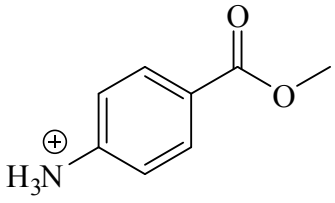
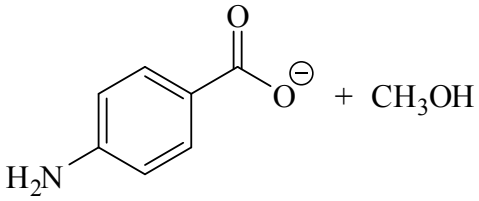
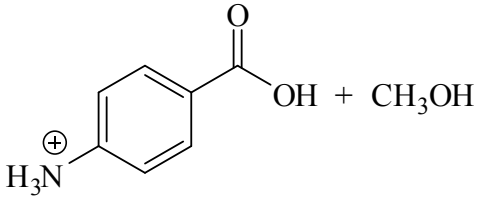
Marks
5

- The structure of methyl 4-aminobenzoate, (**E**), is given below.

(**E**)

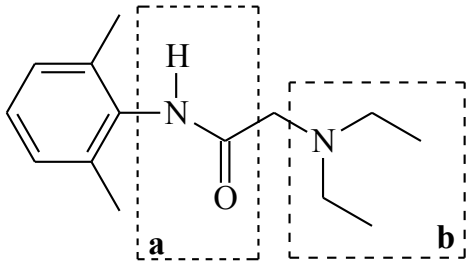


Give the structure(s) of all organic products formed when compound (**E**) is treated with the following reagents. If no reaction occurs, write "NO REACTION".

cold HCl (1 M)	**No hydrolysis of the ester under these conditions. The amine group will be protonated by the strong acid.** 
hot NaOH (4 M)	**Treatment with base will lead to hydrolysis of the ester. In the basic solution, the carboxylic acid will be deprotonated and the amine will not be protonated.** 
hot HCl (4 M)	**Hydrolysis of ester. In acidic conditions, the carboxylic acid will not be deprotonated and the amine group will be protonated.** 

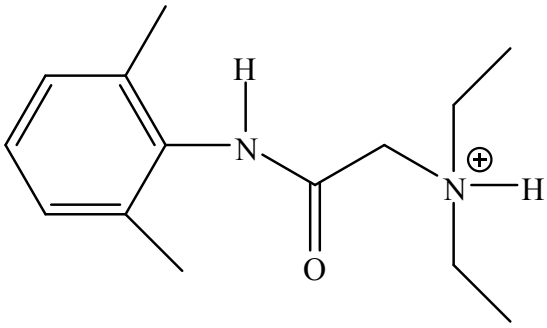
Marks 7

- The structure of lignocaine, a local anaesthetic, is given below.

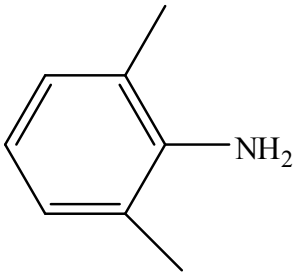


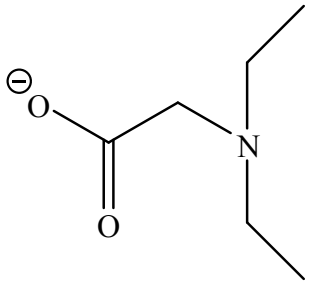
Give the structure(s) of all organic products formed when lignocaine is treated with the following reagents. If no reaction occurs, write "NO REACTION".

cold HCl (1 M)

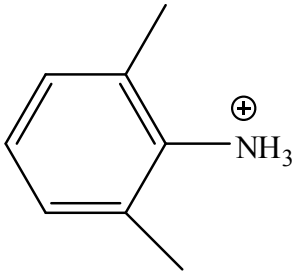


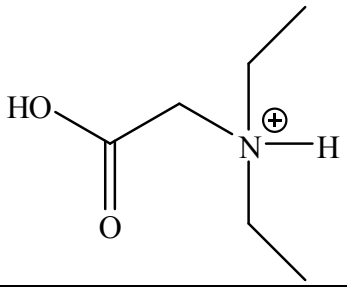
hot NaOH (4 M)





hot HCl (4 M)





- Often pH is used to characterise acidic solutions. Give a brief definition of pH.

Marks 5

pH is a measure of the $H^+(aq)$ ion concentration in a solution and is defined using the equation:

$$\mathbf{pH = -\log_{10}[H^+(aq)]}$$

Describe the difference between a strong acid and a weak acid.

A strong acid dissociates completely in water. For example:

$$\mathbf{HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)}$$

A weak acid dissociated only slightly in water. For example:

$$\mathbf{HF(aq) \rightleftharpoons H^+(aq) + F^-(aq)}$$

The pH of a solution of a strong acid depends on its concentration and a strong acid can give a high pH (corresponding to low $[H^+(aq)]$) if the acid is present in a low concentration.

In general, can pH be used to define the strength of an acid? Explain your answer.

No.

The pH of a solution of a strong acid depends on its concentration. Thus, the pH of a 0.1 M solution of HCl is 1.0 and the pH of a solution of 10^{-6} M HCl is 6.0.

A low pH can arise from a solution of a strong acid or a more concentrated solution of a weak acid.

A high pH can arise from a weak solution of a strong acid or from a stronger solution of a weak acid.