Worksheet 7.4

# Acid equilibria – an extension

**NAME:** **CLASS:**

## INTRODUCTION

The questions in this worksheet include calculations for equilibria involving strong and weak acids and bases. Calculations involving acidity constants, pH and percentage ionisation are included. These concepts are an extension of those presented in the Level 3 Course content.

| No. | Question | Answer |
|---|---|---|
| **1** | **a** Determine the pH of the following acid solutions at 25°C:<br>**i** $[H_3O^+] = 1.0$ mol $L^{-1}$<br>**ii** $[HCl] = 9.05 \times 10^{-8}$ mol $L^{-1}$<br>**b** Determine the pH of the following alkaline solutions 25°C:<br>**i** $[OH^-] = 0.0700$ mol $L^{-1}$<br>**ii** $[NaOH] = 4.00 \times 10^{-12}$ mol $L^{-1}$<br>**iii** $[Ba(OH)_2] = 0.00620$ mol $L^{-1}$<br>**c** Determine the $[H_3O^+]$ for the following solutions 25°C, given that:<br>**i** pH = 1.07<br>**ii** pH = 14.7 | |
| **2** | 250.0 mL of water is added to 45.0 mL of 3.55 mol $L^{-1}$ nitric acid. Determine the pH of the resulting solution. | |

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| No. | Question | Answer |
|---|---|---|
| **3** | 9.35 g of solid NaOH is carefully dissolved in 400 mL of water. Calculate the pH of the resultant solution. | |
| **4** | Silver hydroxide is only sparingly soluble in water. The stability constant for silver hydroxide, $K_{st}(AgOH)$, is $2.0 \times 10^{-8}$. The stability constant is derived from the equation: $Ag^+(aq) + OH^-(aq) \rightleftharpoons AgOH(s)$ where $K_{st}(AgOH) = [Ag^+][OH^-]$ Calculate the pH of a saturated solution of silver hydroxide. | |
| **5** | Write acid ionisation expressions for each of the following monoprotic acids:<br>**a** Hydroxybenzene, $C_6H_5OH$<br>**b** Azoic acid, $HN_3$<br>**c** Hydrogen phosphate ion, $HPO_3^{2-}$ | |

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| No. | Question | Answer |
|---|---|---|
| **6** | Oxalic acid ($C_2H_2O_4$) is a diprotic acid.<br>**a** Write expressions for the first and second acidity constants, $K_{a1}$ and $K_{a2}$, for oxalic acid.<br>**b** Which has the larger value, $K_{a1}$ or $K_{a2}$? | |
| **7** | Calculate the pH of a 0.882 mol $L^{-1}$ solution of the monoprotic arsenious acid, given that the equation for its hydrolysis is:<br>$H_3AsO_3(aq) + H_2O(l) \rightleftharpoons H_2AsO_3^-(aq) + H_3O^+(aq)$<br>$K_a = 5.13 \times 10^{-10}$ | |
| **8** | Calculate the acidity constant of propanoic acid, given that a 0.184 mol $L^{-1}$ solution has a pH of 2.80. The equation for its hydrolysis is:<br>$CH_3CH_2COOH(aq) + H_2O(l) \rightleftharpoons CH_3CH_2COO^-(aq) + H_3O^+(aq)$ | |
| **9** | A 0.350 mol $L^{-1}$ solution of hypobromous acid ionises to the extent of 0.00828%. Determine both the pH and the pKa of this acid, given the equation for its hydrolysis is:<br>$HOBr(aq) + H_2O(l) \rightleftharpoons OBr^-(aq) + H_3O^+(aq)$ | |

| No. | Question | Answer |
|---|---|---|
| **10** | $H_2O_2$ is a weak acid, ionising according to the equation:<br>$H_2O_2$ (l) + $H_2O$(l)<br>$\rightleftharpoons HO_2^-$(aq) + $H_3O^+$(aq)<br>The ionisation constant, $K_a$, for this reaction is $2.27 \times 10^{-12}$.<br>**a** Write an expression for $K_a$ for $H_2O_2$.<br>**b** A 0.44 mol $L^{-1}$ solution of hydrogen peroxide has a pH of 6.0. Determine the percentage ionisation of the acid. | |