

IB HL ACIDS TEST

1. In which of the following is the species in bold acting as a Brønsted-Lowry base?
- A. $\text{NH}_3(\text{aq}) + \text{CH}_3\text{COOH}(\text{aq}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{CH}_3\text{COO}^-(\text{aq})$
 B. **$\text{CH}_3\text{NH}_2(\text{aq})$** + $\text{HCl}(\text{aq}) \rightleftharpoons \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{Cl}^-(\text{aq})$
 C. **$\text{HCO}_3^-(\text{aq})$** + $\text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{CO}_3^{2-}(\text{aq}) + \text{H}_3\text{O}^+(\text{aq})$
 D. $\text{SO}_4^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{HSO}_4^-(\text{aq}) + \text{OH}^-(\text{aq})$
2. A $0.100 \text{ mol dm}^{-3}$ solution of a weak acid, **HA**, has pH of 5.0. What is the $[\text{OH}^-]$ of this solution in mol dm^{-3} at 25°C ?
- A. 9.0 B. 1.0×10^{-3} C. 1.0×10^{-9} D. 1.0×10^{-5}
3. Which of the following is a correct word equation for the formation of sodium sulfate?
- A. sodium hydroxide + sulfuric acid \rightarrow sodium sulfate + hydrogen
 B. sodium carbonate + hydrogen sulfide \rightarrow sodium sulfate + carbon dioxide + water
 C. sodium hydrogencarbonate + sulfuric acid \rightarrow sodium sulfate + carbon dioxide + water
 D. potassium sulfate + sodium hydroxide \rightarrow sodium sulfate + water
4. The pH of pure water at its boiling point is 6.14. From this it can be deduced that
- A. water is acidic at its boiling point
 B. the value of pK_w for water at its boiling point is 12.28
 C. water dissociates more at 25°C than at 100°C
 D. At its boiling point pOH of water is 7.86
5. Which of the following is **not** amphiprotic?
- A. HCO_3^- B. NO_3^- C. H_2O D. H_2PO_4^-
6. Which solution(s) has/have a pH greater than 7?
- I $\text{NH}_4\text{NO}_3(\text{aq})$ II $\text{FeCl}_3(\text{aq})$ III $\text{Na}_2\text{CO}_3(\text{aq})$ IV $\text{NaCl}(\text{aq})$
- A. IV only B. III only C. I and II only D. I only
7. The pH value of a $1.00 \times 10^{-3} \text{ mol dm}^{-3}$ solution of sodium hydroxide is
- A 3 B 8 C 11 D 14
8. HA, HB, HC and HD are weak acids. HA has $K_a=2.0 \times 10^{-5}$, HB has $\text{p}K_a=5.0$, HC has $K_a=3.0 \times 10^{-3}$ and HD has $\text{p}K_a=6.0$. When the acids are arranged in order of increasing strength (weakest first) the order is
- A HD, HB, HC, HA B HC, HB, HD, HA
 C HD, HB, HA, HC D HC, HA, HB, HD
9. The pH values for some solutions are show in the table:
- | Solution | pH |
|----------|-----|
| Q | 2.3 |
| X | 4.3 |
| Y | 8.3 |
| Z | 8.6 |
- Which of the following statements is correct?
- A the $[\text{H}^+(\text{aq})]$ in solution Z is twice the $[\text{H}^+(\text{aq})]$ in solution X
 B the $[\text{H}^+(\text{aq})]$ in solution X is 100 times the $[\text{H}^+(\text{aq})]$ in solution Q
 C the $[\text{H}^+(\text{aq})]$ in solution Q is 10^6 times the $[\text{H}^+(\text{aq})]$ in solution Y
 D the $[\text{H}^+(\text{aq})]$ in solution X is 40 times the $[\text{H}^+(\text{aq})]$ in solution Y

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10. When the following aqueous solutions are arranged in order of **increasing** electrical conductivity (lowest first), what is the correct order?

- I 0.10 mol dm⁻³ Ba(OH)₂
- II 0.10 mol dm⁻³ NH₃
- III 0.10 mol dm⁻³ NaOH

- A I, II, III B III, II, I C I, III, II D II, III, I

11. HOBr(aq), is a weak acid with pK_a=8.70

(a) Derive an equation for the dissociation of HOBr in aqueous solution [1]

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(b) Determine the pH of a 0.0400 mol dm⁻³ solution of HOBr(aq). State any assumption you have made in your calculation. [4]

(c) (i) State the pK_b value for OBr⁻ at 25°C..... [1]

(ii) Determine the pH of a 0.0200 mol dm⁻³ solution of NaOBr(aq) [4]

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- (d) $0.0400 \text{ mol dm}^{-3}$ NaOH(aq) is gradually added to 25.00 cm^3 of $0.0400 \text{ mol dm}^{-3}$ HOBr(aq). After each addition the pH was measured.
- (i) Sketch a titration curve showing the variation in pH for addition of up to 50.00 cm^3 of NaOH(aq). Mark on your sketch, the initial pH, the pH at the equivalence point and the approximate pH after the addition of 50.00 cm^3 of NaOH(aq). [4]

- (ii) Deduce the pH of the solution formed when 12.50 cm^3 of NaOH(aq) had been added to 25.00 cm^3 of HOBr(aq). [1]

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- (e) This titration can also be followed by using an acid-base indicator. Explain, using an equation how an acid base indicator works. [3]

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- (e) A buffer solution can be formed when NaOH(aq) is added to HOBr(aq).

- (i) Explain what is meant by the term *buffer solution*. [1]

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- (ii) Explain why adding 25.00 cm^3 of $0.100 \text{ mol dm}^{-3}$ NaOH(aq) to 40.00 cm^3 of $0.0500 \text{ mol dm}^{-3}$ HOBr(aq) will **not** produce a buffer solution. [3]

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12. One of the gases responsible for acid deposition is NO_2 .

(a) Write an equation for the reaction of NO_2 with water. [1]

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(b) One of the acids in acid deposition is HNO_2 . This dissociates to form the nitrate(III) ion, NO_2^- . Draw a Lewis structure for NO_2^- . [1]

(c) Explain whether NO_2^- can act as a Lewis acid or a Lewis base. [2]

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