

Acid/Base test

Name _____

All working out must be shown on the paper.

- 1) What is the pH of a solution, at 25 °C, with $[H_3O^+] = 0.0252 \text{ M}$,
 $pH = -\log_{10}[H_3O^+] = -\log_{10}0.0252 = 1.6$
- 2) What is the pH of a solution, at 25 °C, with $[OH^-] = 0.001 \text{ M}$
 $[OH^-][H_3O^+] = 10^{-14}$
 Find the $[H_3O^+] \Rightarrow [H_3O^+] = 10^{-14} / 0.001 = 10^{-14} / 10^{-3} = 10^{-11}$
 Now find the pH
 $pH = -\log_{10}[H_3O^+] = -\log_{10}10^{-11} = 11$
- 3) In a 0.1 M H_2CO_3 solution the dominant species is
 Carbonic acid (H_2CO_3) is a weak acid. Therefore will have minimal ionisation. The ionisation reaction given below will hardly proceed to the right.
 $H_2CO_3(aq) + H_2O(l) \Rightarrow H_3O^+(aq) + HCO_3^-(aq)$
 As for option (c) the ratio of H_3O^+ to CO_3^{2-} is 1 to 2 according to the equation below.
 $H_2CO_3(aq) + 2H_2O(l) \Rightarrow 2H_3O^+(aq) + CO_3^{2-}(aq)$
- 4) A 6.0 M H_2SO_4 solution can be described as a ;
 Sulfuric acid is a strong acid. Concentrations of around 6 M are relatively concentrated.
- 5) In a 0.1M HCl solution what is the dominant species?
 HCl is a strong acid and will ionise fully in solution according to the equation below.
 $HCl(aq) + H_2O(l) \Rightarrow H_3O^+(aq) + Cl^-(aq)$
 Very little HCl will remain unreacted and so the dominant species present is H_3O^+ .
 Option (d) is not right. Since HCl is producing H_3O^+ $[H_3O^+] > [OH^-]$
- 6) A 30.0 mL solution, at 25 °C, has a pH of 8.5. Which comment is true?
 A pH of 8.5 can be directly translated to a $[H_3O^+] = 10^{-8.5}$
 Since at 25 °C the following expression is valid $[OH^-][H_3O^+] = 10^{-14}$ it follows that the $[OH^-]$ is given by the expression below
 $[OH^-] = 10^{-14} / 10^{-8.5} = 10^{-5.5}$
- 7) A 40.0 mL solution, at 25 °C, of a 0.001M HCl has 60 mL of distilled water added to it. Which of the options below best describes the change in pH?
 A 0.001M HCl solution has a $[H_3O^+]$ of 0.001 or 10^{-3} , hence a pH of 3.
 To work out the final pH of the diluted solution we need the concentration of H_3O^+ via the expression $C_1V_1 = C_2V_2$ where
 $C_1 = 0.001$
 $V_1 = 0.04L$
 $V_2 = 0.10L$
 $C_2 = ?$
 $C_2 = (0.001 \times 0.04) / 0.1 = 0.0004 = 10^{-3.4}$ so the pH of the final solution is 3.4.
 Option A is correct.
- 8) Which of the following are conjugate acid/base pair?

Conjugate acid / base pairs differ by ONE hydrogen. Option a) is the only conjugate pair.

- 9) What is the pH of a 30.0 mL sample of an unknown weak monoprotic acid with a concentration of 0.02 M.

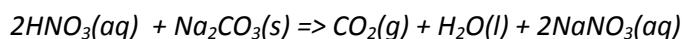
From the information given, it is impossible to calculate the pH of a weak acid as we do not know how much of the acid has ionised and therefore the concentration of H_3O^+ produced.

- 10) Which statement is true?

- a) H_2CO_3 is not amphiprotic, it will act only as an acid.
- b) SO_4^{2-} is not amphoteric as it will act only as a base.
- c) HSO_4^- does not act as a diprotic acid as it has only one proton to give..
- d) H_2O is amphoteric it can act as both an acid and a base according to the equation below
 $\text{H}_2\text{O}(\text{l}) + \text{H}_2\text{O}(\text{l}) \Rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq})$

- 1) Nitric acid (HNO_3) solution is added to sodium carbonate powder (Na_2CO_3) at 25°C .

a) Write the overall balanced equation for the reaction. Give states.



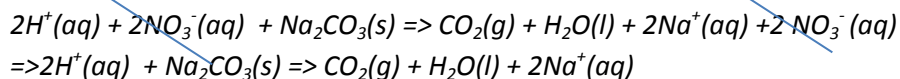
1 mark for balanced equation

1 mark for states

1 mark for products and formulae.

3 marks

b) Write the ionic equation for the above reaction.

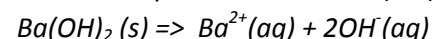


1 mark for a balanced equation

1 mark for removing the spectator ions

2 marks

- 2) What is the pH of a 0.005 M $\text{Ba}(\text{OH})_2$ at 25°C



0.005 M $\text{Ba}(\text{OH})_2$ solution will have an OH^- concentration of 0.01M.

Using the expression below calculate the $[\text{H}_3\text{O}^+]$

$$[\text{OH}^-][\text{H}_3\text{O}^+] = 10^{-14}$$

$$\Rightarrow [\text{H}_3\text{O}^+] = 10^{-14} / 10^{-2} = 10^{-12}$$

$$\Rightarrow \text{pH} = -\log_{10}[\text{H}_3\text{O}^+] = 12$$

1 mark for calculating $[\text{OH}^-]$

1 marks for calculating pH

2 marks

- 3) 3.65 grams of HCl is added to 200 mL of distilled water.

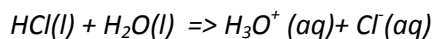
Atomic mass of Cl = 35.5, H = 1.0

- a) What is the pH of the resulting solution?

$$n_{\text{HCl}} = 3.65/36.5 = 0.1 \text{ mol}$$

$$C_{\text{HCl}} = n/V = 0.1/0.2 = 0.5 \text{ M}$$

Since HCl is a strong acid it will completely ionise according to the equation below.



$$\text{Hence } [\text{H}_3\text{O}^+] = 0.5 = 10^{-0.3}$$

$$\text{pH} = 0.3$$

1 mark for calculating concentration of [HCl]

1 mark for calculating pH

2 marks

- b) Calculate the [OH⁻] in the solution.

$$[\text{H}_3\text{O}^+] = 10^{-\text{pH}} = 10^{-0.3}$$

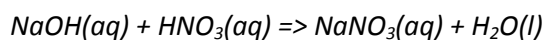
$$\Rightarrow [\text{OH}^-][\text{H}_3\text{O}^+] = 10^{-14}$$

$$\Rightarrow [\text{OH}^-] = 10^{-14}/10^{-0.3} = 10^{-13.7} \text{ M}$$

1 marks

- 4) 30.0 mL of a 0.01M NaOH is mixed with 70.0 mL of a 0.005M HNO₃.

- a) Write a balanced equation for the overall reaction.



1 mark for correct products and formulae

1 mark for balanced and states

2 marks

- b) Which reactant is in excess?

$$\text{Mol of HNO}_3 = C \times V = 0.01 \times 0.03 = 0.0003$$

$$\text{Mol of NaOH} = C \times V = 0.005 \times 0.07 = 0.00035$$

1 mark

- c) What amount in mol of the excess reactant remains?

According to the equation above the reactants react in a ratio 1:1.

HNO₃ is in excess by 0.0005 mol.

2 marks

- d) Calculate the pH of the resulting solution

$$\text{pH} = -\log_{10}[\text{H}_3\text{O}^+] = -\log_{10} 0.0005 = 3.3$$