Acid/Base test

Name _____

All working out must be shown on the paper.

1) What is the pH of a solution, at 25 ^{o}C, with $[H_3O^+] = 0.0252$ M,
   $pH = -\log_{10}[H_3O^+] = -\log_{10}0.0252 = 1.6$
2) What is the pH of a solution, at 25 ^{o}C, with $[OH^-] = 0.001$ M
   $[OH^-][H_3O^+] = 10^{-14}$
   Find the $[H_3O^+]$ => $[H_3O^+] = 10^{-14} / 0.001 = 10^{-14} / 10^{-3} = 10^{-11}$
   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 acc4roding 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 ^{o}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 ^{o}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 ^{o}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
   $C_1 = 0.001$
   $V_1 = 0.04$L
   $V_2 = 0.10$L
   $C_2 = ?$
   $C_2 = (0.001 \times 0.04) / 0.1 = 0.0004 = 10^{-3.4}$ 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
   $H_2O(l) + H_2O(l) \Rightarrow H_3O^+(aq) + OH^-(aq)$

1) Nitric acid (HNO_3)solution is added to sodium carbonate powder(Na_2CO_3) at 25 ^oC.
   a) Write the overall balanced equation for the reaction. Give states.
   $2HNO_3(aq) + Na_2CO_3(s) \Rightarrow CO_2(g) + H_2O(l) + 2NaNO_3(aq)$
   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.
   $2H^+(aq) + 2NO_3^-(aq) + Na_2CO_3(s) \Rightarrow CO_2(g) + H_2O(l) + 2Na^+(aq) + 2NO_3^-(aq)$
   $\Rightarrow 2H^+(aq) + Na_2CO_3(s) \Rightarrow CO_2(g) + H_2O(l) + 2Na^+(aq)$
   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 $Ba(OH)_2$ at. 25 ^oC
   $Ba(OH)_2(s) \Rightarrow Ba^{2+}(aq) + 2OH^-(aq)$
   0.005 M $Ba(OH)_2$ solution will have an OH^- concentration of 0.01M.
   Using the expression below calculate the $[H_3O^+]$
   $[OH^-][H_3O^+] = 10^{-14}$
   ⇨ $[H_3O^+] = 10^{-14}/10^{-2} = 10^{-12}$
   ⇨ $pH = -\log_{10}[H_3O^+] = 12$
   1 mark for calculating $[OH^-]$
   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_{HCl} = 3.65/36.5 = 0.1 mol
C_{HCl} = n/V = 0.1/0.2 = 0.5M
Since HCl is a strong acid it will completely ionise according to the equation below.
$HCl(l) + H_2O(l) \Rightarrow H_3O^+(aq) + Cl^-(aq)$
Hence $[H_3O^+] = 0.5 = 10^{-0.3}$
pH = 0.3
1 mark for calculating concentration of [HCl]
1 mark for calculating pH

2 marks

b) Calculate the $[OH^-]$ in the solution.
$[H_3O^+] = 10^{-pH} = 10^{-0.3}$
$\Rightarrow [OH^-][H_3O^+] = 10^{-14}$
$\Rightarrow [OH^-] = 10^{-14}/10^{-0.3} = 10^{-13.7} M$

1 marks

4) 30.0 mL of a 0.01M NaOH is mixed with 70.0 mL of a 0.005M HNO_3.
a) Write a balanced equation for the overall reaction.
$NaOH(aq) + HNO_3(aq) \Rightarrow NaNO_3(aq) + H_2O(l)$
1 mark for correct products and formulae
1 mark for balanced and states

2 marks

b) Which reactant is in excess?
Mol of HNO_3 = C X V = 0.01 X 0.03 = 0.0003
Mol of HaOH = C X V =0.005 X 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.
HNO_3 is in excess by 0.0005 mol.

2 marks

d) Calculate the pH of the resulting solution
$pH = -\log_{10}[H_3O^+] = -\log_{10} 0.0005 = 3.3$