ANSWERS

# Applecross Senior High School

## Year 12 ATAR Chemistry

## Acids and Bases Test

**Name:** _____

| | Possible Marks | Marks Scored | |
|---|---|---|---|
| **Part 1** | **10** | | **%** |
| **Part 2** | **25** | | **%** |
| **Part 3** | **15** | | **%** |
| **Total** | **50** | | **%** |

## Part 1: Multiple Choice Questions [10 marks]

1. In the following reaction

$NH_{3(aq)} + H_2O_{(l)} \leftrightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$

The substances acting as an acid are:

a) $NH_{3(aq)}$ and $H_2O_{(l)}$
b) $NH_{3(aq)}$ and $OH^-{}_{(aq)}$
c) $H_2O_{(l)}$ and $NH_4^+{}_{(aq)}$
d) $H_2O_{(l)}$ and $OH^-{}_{(aq)}$

2. In the reaction below:

$HSO_4^-{}_{(aq)} + H_2O_{(l)} \leftrightarrow H_3O^+{}_{(aq)} + SO_4^{2-}{}_{(aq)}$

The conjugate base is:

a) $HSO_4^-{}_{(aq)}$
b) $H_2O_{(l)}$
c) $H_3O^+{}_{(aq)}$
d) $SO_4^{2-}{}_{(aq)}$

3. Which one of the following compounds, if dissolved in water, would form a solution with a pH less than 7?
   a) $NH_4NO_3$
   b) $CaCl_2$
   c) NaCl
   d) $NaCH_3COO$

4. Which of the following species would not give a visible reaction with dilute hydrochloric acid?
   a) Solid zinc hydroxide
   b) Solid calcium carbonate
   c) A solution of $Pb(NO_3)_2$
   d) A solution of KOH

5. In a titration involving a strong acid and a weak base, which of the indicators listed below would **best** indicate the equivalence point?
   a) Methyl orange
   b) Litmus
   c) Phenolphthalein
   d) Alizarin yellow

6. Which of the following species is both a strong electrolyte and weak acid?

   a) $Na_2CO_3$
   b) $NH_4NO_3$
   c) $CH_3COOH$
   d) $NH_4OH$

7. Consider the ethanoic acid / ethanoate buffering system shown below.

$$CH_3COOH\ (aq) + H_2O\ (l) \leftrightarrows CH_3COO^-\ (aq) + H_3O^+\ (aq)$$

   Which of the following conditions would be most effective in producing the greatest buffering capacity when a small amount of either acid or base is added?

   (a) A high concentration of $CH_3COOH$
   (b) A high concentration of $CH_3COO^-$
   (c) A high, equimolar concentration of both $CH_3COOH$ and $CH_3COO^-$
   (d) A low, equimolar concentration of both $CH_3COOH$ and $CH_3COO^-$

8. When pure water is kept in the fridge, the pH rises above 7. This is because;

   (a) The water has become slightly basic
   (b) There is a higher concentration of $OH^-$ ions than $H_3O^+$ ions
   (c) The self-ionisation of water occurs to a lesser extent
   (d) The value of $K_w$ is higher

9. A solution is acidic if:

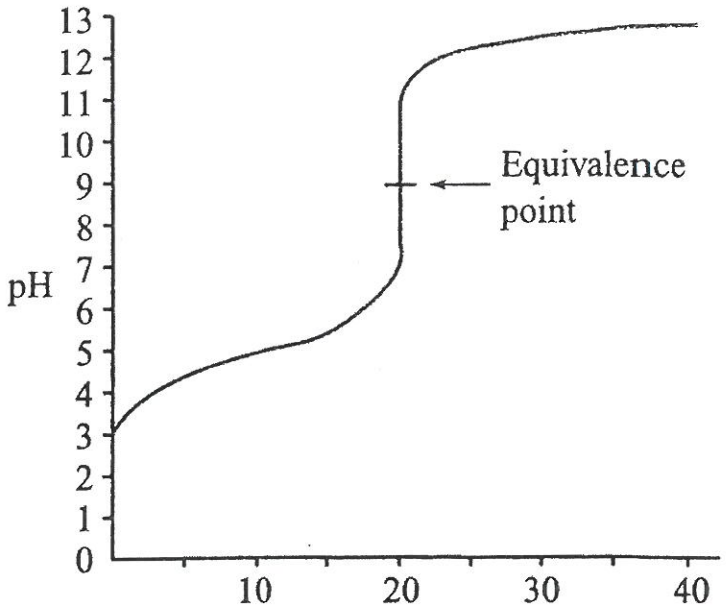
a) $[H^+] = 10^{-14}\ molL^{-1}$
b) $[OH^-] = 10^{-8}\ molL^{-1}$
c) $[H^+] = 10^{-7}\ molL^{-1}$
d) $[OH^-] = 10^{-7}\ molL^{-1}$

10. When titrating an ethanoic acid solution with a sodium hydroxide solution, a student closed the burette tap immediately when the indicator phenolphthalein, changed colour from colourless to pink. The burette was turned off at this point because:

a) Phenolphthalein has its colour change at about the pH of a sodium ethanoate solution.
b) The pink colour indicated that too much alkali solution was added.
c) The solution was neutral
d) Any further addition of sodium hydroxide solution would cause sodium ethanoate to be precipitated.

## Part 2: Short Answer Questions [25 marks]

1. Look at the titration curve in the diagram below.




a) Identify the type of solution that was placed in the burette. (Strong) base

b) Identify the type of solution in the pipette. (Weak) acid

c) Give an example of the type of acid that could have been used in this titration.
$CH_3COOH$

d) Determine the pH of the endpoint for this titration. ~ 9

[4 marks]

2. The major buffer system in human blood is the acid-base pair $H_2CO_{3(aq)}/HCO_3^-{}_{(aq)}$

(a) Which one of the pair acts to soak up, or neutralize, a change which would cause a lowering of pH $HCO_3^-$

[1 mark]

(b) Support your answer to the above question with an equation showing the species working to bring pH back to the desired pH level.

[1 mark]

$$HCO_3^- + H^+ \rightleftharpoons H_2CO_3$$

or

$$H_2CO_3 + H_2O \rightleftharpoons HCO_3^- + H_3O^+$$

3. In an experiment to test the solubility of carbon dioxide in water, tablets that dissolve to produce $CO_2$ were added to equal volumes hot water and ice-cold water. After all reaction had finished, the two solutions were tested with an indicator and dilute sodium hydroxide solution. It was indeed found that more $CO_2$ had dissolved into the cold water.

Write an equation to show the solution of $CO_2$ (g) into water and indicate whether the $\Delta H$ value for this reaction is positive or negative.

[2 marks]

more in cold temp ∴ $CO_2(g) \rightleftharpoons CO_2(aq) + heat$

$CO_2 + H_2O \rightleftharpoons H_2CO_3 + heat$ (exo)

↑T favours endo.

↓T ∴ exo.

$\Delta H = -ve$ ✓

4. In a $1.55 \times 10^{-3}$ $molL^{-1}$ KOH solution, determine:

a) concentration of hydrogen ions

[2 marks]

$[H^+] = \frac{10^{-14}}{1.55 \times 10^{-3}}$ ✓

$= 6.45 \times 10^{-12}$ mol/L ✓

b) pH

[2 marks]

$pH = -\log 6.45 \times 10^{-12}$ ✓✓

$= 11.2$

5. If the pH of 0.00500 $molL^{-1}$ solution of hydrogen cyanide (HCN) is 6.40, calculate what percentage of the hydrogen cyanide in the solution has been ionized.

[4 marks]

$[H^+] = 10^{-6.40}$

$= 3.98 \times 10^{-7}$ mol/L ✓✓

$\% = \frac{3.98 \times 10^{-7}}{5 \times 10^{-3}} \times 100$

$= 7.96 \times 10^{-3}$ % ✓✓

6. Write balanced **net ionic** equations and give observations for the reactions that occur between the following reactants.

a) Cobalt (II) hydrogen carbonate solid is added to 1 M hydrochloric acid solution.

Equation:

$Co(HCO_3)_{2\,(s)} + 2H^+_{(aq)} \rightarrow Co^{2+}_{(aq)} + 2H_2O + 2CO_2$

[2 marks]

Observation: purple solid dissolves to form purple sol$^n$ & c'less, o'less gas

[1 mark]

b) Solid ammonium nitrate is mixed with solid calcium hydroxide and heated gently.

Equation:

$2NH_4NO_{3\,(s)} + Ca(OH)_2 \rightarrow Ca^{2+}_{(aq)} + 2NO_3^- + 2NH_3 + 2H_2O$

[2 marks]

Observation: c'less, pungent gas produced

~~white solids get~~ c'less liquid produced

[1 mark]

c) A small piece of potassium metal is placed in a beaker containing dilute phosphoric acid.

Equation: $2K + 2H^+ \rightarrow 2K^+ + H_2$

$3K + H_3PO_4 \rightarrow 3K^+ + PO_4^{3-} + \frac{3}{2}H_{2(g)}$

[2 marks]

Observation: grey solid dissolves to form c'less sol$^n$ and c'less o'less gas.

[1 mark]

## Part 3: Extended Answer Questions [15 marks]

1. A sample of commercial vinegar contains 4.13% of acetic acid by mass. A 15.12g sample of the vinegar was dilute to 100.0mL and 25.00mL of a 0.242 $molL^{-1}$ sodium hydroxide solution was then added.

   a) Write the equation for the reaction between acetic acid and sodium hydroxide. [1 mark]

   $CH_3COOH + NaOH \rightarrow H_2O + NaCH_3COO$ ✓

   b) Calculate the number of moles of each of the two reagents before mixing. [3 marks]

   $n(CH_3COOH) = \frac{\frac{4.13}{100} \times 15.12}{60.052} = 0.0624$ ✓

   $= 0.0104$ mol ✓

   $n(NaOH) = cV$

   $= 0.242 \times 0.025$

   $= 0.00605$ mol ✓

   c) Determine the limiting reagent. [1 marks]

   1 : 1 ratio ∴ $n(NaOH) = n(CH_3COOH)$

   ∴ $CH_3COOH$ is in xs.

   NaOH is lim ✓

   d) Calculate the concentration of acetate ions in the final solution. [2 marks]

   $n(CH_3COO^-) = n(CH_3COOH) = 0.00605$ mol ✓

   $V_T = 0.125$ L

   $c = \frac{0.00605}{0.125} = 4.84 \times 10^{-2}$ M ✓

2. A chemist needed to find the percentage of calcium carbonate in a sample of limestone rock. She started the analysis by dissolving 0.468 g of the limestone rock in 50.00 mL of 0.135 $molL^{-1}$ hydrochloric acid. She then boiled the mixture gently to ensure the reaction was complete and to expel all the carbon dioxide. Finally the excess acid was titrated with 22.50 mL of 0.0925 $molL^{-1}$ potassium hydroxide solution. Calculate the mass of the calcium carbonate in the rock sample and hence the percentage of calcium carbonate in the sample. [8 marks]

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ ✓

$HCl + KOH \rightarrow KCl + H_2O$

$n(HCl)_{total} = cV = 0.135 \times 0.05$

$= 6.75 \times 10^{-3}$ mol ✓

$n(KOH) = cV = 0.0925 \times 0.0225$ ✓

$= 2.0813 \times 10^{-3}$ mol

$\therefore n(xs\ HCl) = 2.0813 \times 10^{-3}$ mol ✓

$n(HCl\ reacted) = 6.75 \times 10^{-3} - 2.0813 \times 10^{-3}$ ✓

$= 4.669 \times 10^{-3}$ mol

$\therefore n(CaCO_3) = \frac{1}{2} \times 4.669 \times 10^{-3}$

$= 2.334 \times 10^{-3}$ mol ✓

$m(CaCO_3) = 2.334 \times 10^{-3} \times 100.09$ ✓

$= 0.2336$ g

$\%\ CaCO_3 = \frac{0.2336}{0.468} \times 100$ ✓

$= 49.9\%$

# Applecross Senior High School

## Year 12 ATAR Chemistry

## Acids and Bases Test

**Name:** _____

**Please place a cross (X) on the correct answer.**

| | | | | |
|---|---|---|---|---|
| 1 | A | B | C | D |
| 2 | A | B | C | D |
| 3 | A | B | C | D |
| 4 | A | B | C | D |
| 5 | A | B | C | D |
| 6 | A | B | C | D |
| 7 | A | B | C | D |
| 8 | A | B | C | D |
| 9 | A | B | C | D |
| 10 | A | B | C | D |