**YEAR 12 CHEMISTRY - ATCHE**

**TOPIC TEST**

**ACIDS AND BASES**

**Recommended time: 50 minutes**

**Total marks**

**/51**

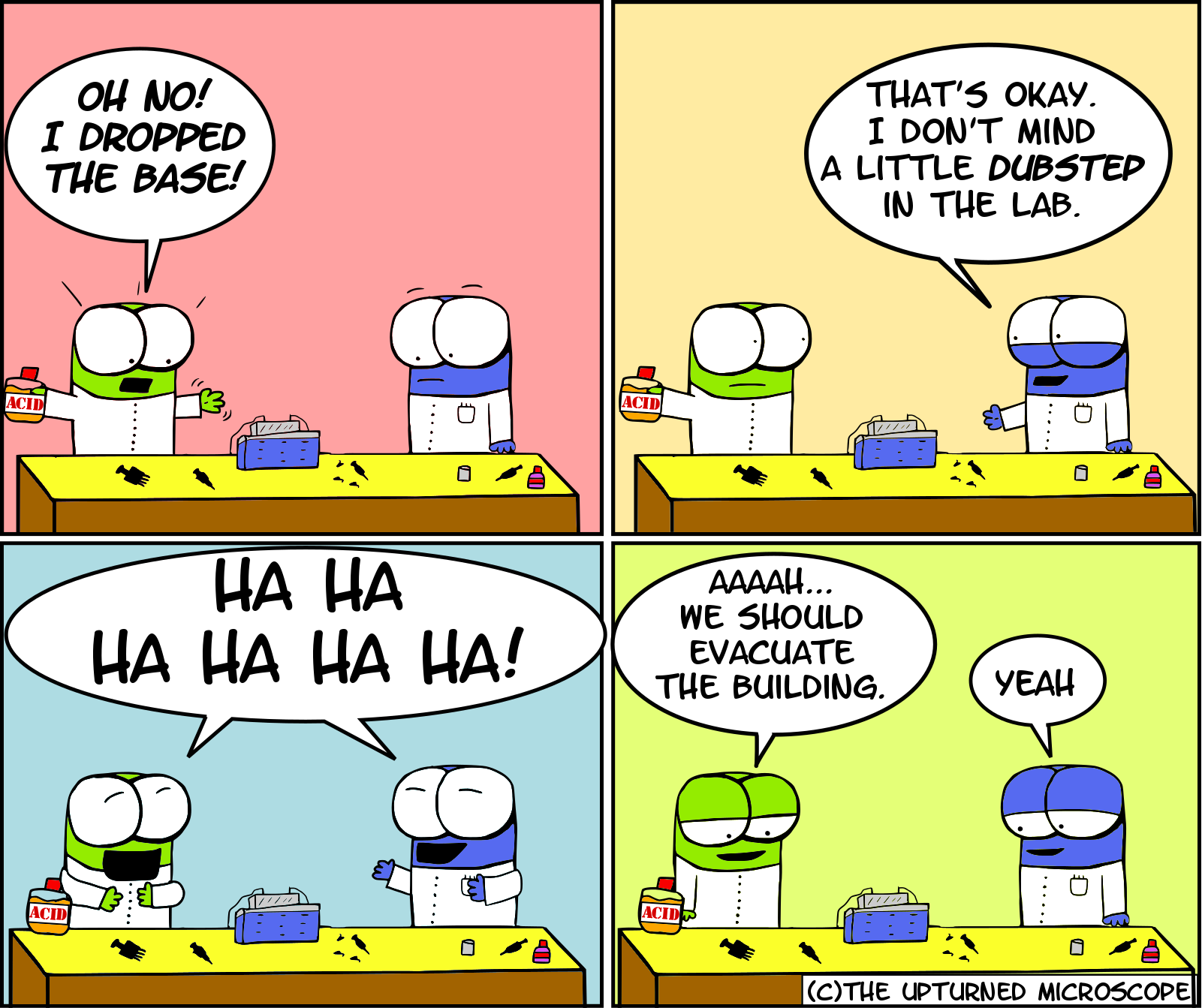
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Teacher: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Weighting: 5% of year**

*Multiple Choice: 19 Marks*

*Short Answer: 32 Marks*



**Multiple Choice ( 19 Marks )**

1. Which option correctly identifies the conjugate acid-base pairs in the following reaction?

CH3COOH (aq) + H2O (l) ↔ H3O+ (aq) + CH3COO ─ (aq)

1. CH3COOH and H2O
2. CH3COOH / CH3COO─  and H3O+ / H2O
3. CH3COOH / H2O and H3O+ / CH3COO ─
4. CH3COOH and CH3COO ─
5. Pure water undergoes self-ionisation according to the following equation:

2 H2O (**l**) ↔ H3O+ (aq) + OH - (aq)

The equilibrium constant (Kw) for this reaction is 2.92 x 10-15 at a temperature of 283K.

What is the pH of the water at this temperature?

1. 6.73
2. 7.00
3. 7.27
4. 14.80
5. Consider the following reaction : HCN(aq) + NH3(aq) ⇄ CN―(aq) + NH4+(aq)

Which of the species in this equilibrium mixture are ***acting as bases***?

* 1. HCN(aq) and NH4+(aq)
  2. NH3(aq) and CN―(aq)
  3. HCN(aq) and CN―(aq)
  4. NH3(aq) and NH4+(aq)

1. The pH of an aqueous solution registers 11.0 on a pH meter. Which of the following solutions could be its identity?
   1. 0.0010 molL-1 KOH
   2. 0.0100 molL-1 NaOH
   3. 0.0010 molL-1 HCl
   4. 0.0050 molL-1 Ca(OH)2
2. Consider the table below regarding the acidity constants (measured at 25 oC) of three monoprotic organic acids.

|  |  |
| --- | --- |
| Propanoic acid (CH3CH2COOH) | Ka = 1.3 x 10-5 |
| Ethanoic acid (CH3COOH) | Ka = 1.8 x 10-5 |
| Methanoic acid (HCOOH) | Ka = 1.8 x 10-4 |

From this data, we could conclude that

1. as the acid’s number of carbon atoms increases, the strength of the acid increases.
2. increasing the temperature will increase the strength of the acids.
3. solutions of methanoic acid will always have a lower pH than solutions of propanoic acid.
4. a 0.1 mol L–1 solution of propanoic acid will have a higher pH than a 0.1 mol L–1 solution of methanoic acid.
5. The autoionization of water can be represented by the equation below.

H2O(l) + H2O(l) + heat ⇌ H3O+(aq) + OH-(aq)

Distilled water at a temperature of 15 °C would have

1. a concentration of hydronium ions greater than 1.0 x 10-7 mol L-1.
2. a concentration of hydroxide ions greater than 1.0 x 10-7 mol L-1.
3. a Kw value greater than 1.0 x 10-14.
4. a pH greater than 7.
5. Which statement best describes the equivalence point in a titration between a strong acid and a strong base?
6. The point at which equal moles of H+ ions and OH- ions have been added together.
7. The point at which equal moles of acid and base have been added together.
8. The point at which the first sign of a colour change occurs.
9. The point at which the rate of the forward reaction equals the rate of the reverse reaction.
10. Four beakers (A, B, C and D) were placed on a laboratory bench, each containing distilled water and a pH meter was used to measure their pH. A small sample of a different salt was then dissolved into each beaker, according to the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Beaker A** | **Beaker B** | **Beaker C** | **Beaker D** |
| + NH4NO3(s) | + MgF2(s) | + CH3COOK(s) | + Na3PO4(s) |

The pH of the solution in beaker

1. A would be above 7.
2. B would be below 7.
3. C would be below 7.
4. D would be above 7.
5. Which one of the following underlined species is acting as an acid?
   1. CH3CH2CH2CH2NH2 + CH3COOH ⇌ CH3CH2CH2CH2NH3+ + CH3COO-
   2. HSO3- + NH3 ⇌ SO32- + NH4+
   3. NH4+ + CH3COO- ⇌ NH3 + CH3COOH
   4. [Fe(H2O)6]3+ + H2O ⇌ [Fe(OH)(H2O)5]2+ + H3O+
6. Which of the following classifications is correct?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **KCl** | **CH3COOK** | **NH4Cl** | **KHSO4** |
| a) | Neutral | Basic | Acidic | Acidic |
| b) | Neutral | Basic | Acidic | Basic |
| c) | Acidic | Acidic | Basic | Basic |
| d) | Neutral | Acidic | Basic | Acidic |

Questions 11 and 12 refer to the table below.

|  |  |  |
| --- | --- | --- |
| Name of indicator | pH range | Colour (low pH – high pH) |
| 1. Methyl red | 4.4 – 6.2 | Red- yellow |
| 1. Bromothymol blue | 6.0 – 7.6 | Yellow – blue |
| 1. Phenolphthalein | 8.3 – 10.0 | Colourless – pink |
| 1. Methyl violet | 0.0 – 2.0 | Yellow – violet |

1. A chemist uses a 0.1034 molL-1 sodium hydroxide solution to standardise a nitric acid solution. Which of the following indicators would be suitable?
   1. 2 only.
   2. 2, 3 and 4 only.
   3. 1, 2 and 3 only.
   4. All of 1, 2, 3 and 4.
2. If methyl red is used in a titration between ethanoic acid (added from burette) and a standard solution of sodium hydroxide (in a conical flask with indicator) then:
   1. The end point of the titration would occur after the equivalence point.
   2. The end point would occur at the equivalence point of the titration.
   3. No colour change would occur.
   4. The end point of the titration would occur before the equivalence point has been reached.
3. What would be the **most** likely pH of a 0.10 mol L-1 solution of sulfuric acid?
4. Less than 0.5
5. Between 0.5 and 1
6. Exactly 1
7. Approximately 1.5
8. Which of the following does **not** contribute to the problems faced by calcifying species as a direct result of ocean acidification?
   1. A decrease in ocean CO32-(aq) concentration.
   2. A decrease in ocean Ca2+(aq) concentration.
   3. An increase in ocean H3O+(aq) concentration.
   4. A decrease in the presence of CaCO3(s).
9. Which row of the table describes what happens when a solution of a weak acid is diluted?

(Assume constant temperature)

|  |  |  |
| --- | --- | --- |
|  | **Ka** | **Extent of Acid Ionisation** |
|  | Decreases | Increases |
|  | Decreases | Decreases |
| (c) | Remains the same | Increases |
| (d) | Remains the same | Decreases |

1. Diagram, rectangle

   Description automatically generatedWhich of the following **correctly** identifies the labels represented by X, Y and Z?

|  |  |  |  |
| --- | --- | --- | --- |
|  | **X** | **Y** | **Z** |
| (a) | Concentration | Volume of acid added | Equivalence point |
| (b) | pH | Volume of base added | Indicator end point |
| (c) | Volume of acid added | Equivalence point | pH |
| (d) | pH | Volume of base added | Equivalence point |

Use the following information to answer Questions 17 and 18.

*A chemist is titrating a volume of an unknown monoprotic acid against 50mL of 0.30M NaOH, using methyl red as an indicator. The chemist observes the first permanent colour change at 23.65 mL.*

1. A valid conclusion that can be drawn from this information is that:
   1. the concentration of the unknown compound is 0.14 M.
   2. the concentration of the unknown compound is 0.5M.
   3. the concentration of the unknown compound is 0.28M.
   4. the concentration of the unknown compound is 1.0M.
2. If the titration is repeated several times, averaging the results will reduce the
   1. accuracy of the results.
   2. reliability of the results.
   3. effect of random errors.
   4. effect of systematic errors
3. A student used the following method to titrate an acetic acid solution of unknown concentration with a standardised solution of dilute sodium hydroxide:

• Rinse burette with deionised water.

• Fill burette with sodium hydroxide solution.

• Rinse pipette and conical flask with acetic acid solution.

• Pipette 25.00 mL of acetic acid solution into conical flask.

• Add appropriate indicator to the conical flask.

• Titrate to endpoint and record volume of sodium hydroxide solution used.

Compared to the actual concentration of the acetic acid, the calculated concentration will be

1. Lower
2. Higher
3. the same
4. different, but higher or lower cannot be predicted.

**END OF MULTIPLE CHOICE QUESTIONS**

**Short Answer ( 32 Marks )**

1. Malic acid (H2C4H4O5) is a weak, diprotic acid. The equation for the first stage of dissociation is shown below.

H2C4H4O5(aq) + H2O(l) ⇌ HC4H4O5-(aq) + H3O+(aq)

* 1. Write the equation for the second stage of ionisation of malic acid. (2 marks)

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* 1. Malic acid can completely react with a solution of potassium hydroxide to form a salt. Will the salt formed be acidic, neutral, or basic? Justify your answer using chemical equations.

(4 marks)

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* 1. Calculate the pH of the potassium hydroxide solution used in part b, given that 0.130g was dissolved into 25.0mL Assume temperature of 25°C.

(3 marks)

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1. Propanoic acid, CH­3CH2COOH, is a weak monoprotic acid. An acidic buffer solution is prepared by reacting 40.0mL of 1.00molL-1 propanoic acid with 20.0mL of 1.00molL-1 potassium hydroxide solution.
   1. Write an equation for the buffer system that was produced.

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|  |

(2 marks)

* 1. Explain why the two quantities specifically were used to make this buffer solution.

(3 marks)

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* 1. Using the chemical equation from PART A, and collision theory, explain how this buffer solution operates when a few drops of sodium hydroxide (NaOH) are added.

(4 marks)

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1. Oxalic acid is a diprotic acid, of which crystals are commonly used as a primary standard in acid-base volumetric analysis.
   1. List **one** characteristics you expect oxalic acid crystals to have to justify this classification as a suitable primary standard.

(1 mark)

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A number of 2.50 g samples of oxalic acid crystals had been carefully weighed, sealed, and labelled H2C2O4•nH2O.

**Step 1:** One 2.50 g sample was very carefully dissolved in an empty beaker using distilled water. The resulting solution (H2C2O4 (aq)) was then transferred into a 250.00 mL volumetric flask and then made up to 250.00 mL.

**Step 2:** A burette was filled with this solution and was used to titrate a 25.00 mL sample of 0.100 mol L-1 NaOH using a suitable indicator.

**Step 3:**Titrations were repeated until a consistent end point was obtained.

The student’s results were as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Final reading (mL)** | 20.65 | 19.60 | 20.75 | 21.85 |
| **Initial reading (mL)** | 4.45 | 3.90 | 4.95 | 5.95 |
| **Titration volume (mL)** |  |  |  |  |

* 1. Write the equation of the reaction taking place during the titration.

(1 mark)

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* 1. Complete the table and determine the average titre value for the oxalic acid solution.

(1 mark)

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* 1. Calculate the mass of oxalic acid in the 2.50g sample. (4 marks)

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* 1. Use your result to determine the value of ‘n’ in H2C2O4.**n**H2O. (3 marks)

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1. Acids and bases exist as conjugate acid–base pairs. Below is a table showing the Ka value for a number of acids and the Kb for the corresponding conjugate bases.

|  |  |  |  |
| --- | --- | --- | --- |
| **Some Conjugate Acid–Base Pairs at 25 °C** | | | |
| **Acid** | **Ka** | **Base** | **Kb** |
| HF | 6.8 x 10–4 | F– | 1.5 x 10–11 |
| CH3COOH | 1.8 x 10–5 | CH3COO– | 5.6 x 10–10 |
| H2CO3 | 4.3 x 10–7 | HCO3– | 2.3 x 10–8 |
| NH4+ | 5.6 x 10–10 | NH3 | 1.8 x 10–5 |
| HCO3– | 5.6 x 10–11 | CO32– | 1.8 x 10–4 |

1. “The stronger the acids, the stronger the conjugate base.” State whether this statement is true or false, justifying your answer using the data provided.

(2 marks)

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1. Use the dihydrogen phosphate ion to demonstrate conjugate acid-base pairing with a labelled equation.

(2 marks)

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**END OF TEST**