

Topic 8.3 pH Scale

Past Exam Questions (Paper 1, 2)

1. [1 mark]

What is the correct expression for the ionic product constant of water, K_w ?

- A. $K_w = \frac{[H^+]}{[OH^-]}$
- B. $K_w = \frac{[H_2O]}{[H^+][OH^-]}$
- C. $K_w = [H^+] + [OH^-]$
- D. $K_w = [H^+][OH^-]$

2. [1 mark]

What is the pH of the solution formed when 10 cm^3 of HCl(aq) with pH 1.0 is added to 990 cm^3 of water?

- A. 1.5
- B. 2.0
- C. 2.5
- D. 3.0

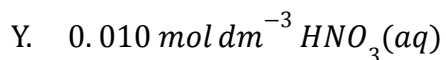
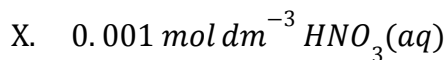
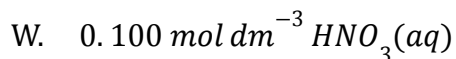
3. [1 mark]

The pH of a solution changes from $\text{pH} = 2$ to $\text{pH} = 5$. What happens to the concentration of the hydrogen ions during this pH change?

- A. It decreases by a factor of 1000
- B. It increases by a factor of 1000
- C. It decreases by a factor of 100
- D. It increases by a factor of 100

4. [1 mark]

Three aqueous solutions of nitric acid are listed below.



What is the correct order of **increasing** pH of these solutions?

A. $W < X < Y$

B. $W < Y < X$

C. $X < W < Y$

D. $X < Y < W$

5. [1 mark]

A solution of acid HX has a pH = 1 and a solution of acid HY has a pH = 3. Which statement **must** be correct?

A. HX is a stronger acid than HY.

B. HY is a stronger acid than HX.

C. The $[H^+]$ in the solution of HX is 100 times greater than the $[H^+]$ in the solution of HY.

D. The $[H^+]$ in the solution of HY is 100 times greater than the $[H^+]$ in the solution of HX.

6. [1 mark]

A solution of 50 cm^3 hydrochloric acid has a pH of 4. What is the final pH if 450 cm^3 of water is added?

A. 3

B. 4

C. 5

D. 6

7. [1 mark]

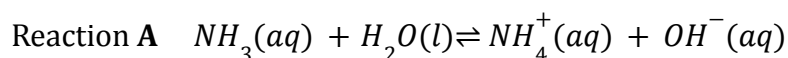
10.0 cm^3 of a solution of a strong acid with a pH of 3 is added to a volumetric flask and the total volume is made up to 1.00 dm^3 by adding distilled water. The resulting solution is then thoroughly mixed.

What is the pH of the diluted solution?

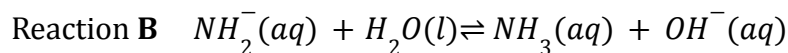
- A. 1
- B. 2
- C. 4
- D. 5

8a. [2 marks]

The equations of two acid-base reactions are given below.



The reaction mixture in **A** consists mainly of reactants because the equilibrium lies to the left.



The reaction mixture in **B** consists mainly of products because the equilibrium lies to the right.

For each of the reactions **A** and **B**, deduce whether water is acting as an acid or a base and explain your answer.

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8b. [2 marks]

Two acidic solutions, **X** and **Y**, of equal concentrations have pH values of 2 and 6 respectively.

Calculate the hydrogen ion concentrations in the two solutions and identify the stronger acid.

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8c. [1 mark]

Determine the ratio of the hydrogen ion concentrations in the two solutions **X** and **Y**.

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9a. [2 marks]

Black coffee has a pH of 5 and toothpaste has a pH of 8. Identify which is more acidic **and** deduce how many times the $[H^+]$ is greater in the more acidic product.

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9b. [3 marks]

Samples of sodium oxide and sulfur trioxide are added to separate beakers of water. Deduce the equation for **each** reaction **and** identify each oxide as acidic, basic or neutral.

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10. [1 mark]

Arsenic and nitrogen play a significant role in environmental chemistry. Arsenous acid, H_3AsO_3 , can be found in oxygen-poor (anaerobic) water, and nitrogen-containing fertilizers can contaminate water.

Nitric acid, HNO_3 , is strong and nitrous acid, HNO_2 , is weak.

When lime was added to a sample of soil, the pH changed from 5 to 7. Calculate the **factor** by which the hydrogen ion concentration changes.

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11. [1 mark]

Acids play a key role in processes in everyday life.

The wine industry is important to the economy of many countries. Wine contains ethanol. In a laboratory in Chile, chemists tested the pH of a bottle of wine when opened and found it to have a pH of 3.8. After a few days, the pH had decreased to 2.8.

Deduce the change in hydrogen ion concentration, $[\text{H}^+]$.

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12a. [2 marks]

A student used a pH meter to measure the pH of different samples of water at 298 K.

Sample	pH $\pm$ 0.1
Rain water	5.1
River water	4.4
Tap water	6.5
Bottled water	7.1

Determine the ratio of $[H^+]$ in bottled water to that in rain water.

$$\frac{[H^+] \text{ in bottled water}}{[H^+] \text{ in rain water}}$$

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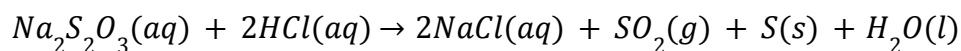
12b. [1 mark]

The acidity of non-polluted rain water is caused by dissolved carbon dioxide. State an equation for the reaction of carbon dioxide with water.

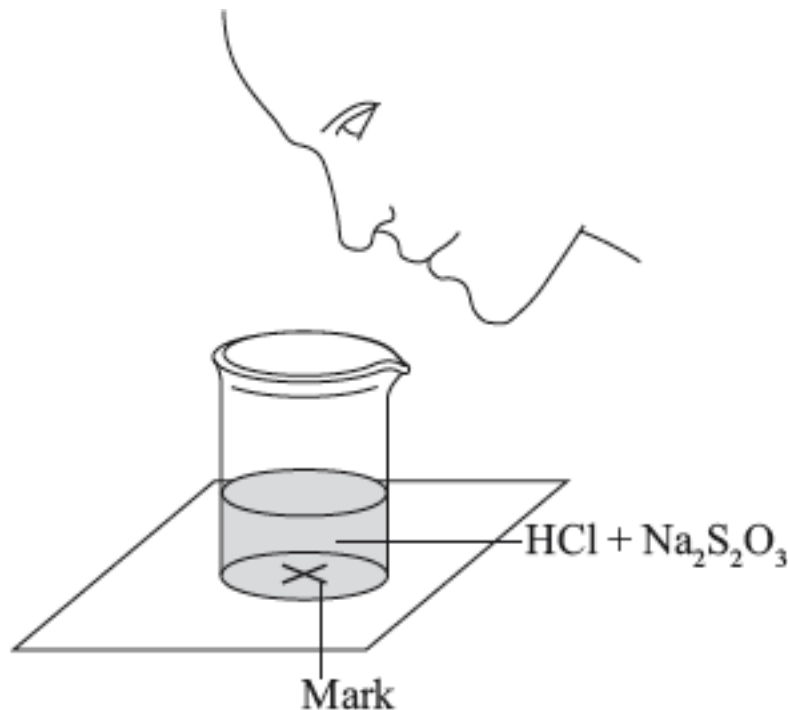
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13. [3 marks]

A group of students investigated the rate of the reaction between aqueous sodium thiosulfate and hydrochloric acid according to the equation below.



The two reagents were rapidly mixed together in a beaker and placed over a mark on a piece of paper. The time taken for the precipitate of sulfur to obscure the mark when viewed through the reaction mixture was recorded.



Initially they measured out 10.0 cm^3 of $0.500 \text{ mol dm}^{-3}$ hydrochloric acid and then added 40.0 cm^3 of $0.0200 \text{ mol dm}^{-3}$ aqueous sodium thiosulfate. The mark on the paper was obscured 47 seconds after the solutions were mixed.

The teacher asked the students to devise another technique to measure the rate of this reaction.

(i) One group suggested recording how long it takes for the pH of the solution to change by one unit. Calculate the initial pH of the original reaction mixture.

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(ii) Deduce the percentage of hydrochloric acid that would have to be used up for the pH to change by one unit.

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