#CRESTInnovator

CREST Science Olympiad (CSO)
Worksheet for
Class 10

Topic

Acids and Bases

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Worksheet on Acids and Bases

1. **You have two solutions, Solution A with a pH of 3.0 and Solution B with a pH of 5.0. Calculate the ratio of the hydrogen ion concentrations ($[H^+]$) in Solution A to Solution B. Which solution is more acidic?**

   a. 100:1, Solution A is more acidic.
   b. 1:100, Solution B is more acidic.
   c. 10:1, Solution A is more acidic.
   d. 1:10, Solution B is more acidic.

2. **Classify the following substances as acid or base:**

   I. $Mg(OH)_2$
   II. HCl
   III. KOH
   IV. H_3PO_4
   V. HNO_3

   a. Acid: II, IV, V; Base: I, III
   b. Acid: I, II, V; Base: III, IV
   c. Acid: I, III, V; Base: II, IV
   d. Acid: I, III; Base: II, IV, V

3. **When nitric acid (HNO_3) reacts with magnesium (Mg), what are the products of the reaction, and what type of reaction is it?**

   a. Products: Magnesium nitrate ($Mg(NO_3)_2$) and hydrogen gas (H_2); Single-displacement reaction
   b. Products: Magnesium oxide (MgO) and nitrogen gas (N_2); Synthesis reaction
   c. Products: Magnesium chloride ($MgCl_2$) and water (H_2O); Double-displacement reaction
   d. Products: Magnesium sulphate ($MgSO_4$) and oxygen gas (O_2); Decomposition reaction

4. **A student mixes a strong acid (pH 1) with a strong base (pH 13) in a beaker. The resulting pH is 7. Explain why this pH is neutral, even though the original solutions were strongly acidic and basic.**

   a. The pH meter is malfunctioning.
   b. The solutions have completely neutralised each other.
   c. The student made an error in measuring the pH.
   d. This result is not possible; it must be an experimental error.

5. **In the dissociation of hydrochloric acid (HCl) in water, what role does water play in the formation of hydronium ions?**

   a. Water acts as a catalyst in the dissociation process.
   b. Water provides electrons to form hydronium ions.
   c. Water attracts chloride ions to form hydronium ions.
   d. Water attracts hydrogen ions to form hydronium ions.

Answer Key

1. c - The pH scale is a logarithmic scale, and the relationship between pH and hydrogen ion concentration ($[H^+]$) is as follows:

$pH = -\log_{10}[H^+]$

To calculate the ratio of $[H^+]$ in Solution A to Solution B, we can first calculate the hydrogen ion concentrations for both solutions and then compare them.

For Solution A (pH = 3.0):
$[H^+]$ Solution A = $10^{-pH} = 10^{-3} = 0.001$ M

For Solution B (pH = 5.0):
$[H^+]$ Solution B = $10^{-pH} = 10^{-5} = 0.00001$ M

Now, let's compare the two concentrations:
$[H^+]$ Solution A : $[H^+]$ Solution B = 0.001 M:0.00001 M

To simplify this ratio, we can express both concentrations in the same units (e.g., both in millimoles per litre, mM):
[H+] Solution A : [H+] Solution B = 1 mM:0.01 mM

Solution A has a higher hydrogen ion concentration (10 times higher) than Solution B, indicating that it is more acidic. The pH scale is inversely proportional to $[H^+]$, meaning lower pH values correspond to higher $[H^+]$ concentrations and stronger acidity.

2. a - Acid: II, IV, V; Base: I, III

3. a - In the reaction between nitric acid (HNO_3) and magnesium (Mg), a single-displacement reaction occurs, where the magnesium displaces the hydrogen from the nitric acid, forming magnesium nitrate and hydrogen gas as products.

4. c - When a strong acid and a strong base are mixed in equal amounts, they undergo a neutralisation reaction, resulting in a pH of 7, which is considered neutral. The hydrogen ions (H^+) from the acid and the hydroxide ions (OH^-) from the base combine to form water (H_2O), effectively neutralising the acidity and basicity of the original solutions.

5. d - In the dissociation of hydrochloric acid (HCl) in water, water molecules play a crucial role in attracting and stabilising the positively charged hydrogen ions (H^+), forming hydronium ions (H_3O^+). Water's partial negative charge on its oxygen atom attracts the positively charged H^+ ion, leading to the formation of H_3O^+ ions. This process is essential in aqueous acid solutions and represents the actual behaviour of hydrogen ions in water.

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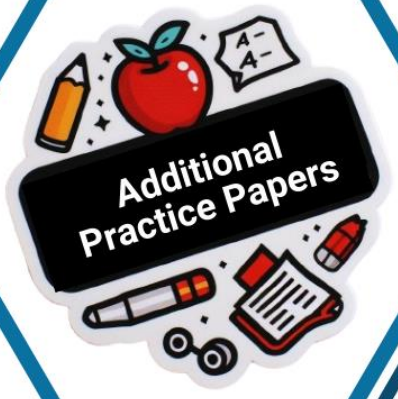

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