

Test

Digital Acid-Base Chemistry

Final Report - Answer Guide

Institution	SI Curriculum Development University
Session	Test
Course	Test
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Test Your Knowledge

Match each term with the best description.

Terms to match:

- A base
- A pH indicator
- An acid
- pH

Descriptions to match:

- Changes color and suggests the amount of Hydrogen ions $[H^+]$ in a solution
- Accepts protons or produces hydroxide ions (OH^-) in an aqueous solution
- A measure of the concentration of hydrogen ions, $[H^+]$, in a solution
- Donates hydrogen ions (H^+) to other substances in a solution

Correct answers:

1 A pH indicator 2 A base 3 pH 4 An acid

Classify each chemical as an acid or base.

	Acid	Base
⚡ CH₃NH₂	1	2
⚡ HCOOH		
⚡ HF		
⚡ HNO₃		
⚡ KOH		
⚡ NH₃		

Correct answers:

1 HF HCOOH HNO₃ 2 CH₃NH₂ KOH NH₃

Predict the color that results from adding a drop of bromothymol blue (BTB) to each solution.

⚡ 1 M HCl ⚡ 1 M NaOH ⚡ A solution containing 10 mL of 1 M NaOH and 10.0 mL of 1 M HCl ⚡ A substance with a pH of 3 ⚡ A substance with a pH of 7 ⚡ A substance with a pH of 10		
Blue	Green	Yellow
1	2	3

Correct answers:

1 1 M NaOH A substance with a pH of 10

2 A solution containing 10 mL of 1 M NaOH and 10.0 mL of 1 M HCl
A substance with a pH of 7

3 1 M HCl A substance with a pH of 3

Label each substance in the chemical reaction.

⚡
Conjugate base

⚡
Hydronium ion

⚡
Strong acid

⚡
Water

$$\text{HCl}_{(aq)} + \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{H}_3\text{O}^+_{(aq)} + \text{Cl}^-_{(aq)}$$

1

2

3

4

Correct answers:

1 Strong acid 2 Water 3 Hydronium ion 4 Conjugate base

Exploration

The greater the number of hydrogen ions in a solution, the more acidic the solution.

- ☒ True
- ☐ False



Bases feel slippery to the skin because they degrade the ____ and ____ in the skin.

- ☐ fatty acids; dirt
- ☐ bacteria; oils
- ☒ fatty acids; oils
- ☐ All of the above



The logarithm for pH is based on a scale of ____.

- ☐ 1
- ☒ 10 ✓
- ☐ 100
- ☐ 1000

A pH ____ changes color at a specific pH or over the course of a pH range.

- ☐ scale
- ☒ indicator ✓
- ☐ value
- ☐ None of the above

Strong acids and bases only partially dissociate in water.

- ☐ True
- ☒ False ✓

A conjugate acid is formed when the acid accepts a proton.

- ☐ True
- ☒ False ✓

Exercise 1

You have two beakers. One contains 500 mL of an NH_4OH (weak base) solution and one contains 500 mL of an NaOH (strong base) solution. You test the pH of the two solutions. Which one has the higher pH? How do you know?

Without knowing the concentrations of the two solutions, we can't say which has the higher pH. Just because a base is weak does not mean it automatically has a lower pH than a strong base.

Why might some scientists use litmus paper to evaluate pH? When is a digital pH probe needed?

Litmus paper is a quick, simple method for determining pH if an exact value isn't needed. A pH probe will give an exact value when more specificity is required.

Looking at the simulation of a strong acid in water, what particle appears to be missing? (Hint: use the Graph View to visualize). Why is this the case? What is different about what happens to the particles of a weak acid or base vs a strong acid or base in water?

The HA particle appears to be missing. This is because the proton dissociates completely from A⁻ in a strong acid.

Weak acids and bases do not completely dissociate in water--looking at the simulation, there are HA and BOH particles present in solutions of weak acids and bases.

You have three beakers. The first contains a solution of 0.10 M hydrocyanic acid (weak acid); the second contains a solution of 0.10 M acetic acid (weak acid); the third contains a solution of 0.10 M nitric acid (strong acid). Without further information, can you make any claims about which solution will have the lowest pH? Can you make any claims about which solution will have the highest pH?

Nitric acid will have the lowest pH, because it is a strong acid at the same concentration as the two weak acids it's being compared to. However, we can't make any claims about which weak base has the higher pH without knowing which is weaker.

If a more concentrated initial solution of sodium bicarbonate was used in beaker C, would it require more or less bicarbonate to neutralize the acid? Why?

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Data Table 1: Initial pH Test Results
(SAMPLE ANSWER BELOW)

Container	Chemical Contents	Initial pH
A	water	7
B	HCl	1
C	NaHCO ₃	9

Data Table 2: Neutralization of an Acid
(SAMPLE ANSWER BELOW)

Total NaHCO ₃ Added (g)	Beaker C pH
0.5 (initial)	4
1.0	5
1.5	6

Data Table 3: pH Measures of Default Solutions
(SAMPLE ANSWER BELOW)

	Litmus Color	Estimated pH	pH Probe Reading
Weak Acid	yellow	(should be within 1 pH of unit of true value)	4.50
Strong Acid	orange		2.00
Weak Base	dark green		9.50
Strong Base	blue		12.00

Data Table 4: pH Measures of Custom Solutions
(SAMPLE ANSWER BELOW)

(SAMPLE ANSWER BELOW)						
				Litmus Color	Estimated pH	pH Probe Reading
Acid	Weak	High Conc	Weaker Acid	yellow	(should be within 1 unit of true value)	5.00
			Stronger Acid	pink		0.00
		Low Conc	Weaker Acid	light green		6.50
			Stronger Acid	light orange		3.00

Base	Strong	High Conc		pink		0.00
		Low Conc		orange		3.00
	Weak	High Conc	Weaker Base	dark green		9.00
			Stronger Base	dark blue		14.00
		Low Conc	Weaker Base	green		7.50
			Stronger Base	teal		11.00
	Strong	High Conc		dark blue		14.00
		Low Conc		teal		11.00

Data Table 5: Calculated Acid & Base Values
(SAMPLE ANSWER BELOW)

				[H ⁺]	[OH ⁻]	pOH
Acid	Weak	High Conc	Weaker Acid	1.00x10 ⁻⁵	1.00x10 ⁻⁹	9.00
			Stronger Acid	9.90x10 ⁻¹	1.01x10 ⁻¹⁴	14.00
		Low Conc	Weaker Acid	3.16x10 ⁻⁷	3.16x10 ⁻⁸	7.50
			Stronger Acid	1.00x10 ⁻³	1.00x10 ⁻¹¹	11.00
	Strong	High Conc		1.00	1.00x10 ⁻¹⁴	14.00
		Low Conc		1.00x10 ⁻³	1.00x10 ⁻¹¹	11.00
Base	Weak	High Conc	Weaker Base	1.00x10 ⁻⁵	1.00x10 ⁻⁵	5.00
			Stronger Base	1.01x10 ⁻¹⁴	9.90x10 ⁻¹	0
		Low Conc	Weaker Base	3.16x10 ⁻⁸	3.16x10 ⁻⁷	6.50
			Stronger Base	1.00x10 ⁻¹¹	1.00x10 ⁻³	3.00
	Strong	High Conc		1.00x10 ⁻¹⁴	1.00	0
		Low Conc		1.00x10 ⁻¹¹	1.00x10 ⁻³	3.00

Competency Review

Acids are substances that are characterized by their ability to donate ____, or ____ ions.

- ☒ protons; hydrogen ✓
- ☐ neutrons; hydrogen
- ☐ protons; hydroxide
- ☐ None of the above

The greater the number of hydroxide ions in a solution, the more ____ the solution.

- ☐ acidic
- ☒ basic ✓

Concentrated acids and bases are found in everyday substances such as coffee and hand soap.

- ☐ True
- ☒ False ✓

Based on the logarithm for pH, a pH of 2 is ____ times more acidic than a pH of 4.

- ☐ 2
- ☐ 10
- ☒ 100 ✓
- ☐ None of the above

A neutral substance has a pH of 0.

- ☐ True
- ☒ False ✓

A pH of ____ indicates an acidic solution.

- ☒ 3
- ☐ 7
- ☐ 12
- ☐ None of the above



pH is a measure of the concentration of ____ ions in a solution.

- ☐ water
- ☐ sodium
- ☐ hydroxide
- ☒ hydrogen



In the presence of an acid, water behaves as a(n) ____ and accepts the proton donated by the acid to create a ____ ion.

- ☐ acid; hydrogen
- ☐ base; hydroxide
- ☒ base; hydronium
- ☐ acid; hydronium



Weak acids have a ____ pH than strong acids of the same concentration and ____ dissociate in water.

- ☒ higher; partially
- ☐ higher; fully
- ☐ lower; partially
- ☐ lower; fully



In the presence of an acid, water will behave as a(n) _____. In the presence of a base, water will behave as a(n) _____.

- ☒ base; acid
- ☐ acid; base
- ☐ acid; acid
- ☐ base; base

✓

A(n) _____ reaction occurs when an acid and a base are present in the same solution.

- ☐ oxidation-reduction
- ☐ hydrolysis
- ☒ neutralization
- ☐ None of the above

✓

The reaction below is an example of the dissociation of an acid in water.



- ☒ True
- ☐ False

✓

The pH of a solution with a 1.6×10^{-8} M concentration of hydronium ion is _____.

- ☒ 7.80
- ☐ -7.80
- ☐ 6.20
- ☐ -6.20

✓

Extension Questions

List the conjugate acid or conjugate base for each chemical.

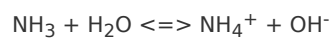
- a. The acid HF
- b. The base KOH

- c. The acid HNO_3
- d. The acid HCOOH
- e. The base CH_3NH_2

(SAMPLE ANSWER BELOW)

- a. The acid HF : F^-
- b. The base KOH : H_2O
- c. The base NH_3 : NH_4^+
- d. The acid HNO_3 : NO_3^-
- e. The acid HCOOH : COOH^-
- f. The base CH_3NH_2 : CH_3NH_3^+

Write the chemical equation of mixing ammonia (NH_3) with water. Identify all the components of the equation as acid, base, conjugate acid, and conjugate base. (SAMPLE ANSWER BELOW)



ammonia: base

water: acid

ammonium ion: conjugate acid

hydroxide: conjugate base