

Exercise walk-through

8.6

Molecular Structure of Acids and Bases

AP Chemistry

Structure and pK_a

Acid strength comes down to how easily the acidic H leaves, and how stable the

conjugate base is:

- **binary acids** : stronger *down* a group (weaker bond)
- **oxyacids** : more oxygens $\Rightarrow$ stronger

$$\text{p}K_a = -\log K_a$$

Smaller $\text{p}K_a$ = stronger acid.

$\text{pH} < \text{p}K_a$: the acid form dominates; $\text{pH} > \text{p}K_a$: the conjugate base dominates.

Why one acid is stronger than another

the principle

an acid is stronger when its **conjugate base is more stable**

electronegativity

more electronegative atoms nearby pull electron density away and stabilise the negative charge

resonance

a charge spread over several atoms is far more stable – why carboxylic acids beat alcohols

atomic size

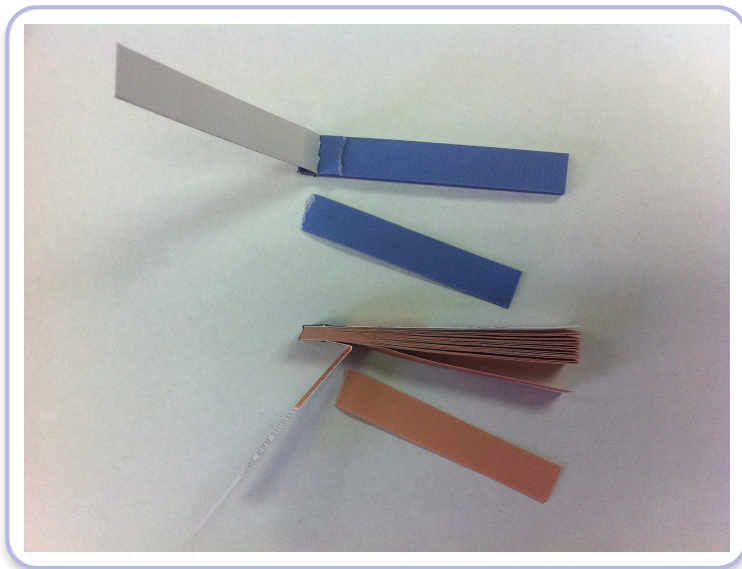
down a group, a larger atom spreads the charge better – HI is stronger than HF

an indicator

itself a weak acid whose protonated and deprotonated forms have **different colours**, so it changes colour over its own pK_a range

Never argue from the acid; argue from the **anion left behind**. Every structural rule here is about stabilising that charge.

Introduction to Acids and Bases



Litmus paper: acid–base indicators change colour with H^+ concentration (pH)

Bronsted-Lowry, and the autoionization of water

an acid

a proton (H^+) donor

a base

a proton acceptor

conjugate pairs

when an acid donates, what remains is its conjugate base;
a base that accepts becomes its conjugate acid

the hydronium
ion

H_3O^+ – what a proton actually forms in water

autoionization

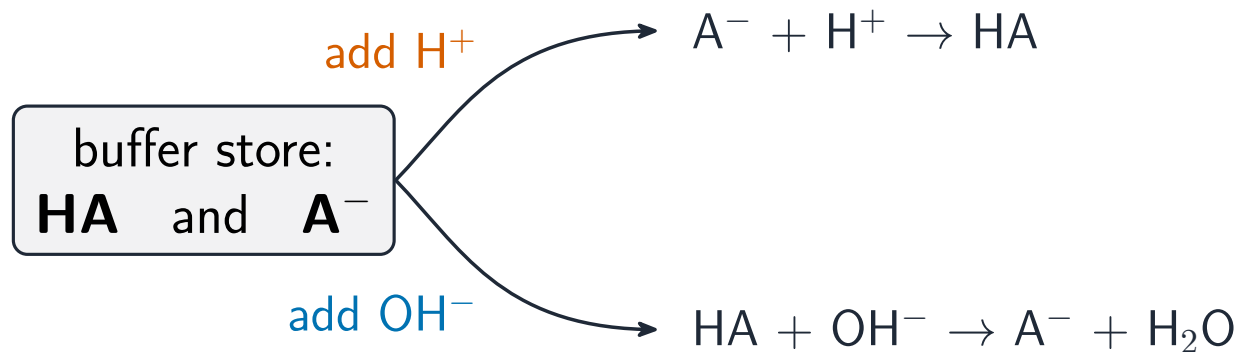
$2\text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$, which is why pure water conducts
a tiny current

K_w

the ion-product constant of water :
 $[\text{H}_3\text{O}^+][\text{OH}^-] = 1.0 \times 10^{-14}$ at 25°C

K_w is temperature-dependent, so neutral pH is 7.00 only at 25°C . Warm water is still neutral at a lower pH.

Properties of Buffers



either way, the pH barely changes

A buffer resists pH change by mopping up added acid or base

Exercises 2.1-2.3

2.1 Which is the stronger acid, HCl or HI?

[1]

2.2 Which is stronger, HClO_4 or HClO ?

[1]

2.3 What two bond properties make an acid ionize more easily?

[2]

Exercises 2.1-2.3

2.1 Which is the stronger acid, HCl or HI? [1]

2.1

- HI
-

2.2 Which is stronger, HClO_4 or HClO ? [1]

2.2

- HClO_4
-

2.3 What two bond properties make an acid ionize more easily? [2]

2.3

- A weaker H-X bond; a more polar H-X bond

Exercises 3.1-3.2

3.1 Among oxoacids of the same central atom, more oxygen atoms make the acid [1]

☐

A weaker

B stronger

C neutral

D basic

3.2 Rank HClO , HClO_2 , HClO_3 from weakest to strongest acid, with a reason. [3]

Exercises 3.1-3.2

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- A weaker
- B stronger
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3.1 B

- stronger

3.2 Rank HClO , HClO_2 , HClO_3 from weakest to strongest acid, with a reason. [3]

3.2

- $\text{HClO} < \text{HClO}_2 < \text{HClO}_3$; more oxygen atoms pull electron density from the O–H bond and stabilize the anion, increasing acid strength

Exercise 3.3

3.3 Explain why HI is a stronger acid than HF, even though F is more electronegative.[2]

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3.3

- The H–I bond is much weaker than H–F (I is a large atom), so H^+ is released more easily; the weaker bond outweighs F's higher electronegativity