

TSSMTM
Creating VCE Success

SAMPLE

Chemistry
Teach Yourself Series
Topic 1: pH (Unit 2)

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Acids and bases

As it appears in Unit 2

Substances can be classified as **acids**, **bases** or neither (**neutral**). They can be classified by testing their properties or studying their chemical formula.

Properties

Properties of acids	Properties of bases
Turn blue litmus red Sour taste Can react with metals to produce hydrogen (not all) Can neutralize bases	Turn red litmus blue Soapy feel Can neutralize acids

Examples

Acids	Neutral	Basic (or alkaline)
HCl H ₂ SO ₄ HNO ₃ CH ₃ COOH	Hexane C ₆ H ₁₄ Ethanol C ₂ H ₅ OH	NaOH LiOH Ca(OH) ₂ NH ₃

The examples above show the definition of an acid or base is not as simple as the presence or absence of hydrogen atoms or OH groups.

Characteristic reactions of acids

Many of the reactions of acids follow general rules;

- acid + metal → salt + hydrogen gas
 $2\text{HCl}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$
- acid + carbonate → salt + carbon dioxide + water
 $2\text{HCl}(\text{aq}) + \text{CaCO}_3(\text{s}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- acid + base → salt + water
 $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$

Review Questions

1. Write a balanced equation for each of the following reactions.

a. nitric acid + magnesium

b. sulfuric acid + magnesium carbonate

c. nitric acid + lithium hydroxide

2. Classify the following as acids or bases or neutral.

HF _____ Mg(OH)₂ _____ HBr _____ C₂H₆ _____ KOH _____

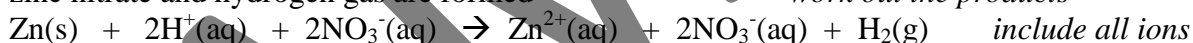
Ionic equations

Ionic equations can be used to provide **more detail** about the reactions occurring. **Spectator ions** are **omitted**.

Examples: Write ionic equations for the following reactions:

1. zinc metal in nitric acid.

zinc nitrate and hydrogen gas are formed



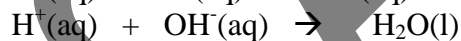
work out the products

include all ions

delete spectator ions

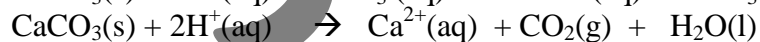
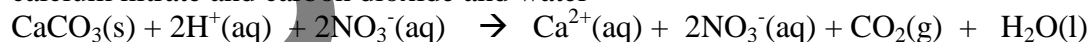
2. hydrochloric acid and lithium hydroxide solutions

lithium chloride and water



3. calcium carbonate added to nitric acid

calcium nitrate and carbon dioxide and water



Review Question

3. Write ionic equations for each of the following;
- a. hydrochloric acid and iron
-

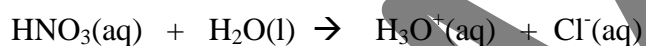
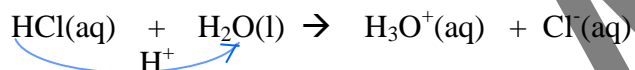
b. sulfuric acid and potassium hydroxide

c. hydrochloric acid and sodium carbonate solid

Acid definition:

A substance that can donate a proton (H^+)

Examples



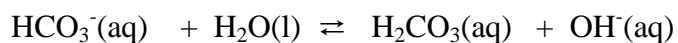
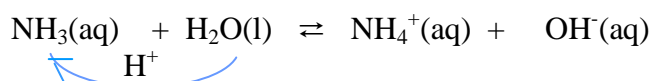
HCl acts as an acid because it donates an H^+ to water. Water is now H_3O^+ , known as a hydronium ion. A chloride ion is also formed.

Hexane is not acidic as it does not donate any of its hydrogen atoms.

Base definition:

A substance that can accept a proton (H^+)

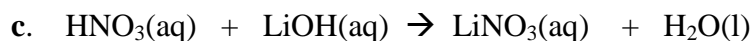
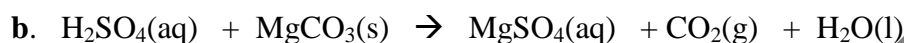
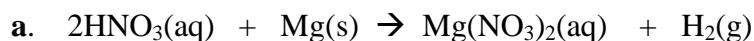
Examples



Ammonia, NH_3 , acts as a base when it accepts a proton to form NH_4^+ .

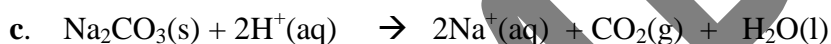
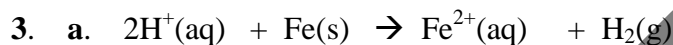
Solutions to Review Questions

1.



2. Classify the following as acids or bases or neutral.

HF acid $\text{Mg}(\text{OH})_2$ base HBr acid C_2H_6 neutral KOH base

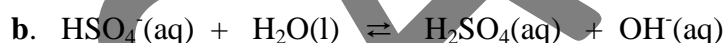


4.

a. HBr(aq): acid $\text{H}_2\text{O}(\text{l})$: base

b. $\text{CH}_3\text{COO}^-(\text{aq})$: base $\text{H}_2\text{O}(\text{l})$: acid

5.

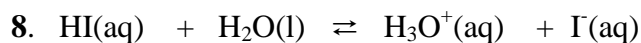


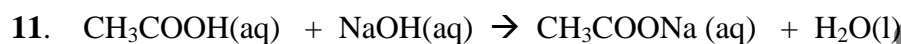
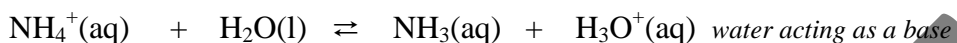
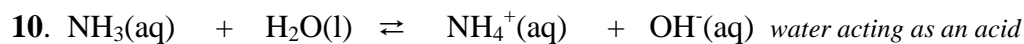
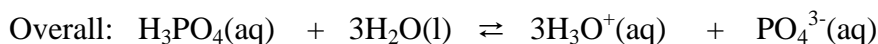
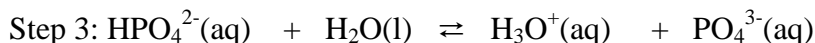
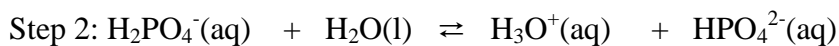
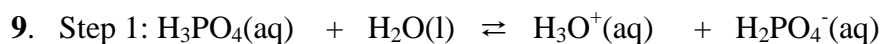
6.

a. HI / I^- b. H_2PO_4^- / HPO_4^{2-} c. NH_4^+ / NH_3

7.

a. HS^- / H_2S b. H_2PO_4^- / H_3PO_4 c. NH_3 / NH_4^+





12.

a. $\text{pH} = -\log_{10}(1.0) = 0$

b. $\text{pH} = -\log_{10}(0.10) = 1$

c. $\text{pH} = -\log_{10}(0.00001) = 5$

13.

concentration M	pH
1.0	0
0.10	1
0.001	3
0.10	1
0.0001	4
0.000001	6

14.

a. $[\text{H}_3\text{O}^+] = 10^{-1} = 0.1 \text{ M}$

b. $[\text{H}_3\text{O}^+] = 10^{-5} = 0.00001 \text{ M}$

15.

a. $[\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$

$[\text{OH}^-] = 0.001 = 10^{-3}$

$\Rightarrow [\text{H}_3\text{O}^+] \times 10^{-3} = 10^{-14}$

$\Rightarrow [\text{H}_3\text{O}^+] = \frac{10^{-14}}{10^{-3}} = 10^{-11} \quad \Rightarrow \text{pH} = -\log(10^{-11}) = 11$

b. $[\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$

$[\text{OH}^-] = 0.01 \times 2 = 0.02$

$\Rightarrow [\text{H}_3\text{O}^+] \times 0.02 = 10^{-14}$

$\Rightarrow [\text{H}_3\text{O}^+] = \frac{10^{-14}}{0.02} = 5 \times 10^{-13} \quad \Rightarrow \text{pH} = -\log(5 \times 10^{-13}) = 12.3$

16. a. Dilution factor of 100 \Rightarrow pH rises by 2 to 4.

b. Dilution factor of 10 \Rightarrow pH drops by 1 to 11.