

Chem!stry

Name: ()

Class:

Date: / /

Defining Rules for the Reactions of Acids – Answers

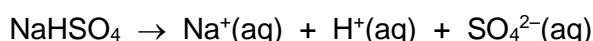
Part One – Definition of an Acid:

The following chemicals are all classified as acids.

Note: (aq) means *aqueous* – dissolved in water. H⁺ is the symbol for a *hydrogen ion*.

Name	Formula	Equation for Acid Dissolving in Water to form an Acidic Solution	Basicity	Strong or Weak Acid
hydrochloric acid	HCl	$\text{HCl}(\text{aq}) \rightarrow \text{H}^+(\text{aq}) + \text{Cl}^-(\text{aq})$	monobasic	strong
nitric acid	HNO ₃	$\text{HNO}_3(\text{aq}) \rightarrow \text{H}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$	monobasic	strong
sulfuric acid	H ₂ SO ₄	$\text{H}_2\text{SO}_4(\text{aq}) \rightarrow 2\text{H}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$	dibasic	strong
phosphoric acid	H ₃ PO ₄	$\text{H}_3\text{PO}_4(\text{aq}) \rightleftharpoons 3\text{H}^+(\text{aq}) + \text{PO}_4^{3-}(\text{aq})$	tribasic	weak
ethanoic acid	CH ₃ COOH	$\text{CH}_3\text{COOH}(\text{aq}) \rightleftharpoons \text{CH}_3\text{COO}^-(\text{aq}) + \text{H}^+(\text{aq})$	monobasic	weak

1. Study the equations for the chemicals dissolving in water to form acidic solutions and identify what they all have in common. Sodium hydrogen sulfate, formula NaHSO₄, dissolves in water according to the equation given below, but it is **not** classified as an acid:



Refer to the equations given in the table along with the equation for sodium hydrogen sulfate.

Use this information to write a universal statement that defines what an acid is.

Acids are chemicals that ionise when dissolved in water to produce hydrogen ions, symbol H⁺, as the *only* positive ion.

2. Hydrochloric acid, nitric acid and ethanoic acid are *monobasic*, sulfuric acid is *dibasic* and phosphoric acid is *tribasic*. Study the equations for the chemicals dissolving in water to form acidic solutions once again. Use evidence from the equations to write statements that define what *monobasic*, *dibasic* and *tribasic* acids are.

When dissolved in water, a monobasic acid can ionise to produce a maximum number of *one* hydrogen ion per molecule of acid / 1 H⁺ ion can be donated / 1 H⁺ ion can be replaced.

When dissolved in water, a dibasic acid can ionise to produce a maximum number of *two* hydrogen ions per molecule of acid / 2 H⁺ ions can be donated / 2 H⁺ ions can be replaced.

When dissolved in water, a tribasic acid can ionise to produce a maximum number of *three* hydrogen ions per molecule of acid / 3 H⁺ ions can be donated / 3 H⁺ ions can be replaced.

3. Hydrochloric acid, nitric acid and sulfuric acid are classified as *strong acids*, while phosphoric acid and ethanoic acid are classified as *weak acids*. The → symbol means that the chemical change is *complete*, moving from left-to-right. The ⇌ symbol means that the chemical change is *incomplete*, as the reaction can move from left-to-right, and also from right-to-left. Use this information to write statements that define what *strong* and *weak* acids are.

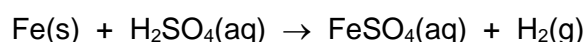
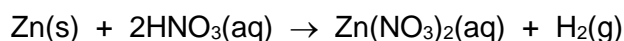
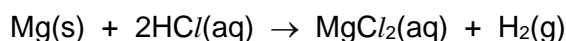
A strong acid will *completely / fully* ionise when dissolved in water (to produce hydrogen ions as the only positive ion).

A weak acid will *incompletely / partially* ionise when dissolved in water (to produce hydrogen ions as the only positive ion).

Part Two – Reactions Between Acids and Metals:

In Chemistry, a *salt* is an ionic compound comprising of a positively charged ion (cation) and a negatively charged ion (anion). The positively charged ion is *nearly* always a metal (the exception being the ammonium ion, NH₄⁺), and the negatively charged ion is always a non-metal. An example of a salt is magnesium chloride, formula MgCl₂, which comprises of a single positive magnesium ion, Mg²⁺, and two negative chloride ions, Cl⁻.

Study the three reactions of acids and metals given below:



1. What do all of the reactions have in common? Use this information to write a universal statement that describes the reaction between an acid and a metal.

An acid reacts with a metal to produce a salt and hydrogen gas as the only reaction products.

2. The reactivities of some metals are given in the table below. The non-metal, hydrogen, has been included for reference.

most reactive	least reactive
potassium > sodium > calcium > magnesium > zinc > iron > [hydrogen] > copper > silver	

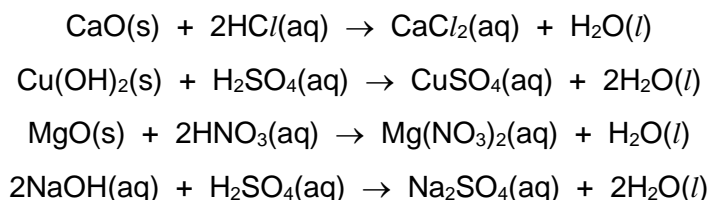
Predict which metals will **not** react with water. Give an explanation for your answer.

The metals copper and silver will not react with acids. Copper and silver are both less reactive than hydrogen. According to evidence from the balanced chemical equations, the metals that react with acids are all more reactive than hydrogen.

Part Three – Reactions Between Acids and Bases:

In Chemistry, *bases* are metal oxides and metal hydroxides. Examples include calcium oxide, formula CaO, and copper(II) hydroxide, formula Cu(OH)₂. If the base is soluble in water, then it can be further classified as an *alkali*.

Study the four reactions of acids and bases given below:



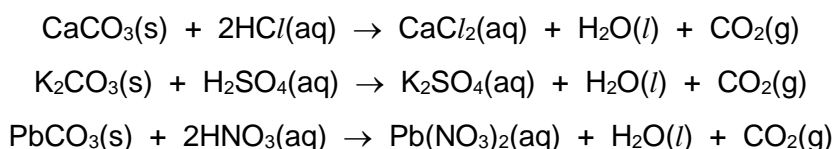
What do all of the reactions have in common? Use this information to write a universal statement that describes the reaction between an acid and a base.

An acid reacts with a base to produce a salt and water as the only reaction products.

Part Four – Reactions Between Acids and Carbonates:

Metal carbonates are compounds that contain a positively charged metal ion (cation) and a negatively charged carbonate ion (anion). A common example of a metal carbonate is chalk, whose chemical name is calcium carbonate, formula CaCO₃, which comprises of a single positive calcium ion, Ca²⁺, and a single negative carbonate ion, CO₃²⁻.

Study the three reactions of acids and metal carbonates given below:



What do all of the reactions have in common? Use this information to write a universal statement that describes the reaction between an acid and a metal carbonate.

An acid reacts with a metal carbonate to produce a salt, water and carbon dioxide as the only reaction products.