Compounds Containing Hydrogen (Acids and others)

The names of molecular compounds containing hydrogen do not usually conform to the systematic nomenclature guidelines.

Many are called by the common, nonsystematic names or by names that do not indicate explicitly the number of H atoms present.

Examples (do not need to memorize all these, should know familiar ones like ammonia, water):

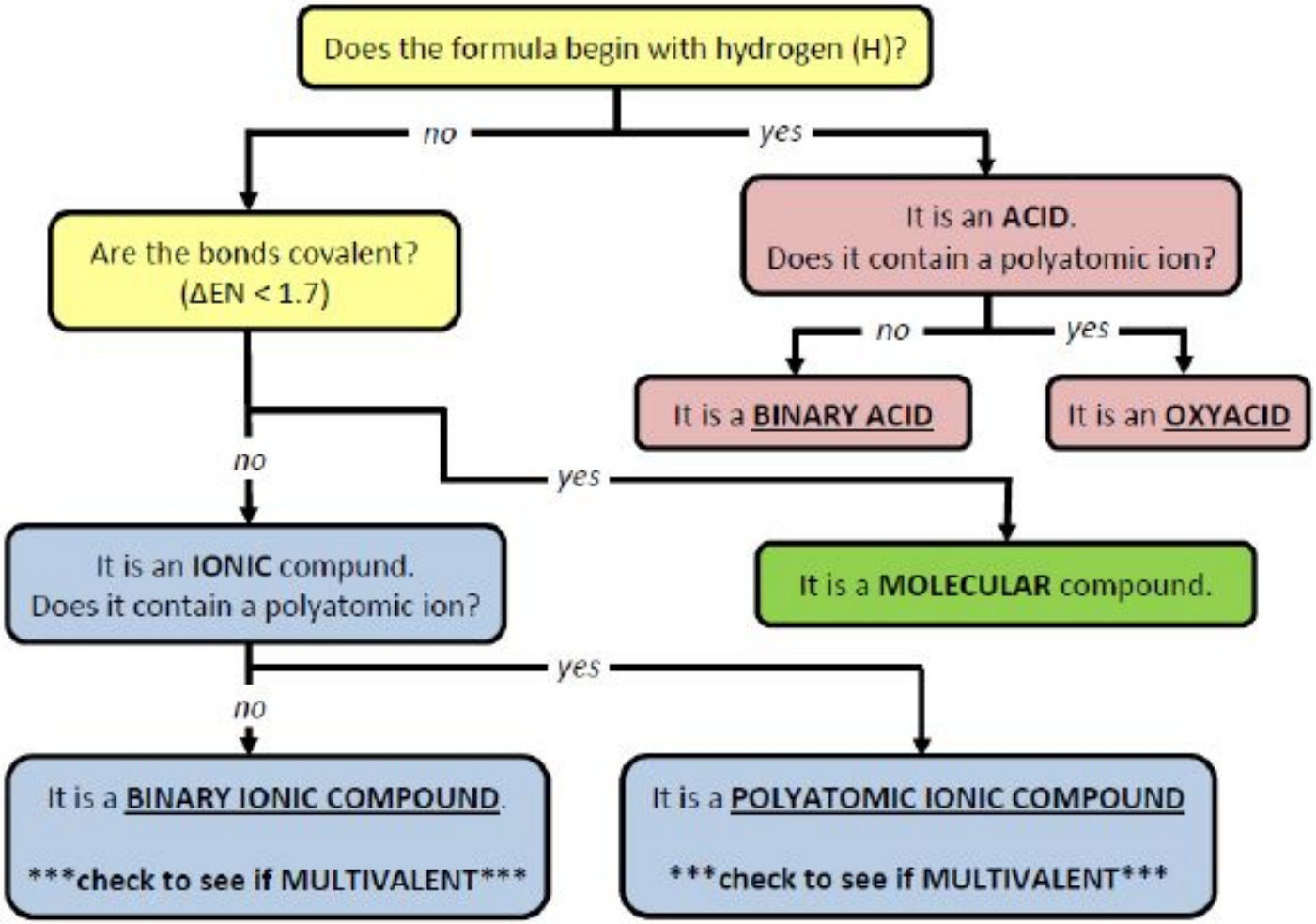
B_2H_6	Diborane
SiH_4	Silane
NH_3	Ammonia
PH_3	Phosphine
H_2O	Water
H_2S	Hydrogen sulfide

Use these Slides in Present Mode: on the practice slides the yellow boxes will disappear on click AFTER you have tried them. Please WRITE your answers, don't just think them. Writing or speaking completes the thinking process and promotes MUCH better learning.

TECH SOLUTIONS

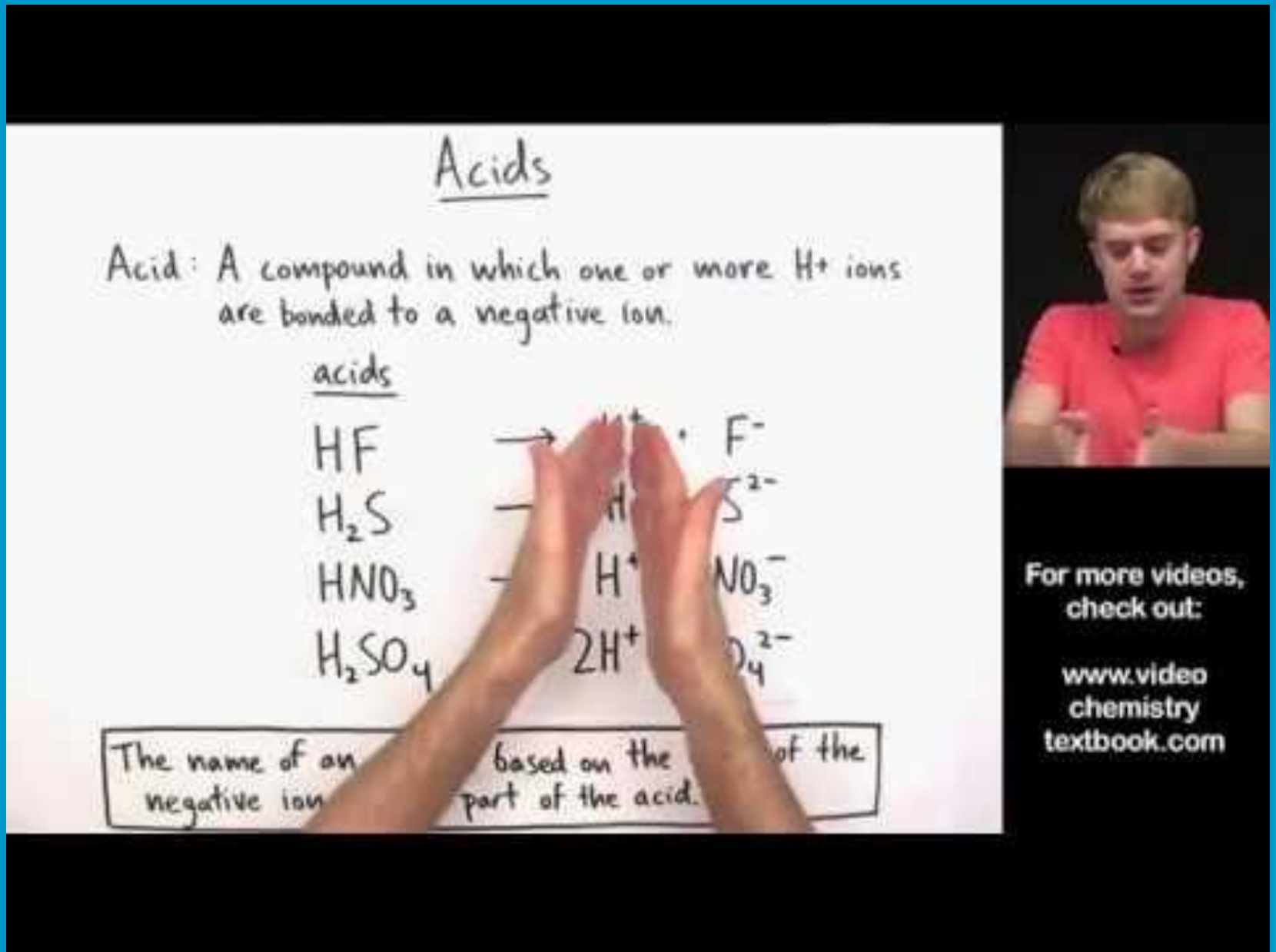
Look for this box throughout for alternative methods for those with slower internet etc. HINT: you can work in Offline mode after accessing once on a device (under file OR settings, depending on device) OR you can print the presentation. It has all the information and you can access the videos as needed when possible.

Nomenclature Decision Flowchart



Video Description OR Skip to Written if preferred.

Click HERE to go to Slide with Video with Practice problems to try



Pneumonic for recalling the patterns you will learn

"My r**ide** has **hydro**l**ic**s, I **ate** something **ic**ky, and Spr**ite** is delici**ous**."

Acid-Forming Compounds

A compound must contain at least one ***ionizable hydrogen atom*** (forms an H+ ion in water) to be an acid upon dissolving.

TABLE 5.7 Some Simple Acids

Formula	Binary compound name	Acid name
HF	Hydrogen fluoride	Hydrofluoric acid
HCl	Hydrogen chloride	Hydrochloric acid
HBr	Hydrogen bromide	Hydrobromic acid
HI	Hydrogen iodide	Hydroiodic acid

Naming Acids: Binary acids

- All acids start with H (e.g. HCl, H_2SO_4)
- TWO acid types exist: binary acids and oxyacids

Binary Acids: H + non-metal. E.g. HCl

Oxyacids: H + polyatomic ion. E.g. H_2SO_4

ACIDS

- The two acid types have different naming rules.

Binary acids: naming depends on state → the molecules only have acidic properties when dissolved in water (aqueous state).

• If it's NOT aqueous it is named with ionic rules:
hydrogen + non-metal name
eg. $HCl_{(g)}$ = hydrogen chloride

•If it IS aqueous: hydro + non-metal + ic acid
$HCl_{(aq)}$ = hydrochloric acid

Pneumonic for recalling the patterns you will learn

My r**ide** has **hydro**l**ic**s matches this naming pattern

Practice (Present mode!- pay attention to state

$HBr_{(s)}$

$HI_{(aq)}$

$H_2S_{(aq)}$

$H_2S_{(g)}$

TECH SOLUTIONS

See slides at the end without the boxes. If printed off or working in offline mode, cover the answers and attempt to name.

Naming Acids: Oxyacids

Click to watch a video on naming oxyacids with practice for simple acids as well. **The rules are written on the next slide for you.**

Practice questions are embedded. Please attempt them for your learning but they are NOT formally assessed.

TECH SOLUTION

Link to youtube video without embedded questions for those with limited internet access. Use printable resources to practice.

Naming Acids: Oxyacids

1) name the polyatomic ion

2) replace ate with ic OR ite with ous

3) change non-metal root for pronunciation (eg sulphuric is nicer to say than sulphic)

4) add "acid" to the name

E.g. H_2SO_3 → **follow steps #1-4 above:**

1) sulphite, 2) sulphous,
3) sulphurous, 4) sulphurous acid

Final name

Pneumonic for recalling the patterns you will learn

I **ate** something **ic**ky, and Spr**ite** is delici**ous**.”

This part of the pneumonic matches these naming rules

Rule Summary & Exceptions

Acids

-Compound where one or more H+ ions are bonded to a negative ion

Binary Acids

-Hydrogen + Nonmetal

Binary compound name→**ide**

Ex. $HF_{(g)}$ Hydrogen fluor**ide**

- Acid name

ide→Hydro____-ic acid

Ex. $HF_{(aq)}$ = Hydrofluoric acid

Oxyacids

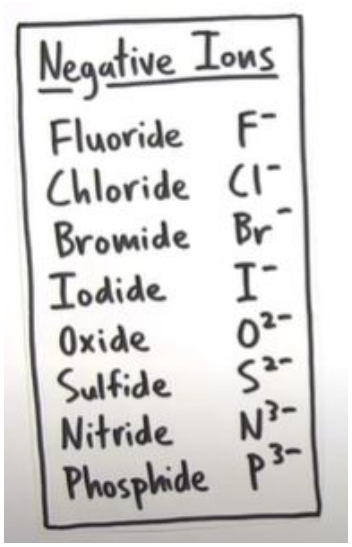
- H + polyatomic ion

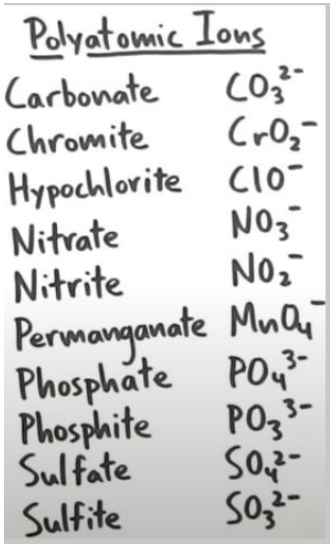
ate → **-ic acid**

Ex. H_2CO_3 = Carbon**ic acid**

ite → **-ous acid**

Ex. HNO_2 = Nitr**ous acid**





Important exceptions(polyatomic ion):

-phosphate= phosph**or**ic acid

-Phosphite=Phosph**or**ous acid

-Sulfate=Sulf**ur**ic acid

-Sulfite= Sulf**ur**ous acid

Practice (in present mode, boxes disappear on click after you try them.

1. nitrous acid

2. phosphoric acid

3. $HClO_{(aq)}$

4. $H_2CO_{3(aq)}$

TECH SOLUTIONS
See slides at the end without the boxes. If printed off or working in offline mode, cover the answers and attempt to name.

Special Nomenclature Case - Hydrates

A hydrate is an ionic compound that has water molecules incorporated into their solid structures. NOTE: these are NOT acids. ANY ionic compound that does this with water is a hydrate.

Writing the formula: name of ionic compound · #H_2O

Olmsted Williams

Pg 89

The Hydrate of copper sulfate is the pentahydrate, and the anhydrous copper sulfate will absorb water to form the Hydrate.

$CuSO_4 \cdot 5\ H_2O$

Copper(II)sulfate·pentahydrate

Special case → Hydrates

A ***hydrate*** is a compound that has a specific number of water molecules trapped within its solid structure. The water trapped in the solid crystal is called the water of hydration.

For example, in its normal state, copper(II) sulfate has five water molecules associated with it. Name compound as usual. Add hydrate with the prefix indicating the number of water molecules.

Systematic name: copper(II) sulfate pentahydrate

Formula: $\boldsymbol{CuSO_4 \cdot 5H_2O}$

Some other hydrates are

$BaCl_2 \cdot 2H_2O$

$LiCl \cdot H_2O$

$MgSO_4 \cdot 7H_2O$

$Sr(NO_3)_2 \cdot 4H_2O$

Note the dot between the main compound and associated water molecules.

Optional 3 minute video on Hydrates

Click here

{FYI, I can't embed the ones with questions inserted into Slides)

Hydrates - Anhydrous

When the water molecules are driven off by heating, the resulting compound, $CuSO_4$, is sometimes called anhydrous copper(II) sulfate.

Anhydrous means the compound no longer has water molecules associated with it.
This is why we use a dot in the formula because the heating of the compound removes the ASSOCIATED water molecules but does not alter the salt formula OR properties. The water is NOT bound to or part of the salt.

Watch a Hydrate Expt (<3mins)

{Not req'd if you have tech challenges but good to watch if possible}

RECALL: Bases & Naming

Reminder: A **base** can be defined as a substance that yields hydroxide ions (OH^-) when dissolved in water. There are no special naming rules for bases.

NaOH	sodium hydroxide
KOH	potassium hydroxide
$Ba(OH)_2$	barium hydroxide

For Interest : Familiar Compounds

TABLE 5.11 Common and Systematic Names of Some Familiar Inorganic Compounds

Formula	Common name	Systematic name
H_2O	Water	Dihydrogen monoxide
NH_3	Ammonia	Trihydrogen nitride
CO_2	Dry ice	Solid carbon dioxide
NaCl	Salt	Sodium chloride
N_2O	Nitrous oxide, laughing gas	Dinitrogen monoxide
$CaCO_3$	Marble, chalk, limestone	Calcium carbonate
$NaHCO_3$	Baking soda	Sodium hydrogen carbonate
$MgSO_4 \cdot 7H_2O$	Epsom salt	Magnesium sulfate heptahydrate
$Mg(OH)_2$	Milk of magnesia	Magnesium hydroxide

If you are feeling confident, you CAN STOP HERE and continue to the nomeclature sheets practice on the unit plan. Remaining slides provide more Worked examples and another video for those that need further assistance.

Worked Example 5.10

Name the following species: (a) BrO_4^-, (b) HCO_3^-, and (c) H_2CO_3.

Strategy Each species is either an oxyanion or an oxyacid. Identify the "reference ion" (the one with the *–ate* ending) for each, and apply the rules to determine appropriate names.

Solution (a) BrO_4^- has one more O atom than the bromate ion (BrO_3^-), so BrO_4^- is the *perbromate* ion.

(b) CO_3^{2-} is the carbonate ion. Because HCO_3^- has one ionizable hydrogen atom, it is called the *hydrogen carbonate ion*.

(c) With two ionizable hydrogen atoms and no charge on the compound, H_2CO_3 is *carbonic acid*.

Worked Example 5.11

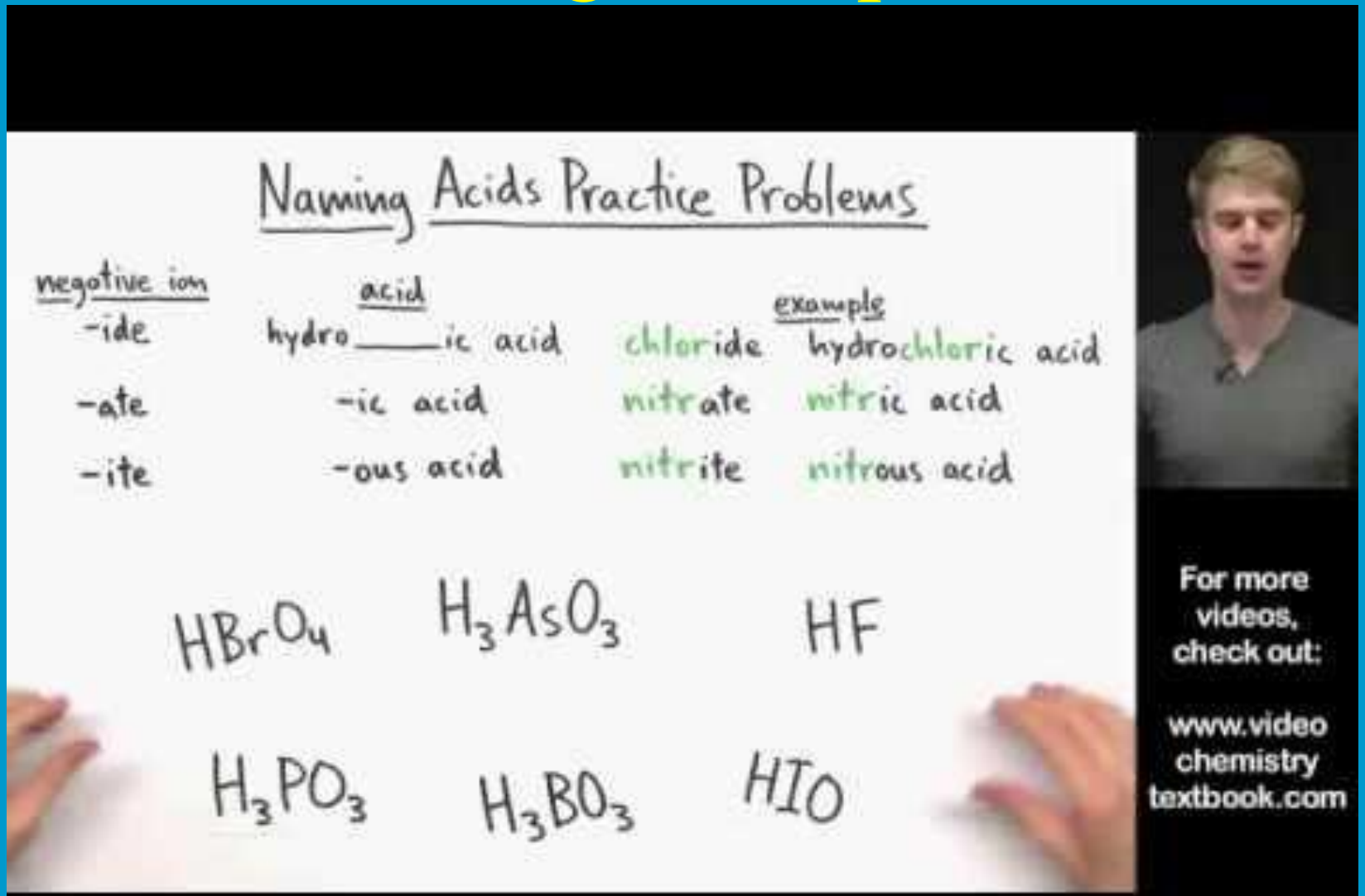
Determine the formula of sulfurous acid.

Strategy The *–ous* ending in the name of an acid indicates that the acid is derived from an oxyanion ending in *–ite*. The oxyanion must be sulfite, SO_3^{2-}, so add enough hydrogen ions to make a neutral formula.

Solution The formula of sulfurous acid is H_2SO_3.

Think About It Remembering all these names and formulas is greatly facilitated by memorizing the common ions that end in *-ate*.

Naming acids practice



Tech solutions:
Remainder of Slides are duplicates of above to help those with tech challenges.

Stop here if you were able to fully access the presentation above.

Practice (Present mode!- pay attention to state

$HBr_{(s)}$ **hydrogen bromide**

$HI_{(aq)}$ **hydroiodic acid**

$H_2S_{(aq)}$ hydrosulfuric acid

$H_2S_{(g)}$ **hydrogen sulfide**

TECH SOLUTIONS
See slides at the end without the boxes. If printed off or working in offline mode, cover the answers and attempt to name.

Practice (in present mode, boxes disappear on click after you try them.

1. nitrous acid — $HNO_{2(aq)}$
2. phosphoric acid — $H_3PO_{4(aq)}$
3. $HClO_{(aq)}$ — hypochlorous acid
4. $H_2CO_{3(aq)}$ — carbonic acid