Welcome to our CHEM 4 lecture

Review question: Writing Net Ionic Equations
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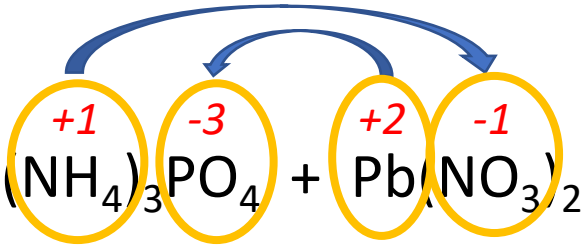
1) What is on the product side of the balanced net ionic equation (NIE) when aqueous solutions of ammonium phosphate and lead(II) nitrate are combined?
   A) $2\ Pb_3(PO_4)_2(s)$
   B) $6\ NH_4NO_3(s) + 3Pb^{2+}(aq) + 2PO_4^{3-}(aq)$
   C) $6\ NH_4NO_3(s)$
   D) $6\ NH_4^+(aq) + 6\ NO_3^-(aq) + Pb_3(PO_4)_2(s)$
   E) $Pb_3(PO_4)_2(s)$
   F) $4\ NH_4NO_3(s)$
   G) "No Reaction" (all the ions are spectators)

See work shown on next slide…

Work shown for question from previous slide…

1) What is on the product side of the balanced net ionic equation (NIE) when aqueous solutions of ammonium phosphate and lead(II) nitrate are combined?

Answer:



Reactants: $(NH_4)_3PO_4 + Pb(NO_3)_2$ **Products:** $NH_4NO_3 + Pb_3(PO_4)_2$

Molecular: $2\ (NH_4)_3PO_4(aq) + 3\ Pb(NO_3)_2(aq) \rightarrow 6\ NH_4NO_3(aq) + Pb_3(PO_4)_2(s)$

The states come from the solubility rules we saw last class

Complete ionic:

$6NH_4^+(aq) + 2PO_4^{3-}(aq) + 3Pb^{2+}(aq) + 6NO_3^-(aq) \rightarrow 6NH_4^+(aq) + 6NO_3^-(aq) + Pb_3(PO_4)_2(s)$

Cancel the spectator ions

Keep the (s) together

NIE: $2\ PO_4^{3-}(aq) + 3\ Pb^{2+}(aq) \rightarrow Pb_3(PO_4)_2(s)$

The next few weeks…

Week 13: November 23 (Monday)	November 25(Wednesday)	November 27 (Friday)
Before class: • Read 7.8 [acid-base reactions] (*30 min*) **PAL worksheets for week 13:** A and no PALs	**No live lecture today** **In lieu of lecture:** • No new reading, continue with 7.8 [gas forming reactions] • Asynchronous lecture: PowerPoint slides and recording *(45 min)* • MasteringChemistry: Assign #28a (*60 min*) **[Due: M, 11/30]** • Before class on **F, 12/11** is the last day to submit late homework for credit. • Prepare for our review session **[W, 12/2]** and Exam#3 **[F, 12/4].** ◦ Learning outcomes for Exam #3 ◦ Practice: A, B, C and D *(50 min each)*	**No Class:** Thanksgiving Holiday
After class: • Today's PowerPoint slides and recording *(45 min)* • MasteringChemistry #28 (*20 min*) **[Due: M, 11/30]** • You have from today until Dec 11 to complete your online CHEM 4 student evaluation. Here is a video explaining the process.		

Week 14: November 30 (Monday)	December 2 (Wednesday)	December 4 (Friday)
Before class: • Read 7.9-7.10 [types of reactions] (*1 hr*) **PAL worksheets for week 14:** A	**Before class:** • I'll spend the review session answering your questions from **Practice Exam #3** (A, B, C and D)	**Today in class: Exam #3 (in Canvas)** • Learning outcomes for Exam #3 • **Covers:** Cumulative, but stresses material since last exam (6.1-6.9, 3.7, 7.1-7.10). • **Practice**: A, B, C and D *(50 min each).(50 min each).*
After class: • Today's PowerPoint slides and recording *(45 min)* • MasteringChemistry #29 (*50 min*) **[Due: W, 4/29]** • Prepare for our review session **[W, 12/2]** and Exam#3 **[F, 12/4].** ◦ Learning outcomes for Exam #3 ◦ Practice: A, B, C and D *(50 min each)* ◦ Email Jeff (**jparadis@csus.edu**) with any practice exam questions you want him to go over during the review session on Wednesday. **Priority will be given to questions sent by 12 noon on Tuesday, Dec 1.**	**After class:** • Finish preparing for Exam#3 **[F, 12/4].** ◦ Learning outcomes for Exam #3 ◦ Practice: A, B, C and D *(50 min each)*	**After class:** • Before class on **F, 12/11** is the last day to submit late homework for credit. • You have until Dec 11 to complete your online CHEM 4 student evaluation in Canvas. Here is a video explaining the process.

CHEM 4 lecture

Monday, November 23, 2020

Sec 7.8

Acid-base reactions

Reading question: Acids and bases (Sec 7.8)
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2) Which of the following statements about acids and bases is false?

A) Acids taste sour and can dissolve some metals

B) Lemons, limes, and vinegars contain acids

C) Bases taste sweet and feel sticky

D) Acids generate H^+ ions when added to water

E) Neutralization reactions generally form water and a salt

F) $HClO_4(aq)$ is called perchloric acid

G) Bases generate OH^- ions when added to water

H) Soap, coffee, and milk of magnesia contain bases

Background: Acids and bases

- Review how to name acids (chapter 5.9)
- Easy to recognize: formula starts with "H" and usually written with "(aq)"
- Not in your book: Acids can be **strong** or **weak**. [In CHEM 4, I'll tell you which.]

Example:

nitric acid = strong acid

$HNO_3(aq) \rightarrow H^+(aq) + NO_3^-(aq)$

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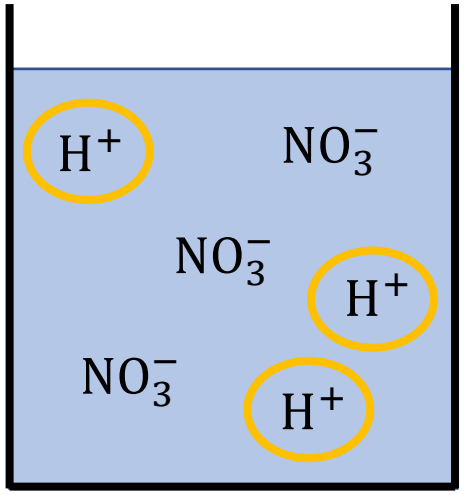
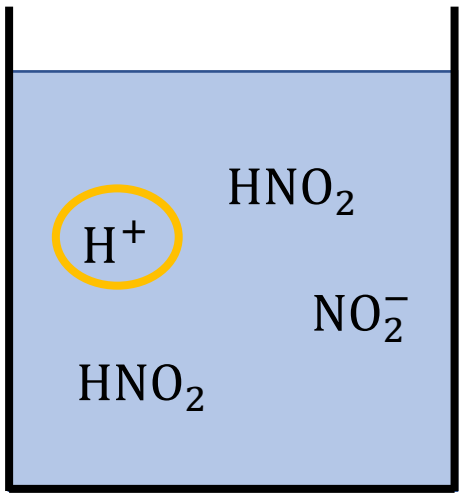


Strong acids, like HNO_3, are good at doing what acids do… they make a lot of H^+ ions.

nitrous acid = weak acid

$HNO_2(aq) \leftrightarrow H^+(aq) + NO_2^-(aq)$

95% left *5%*



Weak acids, like HNO_2, are not good at being acids… they don't make a lot of H^+ ions. **Leave weak acids together in NIE**

Clicker question: Drawing acids

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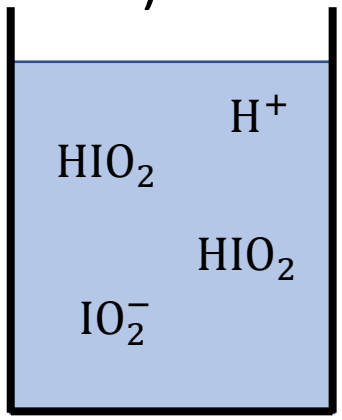
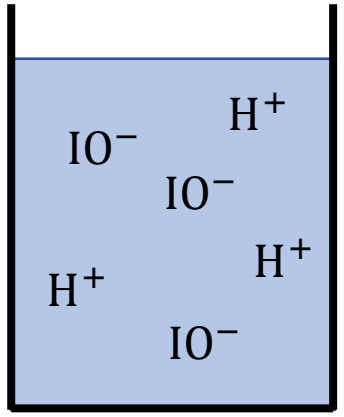
3) Which of the following is the best representation of hypoiodous acid (a weak acid) in water?

HIO (aq)

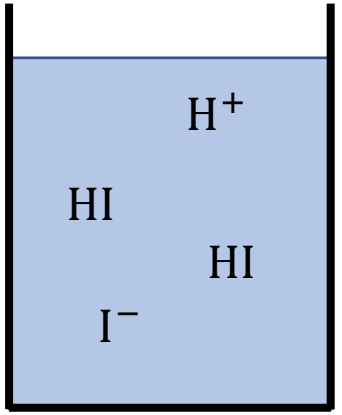
A)



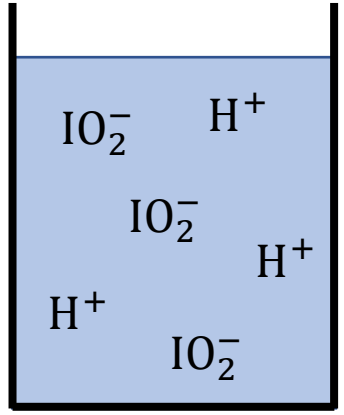
B)



C)

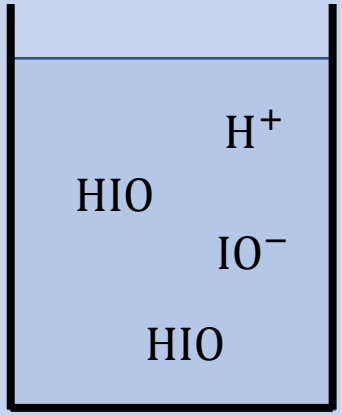


D)

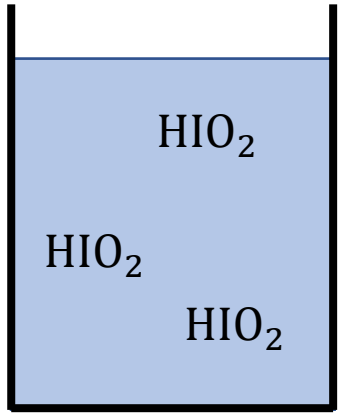


A), C), D) and F) have the wrong acid formula. B) and H) have the right formula, but B) looks like a strong acid and H) doesn't look like an acid.

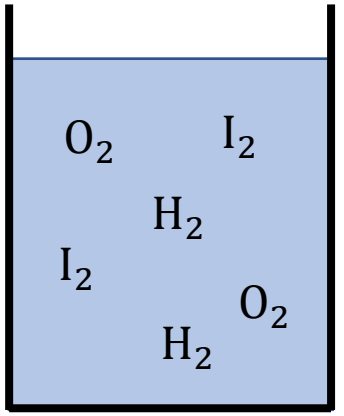
E)



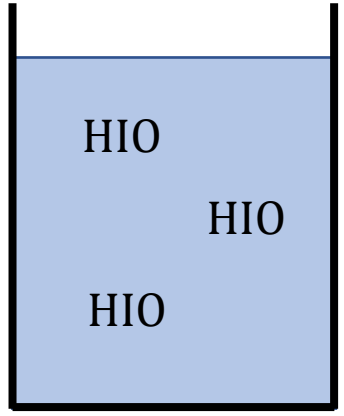
F)



G)



H)



Background: Acids and bases

- Not in your book: Bases can be **strong** or **weak**.
- Strong bases are the soluble metal hydroxides (from our solubility rules):

  $LiOH$, $NaOH$, KOH, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$.
- The only weak base you need to know right now is ammonia: NH_3.

Example:

calcium hydroxide = strong base

$Ca(OH)_2(aq) \rightarrow Ca^{2+}(aq) + 2OH^-(aq)$

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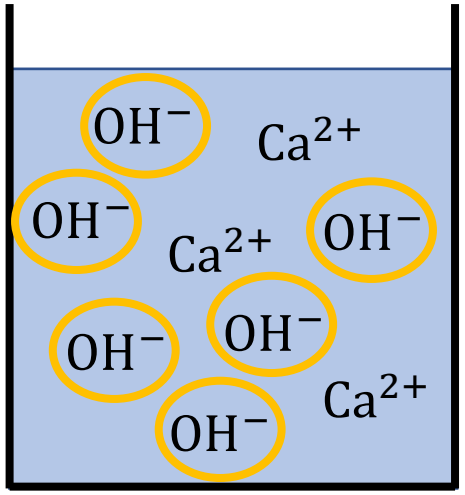
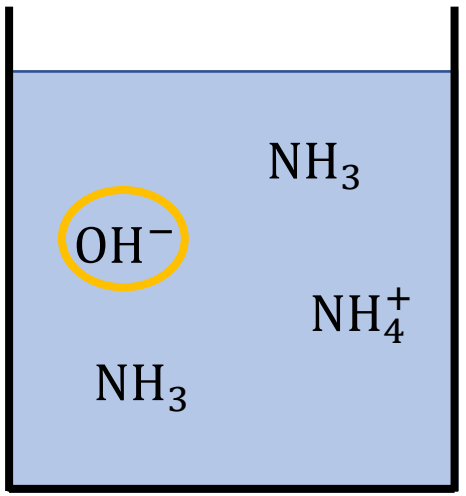


Strong bases, like $Ca(OH)_2$, are good at doing what bases do… they make a lot of OH^- ions.

ammonia = weak base

$NH_3(aq) + H_2O(l) \leftrightarrow NH_4^+(aq) + OH^-(aq)$

95% left *5%*



Weak bases, like NH_3, are not good at being bases… they don't make a lot of OH^- ions. **Leave weak bases together in NIE**

Background: Acid-base neutralization reactions

- Also called neutralization reactions
- Generic form: **Acid + Base → Salt + Water**
- To predict the "salt", we use the same approach as in our precipitation reactions… we switch the ions. The H^+ from the acid and the OH^- from the base make the H_2O.

Example: Write the NIE for the reaction of aqueous hydrobromic acid (a strong acid) with barium hydroxide (a strong base).

Reactants: $\overset{+1\ -1}{HBr(aq)} + \overset{+2\ \ -1}{Ba(OH)_2(aq)}$ **Products:** $H_2O(l) + BaBr_2(aq)$

Molecular: $2\ HBr(aq) + Ba(OH)_2(aq) \rightarrow 2\ H_2O(l) + BaBr_2(aq)$

acid *base* *water* *salt*

Complete ionic: $2H^+(aq) + 2Br^-(aq) + Ba^{2+}(aq) + 2OH^-(aq) \rightarrow 2\ H_2O(l) + Ba^{2+}(aq) + 2Br^-(aq)$

NIE: $2\ H^+(aq) + 2\ OH^-(aq) \rightarrow 2\ H_2O(l)$

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

Clicker question: Balancing a chemical reaction
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4) Below is the molecular equation for the reaction of acetic acid (a weak acid) and potasium hydroxide. Which of the following is the NIE for this reaction?

$HC_2H_3O_2(aq) + KOH(aq) \rightarrow H_2O(l) + KC_2H_3O_2(aq)$

weak acid base water salt

A) $HC_2H_3O_2(aq) + KOH(aq) \rightarrow H_2O(l) + KC_2H_3O_2(aq)$
B) $C_2H_3O_2^-(aq) + K^+(aq) \rightarrow KC_2H_3O_2(aq)$
C) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
D) $HC_2H_3O_2(aq) + OH^-(aq) \rightarrow H_2O(l) + C_2H_3O_2^-(aq)$
E) "No Reaction" (all the ions are spectators)

Answer: Leave both the H_2O (a liquid) and the $HC_2H_3O_2$ (a weak acid) together

Complete: $HC_2H_3O_2(aq) + K^+(aq) + OH^-(aq) \rightarrow H_2O(l) + K^+(aq) + C_2H_3O_2^-(aq)$

NIE: $HC_2H_3O_2(aq) + OH^-(aq) \rightarrow H_2O(l) + C_2H_3O_2^-(aq)$