Silver acetate, $AgC_2H_3O_2$, precipitates.

(c) barium nitrate + ammonium phosphate $\rightarrow$ barium phosphate + ammonium nitrate
barium phosphate—low solubility
ammonium nitrate—soluble
Barium phosphate, $Ba_3(PO_4)_2$, precipitates.

(d) sodium hydroxide + calcium nitrate $\rightarrow$ calcium hydroxide + sodium nitrate
calcium hydroxide—low solubility
sodium nitrate—soluble
Calcium hydroxide, $Ca(OH)_2$, precipitates.

3. (a) Sr(NO3)2(aq) + Na2SO4(aq) $\rightarrow$ SrSO4(s) + 2 NaNO3(aq)
$Sr^{2+}_{(aq)} + 2\,NO^{-}_{3(aq)} + 2\,Na^{+}_{(aq)} + SO^{2-}_{4(aq)} \rightarrow SrSO_{4(s)} + 2\,Na^{+}_{(aq)} + 2\,NO^{-}_{3(aq)}$ (total ionic equation)
$Sr^{2+}_{(aq)} + \cancel{2\,NO^{-}_{3(aq)}} + \cancel{2\,Na^{+}_{(aq)}} + SO^{2-}_{4(aq)} \rightarrow SrSO_{4(s)} + \cancel{2\,Na^{+}_{(aq)}} + \cancel{2\,NO^{-}_{3(aq)}}$
$Sr^{2+}_{(aq)} + SO^{2-}_{4(aq)} \rightarrow SrSO_{4(s)}$ (net ionic equation)

(b) $NaC_2H_3O_{2(aq)} + AgNO_{3(aq)} \rightarrow AgC_2H_3O_{2(s)} + NaNO_{3(aq)}$
$Na^{+}_{(aq)} + C_2H_3O_2{}^{-}_{(aq)} + Ag^{+}_{(aq)} + NO^{-}_{3(aq)} \rightarrow AgC_2H_3O_{2(s)} + Na^{+}_{(aq)} + NO^{-}_{3(aq)}$ (total ionic equation)
$\cancel{Na^{+}_{(aq)}} + C_2H_3O_2{}^{-}_{(aq)} + Ag^{+}_{(aq)} + \cancel{NO^{-}_{3(aq)}} \rightarrow AgC_2H_3O_{2(s)} + \cancel{Na^{+}_{(aq)}} + \cancel{NO^{-}_{3(aq)}}$
$Ag^{+}_{(aq)} + C_2H_3O_2{}^{-}_{(aq)} \rightarrow AgC_2H_3O_{2(s)}$ (net ionic equation)

(c) $3\,Ba(NO_3)_{2(aq)} + 2\,(NH_4)_3PO_{4(aq)} \rightarrow Ba_3(PO_4)_{2(s)} + 6\,NH_4NO_{3(aq)}$
$3\,Ba^{2+}_{(aq)} + 6\,NO^{-}_{3(aq)} + 6\,NH^{+}_{4(aq)} + 2\,PO^{3-}_{4(aq)} \rightarrow Ba_3(PO_4)_{2(s)} + 6\,NH^{+}_{4(aq)} + 6\,NO^{-}_{3(aq)}$ (total ionic equation)
$3\,Ba^{2+}_{(aq)} + \cancel{6\,NO^{-}_{3(aq)}} + \cancel{6\,NH^{+}_{4(aq)}} + 2\,PO^{3-}_{4(aq)} \rightarrow Ba_3(PO_4)_{2(s)} + \cancel{6\,NH^{+}_{4(aq)}} + \cancel{6\,NO^{-}_{3(aq)}}$
$3\,Ba^{2+}_{(aq)} + 2\,PO^{3-}_{4(aq)} \rightarrow Ba_3(PO_4)_{2(s)}$ (net ionic equation)

(d) $2\,NaOH_{(aq)} + Ca(NO_3)_{2(aq)} \rightarrow Ca(OH)_{2(s)} + 2\,NaNO_{3(aq)}$
$2\,Na^{+}_{(aq)} + 2\,OH^{-}_{(aq)} + Ca^{2+}_{(aq)} + 2\,NO^{-}_{3(aq)} \rightarrow Ca(OH)_{2(s)} + 2\,Na^{+}_{(aq)} + 2\,NO^{-}_{3(aq)}$ (total ionic equation)
$\cancel{2\,Na^{+}_{(aq)}} + 2\,OH^{-}_{(aq)} + Ca^{2+}_{(aq)} + \cancel{2\,NO^{-}_{3(aq)}} \rightarrow Ca(OH)_{2(s)} + \cancel{2\,Na^{+}_{(aq)}} + \cancel{2\,NO^{-}_{3(aq)}}$
$Ca^{2+}_{(aq)} + 2\,OH^{-}_{(aq)} \rightarrow Ca(OH)_{2(s)}$ (net ionic equation)

Making Connections

4. Pollutants in natural water can enter the water cycle through runoff from agricultural areas or landfills, or industrial tailings ponds. Some pollutants are toxic and/or noxious at extremely low concentrations, so they may be dangerous even if they have very low solubility.

1.16 ACTIVITY: ANALYZING A HOUSEHOLD CLEANING PRODUCT

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Materials

(a) Student answers will vary depending on the cleaning product chosen. Possible ions are ammonium ions and/or hydroxide ions. We will need a solution containing calcium ions.

Observations

Table 1 Precipitation Reactions

Ionic solution	Reacting ions	Formation of precipitate? (P or NP)	Precipitate formed	Ion present
OH^-	Ca^{2+}	P	calcium hydroxide, $Ca(OH)_2$	OH^-

Student answers will vary depending on which cleaning product they are using.

Analysis

(b) Student answers will vary. In the example, hydroxide ions are present in the cleaning product.

(c) Qualitative analysis of consumer products is integral to maintaining product standards. If products are not subjected to quality control tests, manufacturers could produce defective or unsafe products that may harm consumers, who will then no longer buy the product. Manufacturers of all kinds of products (food, mechanical, technological, etc.) depend on quality control technicians to ensure that products meet proper standards.

(d) $Ca^{2+}_{(aq)} + 2\ OH^{-}_{(aq)} \rightarrow Ca(OH)_{2(s)}$

Evaluation

(e) Student answers will vary. Calcium chloride was effective in causing hydroxide ions to precipitate.

1.17 ACTIVITY: DETERMINING THE PRESENCE OF IONS IN A SOLUTION

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Experimental Design

(a) Using the flow chart in **Figure 1** of the Student Text, the presence of ferrocyanide, chloride, and sulfate ions will be tested, one at a time, using precipitation reactions. If a precipitate forms, it will be removed using a centrifuge. After removing the precipitate, the remaining supernate will be further tested for any remaining ion(s).

Procedure

(b) Student answers will vary. A sample procedure is provided below.

1. Obtain a sample solution from the teacher and place it in the test-tube rack.
2. Obtain three test tubes from the teacher, each containing one of the following solutions: silver nitrate, $AgCl_{(aq)}$, barium nitrate, $Ba(NO_3)_{2(aq)}$, and zinc nitrate, $Zn(NO_3)_2$. Place these test tubes in the test-tube rack.
3. Carefully pour the sample solution from the test tube into a centrifuge tube so that the centrifuge tube is $\frac{1}{3}$ full.
4. Using an eyedropper, add a few drops of zinc nitrate solution to the sample solution. Observe what happens. Record your observations. If a precipitate forms, continue adding zinc nitrate solution until no more precipitate forms, then go to step 5. If no precipitate forms, go to step 7.
5. Place the centrifuge tube containing the precipitate into the centrifuge. (Your teacher will give you specific instructions on how to use the centrifuge in your school). Spin for approximately 1 min.
6. Remove the centrifuge tube and slowly decant the supernate into a clean centrifuge tube. Place the centrifuge tube containing the precipitate into the test-tube rack.
7. Using a clean eyedropper, add a few drops of barium nitrate solution to the sample solution or supernate. Observe what happens. Record your observations. If a precipitate forms, continue adding barium nitrate solution until no more precipitate forms, then go to step 8. If no precipitate forms, go to step 10.
8. Place the centrifuge tube containing the precipitate into the centrifuge. Spin for approximately 1 min.
9. Remove the centrifuge tube and slowly decant the supernate into a clean centrifuge tube. Place the centrifuge tube containing the precipitate into the test-tube rack.
10. Using a clean eyedropper, add a few drops of silver nitrate solution to the sample solution or supernate. Observe what happens. Record your observations.