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).

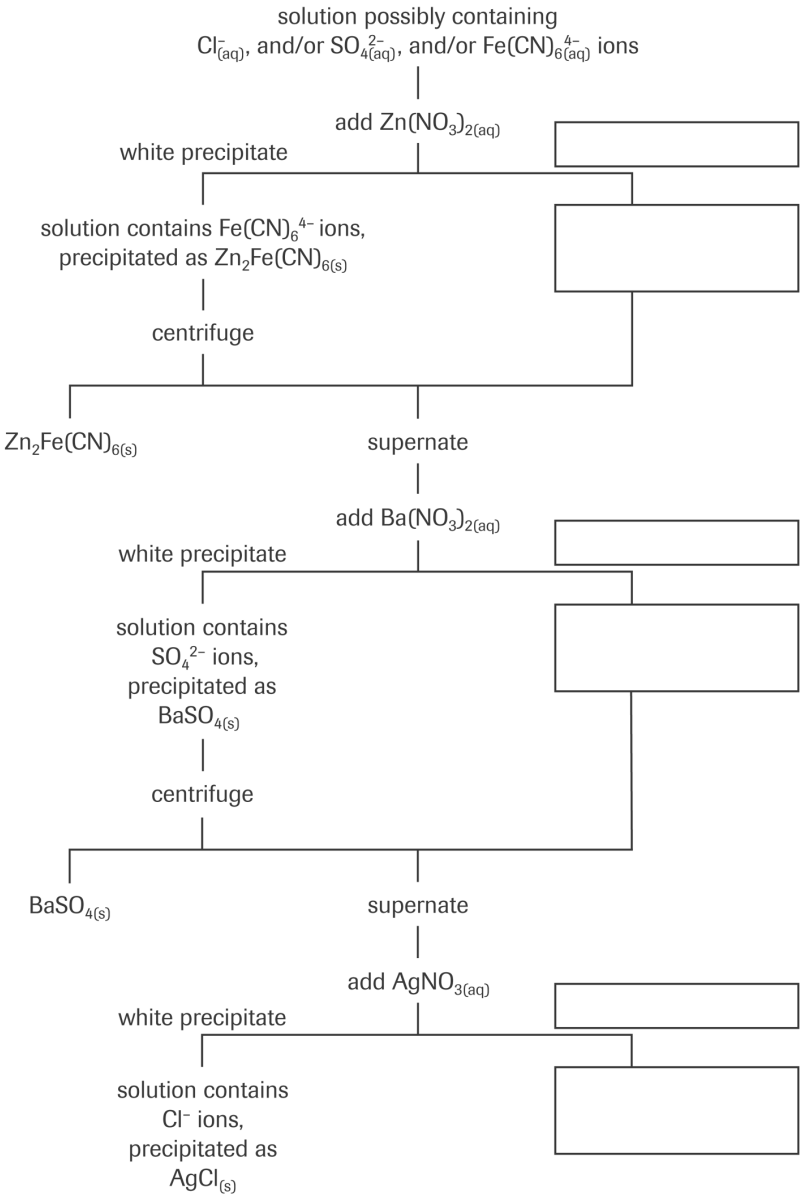
Procedure

(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.

Observations

Student answers will vary. A sample flow chart is provided, assuming that all three ions were present.



Analysis

(c) Student answers will vary depending on the sample they are provided with. In this example, the sample contained all three ions: ferrocyanide, $Fe(CN)_{6(aq)}^{4-}$, chloride, $Cl^-_{(aq)}$, and sulfate, $SO_{4(aq)}^{2-}$, ions.

(d) All the possible net ionic equations are as follows.

$2\ Zn^{2+}_{(aq)} + Fe(CN)^{4-}_{6(aq)} \rightarrow Zn_2Fe(CN)_{6(s)}$

$Ba^{2+}_{(aq)} + SO^{2-}_{4(aq)} \rightarrow BaSO_{4(s)}$

$Ag^{+}_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

Evaluation

(e) Two possible sources of error are the use of impure solutes and incomplete precipitation of ions. To reduce these sources of error, make sure that pure solvents are used when making up the solutions, and make sure that the ions in solutions have completely precipitated before placing the precipitate into the centrifuge.