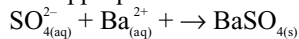


Analysis

- (j) The appropriate balanced chemical equation is:



Results will vary depending on values obtained in the experiment. Using the data in **Table 2**,

$$[\text{SO}_4^{2-}] = \frac{22 \text{ mg}}{0.040 \text{ L}} = 550 \text{ mg/L}$$

The concentration of sulfate ions in the water sample is 550 mg/L.

- (k) Answers may vary depending on experimental results. Using the data in (j), the concentration of sulfate ions in the local water supply is 550 ppm.

Evaluation

- (l) Potential sources of error include recording an inaccurate mass for the filter paper and precipitate since most school laboratory scales are not precise for very small masses. Some precipitate could have been lost from not rinsing the beaker completely, while transferring the filter paper from the funnel to the 150-mL beaker, or while transferring the dried filter paper from the beaker to the scale. Other sources of error include measurement errors and insufficient drying.
- (m) Suggestions for reducing the sources of error include placing the funnel and filter paper inside a beaker for drying instead of removing the wet filter paper from the funnel. Placing the funnel and filter paper inside a beaker for drying would prevent any loss of precipitate when transferring the wet filter paper from the funnel to the beaker. Taking care to make accurate measurements and using an accurate scale to measure the mass could also reduce experimental errors.

Synthesis

- (n) Student answers may vary depending on experimental results. Using the sample data, the sulfate ion concentration was calculated to be 550 ppm. **Table 2** in Section 4.3 gives the aesthetic objective of sulfate as <500 ppm. Therefore, the sulfate concentration in the water sample exceeds the aesthetic objective.

4.5 TECH CONNECT: WATER DISINFECTION METHODS

TRY THIS ACTIVITY: A SIMPLE DISTILLATION

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- (a) The liquid that collects on the underside of the watch glass is clear and colourless.
- (b) Water vapour forms in the beaker because, as the water is being heated, it is evaporating, and changing from a liquid to a gaseous state.
- (c) As the water vapour comes into contact with the cool watch glass, the water condenses, or changes from a gaseous to a liquid state.
- (d) Student answers may vary. Students should explain that it appears that distillation has removed all traces of dissolved salt from the water since there is no visible residue remaining on the microscope slide after evaporation of the distilled water.

TECH CONNECT 4.5 QUESTIONS

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Understanding Concepts

1. Student answers may vary. Students may explain that most Canadians are concerned about biological contaminants in their water supply, rather than chemical and physical contamination, because of the Walkerton tragedy.

2. Water purification methods are listed in **Table 1**. Students only need list four methods.

Table 1 Advantages and Disadvantages of Various Water Purification Methods

Purification method	Advantages	Disadvantages
chlorination	<ul style="list-style-type: none">effective against many biological contaminants	<ul style="list-style-type: none">toxicitybad taste and odourproduces trihalomethanes (THMs)
ultraviolet radiation	<ul style="list-style-type: none">destroys microorganismsno odour or tasteno residual chemicals	<ul style="list-style-type: none">does not remove chemical contaminants
distillation	<ul style="list-style-type: none">removes biological and chemical contaminants	<ul style="list-style-type: none">does not remove all organic chemical compoundselectrical costs are a factor
ozone	<ul style="list-style-type: none">inactivates and oxidizes biological contaminants	<ul style="list-style-type: none">small amounts of THMs may be formeddisinfection is temporary as standing water may be re-contaminated
carbon filtration	<ul style="list-style-type: none">removes residual contaminants from treated water	<ul style="list-style-type: none">filters become clogged quickly and may re-contaminate water
multi-barrier approach	<ul style="list-style-type: none">combines positive attributes of several methodsmaximum efficiency	<ul style="list-style-type: none">may be expensive

Extension

3. Student answers may vary. A variety of home water treatment methods are presented below and summarized in **Table 2**.

Reverse osmosis water treatment

During reverse osmosis, water is forced through a fine membrane, which removes the dissolved minerals. The water first passes through a sediment filter to remove large particles from the water that could plug up the membrane. Water is then forced through the membrane. The treated water then collects in a holding tank while the contaminated water goes down the drain. Water from the tank flows through a carbon filter to remove organic chemicals and then out the tap.

Biological treatment

Biological processes involve a filter and existing biological life in the water. Conditions in the water enable the growth of desirable organisms within the filter that can biodegrade unwanted substances, such as organic matter, iron, or arsenic. Some biological processes regenerate the adsorption capability of exhausted carbon.

Ceramic filters

Water is passed through a porous ceramic filter, which removes bacteria and parasites.

Table 2 Advantages and Disadvantages of Alternative Water Purification Methods

Purification method	Advantages	Disadvantages
reverse osmosis	<ul style="list-style-type: none"> produces high quality drinking water 	<ul style="list-style-type: none"> membrane gets clogged by bacteria, hard water scale, iron, and silt does not remove nitrates membranes cannot tolerate chlorine maintenance of equipment is critical require adequate pressure to force the water through the membrane
biological treatment	<ul style="list-style-type: none"> can treat water that contains much dissolved organic matter 	<ul style="list-style-type: none"> maintenance of conditions for biological organisms important
ceramic filter	<ul style="list-style-type: none"> easy to use 	<ul style="list-style-type: none"> limited volume of water can be treated not able to remove certain viruses filters plug up quickly if the water contains particulate matter or is turbid

4.6 CASE STUDY: PROTECTING CANADA'S GREAT LAKES ENVIRONMENT

SECTION 4.6 QUESTIONS

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Understanding Concepts

- The Great Lakes Action Plan for Hamilton Harbour has addressed the following goals and objectives:
 - to establish a healthy environment
 - to restore an area of concern
 - to control the introduction of non-native species
 - to protect and promote human health
 - to reduce harmful pollutants
 - to promote the sustainable use of the Great Lakes Basin
 - Student answers may vary. Students may answer that it is important to strive towards meeting each goal and objective of the Great Lakes Action Plan. However, it may not be necessary to achieve each target before an AOC is removed from the list.
- Student answers may vary. One reason for the success of the RAP for Hamilton Harbour has been the direct involvement of local citizens. The contribution of many community members working together significantly decreased the amount of waste entering the water.
- Student answers may vary. Two possible examples of evidence of the successful restoration of Hamilton Harbour include the construction of shoreline trails and parks for human recreation and a significant increase in local fish populations.
- Decreased exposure to water-borne contaminants has improved the health of Hamilton's citizens. Improved access to shoreline trails has made it possible for people to participate in physical fitness activities in and around the harbour.

Extension

- Student answers will vary depending on the AOC selected for study. Detailed information on each of the 42 Great Lakes Remedial Action Plans may be found at <http://www.on.ec.gc.ca/water/greatlakes/raps/>.

Thunder Bay

Thunder Bay, located on the north shore of Lake Superior, is one of Canada's major ports. This area has been identified as an AOC because of poor water quality resulting from discharges from the forest products industry. There are four pulp and paper mills that operate in the Thunder Bay AOC. Industrial and municipal waste, agricultural runoff, and pollutants all contribute to the problems identified in **Table 1**.