6. $m_{Cu} = ?$

$m_{Cu_2O} = 286.2\ g\ Cu_2O$

$m_{Cu_2S} = 286.2\ g\ Cu_2S$

Balanced chemical equation	$2\ Cu_2O_{(s)}$ +	$Cu_2S_{(s)}$ →	$6\ Cu_{(s)}$ +	$SO_{2(g)}$
Before reaction	286.2 g	286.2 g	0 g	0 g
Reaction according to balanced chemical equation	2 mol (286.20 g)	1 mol (159.16 g)	6 mol (381.30 g)	1 mol (64.06 g)
After reaction	0 g	127.0 g	?	

From the table, the limiting reagent is $Cu_2O_{(s)}$ and the excess reagent is $Cu_2S_{(s)}$.

$$n_{Cu_2O} = 286.2\ \cancel{g\ Cu_2O} \times \frac{1\ mol\ Cu_2O}{143.1\ \cancel{g\ Cu_2O}}$$

$$n_{Cu_2O} = 2.000\ mol\ Cu_2O$$

$$n_{Cu} = 2.000\ \cancel{mol\ Cu_2O} \times \frac{6\ mol\ Cu}{2\ \cancel{mol\ Cu_2O}}$$

$$n_{Cu} = 6.000\ mol\ Cu$$

$$m_{Cu} = 6.000\ mol\ Cu \times \frac{63.55\ g\ Cu}{1\ \cancel{mol\ Cu}}$$

$$m_{Cu} = 381.3\ g\ Cu$$

The mass of copper obtained from the reaction is 381.3 g.

The combined calculation is as follows:

$$m_{Cu} = 286.2\ \cancel{g\ Cu_2O} \times \frac{1\ \cancel{mol\ Cu_2O}}{143.1\ \cancel{g\ Cu_2O}} \times \frac{6\ \cancel{mol\ Cu}}{2\ \cancel{mol\ Cu_2O}} \times \frac{63.55\ g\ Cu}{1\ \cancel{mol\ Cu}}$$

$$m_{Cu} = 381.3\ g\ Cu$$

The mass of copper obtained from the reaction is 381.3 g.

2.11 INVESTIGATION: THE LIMITING REAGENT IN A CHEMICAL REACTION

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Prediction

(a) According to the stoichiometric method, 2.32 g of strontium sulfate precipitate will be produced from the reaction of 2.00 g of strontium chloride with excess copper(II) sulfate. The reaction equation is shown below.

Balanced chemical equation	$SrCl_{2(aq)}$ +	$CuSO_{4(aq)}$ →	$SrSO_{4(s)}$ +	$CuCl_{2(aq)}$
Before reaction	2.00 g		0 g	
Reaction according to balanced chemical equation	1 mol (158.52 g)		1 mol (183.68 g)	
After reaction	0 g		?	

$$n_{SrCl_2} = 2.00 \text{ g } SrCl_2 \times \frac{1 \text{ mol } SrCl_2}{158.52 \text{ g } SrCl_2}$$

$$n_{SrCl_2} = 0.0126 \text{ mol } SrCl_2$$

$$n_{SrSO_4} = 0.0126 \text{ mol } SrCl_2 \times \frac{1 \text{ mol } SrSO_4}{1 \text{ mol } SrCl_2}$$

$$n_{SrSO_4} = 0.0126 \text{ mol } SrSO_4$$

$$m_{SrSO_4} = 0.0126 \text{ mol } SrSO_4 \times \frac{183.68 \text{ g } SrSO_4}{1 \text{ mol } SrSO_4}$$

$$m_{SrSO_4} = 2.32 \text{ g } SrSO_4$$

or

$$m_{SrSO_4} = 2.00 \text{ g } SrCl_2 \times \frac{1 \text{ mol } SrCl_2}{158.52 \text{ g } SrCl_2} \times \frac{1 \text{ mol } SrSO_4}{1 \text{ mol } SrCl_2} \times \frac{183.68 \text{ g } SrSO_4}{1 \text{ mol } SrSO_4}$$

$$m_{SrSO_4} = 2.32 \text{ g } SrSO_4$$

Experimental Design

(b) Strontium chloride is dissolved in water and mixed with a solution containing excess copper(II) sulfate. The precipitate is separated by filtration, and then dried and weighed.

Materials

(c)

eye protection	wash bottle of distilled water
lab apron	laboratory scoop
$SrCl_{2(s)}$	centigram balance
$CuSO_4 \cdot 5H_2O_{(s)}$	stirring rod
150-mL beaker	filter paper
250-mL beaker	filter funnel, funnel holder, and stand
400-mL beaker	watch glass

Procedure

(d)
1. Obtain 2.56 g of $CuSO_4 \cdot 5H_2O_{(s)}$ in a clean, dry 150-mL beaker.
2. Dissolve the solid in approximately 75 mL of distilled water.
3. Obtain 2.00 g of $SrCl_{2(s)}$ in a clean, dry 250-mL beaker.
4. Dissolve the solid in approximately 75 mL of distilled water.
5. While stirring, slowly pour the $CuSO_{4(aq)}$ into the $SrCl_{2(aq)}$ and record the observations.
6. Measure and record the mass of a piece of filter paper.
7. Filter the mixture.
8. Set the filter paper and precipitate aside to dry overnight.
9. Measure and record the mass of the filter paper and precipitate.

Observations

(e) mass of 250-mL beaker = 102.41 g
mass of 250-mL beaker + $SrCl_{2(s)}$ = 104.41 g
mass of 150-mL beaker = 68.83 g
mass of 150-mL beaker + $CuSO_4 \cdot 5H_2O_{(s)}$ = 71.39 g
mass of filter paper = 0.90 g
mass of filter paper and precipitate = 3.24 g
The blue copper(II) sulfate solution mixed with the strontium chloride solution to produce a white precipitate and a blue solution.

Analysis

(f) mass of precipitate = 3.24 g – 0.90 g = 2.34 g

(g) According to the observations collected in this experiment, the mass of the strontium sulfate precipitate from the reaction of strontium chloride and copper(II) sulfate solutions was determined to be 2.34 g.

Evaluation

(h) The major source of error is likely caused by the number of mass measurements made. Making more measurements would help to reduce the error.

(i) The filtration design is adequate, and there are no obvious improvements to be made. Adequate care was taken in filtering and washing the precipitate.

$$\% \text{ difference} = \frac{2.34 \text{ g} - 2.32 \text{ g}}{2.32 \text{ g}} \times 100$$

$$\% \text{ difference} = 0.86\%$$

Based on the very low percent difference, the Prediction is valid.

(j) The stoichiometric method is valid because the Prediction was verified.

2.12 PERCENTAGE YIELD

PRACTICE

(Pages 158–159)

Understanding Concepts

1. $m_{C_7H_6O_3}$ used = 2.00 g $C_7H_6O_3$

   actual yield = 1.65 g $C_8H_8O_3$

Balanced equation	$C_7H_6O_{3(s)}$ +	$CH_3OH_{(l)}$ →	$C_8H_8O_{3(l)}$ +	$H_2O_{(l)}$
Given mass (g)	2.00		1.65	
Molar mass (g/mol)	138.13	32.05	152.16	18.02