Lab 9.1 Single-Replacement Reactions

Use with Section 9.2

Objectives

- Classify reactions as single-replacement chemical reactions.
- Use numbers to write balanced equations for single-replacement reactions.
- Sequence metals into an activity series.

Process Skills

Acquiring and analyzing information, collecting and interpreting data, drawing a conclusion, hypothesizing, measuring and using numbers, observing and inferring, predicting, sequencing

Time Allotment

1 class period to collect data; 1 class period to write equations and determine activity

Materials

See pages 11T–20T for materials.

(Visit the Chemistry Web site at **glencoe.com** *to find links about safety in the laboratory.)*

Alternative Materials

- Aluminum, iron, or nickel may be used as metals in addition to or in place of the lead, copper, or zinc.
- Any soluble salt solution with the appropriate metal ion may be used. Check for toxicity and hazards.
- Dilute sulfuric acid may be substituted for hydrochloric acid.

Preparation

- Check to make sure that the metal strips will fit into the test tubes you will be using. Cut large sheets of sandpaper into small squares.
- To prepare 3*M* HCl, add 3 mL of concentrated 12*M* HCl to 9 mL of distilled water.
- To prepare 0.2*M* $Pb(NO_3)_2$, dissolve 66 g of lead(II) nitrate in enough water to make 1 L of solution.
- To prepare 0.2*M* $CuSO_4$, dissolve 50 g of copper(II) sulfate in enough water to make 1 L of solution.
- To prepare 0.2*M* $MgSO_4$, dissolve 49 g of $MgSO_4 \cdot 7H_2O$ in enough water to make 1 L of solution.
- To prepare 0.2*M* $AgNO_3$, dissolve 34 g of silver nitrate in enough water to make 1 L of solution.
- For disposal, $Zn(NO_3)_2$, $ZnCl_2$, and $Cu(NO_3)_2$ may be flushed down the drain. $Pb(SO_4)$ should be buried in a landfill designated for hazardous chemicals.

Pre-Lab

1. A single-replacement chemical reaction is one in which one substance from a compound is replaced by another substance.
2. The reactivity of a substance depends on its ability to gain or lose electrons.
3. A more active metal tends to lose electrons more readily than a less active metal.
4. See Hypothesis.

Teaching the Lab

Have students work in groups of two.

- Ask students why they need to clean the pieces of metal with sandpaper.

Data and Observations (Lab 9.1)

Sample Data

Data Table 1	
Test-tube number	**Indication of a chemical reaction**
1	Copper forms on the lead strip. The blue color of the solution slowly becomes less intense.
2	Shiny silver deposits form on copper strip.
3	no reaction
4	Shiny zinc deposits form on the lead strip.
5	no reaction
6	Bubbles of gas form on the zinc strip. The bubbles rise to the top of the test tube.

Hypothesis

The reactivity of an element can be determined by observing its reaction tendencies with other elements. A more active metal will replace a less active metal ion from solution.

Data and Observations

See Data Table 1.

Analyze and Conclude

1–2. See Data Tables 2 and 3.

3. Zn is the most active.

4. Cu is the least active.

5. Pb replaced Cu from solution, establishing that Pb is more active than Cu. Zn replaced Pb from solution. Zn is therefore the most active of the three metals, and Cu is the least active.

6. Ag, Cu, Pb, Zn, Mg

7. Hydrogen is more active than silver or copper but less active than zinc or magnesium.

8. Copper did not replace hydrogen from hydrochloric acid. Copper did not react with silver nitrate. Therefore, the hydrogen is more active than the copper, which is more active than the silver. Zinc replaced the hydrogen from hydrochloric acid. Therefore, the zinc is more active than hydrogen. Zinc did not replace magnesium from solution. Therefore, the magnesium is more active.

9. It would be necessary to test lead with hydrochloric acid to establish if lead was more active than hydrogen.

10. The activity series should match. Any differences could be caused by mislabeling, failure to recognize the evidence of a reaction, or solutions that are too dilute.

Real-World Chemistry

1. Steel is iron with a regulated amount of carbon. The iron is more active than hydrogen. and a replacement reaction would take place, disintegrating the container.

2. Sodium is very active because it has a tendency to lose electrons easily. Therefore, sodium reacts readily in nature to easily form compounds.

3. Magnesium is more active than copper and would react easily with the acid.

Analyze and Conclude (Lab 9.1)

Sample Data

1.

Data Table 2	
Test-tube number	**Chemical equation**
1	$Pb + CuSO_4 \rightarrow PbSO_4 + Cu$
2	$Cu + AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$
3	$Cu + HCl \rightarrow$ no reaction
4	$Zn + Pb(NO_3)_2 \rightarrow Zn(NO_3)_2 + Pb$
5	$Zn + MgSO_4 \rightarrow$ no reaction
6	$Zn + HCl \rightarrow ZnCl_2 + H_2$

2.

Data Table 3		
Test-tube number	**Symbol of more active element**	**Symbol of less active element**
1	Pb	Cu
2	Cu	Ag
3	H	Cu
4	Zn	Pb
5	Mg	Zn
6	Zn	H