

Types of Reactions

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Summer Research Program for Science Teachers

August 2007

Aim: How do we classify different types of reactions?

Objectives:

* SWBAT identify the four basic types of chemical reactions: synthesis, decomposition, single replacement, and double replacement.

* SWBAT describe the key features of each type of reaction.

* SWBAT explain the differences between the different types of reactions.

* SWBAT cite one example of each type of reaction.

* SWBAT evaluate a chemical expression and determine its type.

Materials:

General:

- Gloves
- Goggles
- Lab apron

Single Replacement Reaction:

- Mossy zinc
- 3 M HCl
- Test tube and test-tube rack
- Beral pipet (disposable)

Double-Replacement Reaction:

- 0.5 M PbCl_2 (or $\text{Pb}(\text{NO}_3)_2$, if you prefer)
- 0.5 M NaI (or KI , if you prefer)
- Beral pipet (disposable)

Synthesis Reaction:

- Magnesium ribbon
- Tongs
- Striker
- Bunsen burner

Decomposition Reaction:

- Table sugar
- Concentrated (18 M) sulfuric acid—DANGER! HIGHLY CORROSIVE!
- Small beaker (~100 mL)
- 10-mL glass pipette tip and pipetter

Preparation:

This lesson will require careful preparation. If it is well prepared, the lesson should fit nicely into a 45-minute block.

Single Replacement:

1. Place a scoopful of mossy zinc into the bottom of a test tube.
2. Place the test tube in a test-tube rack.
3. Place the HCl in its container by the rack, and label the Beral pipette, "3 M HCl ."

Double Replacement:

1. Label the Beral pipette with the concentration and identity of the lead solution.
2. Make sure the pipettes and lead and iodide solutions are in the same area, for easy access.

Synthesis:

1. Set the magnesium ribbon and tongs near the Bunsen burner and striker.
2. Make sure the gas line to the classroom is turned on before you begin the lesson.

Decomposition:

1. Fill the small beaker half-full with sugar.
2. Place the sugar, the glass pipette, the pipetter, and the concentrated H₂SO₄ (aq) in the hood!!!!
This part of the lesson must happen in the hood, or it is not safe.
3. Keep the sugar as far away from the sulfuric acid as you can, until you run the demo.

Do Now: (5 minutes)

Students will answer the following questions:

- 1) $\text{___ Zn} + \text{___ HCl} \rightarrow \text{___ ZnCl}_2 + \text{___ H}_2$
- 2) $\text{___ C}_{12}\text{H}_{22}\text{O}_{11} \rightarrow \text{___ C} + \text{___ H}_2\text{O}$

Lesson Structure:

After going over the do now, students will be told that there are four main types of reactions. They will be shown the names of the four types, and asked which one they wish to see first. Each of the four reaction 'sections' will have the following structure:

1. Overview of the reaction type
2. Kinesthetic demonstration (skit) representing that reaction type

3. Demonstration of sample reaction
4. Analysis of reaction equation (according to type)

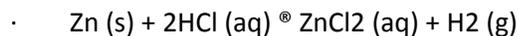
The information for each section is listed below. Write the information on the board as it appears. Teacher information is written in italics.

Single Replacement:

- Single replacement reactions happen when one element replaces another element in a compound.

Kinesthetic demonstration: two friends (a couple, if one exists in the class) walk down the aisle, and another student “takes the place” of one of the pair. Not only is this hilarious—“he stole his girl,” etc.—but it’s simple and effective.

- An example of a single replacement reaction is:



Demonstrate the equation by using the Beral pipette to transfer HCl (aq) to the test tube containing mossy zinc. The reaction will be vigorous. Ask students what they see, and how they know if a reaction is taking place. They may have already seen this reaction earlier in the year; ask them what they remember about hydrogen and its properties. Ask them how this qualifies as single replacement—your objective is to connect the reaction with the skit.

- The zinc has replaced the hydrogen in the compound.

Double Replacement:

- In double replacement reactions, two pairs of elements switch partners—it’s like square dancing.

Students generally know little about square dancing, but if you pair up two boy/girl pairs (or other types of pairs, if your classroom is progressive!) and have them switch partners, the concept is made crystal-clear. Keep asking questions such as, "So who was paired off to begin with? Who's paired up now?" to drive the point home.

- An example of a double replacement reaction is:
- $\text{Pb}(\text{NO}_3)_2 (\text{aq}) + 2\text{NaI} (\text{aq}) \rightarrow 2\text{NaNO}_3 (\text{aq}) + \text{PbI}_2 (\text{s})$

Use the Beral pipette to transfer the lead (II) nitrate to the sodium iodide container. Ask students if they notice anything that implies a reaction is taking place (it should turn yellow). Ask them if they know anything about lead, and whether they think the yellow 'stuff' should be put down the drain. Finally, ask them what the connection is between the equation for the reaction and the 'square off' they just saw.

- The lead and the sodium have 'switched partners.' This tells us it's double replacement.

Synthesis:

- Synthesis means exactly what it says.
- A new substance is synthesized from two or more other substances.

Very simple: have two random students walk from opposite ends of the room, notice each other, say hi, and join hands. This is very funny!

- An example of a synthesis reaction is:
- $2\text{Mg} (\text{s}) + \text{O}_2 (\text{g}) \rightarrow 2\text{MgO} (\text{s})$

Again, very simple: holding the magnesium ribbon with tongs, burn the ribbon in the Bunsen flame. It should turn white. Ask students what tells them a reaction has occurred. Ask them if the ribbon looks

the same as it did to begin with, and if it seems to behave differently (it's powdery now). Have the students examine the equation for a connection to the synthesis skit.

- As you can see, the magnesium oxide was formed (synthesized) from solid magnesium and oxygen gas.

Decomposition:

I highly recommend that you do this one last—it's the most dangerous and most exciting. There will be no higher point to the lesson than this.

*Perform this section entirely in the hood. Students must be at least four feet away from the hood, and the hood must be closed while the reaction takes place. Wear gloves and goggles at all times!**

- Decomposition is the breakdown of one substance into two or more other substances.
- You start off with one material and you end with several materials.

Have five or six students stand in a circle, holding hands. Have them break apart. Encourage them to sit down immediately after breaking away—large demo groups can get wacky!

- An example of a decomposition reaction is:
- $C_{12}H_{22}O_{11} (s) \rightarrow 12C (s) + 11H_2O (l)$

Carefully use the pipet to add about 3 mL of sulfuric acid to the sugar in the beaker. Immediately put the pipet down in the hood, close the hood, and back away. After about 30 seconds, the reaction will begin: a huge black 'snake' will grow out of the sugar, due to the dehydration of the sugar by H_2SO_4 (aq). There's a lot of smoke, and that smoke contains acid, so if you don't have a hood, don't do this. If you have a hood, it's very manageable.

You may or may not be able to recapture the students' focused attention—this reaction is amazing, and it will probably be the end of the period. See if you can elicit a basic connection between the equation on the board and the skit from earlier. If you can, ask for the names of the products.

- In this case, sucrose has decomposed into pure carbon and water.