

Evidence of a Chemical Reaction

Fall 2023

- Goal:** 5.PS1.4 Evaluate the results of an experiment to determine whether the mixing of two or more substances result in a change of properties.
7.PS1.4 Analyze and interpret chemical reactions to determine if the total number of atoms in the reactants and products support the Law of Conservation of Mass.

Lesson Outline

I. Introduction

Question students about the difference between physical and chemical change. Explain what constitutes evidence of chemical reactions.

II. Safety Concerns

Discuss safety issues. Demonstrate how students will use the small dispensing bottles and the 24-well culture plate.

III. Determining if a Chemical Change has Occurred

Tell students to follow the instructions on the instruction sheet. You will still need to guide them through the procedures, making sure they understand the instructions. Discuss results with students after they finish each row. Chemical equations for Rows A, B, C are given.

Row A: Chemical Reactions That Give a Precipitate (solid)

Do Demonstration. Students should realize that if the solution turns cloudy, a solid (precipitate) is forming.

Row B: Chemical Reactions That Involve a Color Change

Do demonstration. Formation of complex ions cause color changes. Ex: Thiocyanate (SCN^-) anion bonds strongly to the Fe^{3+} ion in solution to give an intense deep red color.

Row C: Chemical Reactions That Produce a Gas

Do demonstration. Students look carefully at the bubbles produced in solutions.

IV. Analyzing Results

Emphasize the chemistry of carbonates and bicarbonates. Students predict the reaction between marble and HCl.

V. Review Questions and Equations for Chemical Reactions

VI. Hand out wallet-sized periodic tables

Materials

- 34 safety goggles for students and instructor
- 15 24-well culture plates with lids
- 15 plastic plates (to catch any spillage from well plates)
- 1 Demonstration Bag A - contains (1) 2 oz bottle of 0.1 M CaCl_2 , (1) 2 oz bottle of 2.5 M Na_2CO_3 , (2) 10 oz clear cups
- 1 Demonstration Bag B – contains (1) 2 oz bottle of 0.05 M $\text{Na}_2\text{S}_2\text{O}_3$, (1) 2 oz bottle of 0.01 M I_2 , (2) 10 oz clear cups
- 1 Demonstration Bag C - contains (1) 2 oz bottle of 1 M HCl , (1) jar of Na_2CO_3 , (1) teaspoon, and (1) 10 oz clear cup
- 15 ziploc bags containing the following:
 - 6 plastic droppers (in a Ziploc bag) containing bottles of the following solutions
 - 1.0 M HCl hydrochloric acid
 - 2.5 M Na_2CO_3 sodium carbonate
 - 0.5 M NaHCO_3 sodium bicarbonate
 - 0.1 M $\text{Cu}(\text{NO}_3)_2$ copper (II) nitrate
 - 0.1 M $\text{Fe}(\text{NO}_3)_3$ iron (III) nitrate
 - 0.1 M KSCN potassium thiocyanate
- 15 small pieces of marble CaCO_3 (in a small bag)
- 1 binder containing:
 - 34 Instruction Sheets in sheet protectors (one per student)
 - 34 Handouts showing washing soda and baking soda boxes
 - 34 Student observation sheets
- 1 pencil per student (Students should use their own pencils.)
- 35 wallet-sized periodic tables (per class)
- 4 1 oz dropper bottles of each of the following unknowns:
 - Unknown A: Na_2CO_3
 - Unknown B: CaCl_2
 - Unknown C: HCl
 - Unknown D: KSCN
 - Unknown E: NaHCO_3

While one team member starts the introduction, another should write the following vocabulary words on the board:

physical change
solution

chemical change
precipitate

chemical reaction
compound

formula
mixture

I. Introduction

Ask students: What is the difference between a physical change and a chemical change?

Be sure to include the following information in the discussion:

- **A physical change** does not change the chemical properties of a substance.
 - No new substance is formed during a physical change.
 - Only the physical properties are changed.
 - Examples of physical changes include changes in the size, shape, or state of matter. For example, ice, liquid water, and steam. In each of these states, water has physically changed (from solid, liquid, gas), but not chemically.
- **A chemical change** does change the chemical properties of a substance.
 - One or more new substances are formed in a chemical change.

- A chemical change cannot be easily reversed.
- Examples include: burning paper, digestion of food, bananas browning

Ask students: How can you tell when a chemical change has occurred? *Some possibilities include: a gas given off, color change, precipitation, explosion, burning, etc.*

Tell students what to look for to determine if a chemical change has occurred:

When solutions of two compounds are mixed, it is often possible to determine whether or not a chemical reaction has occurred through visual observation.

Evidence of a chemical change might be **a color change, a gas given off (it may smell), the formation of a precipitate (a new solid), or an energy (temperature, light) change.**

Write these observations on the board and share the following explanation with students.

- A **color change** occurs when two solutions are mixed and a new color is produced.
 - BUT, if the color of one solution becomes a paler shade, that change is caused by dilution from the other solution and does not qualify as a color change.
- Bubbles or fizz indicate that a **gas is given off**.
 - BUT, make sure that students understand that the bubbles given off in a soda pop drink is NOT evidence of a chemical change. This is just excess gas that is released when the top is opened. Carbonated beverages contain carbon dioxide gas dissolved under pressure and removing the top lowers the pressure and allows carbon dioxide bubbles to escape.
- A **precipitate** forms when two substances react to give a new solid compound that does not dissolve in water.
 - A precipitate may look like a cloudy solution, fine grains in a solution, a swirl, or a fluffy solid.

Note: When two clear solutions are mixed and a white precipitate forms, this whitish color does not count as a color change. The change should be recorded only as the formation of a precipitate.

- **An energy change** can be either a physical or chemical change. These changes will be studied in the Endothermic/Exothermic lesson. A chemical energy change occurs in a lightstick when chemicals mix to produce light. A physical energy change occurs when you freeze water. Energy is removed from water, causing the water to freeze and its temperature to change.

Important: Scientists do not rely on just visual observations to determine if a chemical or physical change has occurred. The only real evidence is the formation of new substances, with different chemical formulas from the reactants.

Your Notes:

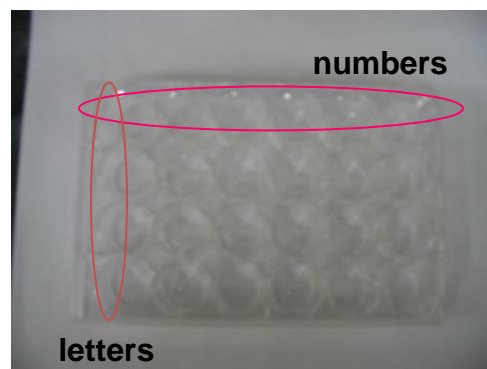
II. Safety Concerns

- Tell students they must put on safety goggles before mixing any solutions.
- If anyone gets any of the chemicals on their skin or in their eyes, they should flush immediately with water. Although the solutions are dilute, they could still cause eye damage, especially the 1.0 M HCl.
- Emphasize to students how important it is for them to follow directions.

Organize students in **pairs** and distribute the following materials to each pair of students:

- 2 safety goggles
- 1 24-well culture plate
- 1 plastic plate
- 1 Ziploc bag containing 6 dropping bottles of solutions
- 2 Instruction Sheets
- 2 Chemical Reactions Observation Sheets

- Instructor should put on their safety goggles and keep them on until students are finished mixing chemicals.
- Have students look at the 24-well plate and the instructions at the top of the Chemical Reactions Lab Sheet.
- Show students how to find the letters A, B, C, D as well as the numbers 1 - 6 on the 24-well plate. (Letters are imprinted in the plastic along the right side; numbers are imprinted across the top and the bottom. These are tiny and may be difficult to see.)
- Show students how to **match the grid on the lab sheet to the 24-well plate**. Tell students to place the 24-well plate on the plastic plate.



Give the following instructions to the students:

1. The formulas of the compounds being used in a reaction are listed on the observation sheet. The labels on the dropper bottles list both the name and formula of the compounds. Show students how to be careful when matching the formulas (some of the formulas are very similar).

Your Notes:

2. Show students one of the bottles and demonstrate how to get drops out of the bottle. Dropper bottles are easy to use. Apply slow, gentle pressure. Do not remove the red cap from a bottle until it is to be used. Put the cap back on the bottle immediately after use.
- When using two solutions, put a squirt of the first solution in the correct well so that it is one-fourth full (we do not want students to spend time counting drops). Then add one squirt of the second solution. The well should now be half full.



3. Tell students they will perform the reactions for one row only, then stop and discuss the results with the instructors. Tell the partners to take turns doing the experiments as they follow the grid on the lab sheet. Both students record their observations on the lab sheet. Students can record NR if No Reaction occurs. Otherwise, they will record color change, gas given off, or precipitate formed.
4. **Tell students to follow the instructions on the instruction sheet for mixing solutions.** (The instruction sheet lists the same directions as are given below.)

III. Determining If a Chemical Change Has Occurred

Note: Instructors need to monitor the students closely to be sure contamination does not occur. Ensure that students use the correct bottle.

Stop and discuss results with students after each row. This is preferable to waiting until students finish all of the experiment since some will finish very quickly and then be bored waiting for others to catch up.

One team member should draw a picture of the well plate on the board with all of the rows labeled. Write on this when discussing the results with the students.

The beginning of each reaction is given on the student observation sheet. Students should complete each equation on the board after the reactions in each row are completed.

Your Notes:

A. Chemical Reactions that Give Precipitates - Row A

Demonstration: Show students what a precipitate looks like by doing the following demonstration.

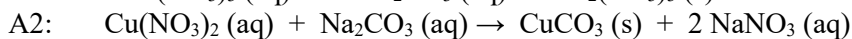
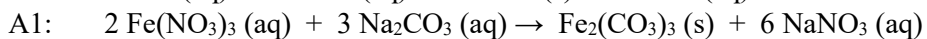
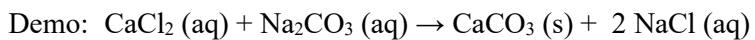


- Take the demonstration bag marked ROW A. Remove the 2 oz bottles of solutions and the two 10 oz clear cups. Empty each 2 oz bottles into separate cups. Hold the two cups up so the students can see what happens, and then pour one solution into the other. A white solid (precipitate) forms. Point this out as an example of a chemical reaction in which a precipitate forms to the students.
- Tell students to use the grid on the lab sheet to perform the experiments in Row A.

Note: For each activity **DO NOT** record the results until the students have completed the experiments for the row since they may wait to copy the answers from the board.

Review and Equations:

- Ask students what evidence indicated that a chemical reaction occurred.
 - *A precipitate formed in A1 and A2.*
- Put the results on the board. **A1:** *precipitate* **A2:** *precipitate*
- Write the following equations on the board:



Your Notes:

B. Chemical Reactions that Involve a Color Change - Row B

Demonstration: Show students what a color change looks like by doing the following demonstration.



- Take the demonstration bag marked ROW B. Remove the 2 oz bottles of solutions and the two 10 clear plastic cups. Empty each 2 oz bottles into separate cups. Hold the two clear containers up, and tell students to notice that one is a clear colorless solution, and the other is a clear, brown solution. Pour the colorless solution into the brown solution, and ask students to describe what happens. The brown solution turns colorless, but it is still clear (i.e no precipitation). Explain to students that a chemical reaction has taken place because the brown solution turned colorless upon addition of the clear solution.
- Tell students to use the grid on the lab sheet to perform the experiments in Row B.

Background for Instructors Only: This is an oxidation-reduction reaction in which iodine is reduced to iodide ion, I_2 and thiosulfate ion, $\text{S}_2\text{O}_4^{2-}$ is oxidized to tetrathionate ion, $\text{S}_4\text{O}_6^{2-}$.

Review and Equations:

- Ask students what evidence indicated that a chemical reaction occurred.
 - A color change occurred.
- Put the results on the board. **B1:** color change to deep red **B2:** color change to pale green.
- Write the following equations on the board:
Demo: $\text{I}_2(\text{aq}) + 2 \text{Na}_2\text{S}_2\text{O}_3(\text{aq}) \rightarrow 2 \text{NaI}(\text{aq}) + \text{Na}_2\text{S}_4\text{O}_6(\text{aq})$
B1: $\text{Fe}(\text{NO}_3)_3(\text{aq}) + \text{KSCN}(\text{aq}) \rightarrow \text{Fe}(\text{SCN})(\text{NO}_3)_2(\text{aq}) + \text{KNO}_3(\text{aq})$
B2: $\text{Cu}(\text{NO}_3)_2(\text{aq}) + \text{KSCN}(\text{aq}) \rightarrow \text{Cu}(\text{SCN})(\text{NO}_3)(\text{aq}) + \text{KNO}_3(\text{aq})$
pale green color

Your Notes:

Background for Instructors Only: Color changes with metal ion solutions are caused by the formation of complex ions. In the present case, the SCN^- (thiocyanate) anion bonds strongly to the Fe^{3+} (iron) ion in solution to give a intense deep red color. The SCN^- anion also bonds to Cu(II) (copper) ion but not as strongly, so more SCN^- has to be added before the pale green color is seen.

C. Chemical Reactions that Produce a Gas - Row C

Note: Tell students they will have to look very closely and quickly as soon as they add the second solution to the first solution. The bubbles of gas are small and come off as soon as the solutions are mixed.

Demonstration: Show students what a chemical change that produces a gas looks like by performing the demonstration first.



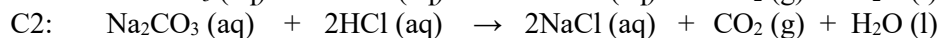
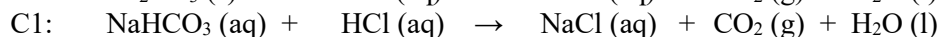
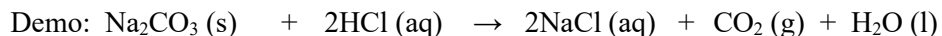
- Take the demonstration bag marked ROW C. Hold the cup up and ask students to watch very carefully what happens. Put 1 teaspoon of the solid (Na_2CO_3) into the cup and empty the 2 oz bottle (HCl) into it. Ask students to describe what happens.
 - A bubbling up (slight foaming) which quickly subsides indicates a gas is given off. Tell students to watch very carefully for bubbles of gas when they are doing **Row C** because they may be difficult to see.
- Tell students to use the grid on the lab sheet to perform all the experiments in Row C.

Review and Equations:

- Ask students what evidence indicated that a chemical reaction occurred.
 - *Bubbles/gas was given off.*
- Put the results on the board. *C1: bubbles/gas C2: bubbles/gas*

Your Notes:

- Write the following equations on the board:



IV. Analyzing Results

Hand out the copies of washing soda and baking soda boxes.

Carbonates:

- Write CO_3^{2-} on the board and tell students that formulas that include “ CO_3 ” as part of the formula are called **carbonates**. The carbonate ion has 2 negative charges on it.
- One form of carbonate, sodium carbonate is commonly referred to as “washing soda.” It is part of many laundry detergents and dish washing detergents.
- Tell students to look at the ingredients of the copy of a **washing soda box**. Sodium carbonate is listed as an ingredient.

Bicarbonates:

- Write HCO_3^- on the board and tell students that formulas that include “ HCO_3 ” as part of the formula are called **bicarbonates**. The bicarbonate ion has 1 negative charge associated with it.
- A common source of bicarbonate is **baking soda**, whose scientific name is sodium bicarbonate. Sodium bicarbonate is used for baking and as a deodorizer. Tell students to look at the ingredient label on baking soda and notice it says **sodium bicarbonate**.

Reactions of Carbonates and Bicarbonates:

- Ask students to look at each box in row C and circle the formulas that have “ CO_3 ” or “ HCO_3 ” as part of the formula. .
- Write HCl on the board.
 - Tell students that HCl is an acid called hydrochloric acid.
 - Tell students to put boxes around all the HCl’s in Row C.
- Ask students what happened in row C when an acid was added to a carbonate or bicarbonate. *A gas was given off.*
- Ask students if they have ever made a “volcano” at home or at school. Ask students if they remembered what they added to make the “lava”. Most likely, they used vinegar and baking soda. Vinegar is an acid, and when added to baking soda (sodium bicarbonate), it bubbles as it releases a gas.

Your Notes:

- Ask students what happens when you add an acid to carbonate or bicarbonate. *When an acid is added to a carbonate or bicarbonate a **chemical reaction occurs**. This is evidenced by the fact that a gas is given off.*
- Tell students that the gas given off in these reactions is carbon dioxide.

Identifying Carbonates Using Chemical Reactions:

- Tell students that chalk, limestone and marble are all calcium carbonate. If the formula for calcium carbonate is CaCO_3 , what might happen if an acid (HCl) is added to marble? *It will bubble (give off a gas).*
- Write the first half of the equation, $\text{CaCO}_3 (\text{s}) + \text{HCl} (\text{aq}) \rightarrow \dots$ on the board, and ask students to hypothesize what will happen, and what the products will be.

The gas will be CO_2 .

The full equation is:



- Have instructors hand out a piece of marble to each pair of students. Tell students that they are going to test their hypothesis to see if the marble will bubble when HCl is added.
- Have students add the marble to C5 and to squirt some HCl into the well. Ask students what happened. Was their hypothesis correct? *Yes, it should bubble when HCl is added.*
- Tell students that many statues are made of limestone and marble. Ask students what they think happens to statues when acid rain falls on them. *The carbonate in the statue reacts with acid liberating a gas and causing the statue to decompose.*

Background Information (in case students ask about acid rain): Acid rain is caused by the presence of varying amounts of sulfuric acid and nitric acid. Fossil fuels, particularly coal and oil, contain sulfur as an impurity. When fossil fuels are burned, the sulfur combines with oxygen to form sulfur oxides that are gases released into the air. When it rains, the water reacts with these gases to form sulfuric acid. When vehicles burn gasoline or diesel fuel, nitrogen oxides are emitted into the air, and these react with water to produce nitric acid. The amount of sulfuric acid and nitric acid in acid rain depends on the location. The acid rain in Nashville is primarily caused by nitric acid from the high density of vehicles, while the acidity of rain in industrialized areas will be caused by the presence of both sulfuric and nitric acids. As a result of the Clean Air Act, industrial and power plants are emitting much lower amounts of sulfur oxides. However, the emission of nitric oxides from vehicle exhausts is still a problem.

Your Notes:

VI. Review Questions

Ask students:

- What is a physical change?
- What is a chemical change?
- How do we know when a chemical change has occurred? (answer on p. 3)

VII. Clean-up

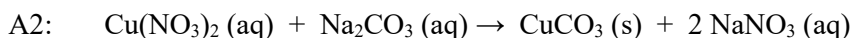
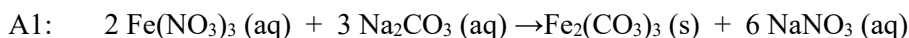
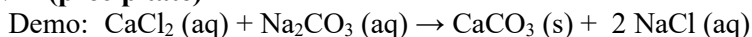
- Have students put the dropper bottles back in the ziplock bag. **Make sure all red lids are on dropper bottles and that the bottles are all upright. Leaks make for nasty clean-up tasks.**
- Collect the ziploc bags and the goggles.
- Place the lids on the 24-well plates and carefully put them in the Rubbermaid container. Place the lid on the Rubbermaid container and put it in the bottom of the box. (If you can rinse them out at the school, do so, PLEASE)
- Place the ziploc bags and other materials in the box.
- Collect all instruction sheets in sheet protectors and put them in the box.

Give each student a wallet-sized Periodic Table.

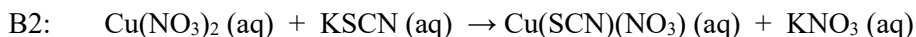
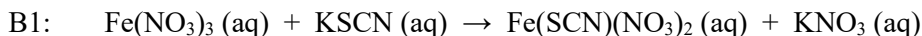
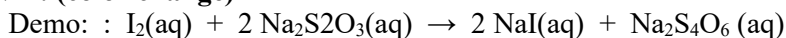
Chemical Equations for Chemical Reactions in this Lesson

Abbreviations: s = solid, aq = aqueous, g = gas, l = liquid, NR = no reaction

Row A (precipitate)

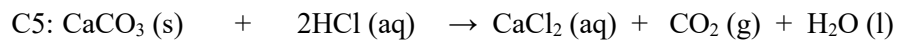
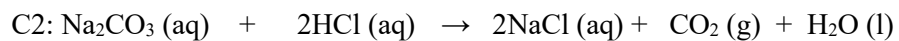
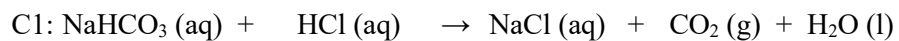
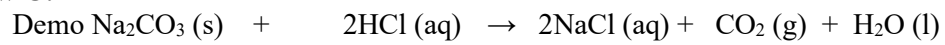


Row B: (color change)



Your Notes:

Row C:



Add unknowns as extension

Lesson originally written by

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Your Notes:

Chemical Reactions Observation Sheet

Name _____

Vocabulary Words: physical change, chemical change, chemical reaction, formula, solution, precipitate, compound, mixture

In each box, use the following choices to record your observations: color change, precipitate formed, gas given off, NR (no reaction)

Add other observations if you wish. Ex: lots of bubbles, fizz, small or large bubbles, cloudy precipitate.

| | | | | | |
|--|--|-----------|-----------|---|-----------|
| A1 Fe(NO ₃) ₃ + Na ₂ CO ₃ | A2 Cu(NO ₃) ₂ + Na ₂ CO ₃ | A3 | A4 | A5 | A6 |
| B1 Fe(NO ₃) ₃ + KSCN | B2 Cu(NO ₃) ₂ + KSCN | B3 | B4 | B5 | B6 |
| C1 <u>baking soda solution</u> NaHCO ₃ + HCl | C2 <u>washing soda solution</u> Na ₂ CO ₃ + HCl | C3 | C4 | C5 <u>marble solid</u> CaCO ₃ + HCl | C6 |

HCl - hydrochloric acid Na₂CO₃ - sodium carbonate NaHCO₃ - sodium bicarbonate Cu(NO₃)₂ - copper (II) nitrate Fe(NO₃)₃ - iron (III) nitrate
 KSCN - potassium thiocyanate CaCl₂ - calcium chloride NaHCO₃ - baking soda Na₂CO₃ - sodium carbonate

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**Chemical Reactions Lab Sheet
Answer Key**

| | | | | | |
|---|---|-----------|-----------|--|-----------|
| A1 Fe(NO ₃) ₃ + Na ₂ CO ₃ precipitate | A2 Cu(NO ₃) ₂ + Na ₂ CO ₃ precipitate | A3 | A4 | A5 | A6 |
| B1 Fe(NO ₃) ₃ + KSCN color change - deep red | B2 Cu(NO ₃) ₂ + KSCN color change - pale green color | B3 | B4 | B5 | B6 |
| C1 <u>baking soda solution</u> NaHCO ₃ + HCl gas given off | C2 <u>washing soda solution</u> Na ₂ CO ₃ + HCl gas given off | C3 | C4 | C5 <u>marble solid</u> CaCO ₃ + HCl gas given off | C6 |

HCl - hydrochloric acid Na₂CO₃ - sodium carbonate NaHCO₃ - sodium bicarbonate Cu(NO₃)₂ - copper (II) nitrate Fe(NO₃)₃ - iron (III) nitrate
KSCN - potassium thiocyanate CaCl₂ - calcium chloride NaHCO₃ - baking soda Na₂CO₃ - sodium carbonate

Instruction Sheet

Evidence that a Chemical Reaction Has Taken Place

Spring 2012

I. Introduction

Discussion of the difference between a physical change and a chemical change

II. Preparation for Mixing Solutions

Instructors demonstrates how to use the small dispensing bottles and the 24-well culture plate. Safety goggles must be worn while mixing any chemicals.

Students work in pairs.

- Look at the 24-well plate and the instructions at the top of the Chemical Reactions Lab Sheet.
- Find the letters A, B, C, D and the numbers 1 - 6 on the 24-well plate. (Letters are imprinted in the plastic along the right side; numbers are imprinted across the top and the bottom. These are tiny and may be difficult to see.)
- Match the grid on the lab sheet to the 24-well plate.
- The instructors will go over the following instructions:
 1. The formulas of the compounds being used in a reaction are listed for each specific well on the corresponding section of the lab sheet.
The labels on the dropper bottles list both the names and the formulas of the compounds. Be careful when matching the formulas (some of the formulas are very similar).
 2. When using two solutions, put a small squirt of the first solution in the correct well. Then add one squirt of the second solution. If the well is about one-fourth full after the first addition and about one-half full after the second addition, this will give good results. Be sure to use the correct bottle. Dropper bottles are easy to use. Apply slow, gentle pressure. Do not remove the red cap from a bottle until it is to be used. Put the cap back on the bottle immediately after use.
 4. Record your observations on your lab sheets. Record NR if No Reaction occurs. Otherwise, record color change, gas given off, or precipitate formed.

III. Mixing Solutions

ROW A - Chemical Reactions that Give Precipitates

- Watch a demonstration by instructors that illustrates the formation of a precipitate.
- If the solution turns cloudy, a solid (precipitate) is forming.
- Place the 24-well plate on the plate. Partners should take turns doing the experiments as you follow the grid on the lab sheet to perform all the experiments in Row A. Both of you should record your observations on your lab sheet.

ROW B - Chemical Reactions that Involve a Color Change

- Watch a demonstration by instructors that shows a reaction with a color change.
- Use the grid on the lab sheet to perform the experiments in Row B.

ROW C - Chemical Reactions that Produce a Gas

- Watch a demonstration by instructors that illustrates the production of a gas.
- Use the grid on the lab sheet to perform all the experiments in Row C.
- Look very closely and quickly as soon as you add the second solution to the first solution. The bubbles of gas are small and come off as soon as the solutions are mixed.

IV. Analyzing Results

The results of the experiments are used to discuss the chemistry of carbonates and bicarbonates.

An instructor will give you a piece of marble. Place the piece of marble into well C5 and add a squirt of HCl.

V. Review Questions

VI. Clean-up

- Put the dropper bottles back in the ziploc bag. Make sure all red lids are on dropper bottles and that the dropper bottles are UPRIGHT.

VII. Periodic Tables

Each student receives a wallet sized periodic table.

Class Activity Sheet – Extension Activity

Answer these questions after finishing the chemical reactions observation sheet.

NAME _____

1. Write complete, balanced equations for the following:
 - a. one reaction in Row A that gave a precipitate.

 - b. one reaction in Row B that gave a gas.

2. You will be given an unknown colorless solution that contains one of the following compounds dissolved in water.

A. CaCl_2 B. Na_2CO_3 C. KSCN D. HCl E. NaHCO_3

Devise a plan, using any of the dropper bottles from the chemical reaction kit, to determine the identity of your unknown.

- a. What do you think your unknown is? _____ If there is more than one possibility, list both.

 - b. What is your proof for what you've listed in (a)?

 - c. Write balanced chemical equations for the reactions you used to determine the identity of the unknown.
-
3. Now that you're finished, which pair of compounds listed above cannot be completely identified because of their similarity in reactions with solutions in the dropper bottles from the chemical reaction kit?

Class Activity Sheet
ANSWER SHEET

Answer these questions after finishing the chemical reactions observation sheet.

2. Write complete, balanced equations for the following:
- one reaction in Row A that gave a precipitate.
refer to equations in lesson (Section VIII)
 - one reaction in Row B that gave a gas.
refer to equations in lesson (Section VIII)

2. You will be given a colorless solution that contains one of the following compounds dissolved in water.

A. CaCl_2 B. Na_2CO_3 C. KSCN D. HCl E. NaHCO_3

Devise a plan, using any of the dropper bottles from the chemical reaction kit, to determine the identity of your unknown. Then, answer the following questions.

Different plans can be proposed.

- Add Na_2CO_3 or NaHCO_3 solution: If a precipitate forms, the unknown is CaCl_2 .**
 - Add HCl : If a gas is given off, the unknown is either Na_2CO_3 or NaHCO_3 .**
 - Add $\text{Fe}(\text{NO}_3)_3$ solution: If a red color forms, the unknown is KSCN .**
 - Add Na_2CO_3 or NaHCO_3 solution. If a gas is given off, the unknown is HCl .**
 - Add HCl : If a gas is given off, the unknown is either Na_2CO_3 or NaHCO_3 .**
- a. What do you think your unknown is? _____

If there is more than one possibility, list both. **Can't distinguish between Na_2CO_3 or NaHCO_3 since both form a precipitate with CaCl_2 and both give off a gas with HCl .**

- b. What is your proof for what you've listed in (a)?
The proof should be stated something like the answer response in the plans given above, but specific for the unknown. For example, if the unknown was CaCl_2 , the proof statement could be: A precipitate formed when Na_2CO_3 solution was added. The CaCl_2 solution is the only one of the possible unknowns that will give a precipitate with Na_2CO_3 .
- c. Write balanced chemical equations for the reactions you used to determine the identity of the unknown.
refer to equations in lesson (Section VIII)

3. Now that you're finished, which pair of compounds listed above cannot be completely identified because of their similarity in reactions with solutions in the dropper bottles from the chemical reaction kit?

Can't distinguish between Na_2CO_3 or NaHCO_3 since both form a precipitate with CaCl_2 and both give off a gas with HCl .