

# Chemical Reactions Mystery

## Lesson Plan – For Teacher Use Only

### Focus Question

Who stole the equipment from the chemistry store room?

### Learner Objectives

I can:

- Locate the atomic number for different elements
- Write the chemical formulas for compounds when given their names
- Balance chemical equations using correct coefficients
- Use the activity series to select elements that will react with a compound in a single replacement reaction
- Predict the products of a chemical reaction
- Work productively in a group

### Materials

For each clue (2-6) you should have the following:

- **2-3 printouts for the clue** – enough for everyone to see but not enough for one clue per student
- **Centralized location or table** for students at the clue to discuss

For each group you should have the following:

- Printed Pages
  - **"There's Been a Crime" Introduction** - So that students can refer to the original scenario to compare with their clue information
  - **Clue #1** - so that students can consolidate information from the other clues as a group
  - **Clue Sign Up** - to help students organize and make sure that all clues are covered
  - **Conclusion Sheet** - for groups to make their evidence-based conclusions permanent
- **Centralized location or table** for students to make their clues visible to each other. The following may be used:
  - Dry erase markers and whiteboards
  - Chart paper and markers
  - Neon dry erase markers for students to write on black lab benches

For each student you should have:

- **Evidence Notecard Sheets** - for students to record information about their clues
- **Access to the Periodic Table, Polyatomics List, and Activity Series**

### Classroom Setup

Students should start class sitting in groups of 4-5 at a table or some other centralized location.

Clues will be arranged around the room for the jigsaw portion of the activity. If the room is big enough, these stations can be preset, otherwise, it works fine to assign the group tables with clue numbers before they divide and conquer.

Lesson	
3 min	<p><b>Setting the Stage</b></p> <p>Hand out “There’s Been a Crime!” and Clue #1 papers, one of each per group</p> <ul style="list-style-type: none"> <li>• Option 1 <ul style="list-style-type: none"> <li>○ Read through it together with groups following along</li> </ul> </li> <li>• Option 2 <ul style="list-style-type: none"> <li>○ Give time for the groups to read through it on their own</li> <li>○ Popcorn share out what you know from this beginning sheet</li> </ul> </li> </ul>
5 min	<p><b>Outline the Objective – “Who stole the equipment from the chemistry store room?”</b></p> <ol style="list-style-type: none"> <li>1. <i>“In a moment, you will each go out into the field to collect evidence. There are 5 remaining clues, one for each person in your group. Just like in the real world, be diligent in recording your observations and inferences because you won’t be able to take the clue back with you.”</i></li> <li>2. Hand out the “Evidence Sheet”, one per person.</li> <li>3. Have students either write the clue number that they are planning on going to on top of their evidence sheet or fill out a “Clue Sign Up” for their group so they know who will be heading to each clue station</li> <li>4. <i>“You will each have 4 minutes with your clue. Be sure to record any information that you think may be important for your group because you not be allowed to return to the clue. Stay by your clue for the entire time so that all group members have time to fully analyze their clue”</i></li> <li>5. Provide an opportunity for class to ask for clarifications about the process</li> </ol>
10 min	<p><b>Clue Time</b></p> <ol style="list-style-type: none"> <li>1. Each group member goes to a different clue station (Clues 2-6 since Clue #1 is provided to the group) to collect as much relevant information as they can. They must spend the first 5 minutes of this time recording information without talking.</li> <li>2. After 4 minutes have elapsed (or it is clear that everyone is done) provide 3-5 minutes for "clue groups" to put their minds together and discuss how they think their clue will be valuable to their group once they return. It's important that all students have recorded the key points because all clues are required to solve the mystery.</li> <li>3. During this collaboration time, the teacher should complete the following check-ins: <ol style="list-style-type: none"> <li>a. Clue #2 – Check that they have recognized that the initials correspond with the chemical formulas of the “calling card” compound</li> <li>b. Clue #3 – Verify that everyone can agree on a list of 4 possible suspects</li> <li>c. Clue #4 – Recognize that the second equation is the only one without an error. Make sure that they know that this means there is something important about Double Replacement</li> <li>d. Clue #5 – Make sure they recognize that Potassium is the missing metal and the newly created compound must be Potassium Sulfide (<math>K_2S</math>)</li> <li>e. Clue #6 – They should interpret this as Iron (II) Carbonate (<math>FeCO_3</math>)</li> </ol> </li> </ol>

25 min	<b>Pulling it Together</b> <ol style="list-style-type: none"> <li>1. Invite students to return to their original groups.</li> <li>2. <i>"All clues are required to completely solve this mystery. Work together to make your evidence visible to the rest of your group but be mindful that they have important information to share as well. Once all the evidence is 'out on the table', you have the rest of the hour to work together to assemble your clues and make your conclusions"</i></li> <li>3. As students are working, some groups of 4 may need a clue that they didn't get to during the clue time. You can just provide them with that missing page once they have had a chance to share the rest of their information.</li> </ol>
10 min	<b>Conclusions</b> <ol style="list-style-type: none"> <li>1. Once students are confident that they have solved the mystery, have them call you over and present the evidence that has informed their response.</li> <li>2. Once they have found both pieces of evidence or there is only 5 minutes or so left in the period, give the group a conclusion page and instruct them to capture their ideas in a single conclusion statement.</li> <li>3. Groups will naturally finish at different times, it is ok to have different levels of detail in the conclusion statements depending on how much time they have left.</li> </ol>
0-5 min	<b>The Answer</b> <p>Depending on how students do with the task, you can end the period (or start the next period) by going over the solutions together as a class. If most groups get to the at least one of the solutions, it is usually best just to let the task naturally conclude with their conclusions. A teacher revealing the answer sometimes disrupts the feeling of personal discovery and solving a mystery.</p>

### Quiz/Exit Ticket (optional)

Depending on timing, you can provide a formative check for students to provide evidence of individual understanding. This can occur at the end of the class period if there is time or at the beginning of class on the following day.

### Accommodations/Modifications

Encourage groups to work persistently through the challenge and the feeling of being stuck. If it looks like a group has stopped making progress, it may be necessary to provide some hints to help them down a productive path. Try to limit the hints to 1-2 things that will help the group wherever they are at.

Some possible hints to consider:

1. Ask the clue #4 champion what type of reaction they expect the perpetrator used
2. Set of the form of the equation  $\text{_____} + \text{_____} \rightarrow \text{_____} + \text{_____}$  and guide them to clue #1 to fill in what they can about the products
3. Guide the group that the reactant ingredients are connected to clues #5 and #6
4. If the group has the correct double replacement reaction, ask them how FeS points to a suspect

## Solution

The perpetrator is Franklin Edward Sparrow (aka “Iron (II) Sulfide”)

**Clue 1:** The flask contains two substances, liquid Potassium Carbonate ( $\text{K}_2\text{CO}_3$ ) and an unknown solid that are the products of a chemical reaction. The note suggests that the precipitate is important, so this mystery substance is the perpetrator’s “calling card”

**Clue 2:** The “calling card” is a compound that shares the same initials as the suspect

**Clue 3:** The list of suspects can be narrowed down to 4. The atomic number of the elements listed on the slip of paper suggests that the ID must begin with “827”

**Clue 4:** The only equation that does not have an error is the second one, suggesting that the perpetrator used a double replacement reaction to make the “calling card”

**Clue 5:** The only metals higher than Calcium on the activity series are Lithium (Li), Potassium (K), and Strontium (Sr). Of these, only Potassium (K) is missing so the single replacement reaction creates Potassium Sulfide ( $\text{K}_2\text{S}$ )

**Clue 6:** The secret ingredient represented by the picture is Iron (II) Carbonate ( $\text{FeCO}_3$ )

