Lesson Adaptation Activity: Planning and Carrying out Investigations

Related MA STE Framework Standard:

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Lesson Description

Mr. Wells’ 5th grade class is in the middle of a unit on matter and its interactions. In this particular lesson, students are conducting an investigation to determine whether the mixing of several substances results in new substances. Students conduct an investigation where they observe and list the properties of the substances before and after mixing them together. Students then conclude based on the resulting properties of the mixture whether a new substance was formed during the investigation.

Lesson Adaptation A Level 1

Mr. Wells: Alright everyone, so yesterday we talked about physical and chemical changes. Can someone remind me what the difference is between a chemical and a physical change?

Daryl: A chemical change produces a new substance. A physical change does not.

Mr. Wells: That’s right, Daryl. Today, we are going to explore these types changes. Specifically, we are going to determine whether the mixing of different substances results in a chemical change and new substances. To do so, we are going to do an investigation! We are going to mix together sodium bicarbonate, calcium chloride and phenol red solution and we are going to observe what happens. Now how will we know if a chemical reaction has occurred? What are our indicators of a chemical change?

Tracy: The color can change.

Mr. Wells: That’s right, what else?

Raquel: There could be a temperature change.

Cameron: A gas can be produced.

Earl: A solid can form.

Mr. Wells: Very nice, and what do we call that solid which forms from a chemical reaction?

Earl: A precipitate.

Mr. Wells: That’s right! So these are going to be the things we are going to look for when we carry out our investigation today. Let’s begin with some observations of the properties of our substances before mixing them. Here we have sodium bicarbonate or baking soda. Can someone describe the properties of baking soda?

Linda: It is a fine white powder that kind of looks like flour.
Mr. Wells: Okay, I am going to write that on the board. [Writes white, fine-grained, powder] Please follow along and record on the worksheet I provided you. How about the calcium chloride or road salt?

Eric: It is also white but kind of cloudy. It has bigger chunks like little rocks.

Mr. Wells: [Writes white, cloudy, coarse-grained] And what about the phenol red solution?

Linda: It is a liquid and it is red.

Mr. Wells: [Writes red, liquid] Great, now let’s mix our substances together and see what happens. Remember to keep an eye out for any indicators of a chemical change. Okay, let’s begin! First, I am going to put 1 teaspoon of sodium bicarbonate in one corner and 2 teaspoons of calcium chloride in the other corner of a quart sized sealable plastic bag. Now I am going to measure 10 milliliters of phenol red solution into a 1ounce portion cup and carefully place this inside the bag. I have to gently squeeze the air out of the bag and close it as tightly as I can. Next, I am going to spill the phenol red solution out of the portion cup by tilting the bag. Now that substances have mixed together, it is time to observe the properties of the mixture. Be sure to follow along and record our observations in the worksheet I provided you. I will also keep track of them on the board. First, from feeling the bag, I noticed its warmer in the corner of the bag with the road salt and colder in the corner of the bag with the baking soda. It also seems that the color changed from red to yellow. Last, I notice that the bag has expanded and it looks like a solid has formed.

Earl: I think the bag expanded because a gas formed!

Mr. Wells: I think you might be right! I am now going to pass the bag around so everyone can observe the bag. While the bag is going around let’s discuss any evidence of a chemical change you just observed. After our discussion, I want you to answer the final question of the investigation on your own. So what evidence showed that a new substance formed?

Tracy: I think that a new substance formed because a gas inflated the bag and a solid formed in the liquid when you mixed the substances together.

Earl: Also, there was a color change to yellow and the temperature changed in the corners of the bag. That also shows that a chemical change happened.

Mr. Wells: Great, anything else? If not, then you can begin writing your answer to the final question. Remember to think about the indicators of a chemical change and our observations from the investigation.
Mr. Wells: Alright everyone, so yesterday we talked about physical and chemical changes. Can someone remind me what the difference is between a chemical and a physical change?

Daryl: In a chemical reaction, new materials are made. Like when we did the experiment yesterday with the baking soda, sugar, road salt, and that red liquid. In a physical change new materials are not made.

Mr. Wells: That’s right, Daryl. Can someone remind me what we saw when we combined these four substances together?

Tracy: The color changed from red to yellow.

Mr. Wells: That’s right, so a color change indicates a chemical change. What else?

Raquel: There was temperature change where it got warmer on one side and colder on the other side. Also the bag got really big!

Cameron: Yeah, that showed that a gas formed.

Mr. Wells: Good. So a temperature change and gas being formed also indicate a chemical reaction. Anything else?

Earl: A solid formed in the liquid.

Mr. Wells: Very nice, and what do we call solid that forms from a chemical reaction?

Earl: A precipitate.

Mr. Wells: Very nice! Now today, you will be carrying out another experiment involving road salt, sugar, baking soda and phenol red solution. But this time, instead of just putting the materials together in a bag to see what happens, you will be experimenting to figure out what combination of 3 substances actually caused the chemical reaction. It is going to be up to you and your partner to determine the different combinations to test. After you make a list of all the combinations, you are going to test each combination by mixing them together.

Tracy: Will we be mixing the substances in the plastic bag like we did yesterday?

Mr. Wells: Yes, Tracy the mixing directions will be very similar to the directions we used yesterday. Now at the center of the table is a procedure you will follow for each of your chosen mixtures. After making your observations for each trial, you are going to make a decision on whether a chemical change occurred from each mixture. You will also need to explain why you made this decision using evidence. After the investigation I want you discuss and write about which combination resulted in chemical change with your partner. Make sure you discuss evidence from your investigation and that you tie this evidence to what you know about chemical reactions. After everyone is finished we will come back together and discuss. Are there any questions? Ok then, I will call up each partner group to collect the materials and then you can start your experiments. Make sure to wear your goggles for the whole experiment!

Mr. Wells passes out the materials and the students begin their investigations. Mr. Wells circulates the classroom and stops to listen in on one group as they carrying out their investigation.
Tracy: We can only change one thing at a time so let's write down all the different combinations we should try.

*The students make a list of all the different combinations, making sure that they only change one substance at a time.*

Earl: Alright, so we have come up with 4 different combinations. Let’s start our first trial and combine road salt, baking soda, and phenol red solution. You measure out 2 teaspoons of road salt and put it in the left-hand corner of the bag and then measure out 1 teaspoon of baking soda and put it into the right-hand corner of the bag. I will measure out the phenol red solution. [Earl measures out 10 mL of phenol red solution using a graduated cylinder and places it in a 1 oz. portion cup.]

Tracy: Okay. [Tracy measures out the substances using a plastic measuring spoon and places them in each corner of the bag.] I am ready for the phenol red solution now.

Earl: [Earl places the solution in the middle of the bag] Now we need to take the air out of the bag and then shake it up.

Tracy: I want to shake it! [Tracy takes the bag, gently squeezes the air out, and begins shaking the bag.]

Earl: The bag is getting bigger. It looks like its going to pop and the liquid turned yellow! What does it feel like?

Tracy: Its feels warmer in the left corner and colder in the right corner. It is also feels kind of thicker.

Earl: That’s awesome! Now let’s write our observations. [Writes] The bag inflated, the liquid turned yellow, the liquid got thicker.

Tracy: And the left corner got warmer and colder in the right corner got colder. So I think a chemical change occurred.

Earl: Yeah you are right. Now we have to explain how we know, by listing any chemical reaction indicators we saw. I think a gas formed because the bag inflated. I also think a precipitate formed because it got thicker. And the color and temperature definitely changed. So we should include all four of those indicators.

Mr. Wells continues to circulate the classroom and listens in on another as they discuss their conclusion.

Raquel: The road salt, baking soda, and phenol red solution resulted in chemical reaction. I know this because the mixture changed color and temperature changed and it also formed a gas and a solid.

Cameron: This is evidence of a chemical reaction, meaning new substances were made. And now these new substances can’t be changed back to the old substances because their chemical structure has been changed.
Lesson Adaptation C Level 2

Mr. Wells: Alright everyone, so yesterday we talked about physical and chemical changes. Can someone remind me what the difference is between a chemical and a physical change?

Daryl: A chemical change produces a new substance. A physical change does not.

Mr. Wells: That’s right, Daryl. To explore chemical changes, we carried out an investigation yesterday where we combined road salt, sugar, baking soda and phenol red solution in a bag to see what would happen. Can some students remind me what were indicators that a chemical reaction occurred when we combined these four substances together yesterday?

Tracy: The color changed from red to yellow.

Mr. Wells: That’s right, what else?

Raquel: The bag got warmer on one side and colder on the other side. Also it got bigger!

Cameron: Yeah, that showed that a gas formed.

Mr. Wells: Good. Anything else

Earl: A solid formed in the liquid.

Mr. Wells: Very nice, and what do we call a solid that forms from a chemical reaction?

Earl: A precipitate.

Mr. Wells: That’s right! Now today, you will be carrying out another experiment involving road salt, sugar, baking soda and phenol red solution. But this time, instead of just putting the materials together in a bag to see what happens, you will be experimenting to figure out what combination of 3 substances actually caused the chemical reaction. There are four different combinations you will be testing today with your lab partner.

Tracy: Will we be mixing the substances in the plastic bag like we did yesterday?

Mr. Wells: Yes, Tracy the mixing directions will be very similar to the directions we used yesterday. At the center of the table is a procedure for you to follow during the experiment. You will mix the 4 combinations and observe what happens in each. After making your observations for each trial, you are going to check off any indicators of a chemical reaction you saw after mixing. Finally, you are going to make a decision on whether a chemical change occurred in each trial by circling yes or no. After the investigation we will come back together to discuss our results. Are there any questions? Ok then, I will call up each partner group to collect the materials and then you can start your experiments. Make sure to wear your goggles for the whole experiment!

Mr. Wells passes out the materials and the students begin their investigations. Mr. Wells circulates the classroom and stops to listen in on one group as they carrying out their investigation.
Earl: Alright, let’s do the third trial now. You measure out 2 teaspoons of road salt and put it in the left-hand corner of the bag and then measure out 1 teaspoon of baking soda and put it into the right-hand corner of the bag. I will measure out the phenol red solution. [Earl measures out 10 mL of phenol red solution using a graduated cylinder and places it in a 1 oz. portion cup.]

Tracy: Okay. [Tracy measures out the substances using a plastic measuring spoon and places them in each corner of the bag.] I am ready for the phenol red solution now.

Earl: [Earl places the solution in the middle of the bag] Now we need to take the air out of the bag and then shake it up.

Tracy: I want to shake it! [Tracy takes the bag, gently squeezes the air out, and begins shaking the bag.]

Earl: The bag is getting bigger. It looks like it’s going to pop! The liquid is yellow! What does it feel like?

Tracy: It feels warmer in the left corner and kind of colder in the right corner. It is also feels sort of thicker.

Earl: Cool! Let me hold it! [Earl holds the bag]. Wow!

Tracy: Now let’s write our observations. [Writes] Bag inflated, substance turned yellow.

Earl: And the left corner got warmer and colder in the right corner got colder. Also the substance got thicker. What about the evidence?

Tracy: I think a gas formed because the bag inflated. I also think a precipitate formed because it got thicker. And the color and temperature definitely changed. So we should check them all.

Earl: And that means we should circle yes, that a chemical change happened.

Mr. Wells continues to circulate the classroom and brings the class back together after each group is done with their investigations.

Mr. Wells: Now that everyone has finished the investigation, which mixture resulted in a chemical reaction and how do you know?

Raquel: The road salt, baking soda, and phenol red solution resulted in chemical reaction. I know this because the mixture changed color and temperature and it also formed a gas and a solid. This is evidence of a chemical reaction, meaning new substances were made. And these new substances can’t be changed back into the old substances.

Mr. Wells: Very nice, Raquel! Now I want everyone to write down their conclusions below their data tables. Make sure your conclusions have evidence and reasoning like Raquel’s did. Go ahead!
Mr. Wells: Alright everyone, so yesterday we talked about physical and chemical changes. Can someone remind me what the difference is between a chemical and a physical change?

Daryl: In a chemical reaction, new materials are made. Like when we did the experiment yesterday with the baking soda, sugar, road salt, and that red liquid. When they all mixed together, it made a gas. We didn’t have a gas before we started. In a physical change new materials are not made.

Mr. Wells: That’s right, Daryl. A gas being formed indicates a chemical reaction. Can some other students remind me what else we saw when we combined these four substances together?

Tracy: The color changed from red to yellow.

Mr. Wells: That’s right, so a color change also indicates a chemical change. What else?

Raquel: There was temperature change where it got warmer on one side and colder on the other side.

Mr. Wells: Good. So a temperature change is also an indicator. Anything else?

Earl: A solid formed in the liquid.

Mr. Wells: Very nice, and what do we call solid that forms from a chemical reaction?

Earl: A precipitate.

Mr. Wells: That’s right! Now today, you will be carrying out another the experiment involving road salt, sugar, baking soda and phenol red solution. But this time, instead of just putting the materials together in a bag to see what happens, you will be experimenting to figure out what combination of 3 substances actually caused the chemical reaction. It is going to be up to you and your partner to plan how to conduct the investigation and then you will create a data table to record your data. After the investigation I want you discuss and write your conclusions about which combination resulted in a chemical change with your partner. Make sure you discuss evidence from your investigation and that you tie this evidence to what you know about chemical reactions. After everyone is finished, we will come back together and discuss. Are there any questions? Ok then, I will call up each partner group to collect the materials and then you can start your experiments. Make sure to wear your goggles for the whole experiment!

Mr. Wells passes out the materials and the students begin their investigations. Mr. Wells circulates the classroom and stops to listen in on one group as they carrying out their investigation.

Earl: Okay, we need to plan how we will do this investigation. I think we should make our mixtures kind of like we did yesterday. We can put the substances in the plastic bag, then close the bag and mix them up.

Tracy: We should try to keep them separate until we close the bag. We want to make sure we catch all the gas, if it is made when we mix the substances.

Earl: Yeah you are right. I will write down our steps so we don’t forget. What about the combinations? What are we going to test?

Tracy: We can only change one thing at a time so let's write down all the different combinations we should try.
The students make a list of all the different combinations, making sure that they only change one substance at a time.

**Earl:** Alright, so we have come up with 4 different combinations. Now we should make the data table.

**Tracy:** I will write down the 4 mixtures in the first column. Then maybe we can do yes or no columns for the different indicators.

**Earl:** Okay, so we should think about what indicators we saw yesterday. I think we should have a column for gas formed, a column for solid formed, and a column for temperature change. Can you think of anything else?

**Tracy:** Yeah we need a column for if the color changed.

**Earl:** Oh yeah, I forgot.

_The students make their data table and begin their investigation._

**Earl:** Let’s start our first trial and combine road salt, baking soda, and phenol red solution. You measure out 2 teaspoons of road salt and put it in the bag and then measure out 1 teaspoon of baking soda and also put it into the bag. Try not to mix the two substances together yet. I will measure out the phenol red solution. [Earl measures out 10 mL of phenol red solution using a graduated cylinder and places it in 1 oz. portion cup.]

**Tracy:** Okay. [Tracy measures out the substances using a plastic measuring spoon and places them in each corner of the bag.] I am ready for the phenol red solution now.

**Earl:** [Earl places the solution in the middle of the bag] Now we need to take the air out of the bag so we can see if a gas forms.

**Tracy:** Now we have to shake it. [Tracy takes the bag, gently squeezes the air out, and begins shaking the bag.]

**Earl:** The bag is getting bigger. It looks like its going to pop and the liquid turned yellow! What does it feel like?

**Tracy:** Its feels warmer in the left corner and colder in the right corner. It is also feels kind of thicker.

**Earl:** That’s awesome! Now let’s write our observations. [Writes] yes for gas formed, yes for solid formed, yes for temperature change, and yes for color change.

**Tracy:** I think a chemical change occurred!

_Mr. Wells continues to circulate the classroom and returns to Tracy and Earl as they discuss their conclusion._

**Tracy:** The road salt, baking soda, and phenol red solution resulted in chemical reaction. I know this because we recorded yes for all the indicators with this mixture.

**Earl:** This is evidence of a chemical reaction because these indicators mean new materials were made. We didn’t have gas or solid before we started. And now these new substances can’t go back to the old substances because the molecular structure has been changed.

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### Ordering of Adaptations

**Directions:** Order the four adaptations (A-D) along the Science Practice Continuum (Levels 1-4) for the Planning and Carrying out Investigations practice.

<table>
<thead>
<tr>
<th>Adaptations</th>
<th>Level 1</th>
<th>Level 2</th>
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