High School Science Lesson Plan: Chemistry

Introduction
Each lesson in the Adolescent Literacy Toolkit is designed to support students through the reading/learning process by providing instruction before, during, and after reading/learning.

Note that lessons incorporate the gradual release of responsibility model. When this model is used within a single lesson and over several lessons, students are provided with enough instruction and guidance to use the literacy strategies on their own. The following lesson includes some examples of explicit instruction and modeling, guided practice, and independent practice, but students need more practice and feedback than is possible within the context of a single lesson.

Bold print indicates a direct link to the Content Area Literacy Guide where readers will find descriptions of literacy strategies, step-by-step directions for how to use each strategy, and quadrant charts illustrating applications across the four core content disciplines.

The following lesson plan and lesson narrative show science teachers how they can incorporate the use of literacy strategies to support high school students to learn science content and concepts. The lesson is designed for one block period (80–90 minutes) or two traditional classes (50 minutes).

### Instructional Outcomes

ISTE standards: Abilities necessary to do scientific inquiry: Identify questions and concepts that guide scientific investigations.

Content Learning Outcome: Students will activate prior knowledge, make predictions, and then use the text to identify key concepts and synthesize information about chemical reactions that involve heat.

### Literacy Support Strategies and Instruction

**Before reading/learning:** Anticipation/Reaction Guide (explicit instruction and teacher modeling)

- Materials: Teacher-created Anticipation/Reaction Guide based on text material for heat in chemical reactions

**During reading/learning:** Anticipation/Reaction Guide (guided practice)

- Materials: Text material (chapter, section, or pre-selected online text) related to heat in chemical reactions

**After reading/learning:** Anticipation/Reaction Guide (guided practice)

- Materials: Individual students’ Anticipation Reaction Guides

**Before Reading/Learning** (20 minutes)

Literacy outcome: Students will use an Anticipation/Reaction Guide to set a purpose for reading and stimulate interest in the topic of heat in chemical reactions.
**Teacher preparation:** Create an **Anticipation/Reaction Guide** with statements connected to major concepts in the chapter students will be asked to read. See the **Anticipation/Reaction Guide Template** example (below) related to heat in chemical reactions. (Note there are only six statements, not many highly technical terms, a mix of true and false statements, and conceptual questions and statements related to real-life applications. The goal is to create a guide that matches the content of the reading assignment, but contains interesting statements that will provoke interest and thought on the part of students.)

**Anticipation/Reaction Guide Template Example**

**Directions:** Discuss each question with your group. Then fill out the A/R guide on your own, as you may disagree with your group members. Put a check under True or False if you are sure of your answer. Put a ? under True or False if you are guessing.

<table>
<thead>
<tr>
<th>Before Reading</th>
<th>Statements about heat in chemical reactions</th>
<th>During/After Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>True</td>
<td>Heat results from the motion and vibration of particles of matter.</td>
<td>Page # relevant info</td>
</tr>
<tr>
<td>False</td>
<td>The amount of heat a reaction absorbs or releases varies according to the conditions under which the reaction is carried out.</td>
<td>True</td>
</tr>
<tr>
<td>False</td>
<td>The heat transferred in a reaction is always the difference in the energies of reactants and products.</td>
<td>False</td>
</tr>
<tr>
<td>False</td>
<td>The size of a temperature increase depends on how much heat is released, not on the surroundings where the reaction takes place.</td>
<td></td>
</tr>
<tr>
<td>B. Real-world applications</td>
<td>A blast of cold air will freeze something more completely than long exposure at a low temperature.</td>
<td></td>
</tr>
<tr>
<td>False</td>
<td>More heat escapes from certain areas than others—that’s why hats keep you warmer than gloves or socks.</td>
<td></td>
</tr>
</tbody>
</table>

**Teacher facilitation:** Begin by introducing the topic of heat in chemical reactions using the **Anticipation/Reaction Guide** you have prepared. Tell students the purpose of an **Anticipation/Reaction Guide** is to activate prior knowledge and predict what they will be reading about. Pass out the **Anticipation/Reaction Guide** and model it using a **Think-Aloud** on how to fill in the boxes in the **before** reading columns.

Tell students they will fill out the **before** reading section of the **Anticipation/Reaction Guide** by discussing each question in groups of three and then marking their individual responses for each statement. Tell students they will then read the text as a way to find out if their initial thoughts were on target, given the information in the chapter.

Ask students to break into groups of three. Ask them to discuss the next statement in their group and then individually mark their statement true or false. Then ask students to raise their hands if they marked the statement true. Ask for some students to share their rationale. Then ask students who marked the statement false to raise their hands. Again, ask for some reasons why they did this. Do not share the “correct” answer. Ask students to discuss the rest of the questions in their small groups and to individually finish selecting true or false for the rest of the statements on the guide.
During Reading/Learning (35 minutes)

**Literacy outcome:** Students will use the statements in the Anticipation/Reaction Guide to help identify key concepts in the text about chemical reactions that involve heat. Students will practice finding textual evidence for the statements in the guide.

**Teacher facilitation:** Read the first part of the text aloud and ask students to listen for evidence related to the first statement (note: in the guide you create, make sure the first statement is related to the text in the first few paragraphs). Model how to record the page number and where on the page they heard evidence related to the first statement.

1) Tell students that some of the statements are literal or “in the book” statements, and others are “text and me” statements that require inferential thinking. Remind them how to make an inference by discussing a simple statement, such as: *it is cloudy today, so it may rain.*

2) As students read to refute or confirm each statement, ask them to record the page number where relevant information is found in the Reaction section of their Anticipation/Reaction Guide.

3) When they have finished reading the text selection, ask students to record in the last two columns of the guide what they now feel are the correct responses to each of the statements.

Ask students to continue to read the assigned text, focusing on finding the evidence that supports or refutes the statements in the Anticipation/Reaction Guide.

Circulate as students work, quietly observing their Anticipation/Reaction Guide entries. When errors are seen, ask probing questions to help them realize why a mistake was made and have them re-read and clarify the textual evidence.

After Reading/Learning (25 minutes)

**Literacy outcome:** Students will communicate their thinking and synthesize information by discussing their after reading responses for the Anticipation/Reaction Guide.

**Teacher facilitation:** Ask students to combine two of the original small groups of three (you’ll now have groups of six) and share their After Reading Reactions along with the evidence they found.

1) Encourage students to carefully re-read text when there is disagreement about the statement and remind them science concepts should be evidence-based. Remind them science continually evolves but their responses should be based on the answers found in the chapter. Students should note if they think information might be incorrect.

2) Ask students to query other classmates about their true/false choice and have them skim the text to locate evidence that supports their answers.

3) If time allows, ask students to return to their original group of three to further synthesize the chapter information by working together to write two additional scientific concept statements and two additional real-world application statements. Encourage students to write statements that, at first glance, might be true or false.

Ask each original group of three to work together to complete one Exit Slip. An Exit Slip is a quick written response that provides feedback to the teacher about students’ experiences during the lesson. Ask the students to discuss and respond to three questions:
1) How did the **Anticipation/Reaction Guide** change how you read the text?
2) What are two other real-world applications you can think of for something you learned today about heat in chemical reactions?
3) What additional questions do you have about heat in chemical reactions?

At the end of the class:
- Collect the **Anticipation/Reaction Guides**, review student responses, and any new statements that groups generated.
- Collect the **Exit Slips** and review carefully to determine where additional emphasis is needed the next day.

Like all student-completed literacy strategy templates, these completed **Anticipation/Reaction Guides** and **Exit Slips** provide valuable data for teacher reflection. The **Anticipation/Reaction Guide** should not be graded. The student responses should be used to assess student learning and make decisions about next steps in teaching.

**Suggested Subsequent Lessons**
Students can complete several small group laboratory experiments to see how the principles of heat apply to chemical reactions. Students can write lab reports that explain the heat reactions for the major concepts that were summarized in the **Anticipation/Reaction Guide**, e.g., exothermic reactions, endothermic reactions, enthalpy changes, Hess's Law, calorimetric, and kinetic theory. Other **Anticipation/Reaction Guides** can be used with subsequent text chapters, demonstrations, and/or media presentations. The teacher can gradually transfer the responsibility for creating the statements to groups of students, modeling how they can use text headings, graphics, and other concept clues to predict and confirm scientific principles.
High School Chemistry Lesson Narrative: Heat in Chemical Reactions

Teachers: As you read the lesson narrative, think about the following questions. You may want to discuss them with fellow science teachers.

- What does the teacher do to support students’ literacy development and content learning before, during, and after reading/learning?
- What challenges do you anticipate if you were to implement this lesson in your own classroom? How would you prepare to meet these challenges?
- How would you make improvements to this lesson?

Mrs. O’Leary wondered what might hook the students’ interest in the upcoming unit on *heat in chemical reactions*. The textbook chapter was pretty dense and reading the chapter and answering the questions was not working well for students in the course. The “ping-pong” reading that occurred when she asked students to do assigned reading and answer questions did not support close reading of the text or real comprehension, and she knew it was boring. But the textbook had good information in it and she wanted students to read the text and get information from it.

Mrs. O’Leary decided to use an *Anticipation/Reaction Guide* because it is a useful strategy to activate prior knowledge and connect students with the text they will be reading. The students can reflect on their initial choices and make changes to their responses after reading if necessary. Mrs. O’Leary developed the statements for the guide, deliberately including ones that reflected important text concepts, as well as some more general real-life applications students might already know about.

**Before Reading/Learning**

“Today we’re going to begin the unit on *heat in chemical reactions,*” she said. She pointed at the new bulletin board where pictures of fires, volcanoes, chemistry lab testing, food calorie charts, cloud formations, movie posters featuring race cars and explosions, smog-filled cities, ice storms, and some really odd looking bugs emitting light were tacked up. “I want you to pair up and select one of the images on the board, bring it back to your seats and brainstorm some words that connect to the image. Students immediately went to get images and began to talk. After a few minutes, Mrs. O’Leary asked the students to connect with another pair who selected a different image and brainstorm some words that relate to both of the images you selected.” After another few minutes, Mrs. O’Leary asked each foursome to report out one or two words related to both images. Students shouted out answers—heat, explosion, chemical reaction, cold, emissions.

“Okay,” said Mrs. O’Leary, collecting the images. “So I guess you can see how heat in chemical reactions has relevance to your lives. Now we need to get into the nuts and bolts of how heat and chemical reactions are related. There is a lot of information in the text, but this time, instead of just assigning the reading and the questions at the end of the chapter, I’d like to introduce you to a literacy strategy that helps you assess your current knowledge, stay focused when you read, and check how your knowledge has deepened after reading and discussion.”

As she passed out the *Anticipation/Reaction Guide*, several students started reading and answering the statements before she had time to explain what to do. “Have you seen this strategy before?” A few students nodded, so she asked if someone would like to explain to the class what needed to be done and what purpose was achieved by using this strategy. A few students contributed, describing the template and how to fill it out, but none of them explained the purpose of using it. “Whoa! Slow down!” Mrs. O’Leary laughed. “If you know what the
purpose of a literacy strategy is, you have a better chance of having it be helpful! I have noticed that when I assign reading and ask you to answer questions, many of you do not read the text. That means you are missing a lot of information. An Anticipation/Reaction Guide is a good way for you to monitor your own knowledge and learning. When you use it before you read, it helps you set a purpose and activate your thinking. This is not a test. Let’s do the first statement together.”

Mrs. O’Leary read the first statement aloud. Then she modeled her thinking to the class: “I know that when I rub my hands together when I am cold, I get warmer. But that is friction, isn’t it? So that means this must be true. But I can’t see particles in motion. If things that are warmer are in motion, does that make them less stable? But when it is hot, I sure don’t feel like moving around much. I think this is false, but I really am guessing, so I am going to add a question mark.”

“Okay, to help you out a bit, you’ll first talk over the statements in groups of three. Listen carefully, then answer the Anticipation questions on your own because you may not agree with your group’s ideas. The key is to be honest—if you know the information, use checks—but if you’re guessing, use question marks.”

The students moved into groups of three and began to discuss the statements on the guide. Mrs. O’Leary moved to a group of boys who made no move to begin and sat down next to them. “Tony, you like to snow board, right? So what’s worse, being out for half an hour with a gusting 50 mph wind, or being out for four hours on a really cold day with no wind?” When Tony said being in the wind was worse, Alvarez said, “Man, you’re crazy. Half an hour versus four hours outside?” “That’s what this is about!” said Mrs. O’Leary. “Go ahead and start working on the statements—maybe they are not as irrelevant as you think!” Groaning a little, the boys began to discuss the statements.

Moving on to another group, Mrs. O’Leary reflected briefly on how students often seem unmotivated when asked to do their own thinking. She reminded herself that, like anything else, this kind of work takes practice.

During Reading/Learning

“Now you’re going to find out if you and the chemistry book agree. The purpose of the reading we’re about to do is to find the evidence in the text about whether the statements are true or false. Remember, some of the answers are literal and are right there in front of you; they will be directly stated in the chapter. Others may require you to put two and two together—your knowledge and the author’s knowledge. You’ll have to read between the lines. Use the clues in the text and be sure to read the charts and graphs, too, in order to find the evidence you are looking for.” She waited a moment to let the directions sink in as students pulled out textbooks and pencils and rearranged their chairs. “Let’s try the first one together. Put your hand up to stop me as soon as you hear evidence in the text related to the first statement.” Mrs. O’Leary read the first three paragraphs of the chapter, pausing only to explain some vocabulary terms. When she was halfway through the fourth paragraph, Tamara and Chaz both raised their hands and Mrs. O’Leary stopped. “It was what you said right there about the particles in motion,” said Tamara. “Yeah, so your first answer was wrong Mrs. O!” said Chaz.

“Okay, good, let’s look at that and how to fill in the guide to keep track of what we just learned.” Mrs. O’Leary explained how to fill in the remaining columns—the page number where the evidence was found and then how she recorded that she changed her mind, based on the text, about whether she thought it was a true or false statement. Students nodded.
Mrs. O’Leary wanted students to see the reason for continuing to use the Anticipation/Reaction Guide as they read the text. “Now we’re moving into the Reaction part of the Anticipation/Reaction Guide. You thought about what you already know in anticipation of the reading. Now you’re going to be reacting by making decisions, questioning and maybe changing your earlier thinking, and looking for the printed evidence to help you do that. This is how the guide helps you set a purpose and stay focused. You have to be active, engaged readers to do this. Ready? I want you to work in your groups of three. You can read independently and discuss your answers afterward or you can read together, taking turns reading aloud. Either way, be sure to listen to what the text is saying, stop when you hear or read something that seems like evidence for one of these statements, and record the location on your guide.”

The students settled down into their groups to read the chapter. Some groups read silently to themselves and waited to discuss the statements once they finished. Other groups had one student do all the reading, while the other two listened and recorded evidence. Two groups chose to share the reading, taking turns by paragraphs. Students did seem to focus more than usual when given the task to look for specific information. She noticed Tony’s group seemed to be struggling with the reading. She volunteered to take a turn reading, and she modeled again her own thinking aloud for them when she came to something that helped confirm or refute one of the statements on the guide. The fact all three in this group were struggling with the reading helped explain some of their off-task behavior. She looked around the room as she listened to Alvarez read, thinking about how she might change the groupings the next time she did this activity.

She got up to circulate, chatting softly with some of the groups to answer questions. Craig asked, “Mrs. O, why didn’t you put a question about cloud formation on the Anticipation/Reaction Guide? That’s a good real-life application, isn’t it?” She replied, “Save that thought—towards the end of the period you’ll be inventing some statements on your own.” Another group needed help. “We can’t figure this one out, Mrs. O’Leary. The chapter doesn’t explain what a reactant is, and we don’t know what it means either.” She stopped the class for a moment and asked if any other groups had experienced difficulty with “reactant.” Several students nodded and Mrs. O’Leary asked if they could help by sharing a strategy they used to find out the meaning of the word. Beth asked, “Did you try the index?” Someone called out, “There’s a science dictionary on the desk.” “It’s okay to use it?” asked an anxious Patrice. “Sure,” Mrs. O’Leary replied, “Wouldn’t a detective go look up something on the Web or in the police files? The key is you have to find evidence—no guesses and no opinions as you fill out the Reaction part of the Anticipation/Reaction Guide.

After Reading/Learning
Mrs. O’Leary asked students to reflect on their learning and discuss their responses for the Reaction column in the Anticipation/Reaction Guide by getting together with another group. She asked students in each group of six to just go around the group and report each person’s response and where they found the evidence, and then to discuss in the group any disagreements. Students arranged chairs to pull into groups of six, they went to work on their reactions, sharing results, and comparing page numbers for evidence.

She went on, “Now, after reading, we actually come back to the Anticipation part of this guide, where you do your own predicting and questioning. In your original groups of three, each group will review the chapter and create two additional scientific concept statements. This is how you will move to the next level of thinking. Instead of my making statements that you try to confirm or refute, you’ll make your own anticipation statement. You do this by coming up with a question. For example, a few minutes ago, Craig asked me about cloud formation. Let’s see if we can
make up a statement together about how temperature affects cloud formation. Craig, you take a stab at it. Let’s start with a question: How might temperature affect cloud formation?” She wrote that on the white board. “Now, Craig, can you turn this into a true or false statement that we’ll need to find evidence to confirm or refute?” Craig thought for a minute, “Warm air holds more water than cool air?” Mrs. O’Leary wrote the statement on the board under the question about cloud formation. “Great,” she said, “That’s how you go about making your own statements. Start with a question or a prediction about the topic, then turn it into a statement.”

Back in small groups, students moved onto making their own statements. Some groups easily came up with two. Others had more difficulty with the synthesizing activity and Mrs. O’Leary circled the room showing them how she had used the textbook features to create her statements by asking a question about the bold print topics, or using the pictures and charts on the side of the pages to generate ideas about real-life applications.

Before the students left, Mrs. O’Leary asked each group of three to fill out an Exit Slip to provide her with feedback about how the use of the Anticipation/Reaction Guide influenced their reading, what they had learned about heat in chemical reactions, and what questions remained. She collected the Anticipation/Reaction Guides and the questions the groups had generated, and felt pretty pleased about what had been accomplished during the period. She looked forward to reading through the Exit Slips and to refining her introduction to Anticipation/Reaction Guides with the next class.