

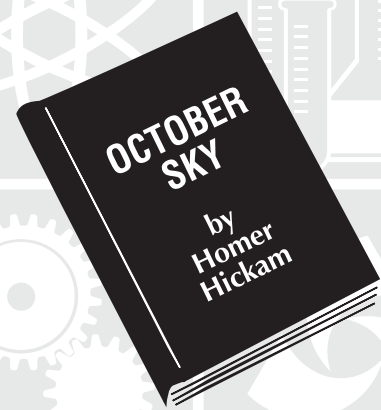
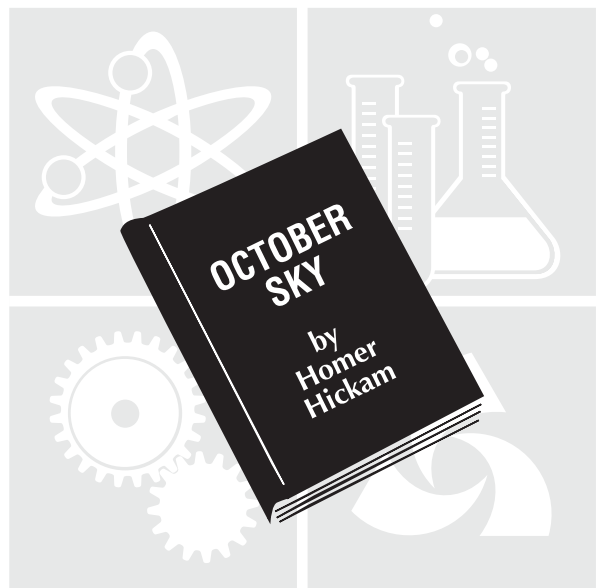
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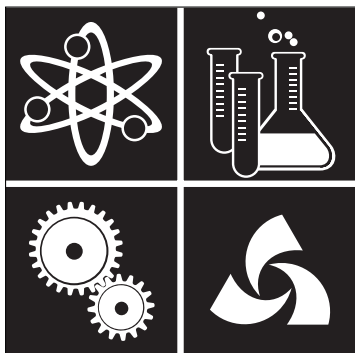
8

Strategic

Science

Teaching





Title of Lesson:

Chemical Reactions



Conceptual Statement:

Chemical reactions are processes in which atoms are rearranged into different combinations of molecules.



Conceptual Learning Sequence:

This lesson is part of a conceptual unit on the structure of matter, and how matter undergoes both physical and chemical changes. It is appropriate after students have a general understanding of the structure of matter in terms of atoms, elements, and compounds. This lesson introduces the nature of chemical reactions, and the evidence for determining if a chemical reaction has occurred.



English Language Learning:

English Language Development standards are referenced in the lesson where appropriate. The hand icon appears throughout the lesson when learning strategies and lesson components are identified as pathways for academic success and reflect critical developmental difference for students who are English learners.



Learning Strategy: (included at the end of this lesson plan)

This lesson uses “Questioning the Author” which helps students transform the author's ideas into their own ideas. Students are prompted to judge whether the author has clearly communicated his ideas, and to attempt to re-state the ideas more clearly. (See Appendix pages 174-177.)

Literature Selection

Title: *October Sky* (originally published as *Rocket Boys*)

Author: Hickam, Homer

Publisher: Random House, New York, 1998.

Annotation: This memoir tells the story of a NASA engineer who grew up in West Virginia in the 1950s, when he was interested in the physics of rockets rather than football and mining.

Genre: Autobiography



Essential Question:

How do different substances interact with each other?

California Science Content Standards:*

Science: Grade 8, Physical Science

Reactions

5. Chemical reactions are processes in which atoms are rearranged into different combinations of molecules. As a basis for understanding this concept:
- a. Students know reactant atoms and molecules interact to form products with different chemical properties.
 - c. Students know chemical reactions usually liberate heat or absorb heat.

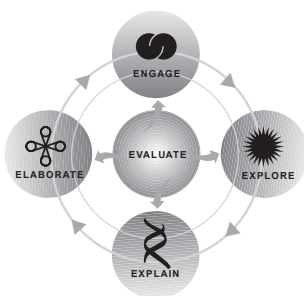


7. Investigation and Experimentation

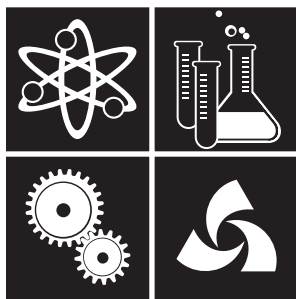
9. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
- a. Plan and conduct a scientific investigation to test a hypothesis.
 - c. Distinguish between variable and controlled parameters in a test.

*Selected standards addressed within this lesson.

Lesson at a Glance



Science Learning Cycle	Objective Science Thinking Process, Learning Strategy	Suggested Time
ENGAGE	Students engage in a real life example of adolescents conducting science experiments as they read about Homer Hickam's beginning attempts to power a rocket. This reading introduces the concept of chemical reactions. Communicating	50 minutes
EXPLORE	By experimenting with copper chloride and aluminum, students directly experience a chemical reaction that involves heat production, changes in color, formation of a precipitate, and production of a gas. Observing, Communicating, Comparing	50 minutes
EXPLAIN	Students compare the results with the three pieces of aluminum foil, and explain their observations in terms of the chemical reaction between copper chloride and aluminum. Communicating, Comparing, Relating	25 minutes
ELABORATE	Students develop a hypothesis about the copper/aluminum reaction. They experimentally test their hypothesis by changing only one variable. Observing, Communicating, Comparing, Relating	75 minutes
EVALUATE	Students evaluate their understanding by describing their hypothesis, experimental design, experimental results, and conclusions. As a homework assignment, students finish reading the book and relate it to continuing investigation and experimentation. Teacher evaluates student understanding of student outcomes in this activity as well as throughout the lesson. Communicating, Comparing, Relating	50 minutes



Chemical Reactions

Teacher Background:

When two or more materials come into contact and change their composition and properties, we refer to that process as a chemical reaction. These kinds of reactions occur all around us and within our bodies. We can readily observe changes that indicate that a chemical reaction has occurred. These include a change in temperature that is not caused by external heating or cooling; the production of a gas that is not due to boiling; the formation of a solid precipitate from a solution; a change in color that does not result from dilution or mixing colors; and the irreversible disappearance of a solid in a liquid (cannot recover the original solid by evaporating the liquid).

We observe the results of chemical reactions at our macroscopic level. Changes at the level of atoms and molecules are the underlying cause of chemical reactions. During any reaction, the atoms involved are neither gained nor lost, but are only rearranged.

This lesson involves the reaction of cupric chloride (cupric means copper that has a net electrical charge of +2) with aluminum. During this reaction, the aluminum changes from being a solid, neutrally charged metal to the positively charged ionic state where it dissolves as a salt (aluminum chloride). Thus, the solid aluminum is observed to disappear. The copper (initially present dissolved as a positively charged ionic salt and combined with chloride) changes to the neutral, metallic state and appears as a copper-colored precipitate. Positively charged copper in solution is blue while positively charged aluminum has a much paler color. Therefore the color of the liquid in the reaction changes from blue to pale gray as the salt changes from cupric chloride to aluminum chloride.

Chemical changes involve interactions among the electrons of the different atoms and molecules. At the atomic level, copper is gaining electrons from aluminum which is why it goes from having a positive charge to being neutral. The aluminum loses electrons and changes from electrically neutral to positively charged.

Many chemical reactions either release or absorb energy. The reaction between cupric chloride and aluminum releases energy as evidenced by the increase in temperature of the solution. Hydrogen gas is also produced as the result of a side reaction.

Related California Content Standards

Language Arts

Reading

2.0 Reading Comprehension (Focus on Informational Materials)

Students read and understand grade-level appropriate material. They describe and connect the essential ideas, arguments, and perspectives of the text by using their knowledge of text structure, organization, and purpose.

Listening and Speaking

2.2 Deliver oral responses to literature:

- a. Interpret a reading and provide insight
- b. Connect the students' own responses to the writer's techniques and to specific textual references.



Grouping: Whole group, groups of 4, individual

For hands-on activities, mix the EL with the fluent English speakers. For debriefing, include at least two EL with native to form discussion groups.

Materials:

Per Class

200 ml 0.5M Copper chloride

25 ml or 50 ml Graduated cylinder

Various materials depending on student hypotheses (See Teacher Tips).

Per Group

- 1 Tray for all the materials
- 20 ml 0.5M Copper chloride in one 10-ounce clear cup
- 2 Empty 10-ounce clear plastic cups
- 3 Pieces of aluminum foil, each 6 cm by 6 cm
- 2 Pairs of latex gloves
- 1 Chopstick (wood or plastic)
- 1 Tweezers
- Paper towels
- Various materials depending on student hypotheses (See Teacher Tips).

Per Student

- 1 Copy of *October Sky*
- Safety goggles
- Student Pages 1.0 and 1.1

Advanced Preparation

1. Purchase or prepare enough 0.5M cupric chloride for the EXPLORE and ELABORATE stages (See Teacher Tips for safety considerations).
2. Cut aluminum foil into 6 cm by 6 cm pieces.
3. Pour 20 ml of 0.5M cupric chloride into one clear 10-ounce cup for each group of students.

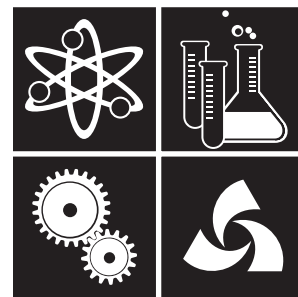
Teacher Resources

Science Safety Handbook for California Public Schools, 1999 Edition, CDE Press.

"Chemical Reactions: Teacher's Guide," Great Explorations in Math and Science (GEMS), Lawrence Hall of Science, University of California at Berkeley.

Teacher Tips:

- Post "Lab Safety Rules" so teacher and students can refer to them while doing the experiments.
- Post a chart that lists observable criteria for a chemical reaction.
- Purchase 0.5M cupric chloride solution from a chemical supply source such as Flinn Scientific (www.flinnsci.com). Alternatively, if you have appropriate storage and safety facilities/equipment/experience, you can prepare a stock solution by dissolving 85 grams of the cupric chloride dihydrate in water to make one liter of solution. Use a fume hood or wear a respirator. In addition, wear a lab apron, gloves, and safety glasses. Cupric chloride dihydrate reagent is highly toxic and has a poor shelf life. The prepared solution is much less hazardous and has a long shelf life.
- Demonstrate the proper technique for safely decanting the liquid just before having the students do that step.
- When you are ready to do the experiment, it must be done in a one class period.
- Have the students submit their hypothesis/proposed experiment at least one day before they will actually test their hypothesis. This will give you/them an opportunity to obtain the necessary materials.
- Students often choose these types of variables for their experiment: amount of aluminum or amount of copper chloride; kind of metal to add to copper chloride (e.g., nail galvanized or not, penny, copper wire, brass screw, aluminum wire, wire mesh); cooling (ice). You might want to have these supplies on hand ahead of time. Do not heat the reaction!
- Wear safety goggles and gloves when handling the solutions, precipitates, and when disposing of the waste. Disposal of solids: Filter out the solids (collect the liquid) and wash with water. Place solid residue in a plastic trash container, not in the classroom wastebasket. Disposal of liquid: The cupric chloride reaction liquid may be disposed down the drain with copious amounts of water if-and only if-your school drains are connected to a sanitary sewer system, with a water treatment plant working on the effluent from your drains. Do not use this disposal procedure if your drains empty into groundwater through a septic system or into a storm sewer. The Science Safety Handbook for California Public Schools (1999 Edition) states that you should determine the kind and quantity of nonhazardous chemicals (waste) that may legally be flushed down sink drains, and that school officials should consult with their county health department and regional water quality control board, and obtain approval from the local publicly owned treatment facility.

**VOCABULARY**

chemical reaction – a chemical change resulting in the transformation of beginning substances (reactants) into changed substances (products)

decant – pour a liquid away from a solid

hypothesis – a testable explanation of observations that relate to a scientific question

precipitate – a solid that deposits from a liquid as a result of a chemical reaction

products – substances formed as a result of a chemical reaction

reactants – substances present before the chemical reaction begins

variable – the one condition of an experimental set-up that is changed when testing a hypothesis

The Science Learning Cycle:

Chemical Reactions



ENGAGE:

1. Introduce students to "Questioning the Author" to help them understand, in their own words and concepts, the content in the text.
2. Model steps 1 and 2 of instructional procedures listed for "Questioning the Author" (See Appendix, page 174). Use the Sputnik example to demonstrate the procedure.
3. Have the students read Chapter 5 of *October Sky*. Ask each student to find at least one paragraph in the chapter that involves a science idea, experiment, or vocabulary word where the student is not certain what the author is saying. Using "Questioning the Author," have students write in their own words what they think the author is trying to say in the selected paragraph.
4. Ask several students to describe the paragraph they chose and the wording they would use to describe what the author is trying to say. In each case, have the class discuss whether the suggested change makes the ideas easier to understand as well as other ways to phrase those ideas.



EXPLORE:

5. Ask students to scan Chapter 5 and look for experiments involving chemical reactions. Chart and discuss their responses.
6. Share what scientists consider as evidence of chemical reactions (e.g., change in temperature, production of a gas, formation of precipitate, change in color, and/or disappearance of a solid) and ask students to categorize their examples from the book.
7. Explain that students are going to experiment with a chemical reaction. Stress the importance of safe laboratory practices, referring to specific actions that must or must not be taken. Inform students that copper chloride is a toxic chemical that should never be put in the mouth, and that harms eyes and skin.
8. Assign students to groups of four and ask them to identify who will assume the following roles: materials manager, investigator, recorder, reporter. Note: have students rotate roles periodically during the experiment.
9. Distribute the instruction and data sheets for Experience a Chemical Reaction (Student Pages 1.0, 1.1). Review the experimental and safety procedures before students commence the activity. Make sure that all students are wearing safety glasses, and that the students handling the chemical solution are wearing latex gloves.
10. Have the materials managers obtain the materials for their group. Instruct the students to follow the procedures and to record their observations with the first piece of foil. After the first piece of aluminum foil has stopped reacting, have the students share their results.
11. Demonstrate the proper procedure for decanting the fluid from the initial reaction cup into an empty cup.
12. Instruct the students to follow the procedure and to record their observations with the second piece of foil. After the second piece of aluminum foil has stopped reacting, have the students decant the fluid into a fresh cup.



EXPLAIN:

13. Have students predict in writing what will happen when they add the third piece of aluminum foil to the fluid. Have them perform the experiment, and record their results.
14. Carefully collect all the solutions and precipitates. Follow appropriate safety procedures in disposing of waste (see Teacher Tips!). Wear safety goggles and gloves when handling the solutions, precipitates, and when disposing of the waste.



The Science Learning Cycle: Chemical Reactions

15. Have the students whiteboard the results from the three trials of the experiment. Ask students to compare results and explain their evidence that a chemical reaction occurred.
16. Ask students to explain what happened to the third piece of aluminum foil. (Note: there should have been no reaction.) Ask students what they would need to do to continue the reaction with the third piece of aluminum foil and why.

**ELABORATE:**

17. Ask students to develop a hypothesis about a change they can make to the aluminum-copper chloride reaction and the effect they will observe. Review with students the concepts of experimental variables and controls. Have them design an experiment to test their hypothesis (see Teacher Tips).
18. Have students submit their hypothesis and experimental design to the teacher (Student Page 2.0). Provide the students with feedback about their hypothesis and experimental design. If necessary, help them develop an acceptable hypothesis.
19. Using appropriate safety procedures, have each group conduct their experiment, and record their observations.

**EVALUATE:**

20. Have each group present their hypothesis, experiment, and results to the class. Ask students to explain their results in terms of chemical reactions (e.g., used half the amount of copper chloride so the amount of aluminum that reacted was reduced; used a metal or form of aluminum that reacted slower or not at all with copper chloride as judged by reduction in color change, gas bubbles, and heat produced). Collect and safely dispose of the waste. (see Teacher Tips).
21. Have the class discuss each group's presentation. Have them describe any changes they would make to the experimental design and/or to critique the group's conclusions.
22. As a homework or continuing classroom assignment, have students finish reading *October Sky*. Ask students to recall events in the book where repeated experimentation resulted in new hypotheses and new learnings.

Teacher Reflection:

1. How does the student work provide evidence that students understand the properties of chemical reactions, and that they know how to plan and conduct a scientific investigation to test a hypothesis?
2. What instructional strategies used in this lesson promote student understanding? How do you know?
3. How does the literature selection support student understanding of the science concepts and processes?
4. How would you modify instruction to ensure understanding of student outcomes by all students?

Experience a Chemical Reaction

You are going to experiment with a chemical reaction involving copper chloride (blue liquid) and aluminum. Copper chloride is a toxic chemical that should never be put in the mouth, and that harms eyes and skin. Wash any spills (particularly on the body or clothing) with large amounts of water.

Identify who in your group is going to serve as materials manager, recorder, reporter, and investigator. The materials manager should obtain the tray of materials that your group needs. The investigator needs to wear latex gloves.

Add one piece of aluminum foil to the copper chloride. Gently use the chopstick to submerge the aluminum foil. Write down all your observations until no more changes occur.

OBSERVATIONS FIRST PIECE OF ALUMINUM FOIL:

After your teacher demonstrates how to decant (pour off) the liquid, decant the remaining liquid into an empty cup. Add a second piece of aluminum foil. Gently use the chopstick to submerge the aluminum foil. Write down all your observations until no more changes occur.

OBSERVATIONS SECOND PIECE OF ALUMINUM FOIL:

Decant the fluid into an empty cup and predict what will happen when you add the third piece of aluminum foil.

PREDICTIONS FOR THIRD PIECE OF ALUMINUM FOIL:

Add the third piece of aluminum foil. Gently use the chopstick to submerge the aluminum foil. Write down all your observations until no more changes occur.

OBSERVATIONS FOR THIRD PIECE OF ALUMINUM FOIL:

The materials manager should bring all your cups and materials in a tray to the collection area. Each student should answer the following questions.

1. Was there any chemical reaction when you first added aluminum to the copper chloride?

What evidence supports your answer?

2. Was there any chemical reaction when you added the second piece of aluminum?

What evidence supports your answer?

3. Was there any chemical reaction when you added the third piece of aluminum?

What evidence supports your answer?

4. How do you explain what happened or did not happen in the third cup?

Our Hypothesis

As a group, develop a hypothesis about a change that you can make to the experiment with copper chloride and aluminum. The hypothesis must be something you can test by changing only one variable. Describe how you will test your hypothesis.

GROUP NAME: _____

OUR HYPOTHESIS:

HOW WE WILL TEST OUR HYPOTHESIS:

TEACHER APPROVAL _____

OUR OBSERVATIONS/DATA:

HOW WE EXPLAIN OUR OBSERVATIONS:

WHAT WE CONCLUDE ABOUT OUR HYPOTHESIS:

Questioning the Author

Questioning the author is an approach designed to engage students in the ideas of the text and build understanding.

Goals

1. Provide a concrete way for students to experience the key to successful comprehension: transforming an author's ideas into a reader's ideas.
2. Encourage students to judge the author's success in making ideas clear and admit to finding difficulties in the text without viewing themselves as failures.
3. Overcome students' tendency to resist grappling with text that does not come easily by stimulating young readers to become engaged with the text and consider ideas deeply.

Teacher Preparation

1. Identify a text to use for modeling the questioning-the-author strategy or prepare a copy of the sample text provided. The text should be representative of the content area textbooks students are expected to read and contain some vague or confusing language so that questioning the author can be modeled.
2. Prepare several passages from content area texts on a variety of topics to use for further applications of the questioning-the-author strategy.

Instructional Procedures

1. Remind students of the presence of an author of a textbook; tell them that textbooks are just someone's ideas written down. Explain that different people write things in different ways and that sometimes textbooks are not written as well or as clearly as they should be because what someone has in their mind to say does not always

come through clearly in their writing. Because written text is the product of a fallible author, students may need to work to figure out what the ideas are behind an author's words.

2. Demonstrate an application of the questioning-the-author strategy to text. Ask your students to follow along as you read a brief text and model your interaction with it. An example follows:

A Russian Traveler

The day is Friday, October 4. The year is 1957. People in many parts of the earth turned on radios and heard strange news. "Russia has used rockets to put a new moon in the sky," said one station.

At this point in the text, express puzzlement over putting "a new moon in the sky." Read the next segment:

The tiny new moon is a metal ball. It has a radio in it. The radio goes "Beep! Beep! Beep!" as the moon travels along.

Express confusion over how a metal ball with a radio in it can be a moon. Continue reading:

The new moon is named Sputnik.

Explain that now you understand, because you remember that the first Russian satellite was named *Sputnik*. Mention that the author could have said that in a clearer way. Then read:

The ship is just big enough to carry a little dog. The ship sends out signals about the dog.

Say: "Oh! There is a dog on the spaceship! I thought they just meant that's what size it was—big enough for a dog!" Read on:

Everywhere people became interested in rockets and spaceships.

STRATEGY INDEX

Student Audience

Beginning readers

Below grade level

At or above grade level

Text Type

Literary

Informational

Special Features

Automaticity with print

Prior knowledge and interest

Discussion about texts

Collaborative learning

Writing emphasis

Graphic representation

Student control of reading process

Student ownership of strategy

Say: “That seems like a big jump from talking about the dog. I guess maybe the author is trying to connect the sentence with the beginning about people all over the world turning on their radios.”

Culminate the discussion by making clear the analogy in a revised version of the text, as follows:

Russia has used rockets to put a satellite into space. The tiny satellite is shaped like a metal ball.

After introducing students to the strategy, proceed with several sessions presenting passages from content area texts on a variety of topics. The teacher’s role is to guide the student through the text, making sense of the author’s words by using prompts. A general procedure for continuing sessions follows in steps 3, 4, and 5.

3. Ask students to read the text and talk about the ideas the author is trying to get across and to judge whether the author has made those ideas clear. As students read, prompts are offered to keep the focus on seeking out and putting together the author’s ideas:

- What is the author trying to tell you?
- Why is the author telling you that?
- Is the message stated clearly?

Examples of further queries developed to guide questioning-the-author discussions are provided on the following pages.

4. As students discover confusing problems in the text, prompt them to recast those ideas in clearer language:

- How could the author have stated the ideas in a clearer way?

- What would you want to say instead?

5. Keep the interaction going by reacting conversationally to the students, sometimes recapping what the students have said or reinforcing a student’s point, saying, “You’re right; that’s not very clear, is it?” or “I think you’ve got something there.” Foster interaction among students by asking a student to elaborate on another student’s comment.

Relevant English–Language Arts Contents Standards

Grade Four: Reading Comprehension

- 2.4 Evaluate new information and hypotheses by testing them against known information and ideas.

Grade Five: Reading Comprehension

- 2.3 Discern main ideas and concepts presented in texts, identifying and assessing evidence that supports those ideas.
- 2.4 Draw inferences, conclusions, or generalizations about text and support them with textual evidence and prior knowledge

The questioning-the-author approach, if skillfully extended, would also address the Literary Response and Analysis standards (grades four through twelve) and the standards under Expository Critique (grades five through twelve).

Further Resources

Beck, Isabel L., and others. “Questioning the Author: A Yearlong Classroom Implementation to Engage Students with Text,” *The Elementary School Journal*, Vol. 96 (March 1996), 4.

Beck, Isabel L., and others. *Questioning the Author*. Newark, Del.: International Reading Association, 1997.

McKeown, Margaret G.; Isabel L. Beck; and M. Jo Worthy. “Grappling with Text Ideas: Questioning the Author,” *The Reading Teacher*, Vol. 46 (April 1993), 7.

Sample I Questioning the Author

Focusing Queries Developed for Informational Text

Goal	Queries
Initiate discussion.	<p>What is the author trying to say?</p> <p>What is the author's message?</p> <p>What is the author talking about?</p>
Help students focus on the author's message.	That's what the author says, but what does it mean?
Help students link information.	<p>How does that connect with what the author already told us?</p> <p>What information has the author added here that connects to or fits in with _____?</p>
Identify difficulties with the way the author has presented information or ideas.	<p>Does that make sense?</p> <p>Is that said in a clear way?</p> <p>Did the author explain that clearly? Why or why not? What's missing? What do we need to figure out or find out?</p>
Encourage students to refer to the text either to show them they have misinterpreted a text statement or to help them recognize that they have made an inference.	<p>Did the author tell us that?</p> <p>Did the author give us the answer to that?</p>

Sample 2 Questioning the Author

Focusing Queries Developed for Narrative Text

Goal

Encourage students to recognize plot development.

Motivate students to consider how problems are addressed or resolved.

Help students recognize the author's technique.

Prompt students to consider characters' thoughts or actions.

Prompt students to predict what a character might do.

Queries

What do you think the author is getting at here?

What's going on? What's happening?

What has the author told us now?

How did the author settle that?

How did the author work that out?

How has the author let you know that something has changed in the story?

How is the author painting a picture here?

How did the author let you see, feel, or smell something?

What is the author doing here? How did the author create humor, suspense, sadness, and so on? Why do you suppose the author used foreshadowing or flashback, and so on?

How do things look for (character's name) now?

What is the author trying to tell us about (character's name)?

Given what the author has already told us, how do you think (character's name) will handle this situation?