UNIT OVERVIEW

CHEMICAL REACTIONS

Unit Issue: The use of chemical reactions to solve problems.

Anchoring Phenomenon: Chemical reactions can be used to solve problems but can also create problems.

Listed below is a summary of the activities in this unit. Note that the total teaching time is listed as 19–25 periods of approximately 45–50 minutes (approximately 4–5 weeks). If you find you cannot finish in this time frame, consider skipping Activity 8, especially if students are familiar with development of a prototype.

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
1. **Investigation: Producing Circuit Boards** After a brief introduction to the function of a circuit board in a computer and other electronic devices, students mask a circuit board and etch it with an acidic copper-etching solution. They then read about the etching process and consider the copper-containing waste it produces.	Properties of substances, circuit boards, evidence, trade-offs LITERACY	Obtain circuit board sample (optional); fill a beaker with water; prepare Student Sheet.		2–3
2. **Laboratory: Evidence of Chemical Change** The class reviews the safety guidelines for working with chemicals in the science classroom. They investigate five chemical changes. For each one, they identify the signs of chemical change and the elements present before and after the reactions. Students discover that in a chemical change, new substances form that have different properties from the starting substances. They are introduced to the idea that the elements in the substances at the beginning and end of the reaction are the same, but they have rearranged into new chemical combinations.	Properties of substances, chemical change, chemical reactions, evidence of reactions LITERACY	Prepare materials for the demonstrations; prepare Student Sheets.	AID A3	2
3. **Reading: Physical Changes and Chemical Reactions** Students read about both physical and chemical changes. They learn how to distinguish these two phenomena at the observable level and begin to describe how they are different at the atomic/molecular scale.	Physical vs. chemical changes at macroscopic and atomic/molecular levels, evidence of reactions, dissolving, precipitate formation LITERACY SENSEMAKING	Prepare Student Sheet.	AID A4	2

CHEMICAL REACTIONS (continued)

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
4. **Modeling: Chemical Reactions at the Molecular Scale** Students use molecular models to investigate the reactants and products of chemical reactions. They apply their experiences with the models to develop the idea that kinds of atoms and the number of each kind of atom in the reactants and products are identical.	Chemical equations, conservation of atoms, reactants, products	Prepare modeling sets.	MOD QUICK CHECK A1	1–2
5. **Talking It Over: Physical or Chemical Change?** Student groups consider six scenarios that describe changes in matter. They apply evidence and logical reasoning to develop arguments about whether each scenario describes a physical change or a chemical reaction.	Properties of substances, chemical and physical changes, chemical reactions SENSEMAKING	Prepare Student Sheets.	AID A3 (Assessment of PE MS-PS1-2)	2–3
6. **Laboratory: Comparing the Masses of Reactants and Products** Students explore the law of conservation of mass. They conduct a precipitation reaction and measure the total mass before and after the reaction. Future activities will build on this concept as students are asked to think about the implications of conservation of atoms and mass in their investigations of chemical methods of waste treatment.	Chemical reactions, mass, reactants, products	Set up electronic balances.	QUICK CHECK A2	1
7. **Modeling: Explaining Conservation of Mass** Students are given evidence about the masses of atoms. They use this to model mass conservation as an outcome of conservation of atoms. This is tied to the concept that the copper from the "Producing Circuit Boards" activity has not gone away; it is just in a different form.	Conservation of atoms, conservation of mass	Prepare modeling sets.	MOD A1 (Assessment of PE MS-PS1-5)	1
8. **Investigation: Chemical Batteries** Students build a chemical battery that transforms chemical energy into electrical energy, which in turn powers a motor. After building an initial prototype battery, students are given a set of criteria and constraints and asked to design a chemical battery that spins faster than the initial prototype for at least 5 min. Students brainstorm, build, test, and evaluate their prototypes.	Energy transformation, batteries, design criteria and constraints	Prepare Student Sheet.		1–2

CHEMICAL REACTIONS (continued)

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
9. **Laboratory: Thermal Energy and Reactions** Students set up two chemical reactions, measuring the temperature of the reactants and products. They use their measurements to identify which reaction releases and which absorbs energy.	Thermal energy, energy change as evidence of reactions, endothermic and exothermic reactions		AID A1	1
10. **Design: Developing a Prototype** Students design a hand warmer and then construct, test, and evaluate a prototype.	Engineering design, criteria, constraints, prototypes, thermal energy, energy transfer, exothermic reactions	Prepare the demonstration hand warmer; prepare the pre-swelled beads 24 hours in advance; prepare Student Sheet.	QUICK CHECK A4	1–2
11. **Design: Refining the Design** Students brainstorm new designs that will allow users to start the chemical reaction when they want to use the hand warmer. These designs may be redesigns of those developed in the previous activity or may be totally new. Students discuss designs and choose one to build as a prototype. Pairs of students exchange prototypes, and test and evaluate them. Students then think about how to further modify their designs.	Engineering design, criteria, constraints, prototypes, thermal energy, energy transfer, exothermic reactions	Prepare the demonstration hand warmer; prepare more pre-swelled beads 24 hours in advance, if needed; prepare Student Sheet.	ENG A3 (Assessment of PE MS-PS1-6)	2–3
12. **Laboratory: Recovering Copper** Students compare the effectiveness of three different metals in extracting copper from the used copper chloride solution from the activity "Producing Circuit Boards." After determining which of the metals removes copper ions from the solution, they examine cost- and health- related information to inform their decisions of which metal to use.	Metal replacement, chemical waste, reclaiming metal waste LITERACY	Fill empty labeled dropper bottles with used etching solution; set up the copper dilutions series; prepare Student Sheet.	E&T A3	2
13. **Laboratory: Another Approach to Recovering Copper** Students compare two double-replacement reactions for recovering the copper waste. They apply what they have learned in this activity and the previous activity to decide which reaction works best to reclaim the copper.	Metal replacement, chemical waste, reclaiming metal waste LITERACY	Refill dropper bottles with used etching solution; set up the control filtration; prepare Student Sheet.	E&T A2	1