Day 1

Introduction to Chemical Reactions

PACING GUIDE

Getting Started
Properties of matter, chemical formulas and evidence of a chemical reaction. **15 mins**

Activity 1
Demonstration (live or via downloaded video) of silver nitrate and copper chemical reaction **15 mins**

Activity 2
Previewing the Chemical Reaction base model **15 mins**

Wrap-Up
Signs of a chemical reaction. **5 mins**

LEARNING OBJECTIVES: Students will. . .

Disciplinary Core Concepts
Differentiate between atoms and ions. Identify evidence of a chemical reaction. Learn the importance of water as a medium for some chemical reactions to occur.

Cross cutting concepts
The initial preview of the base model will suggest that cause and effect relationships may be used to predict both microscopic and macroscopic behavior. The conservation of matter is suggested but not explicitly stated in this first lesson.

Modeling and Simulation
Learn how computer models can be used to run simulations when dangerous or expensive materials are involved. Identify aspects of the chemical reaction that are not included in the base model.

ASSESSMENTS OF UNDERSTANDING:

Complex Adaptive Systems
What features of a complex adaptive system are exhibited in the model of silver nitrate and copper chemical reaction?

Disciplinary Core Ideas
What is the difference between atoms and ions? What evidence of a chemical reaction was seen in real life an in the computer model? Could the chemical reaction take place without water?

Modeling and Simulation
Why might we want to simulate chemical reactions on a computer rather than in real life?

Day 2

Modeling Chemical Reactions

PACING GUIDE

Getting started
Chemical Reaction overview
10 mins

Activity 1
Analyzing the base model
20 mins

Activity 2
Modifying the base model to add/remove water molecules and move the copper rod.
15 mins

Wrap-Up
How does his model help us learn about the chemical reaction? **5 mins**

LEARNING OBJECTIVES: Students will. . .

Disciplinary Core Concepts
Differentiate between chemical and physical properties of substances. Identify atomic symbols and chemical formulas of the reactions in this module. Identify which reactant is limiting and which is in excess. Identify signs of a chemical reaction and when a chemical reaction stops.

Modeling and Simulation
The role of parameters and initial conditions are presented and students gain experience with the representation of entities within the model. The setup procedures and other code block are examined. Automation is observed in this USE phase (student's using a largely pre-built model).

Computer Science
Begin to understand the execution order of code and gain exposure to the CS concepts of "looping", parameters and logic, expressions, variables and functions. Use various debugging and testing methods to ensure program correctness.

ASSESSMENTS OF UNDERSTANDING:

Disciplinary Core Ideas
What is the difference between the chemical and physical properties of copper? Describe how many silver nitrate molecules are needed to react with each copper atom? Which reactant is limiting the reaction? Which reactant is in excess in the reaction? How do we know that a chemical reaction has taken place? How do we know when a chemical reaction has stopped?

Modeling and Simulation
Assessment of whether student was able to implement modifications to the base model.

Computer Science
Use of CS concepts and constructs such as looping, logic, expressions, conditionals, functions and variables.

Day 3

Products of Chemical Reactions

PACING GUIDE

Getting started
When does a chemical reaction stop? **5 mins**

Activity 1
Modifying the model to add the production of copper nitrate
25 mins

Activity 2
Running experiments with different initial quantities of copper or silver nitrate
15 mins

Wrap-Up
What are models good for?
5 mins

LEARNING OBJECTIVES: Students will. . .

Disciplinary Core Concepts
Identify the products of a chemical reaction. Identify the factors that stop a chemical reaction. Learn about concepts of limiting reactants and reactants in excess. Learn the importance of balancing chemical equations.

Crosscutting concepts
Patterns: Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Scale, Proportion, and Quantity: Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Energy and Matter: Matter is conserved because atoms are conserved in physical and chemical processes.

Modeling and Simulation
Learn how to make new breeds and create agents in agent-based modelling. Collect and analyze data to look for patterns.

ASSESSMENTS OF UNDERSTANDING:

Disciplinary Core Ideas
What were the reactants in the chemical reaction we studied? What were the products in the chemical reaction we studied? What determines which are the limiting reactants? What determines which are the reactants in excess? In your own words, describe the law of conservation of mass.

Modeling and Simulation
What aspects of the chemical reaction were included in the base model? What do the agents represent? Are there agents that are not part of the “essential” behavior of the model?

Computer Science
What is an instruction? What is a loop? What is an iteration?

Day 4

Complex Ions in Solution

PACING GUIDE

Getting started
Ionic compounds, ionic equations, and complexes. **10 mins**

Activity 1
Modifying the model further: creating hydrated copper ions and turning the solution blue. **20 mins**

Activity 2
Characterizing the rate of reaction **15 mins**

Wrap-Up
Using computer models in scientific investigations **5 mins**

LEARNING OBJECTIVES: Students will. . .

Disciplinary Core Ideas
Differentiate between chemical equations, ionic equation and net ionic equation. Learn about at least one type of complex ions. Become familiar with rate of a reaction and availability of reactants.

Cross cutting concepts
Patterns: Macroscopic patterns are related to the nature of microscopic and atomic-level structure.
Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Scale, Proportion, and Quantity: Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Energy and Matter: Matter is conserved because atoms are conserved in physical and chemical processes.

Modeling and Simulation
Learn to implement interactions using collisions.

ASSESSMENTS OF UNDERSTANDING:

Disciplinary Core Ideas
What is an example of an ionic compound? Describe what happens to ionic compounds in solution. In the experiment we did today, what determines the rate of silver production? In your own words, describe the shape of the silver production curve and what caused it to have that shape.

Modeling and Simulation
Student modification of the model as an experimental testbed. Adding instrumentation. How can a computer model help in figuring out the impact of availability of reactants?

Computer Science
Describe the logic involved in implementing the three stages of hydrating copper ions.

Day 5

Factors that Impact the Rate of a Chemical Reaction

PACING GUIDE

Getting Started
Availability of reactants as a limiting factor **10 mins**

Activity 1
Factors impacting the rate of reaction: Mixing and Step size. **15 mins**

Activity 2
Running experiments **15 mins**

Wrap-Up
Sharing results and conclusions **10 mins**

LEARNING OBJECTIVES: Students will. . .

Disciplinary Core Ideas
Review findings on how availability of reactants impacts the rate of reaction. Become familiar with rate of a reaction and kinetic energy effect.

Cross cutting concepts
Patterns: Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Scale, Proportion, and Quantity: Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Energy and Matter: Matter is conserved because atoms are conserved in physical and chemical processes.

Modeling and Simulation
Learn how agent movement can impact outcome in simulations. Learn to simulate kinetic energy in an agent-based model. Run virtual experiments to determine how kinetic energy impacts the rate of chemical reaction.

ASSESSMENTS OF UNDERSTANDING:

Disciplinary Core Ideas
What are some factors that impact the rate of reaction? How would you design an experiment to determine the impact of one of the factors? How was an increase in kinetic energy simulated in this lesson? Describe a feedback loop in the chemical reaction studied.

Modeling and Simulation
What real-world aspects did you model? What real-world aspects did you leave out? Why? What experiments did you run in the model? Student model, shared with instructor digitally, will be the principal assessment of this activity.

Computer Science
Student model, shared with instructor digitally, will be the principal assessment of computer science learning.