Student Name: _____

Class: _____

Due Date: _____

Part 1: Key Concepts Review (30 minutes)

Essential Understanding:

- Types of chemical reactions
- Energy changes in reactions
- Factors affecting reaction rates
- Chemical equilibrium

Complete these concept checks:

1. Define and give an example of:
    - Exothermic reaction
    - Endothermic reaction
    - Catalyst
    - Activation energy

2. Draw and label an energy diagram for:
    - A combustion reaction
    - A decomposition reaction

Part 2: Applied Problem Solving (45 minutes)

Scenario 1: Industrial Chemistry

A chemical plant produces hydrogen gas through the water-gas shift reaction:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g) + \text{energy}$$

1. Analyze how these changes would affect hydrogen production:
   - Increasing temperature
   - Adding more CO
   - Removing H_2
   - Adding a catalyst

2. Calculate the theoretical yield if:
   - Initial CO = 5.0 moles
   - Initial H_2O = 4.0 moles
   - Reaction efficiency = 85%

Scenario 2: Environmental Chemistry

Study the formation of acid rain:

$$SO_2 + H_2O + \tfrac{1}{2}O_2 \rightarrow H_2SO_4$$

1. Explain each step of this multi-stage reaction

2. Propose three methods to reduce acid rain formation

3. Calculate the pH if 0.01M H_2SO_4 is formed

Part 3: Research Investigation (60 minutes)

Choose ONE of these topics for detailed research:

1. Green Chemistry in Industry
    - Research 3 examples of green chemistry innovations
    - Analyze their environmental impact
    - Evaluate economic feasibility
    - Suggest future applications
2. Biochemical Reactions in Sports
    - Explain ATP production during exercise
    - Analyze lactic acid formation
    - Connect to athletic performance
    - Suggest optimal training strategies
3. Chemistry in Space Exploration
    - Research rocket fuel reactions
    - Study life support systems
    - Analyze materials science challenges
    - Propose solutions for Mars missions

Extension Activities (Optional)

Choose any combination:

1. Design and explain a chemical battery
    - Draw detailed diagrams
    - Write half-equations
    - Calculate potential voltage
2. Create a chemical reaction simulation
    - Use online modeling tools
    - Show concentration changes
    - Demonstrate equilibrium shifts
3. Write a scientific paper analyzing a recent chemical discovery
    - Include primary research
    - Evaluate methodology
    - Discuss implications

Part 4: Case Studies (40 minutes)

Case Study 1: Industrial Application

A manufacturing plant uses a chemical reaction to produce a product. The reaction is:

$$A + B \rightarrow C + D$$

1. Analyze the reaction and identify the type of reaction

2. Calculate the theoretical yield of the product if 10 moles of A and 10 moles of B are used

Case Study 2: Environmental Impact

A chemical reaction occurs in the environment, releasing a pollutant into the air. The reaction is:

$$X + Y \rightarrow Z + W$$

1. Analyze the reaction and identify the type of reaction

2. Propose a method to reduce the amount of pollutant released into the air

Part 5: Review Questions (30 minutes)

Complete these review questions:

1. What is the difference between an exothermic and endothermic reaction?

2. What is the purpose of a catalyst in a chemical reaction?

3. What is the concept of chemical equilibrium?

Part 6: Assessment (60 minutes)

Section A: Multiple Choice Questions

1. What type of reaction is the combustion of gasoline?

2. What is the purpose of a catalyst in a chemical reaction?

Section B: Short Answer Questions

1. Explain the concept of activation energy

2. Describe the difference between a homogeneous and heterogeneous catalyst

Part 7: Conclusion (10 minutes)

Summary:

Summarize the key concepts learned in this activity

Teacher Notes and Guidance

Introduction:

Provide a brief introduction to the activity and the topics that will be covered

Assessment:

Provide guidance on how to assess student understanding and progress throughout the activity