Name_____ Date_____ Class_____

Student Guide
Save the Dinosaurs with Copper and Zinc!

Introduction

QuickTime™ and a decompressor are needed to see this picture.

Sid is your neighborhood bully and he enjoys mutilating toys. Up until now he has been satisfied using rockets to blast spacemen and cowboy toys into orbit, but this time he has gone too far! He has threatened to dissolve your little brother's dinosaur collection in a bath of Hydrochloric Acid (HCl). Why such a malicious child was given access to such a dangerous chemical is unclear, but it is up to you to save your brother's toys. Being a clever chemist, you remember hearing about the reactivity of certain metals, and that some are less reactive than the Hydrogen in HCl, but you don't remember which ones. Using an electroplating solution to cover dinosaurs with copper or zinc, you will try to find out which would provide the best armor against Sid's devious actions.

Purpose

1. To study redox reactions involving zinc and copper species, while discovering why a reaction does or does not occur.
2. To construct an electrolytic cell capable of plating copper, nickel, and zinc onto an object (plastic dinosaurs) to protect them from hydrochloric acid.
3. To use the armored dinosaurs to study the reactivity of different metals in acid.

Question

1. How do the properties (in this case, reactivity) effect the potential applications of certain materials?

Hypothesis Develop a hypothesis to answer the question listed above.

Key Terms

Oxidation:

Reduction:

Redox Reaction:

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Electroplating:

Voltage:

Conductor:

Activity Series*:*

Materials per Student Group

- Safety glasses
- Gloves
- Two 250 mL beakers
- One petri dish (or clean, plastic surface)
- Two small paint brushes
- Electrical tape
- Tweezers and stirring rod
- One volt meter
- One strip of zinc foil
- One strip of copper foil
- One 1 cm x 6 cm copper strip
- One 1 cm x 6 cm zinc strip
- Two AA batteries with holders and +/- leads
- Four wires with alligator clips
- Two small dinosaur toys (~6 cm long, other plastic objects will work)
- Rio Grande Midas conductive paint
- 150 mL Rio Grande Midas Bright Electro-forming Copper Solution (copper sulfate)
- 150 mL 1 M zinc sulfate
- 300 mL 1 M HCl

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Procedure

A. Exploring the activity series

1) Clean your Petri dish (or plastic reaction surface) with distilled water and dry.

2) User tweezers to place pieces of zinc and copper foil at least 2 cm apart on the reaction surface.

3) Using a pipette place 2 drops of 1 M $CuSO_4$ onto the top of the piece of zinc.

4) Using a pipette place 2 drops of 1 M $ZnSO_4$ onto the top of the piece of copper.

5) Study each set and record your observations in your lab notebook, and answer the following questions for each metal strip. If needed, the drop can be removed with a cotton swab for an easier observation.

    a. Did a reaction occur? If you think a reaction occurred, explain why.

    b. If a reaction did occur, what was the reaction that took place? Include the reaction in both words (ex. Water → Hydrogen + Oxygen) and symbols (ex. $2H_2O \rightarrow 2H_2 + O_2$)

B. Creating a protective coating

1) Using a small paint brush with conductive paint in a fume hood, paint the surface of two dinosaurs. While allowing the dinosaurs to dry for 5-10 minutes, proceed to steps 2 and 3.

2) Prepare two 250 mL beakers with 150 mL of plating solutions in each (one for copper, and one for zinc). Use electrical tape to secure a copper strip to the side of the beaker in the copper plating solution, and a zinc strip in the zinc plating solution.

3) Obtain a battery with battery holder and test the voltage using a voltmeter. The battery should produce at least 1.3 V. Answer the following in your lab notebook.

    a. Why do you think a voltage is necessary for the electroplating to occur?

4) Wrap a copper wire around the neck of each dinosaur leaving enough slack to wrap around a stirring rod. The dinosaur should have enough wire to remain submerged in the solution while the stirring rod rests on the top of the beaker.

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5) Put one dinosaur in each solution.

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Connect the negative lead to the wire around the dinosaurs' neck, and the positive lead to the metal electrode taped to the side of the beaker. Be sure that the dinosaur is not touching the metal electrode.

Figure 1: A completed dinosaur plating set-up for copper

When this step is complete, answer the following question.

a. Is the dinosaur the cathode or anode? How do you know?

6) Allow the dinosaurs to accumulate their armor for 10 minutes. While waiting think about the following questions, and record the answers in your lab notebook.

a. Where is the metal which is plating onto the dinosaur coming from?

b. Is the solution being permanently depleted of metal ions?

7) When the dinosaurs are covered remove them from solution and allow them to dry on a paper towel. Remove the batteries from the set up, and take the metal electrodes out of the solution. Dry them off using a paper towel. Ask your teacher about disposal of the plating solutions, as they will most likely be reused, but should not be put back with the stock solution. Clean beakers using soap and water.

C. Will the armor be enough to save your dinosaur?

1) Pour 100 mL of 1 M hydrochloric acid (HCl) into each clean beaker.

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2) Use your wire and stirring rod to suspend each dinosaur in the HCl bath. Allow the dinosaur to soak for 5 minutes, and record your observations.

Figure 2: Mendeleev has been successfully coated with copper, but will it work?

3) Then take out the dinosaur and rinse it off with distilled water, and lay on a paper towel to dry. Then answer the following questions

   a. Which (if any) of the dinosaurs still have their protective coating?

   b. Why would one coating be better protection against HCl?

   c. If a reaction did occur, what was the reaction that took place? Include the reaction in both words (ex. Water → Hydrogen + Oxygen) and symbols (ex. $2H_2O \rightarrow 2H_2 + O_2$)

Cleanup Plating solutions will be collected in a new container and reused by your teacher. **Do not** place them back in the stock solution. Metal strips can be reused and should be dried off before putting them away. Emory cloth can be used to clean the surface and provide better contact. Ask your teacher about the disposal of the 1 M HCl.

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