



### **Activity #12:**

#### **Designs that Shine! Penny Cleaning with Vinegar and Salt**

*Critical Thinking, Scientific Method, Questioning, Creativity & Design*

(Preparation: 10 minutes / Activity Time: 10-30 minutes)

#### **What Will You Need?**

- Table Salt
- Vinegar
- Q tips (at least one)
- ¼ cup measure
- Teaspoon measure
- A **non-metal** bowl/container (glass, plastic, pyrex, etc.)
- A stirring utensil
- A small handful of dirty, not-shiny Pennies
  - **Optional materials:**
    - Different types of vinegar
    - Lemon or lime juice
    - Different coins

\*Please Note: Any copper or bronze jewelry may react in this experiment - it won't be damaged, but may need to be cleaned afterwards!

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#### **Instructions:**

In your non-metal bowl, add ¼ cup of vinegar and 1 teaspoon of salt. Stir them together until the salt grains are entirely (or mostly) dissolved in the vinegar.

Lay out your dirty pennies on a flat surface.

Dip the swab of a Q tip, into your Vinegar-Salt solution.

Using the wet Q tip swab, draw a design on the surface of a penny (*Some suggestions: Smiley Faces, Spirals, and Lightning Bolts work great!*) and let the wet design sit for 30 seconds - 1 minute.

Give the penny a quick rinse in water, and voila! The part of the penny surface that the liquid solution touched should appear more clean the rest of the penny, and your design can *SHINE!*

Repeat this for as many dirty pennies as you like and create some more cool shiny designs!

**Then, try the same experiment in different ways!** Maybe you could use a different solution of lemon juice, lime juice, or a different type of vinegar? *Try more or less salt in the solution to see if it makes a difference!* Or, try with different coins - will this work on a grimy quarter? *What happens if you DON'T rinse the penny with water after it touches the Vinegar-Salt solution?*

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### **Why does this happen?**

Copper atoms react with oxygen in the air to produce Copper Oxide, which gives our pennies their tarnished, “dirty” appearance on their outer surfaces. When a Copper Oxide covered penny comes into contact with our solution, the vinegar, which contains Acetic Acid, breaks apart the Copper Oxide molecules. As these bonds break down, oxygen atoms are released (you may notice bubbles forming in larger droplets where the Vinegar-Salt solution touches the penny), but the remaining copper atoms that have dissolved into the solution attach to the dissolved salt in solution. This gives us a clean penny surface once the reactions are complete!

### **For a continuation of this experiment, try these:**

- 1) In the **non-metal** bowl with the Vinegar-Salt solution, fully submerge a handful of pennies and let them sit for 10 minutes. Scoop the now shiny pennies out of the bowl, leaving the Vinegar-Salt solution.

As we know, some of the copper from the pennies has bonded with salt ions in the solution. However, the iron molecules in steel will also partially dissolve into the solution.

Place a Steel nail, screw, bolt, washer, or anything made of steel into the solution. Let it sit for 10 minutes to one hour. Take another look, and the steel surface may now have a copper color!

*\*This is the same reason why we ask that you use a glass or plastic bowl instead of a metal mixing bowl!*

**When the iron molecules separate from the steel, they form a bond with the salt in the solution that is stronger than the salt-copper bond. So, the copper gets kicked out! Instead, copper fills the gap left behind on the steel surface, and bonds with the steel, giving the steel surface a coppery-color.**

- 2) Fully submerge a handful of pennies into your **non-metal** mixing bowl with the Vinegar-Salt solution. Let them sit for 10 minutes.

Scoop the pennies out and rinse about half of the total pennies in water. Do not rinse your remaining pennies.

In separate groups of rinsed and unrinsed pennies, let all of the pennies sit for 10 minutes. When you come back, check out the difference in colors between the rinsed and unrinsed pennies!

**When the copper surface of a penny is exposed to oxygen in the air, it becomes oxidized, and a dark-brown Copper Oxide layer forms, which we commonly see on pennies in circulation. However, when pennies oxidize after being in our solution, the copper reacts to both the oxygen in the air AND the chlorine from the salt! This combination makes a blue-green substance called Malachite (mal-a-kite) that covers the copper surface of the pennies.**

Can you think of a famous New York City statue that is a blue-green color? Do you think it has any copper in it?