Instructions Worksheet for Module 2 HOA C
Grouping: Groups (3-4)
Time: 40 minutes

Precautions & Safety:

- **Chemical Safety:** Wear gloves when handling the copper sulfate ($CuSO_4$) solution and biochar. Avoid direct skin or eye contact. If any solution or biochar dust gets on you, rinse immediately and wash with soap.
- **No Ingestion:** Do **not** taste or ingest any materials. Keep food and drinks away from your work area. Copper sulfate is toxic if swallowed.
- **Eye Protection:** If available, wear safety goggles to protect against any splashes when pouring or stirring.
- **Spill Control:** Handle cups and pipettes carefully to prevent spills. In case of a spill, inform the teacher and clean it up immediately (have paper towels ready). Biochar can be messy – avoid creating dust clouds.
- **Hygiene:** Wash your hands thoroughly with soap after completing the activity, even if you wore gloves. Dispose of used materials as instructed (the copper sulfate solution should be disposed of properly per the teacher's guidance).

Materials (per class of ~6 groups):

- Clear plastic cups – ~18 (about 3 cups per group).
- Pre-crushed biochar – ~24 g total (≈2 g per group). Biochar is charcoal made from organic waste; we'll use it as our "waste-to-resource" material.
- Potting soil – ~72 g total (≈6 g soil for each group's Cup B, and 4 g soil + 2 g biochar for Cup C).
- Labels/sticky notes or markers – for clearly labeling each cup (A, B, C).
- Simulated contaminant solution – ~180 mL of 0.5% $CuSO_4$ (Copper Sulfate/Cupric Sulfate; CuSO4(H2O)5)solution (about 10 mL per cup). This bright blue solution represents polluted water (with, say, heavy metals).
    To prepare the 0.5% $CuSO_4$ solution, weigh out 0.90 g of copper(II) sulfate crystals. Add approximately 150 mL of distilled/deionized water to a beaker, then pour in the blue crystals and stir until they are fully dissolved. Transfer the solution to a graduated cylinder. Rinse the beaker with water, then adjust the total volume to 180 mL by adding additional distilled/deionized water. Mix well and label the container.
- Stirring sticks – ~18 (one for each cup, to mix contents).
- Disposable pipettes – ~18 (one for each cup, for accurately measuring 10 mL of solution).
- pH test strips – ~18 (one per cup, minimum, to test acidity before and after; extras in case of re-testing).
- Cheesecloth pieces - 5-6
- Small funnels - 2-3
- 15 ml plastic tubes with lids (Falcon tubes) + tube stand
- 50 ml plastic tubes with lids (Falcon tubes) + tube stand
- Gloves – a box of disposable gloves (ensure each student handling materials wears a pair).

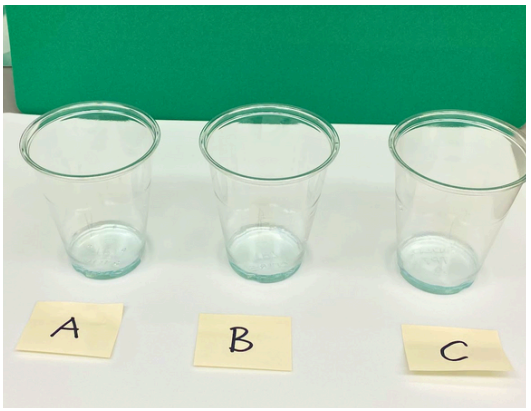
Objective: In this activity, you will see how a **waste-derived material** (biochar, produced by heating organic waste in the absence of oxygen) can be used to **purify contaminated water**. By comparing three setups – one with no treatment, one with soil, and one with soil + biochar – you'll learn how well biochar binds pollutants (in this case, copper sulfate, which gives the water a blue color). This experiment demonstrates a real waste-to-resource strategy: turning agricultural or food waste into biochar that can help solve an environmental problem. You'll practice measuring and observational skills and connect this small lab to broader ideas of sustainability. *Think about how this relates to what you've learned:* biochar is one of the five waste pathways from Lesson A, it ties into the carbon calculations from Lesson B (biochar **locks up carbon** that would otherwise become CO_2), and it shows systems thinking from Lesson C – linking waste management with water quality and climate impact. In short, we're **closing the loop**: using a waste product to clean up pollution, highlighting circular economy principles (waste → resource), and supporting sustainability (clean water, healthy soil, climate action).

Instructions:

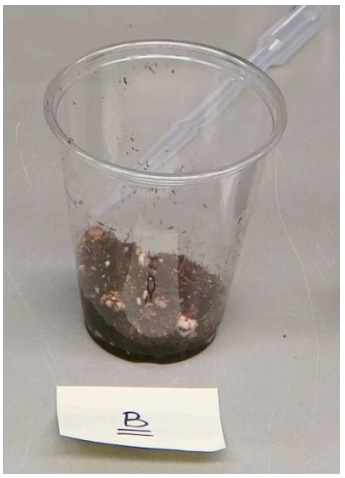
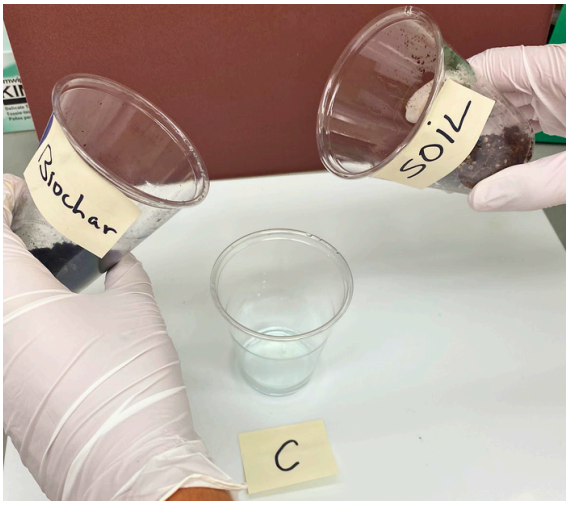
Step 1 - Prepare and Label Cups

Step 1.1 - Label three clear cups for each group:

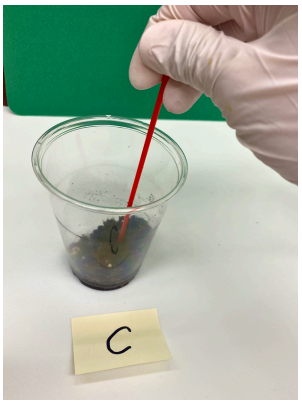
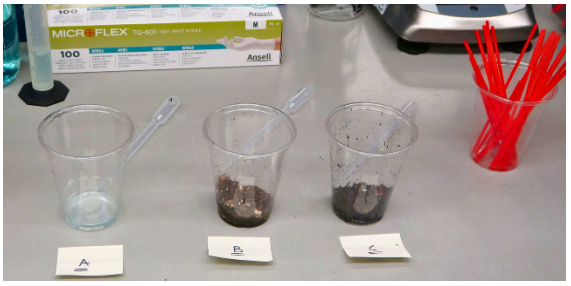
- **Cup A:** "$CuSO_4$ Only" (Control) – This cup will contain the copper sulfate solution with **no treatment**.
- **Cup B:** "$CuSO_4$ + Soil" – This cup will simulate a natural soil filter.
- **Cup C:** "$CuSO_4$ + Soil + Biochar" – This cup adds biochar to the soil to test its enhanced filtering ability.

Step 1.2 - Using a disposable pipette, carefully measure **10 mL** of the blue $CuSO_4$ solution and add it to each cup (A, B, and C). Ensure each cup starts with the same amount of "polluted water." Observe the **starting color** (all cups should be the same shade of blue initially) and, if instructed, measure the initial **pH** of one sample of the solution for reference (it may be slightly acidic).	

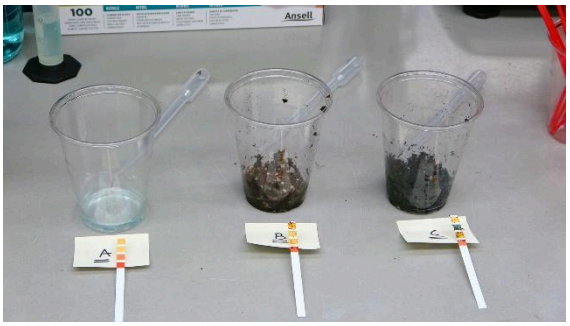
Step 2 – Add Materials (Soil/Biochar). Now add the solid materials:

Step 2.1 - In **Cup B**, add **6.0 grams of potting soil**. (This represents soil acting as a filter medium.)	
Step 2.2 - In **Cup C**, add **4.0 grams of potting soil plus 2.0 grams of pre-crushed biochar**. For best results, premix the soil and biochar before adding, ensuring the biochar is dispersed. (Biochar is light and porous – a little goes a long way!) **Cup A receives no additional material, as it serves as our control.**	

Step 3 – Stir and Wait

Step 3.1 - Use a stirring stick to gently stir each cup for about 30 seconds. Be careful to stir the mixtures evenly without splashing (the solutions are safe to handle with gloves, but can stain or spill).	
Step 3.2 - After mixing, let all cups sit **undisturbed for 7–8 minutes**. **Do not move** the cups during this settling time – this allows the soil and biochar to sink and interact with the contaminant. While you wait, notice any quick changes: Do you see the blue color fading faster in one cup? Are bubbles forming? (Biochar can sometimes release trapped air as it wets.)	

Step 4 – Observe and Record After 7–8 minutes, examine each cup **at eye level**:

Step 4.1 - Look at the **color and clarity** of the liquid in each cup. Is the blue color of the copper solution as intense as before, or has it become lighter/more transparent? Especially compare Cup A (control) with Cups B and C. **Step 4.2 -** Take a **pH test strip** and dip it into each cup (or use a dropper to put a few drops on the strip) to measure the **final pH**. Compare the pH readings between the cups. (Copper sulfate solution may have a pH around 4–5 initially; soil can neutralize acidity, and biochar often	

has an alkaline effect that could raise the pH closer to neutral.)	
Step 4.3 - Note any **other observations**: 1) Do the cups smell different? (Biochar has an earthy, smoky scent; copper sulfate has little odor) 2) Are there particles settled at the bottom? 3) Is one cup of liquid noticeably clearer? 4) Jot down these notes.	

IMPORTANT: Fill in your **Data Collection Worksheet** as you go: record the final color/clarity, pH, and notes for each cup in the Part B table.

Part B: Observations After Settling

After the settling period, observe each cup. Note the clarity (color change) and measure the pH using test strips. Record your observations in the table:

Cup	Final Color & Clarity	Final pH	Notes (odor, particles, etc.)
A (Control)	*(e.g., cloudy blue, etc.)*	*(record)*	*(e.g., strong odor? any sediment?)*
B (Soil)	*(e.g., slightly clearer?)*	*(record)*	*(e.g., soil settled at bottom)*
C (Soil + Biochar)	*(e.g., clearest)*	*(record)*	*(e.g., biochar settled; water clearer)*

Tips for Success:

- **Label First:** Make sure each cup is labeled (A, B, C, and treatment) before you start. It's easy to mix them up if unmarked!
- **Measure Accurately:** Use the pipette to get exactly 10 mL of solution – consistency is key for a fair test. Use the digital scale for soil and biochar measurements; minor errors can affect results when dealing with only a few grams.
- **Stir Gently:** Stirring too vigorously might cause splashes or break the soil into very fine particles that remain suspended longer. Gentle mixing ensures contact without making the water overly muddy.
- **Be Patient:** Allow the full 7–8 minutes for settling. Resist the temptation to shake or move the cups – let gravity and chemistry do their work. You need that time for the soil and biochar to interact with the contaminant.
- **Consistent pH Testing:** If you're checking pH at intervals (say, at 2 minutes, 5 minutes, and final), use a **fresh strip** each time and do it at the **same time** for each cup to

compare fairly. And hold the strip in the liquid for the recommended time so the reading is accurate.

- **Record Immediately:** Write down what you see as soon as the time is up. Colors can slowly change or strips can dry out – capturing data in the moment prevents forgetting details. If the water in Cup C is clearer, describe *how much* clearer. If the pH strip in Cup C turned greenish (indicating a more neutral pH) while Cup A stayed yellow-orange (more acidic), note that difference.
- **Teamwork:** Assign roles in your group (e.g., one person adds soil, one adds biochar, one handles stirring and timing, one records data) to work efficiently. Share observations with each other – someone might notice a subtle color change that others miss.

Skills You'll Use:

- **Scientific Measurement:** You'll practice measuring liquids (mL) and solids (g) precisely, a crucial skill in science (and cooking!).
- **Experiment Design:** Observing a *control* (Cup A) versus *variables* (Cup B vs. Cup C) to understand cause and effect.
- **Data Collection:** Using tools like pH strips and making qualitative observations (color, clarity) to gather evidence.
- **Critical Thinking:** Interpreting what your results mean – does biochar actually make a difference? How can you tell?
- **Systems Connection:** Relating this simple lab to bigger systems. We're combining knowledge of **chemistry**, **environmental science**, and **agriculture**: using a byproduct of farming (biochar from crop waste) to address a pollution issue (water contamination). It's a mini-example of **circular economy thinking** – something you'll continue to explore in sustainable agri-food systems.

By the end of this activity, you'll have firsthand insight into one of the innovative waste-to-resource pathways you learned about. **Biochar** isn't just a concept from Lesson A – here you see it in action, turning bluish "polluted" water clearer. Think about it: if waste (like plant husks or wood chips) can be turned into a tool for **cleaning water** *and* for storing carbon (a climate benefit!), that's a powerful intersection of solutions. 🌱💧 **Have fun, be safe, and observe closely –** you're doing real science that connects to real-world sustainability challenges!