Teacher Guide (Pages 1-4) & Rubric (Pages 5-9) for HOA Module 2 HOA C

Overview & Purpose:
In this hands-on activity, students investigate how **biochar**, a product of organic waste conversion, can be used to remove contaminants from water. The purpose is to reinforce the concept that what we call "waste" (here, biomass turned into biochar) can become a **resource** for solving environmental problems. This ties together key Module 2 themes:

- *Lesson A (Pathways):* Biochar is one of the five waste-to-resource pathways; students now see a concrete **benefit** of that pathway (beyond just carbon data, it can clean water).

- *Lesson B (Carbon Math):* Although this activity's focus is water purification, use it to remind students of biochar's **carbon impact**; it locks away carbon that would otherwise become CO_2 or methane. You can quantitatively discuss how pyrolyzing 1 kg of biomass can sequester ~50% of its carbon for the long term, whereas if that biomass rotted, it would emit greenhouse gases. Relate this to the emission factors they used in Lesson B (e.g., **landfilling 1 kg of food waste ~1.9 kg CO_2-e** emitted). Biochar avoids most of that by storing carbon (turning it into a "carbon vault").

- *Lesson C (Waste Measurement & Systems):* After the experiment, encourage students to discuss how this small-scale solution could scale up. How might a school or farm use biochar? Challenge them to think about **systems integration**: for example, composting handles food scraps, anaerobic digestion produces energy, and *biochar could filter water or be added to soil*, multiple waste valorization methods working together (just as Lesson C emphasizes creating a circular, closed-loop system). This sets the stage for them to design their own waste-to-resource solution (the "mini-pilot" or prototype design project). It also circles back to Module 1's big idea: a **circular economy** approach where one process's waste is another's input.

Setup & Materials:
Before class, prepare the copper sulfate solution (if not provided pre-mixed) and pre-measure soil and biochar for each group (or have balances available and allow students to measure under supervision). Copper sulfate (even at 0.25–0.5%) has a vibrant blue color that students can easily see; ensure the concentration is not so high as to be unsafe. It's low-toxicity at these dilutions, but still handle with care (gloves for all students). If possible, do a quick trial run yourself to see the extent of the color change between soil and biochar, so you know what to expect. Have cleaning supplies ready for spills. Ensure good ventilation if working with fine biochar powder (to avoid students inhaling dust).

Expected Results & Observations:

- **Cup A (Control, $CuSO_4$ only):** This cup should remain *bright blue and relatively straightforward* (no solids added). It's essentially the baseline "polluted water." The pH of the $CuSO_4$ solution alone might be around 5 (slightly acidic). There will be no color change aside from perhaps a very slight lightening if any Cu precipitates (unlikely in a short time). This cup shows the water's appearance without any treatment.

- **Cup B (Soil only):** Soil may have some capacity to adsorb or filter out the copper. Expect Cup B's water to be *somewhat less blue* than Cup A, but likely still visibly tinted blue. Part of the blue color will attach to soil particles, which will then settle. The water might turn a bit **murkier initially** (from mixing with soil), but it will clarify as soil sediments settle to the bottom. After settling, Cup B's water clarity could improve compared to immediately after stirring, but it will probably still have a bluish hue. The **pH** in Cup B may rise slightly toward neutral, since soil often contains minerals that buffer acidity. For

example, if Cup A's pH was ~5, Cup B might end up closer to pH 6 (depending on the soil's properties).

- **Cup C (Soil + Biochar):** This is expected to have the *clearest, least blue water* after settling. Biochar is a highly adsorptive material; it should bind many copper ions, significantly removing that blue color ([Bayar et al. 2024](#)). Students should observe that Cup C's water is noticeably clearer (perhaps almost colorless or a very pale blue) compared to Cups A and B. Any remaining color indicates incomplete adsorption, but the contrast should be apparent. The **pH** in Cup C may be higher than in Cup B, Biochar often has an alkaline pH and can bring the solution closer to neutral (or even slightly basic) by neutralizing some acidity. If students observe the pH strip for Cup C turning green/blue-green (pH ~7–8) compared to yellow/orange for Cup A (~pH 5), it indicates biochar's buffering effect. In terms of **notes**, Cup C might also have the most noticeable settled layer: a mix of black biochar particles and brown soil at the bottom, leaving clearer water above. There may be a mild **earthy smell** in Cup C from the biochar, which some students have noticed.

Teaching tip: After the settling time, have students hold up their Cup C behind a sheet of white paper or in front of a light source; they'll see more clearly that the water is more transparent than in Cup A. This "wow" moment drives home biochar's effectiveness. You can also prompt them to carefully transfer a small amount of water from each cup using a clean pipette and drop it onto a white surface (such as a plastic plate or tray) to compare the intensity of the blue.

Guiding the Discussion:

Once students have recorded their results, lead a discussion with questions such as:

- *"Which cup is clearest? Why do you think that is?"* Students should conclude Cup C (with biochar) is clearest. Emphasize that biochar's porous structure acts like a sponge or magnet for contaminants. Soil alone (Cup B) can trap some pollutants, but adding biochar greatly increases the adsorption surface area ([Bayar et al. 2024](#)).

- *"Did the pH change across the cups? What might that mean?"*, If students observed pH differences, draw out that biochar can also **neutralize acidic solutions**. This can lead into how biochar is beneficial not just for filtering metals but also for improving soil pH when added to acidic soils (a real-world agricultural benefit).

- *"What does this tell us about using waste materials to solve problems?"* Encourage students to see the big picture: We used biochar made from waste to clean water. This is a micro-example of turning a waste problem into a solution. In real-life applications, biochar filters can be utilized for farm runoff or industrial water treatment to capture heavy metals or other pollutants, while also storing carbon. (Indeed, research shows biochar can effectively adsorb metals like lead, cadmium, arsenic, etc. from water; [Bayar et al. 2024](#))

Connect back to **sustainability and circular economy**: In this experiment, waste (biomass -> biochar) addresses pollution (cleaning water) and improves climate outcomes (carbon sequestration). It's a win-win-win scenario, an excellent illustration for students that environmental solutions often integrate multiple systems (waste management, water quality, climate). If students have completed Module 1, remind them of our discussion on transitioning from a linear "take-make-waste" model to a circular one. Here, they have physically demonstrated a circular idea: using a waste byproduct to provide an environmental service (water purification).

Answers to Student Reflection Questions:

1. **Clearest Water, which treatment and why:** Cup C (soil + biochar) should be the clearest. Students should note that Cup A stayed very blue (since nothing was there to remove the blue copper ions), Cup B was somewhat clearer but still blue, and Cup C was dramatically clearer. The reason is that biochar

has a high surface area and porous structure, allowing it to **bind pollutants**. It essentially pulled a lot of the copper out of the water (often by adsorption onto the biochar particles), leaving the water clearer. Soil alone can adsorb some copper, but biochar is engineered (through pyrolysis) to be especially adsorptive. A good student's answer might say: "Cup C is clearest. The biochar in Cup C adsorbed much of the copper sulfate, so less remained dissolved to give the water a blue color. This shows biochar is more effective at removing the pollutant than soil alone."

2. **pH differences between treatments:** Students may observe that the pH in Cup C is higher (less acidic) than in Cup A. Cup B might be intermediate. An expected answer: "Yes, there was a pH difference. The control (Cup A) was acidic (for example, pH ~5). Cup B (with soil) was a bit less acidic (maybe pH ~6), and Cup C (soil + biochar) was close to neutral (~pH 7). This means the biochar helped raise the pH (made the water less acidic). Biochar often contains alkaline minerals/ash that can neutralize acids, so it not only removed the copper but also reduced the acidity of the solution." Even if students didn't get exact numbers, recognizing the trend is important. If they didn't see a change (perhaps due to limitations of the strips or low biochar amount), they might say "no significant difference"; that's okay, but you can clarify that typically biochar does have a liming effect.

3. **What does this tell us about biochar's role in water purification?** Students should conclude that biochar can play a significant role in purifying water by **binding contaminants**. A strong answer will generalize the experiment: "The differences between A, B, and C show that biochar can greatly improve water purification. In our experiment, biochar in Cup C removed more of the copper pollutant than soil alone (Cup B). This indicates that biochar can adsorb or trap pollutants, thereby making water cleaner. So in water purification, biochar could be used as a filter or additive to remove heavy metals or other contaminants." If possible, they might also tie it to real scenarios, e.g., "This suggests that adding biochar to contaminated soil or water could help clean up pollution, such as filtering farm runoff or treating wastewater." We want them to see biochar as a practical solution for environmental cleanup, derived from waste materials.

4. **Other benefits/uses of biochar (connecting to class lessons):** This question invites students to recall or think of biochar's broader impacts, especially those covered in Lesson A or discussions. Expected points include:

   ○ **Climate benefits:** Biochar sequesters carbon. If organic waste is turned into biochar, that carbon is "locked" in a stable form rather than released as CO_2 or CH_4. Students might recall something like "biochar can trap carbon for hundreds of years, helping climate change".
   ○ **Soil health:** Biochar can improve soil fertility and water retention. They might say "it helps soil hold water and nutrients, and provides a habitat for beneficial microbes" (which refers to the "Soil Super-Sponge" and "Microbe Mansion" concepts).
   ○ **Waste management:** It provides a use for agricultural waste (turning crop residues into biochar instead of burning or landfilling them).
   ○ **Others:** If they're creative, they may mention that biochar can reduce odors in compost or be used as a component in building materials, among other applications. But the key ones are climate and soil.
   A full-credit answer could be: "Biochar has several benefits. It helps fight climate change by storing carbon (instead of letting it become CO_2 or methane). It also improves soil health by acting like a sponge in the soil, holding water and nutrients, and providing places for soil microbes to live. Farmers can mix biochar into soil to improve crop growth and reduce the need for fertilizer. So, making biochar from waste not only manages the waste but also creates a product that helps in agriculture and carbon sequestration." Students don't need to list everything, but they should show awareness that biochar is a multifaceted tool (which is

impressive, considering it started as "waste").

Real-World Applications & Extension:

- **Water Remediation:** Share with students that biochar is actively being researched and used to clean up polluted water. For example, filters made of biochar can remove heavy metals from mining runoff or industrial wastewater ([Bayar et al. 2024](#)). In agriculture, biochar can filter nutrients out of farm runoff, preventing algal blooms in downstream water bodies. This experiment was a simplified model of those processes.

- **Soil Amendment:** Reinforce that after using biochar to adsorb pollutants, the biochar is now "loaded" with those substances. Often, used biochar can be safely buried or added to certain soils; in the case of nutrients, that's a benefit (slow-release fertilizer); in the case of heavy metals, it keeps them out of waterways by immobilizing them in soil. This is how a circular solution can address multiple issues: waste → biochar, biochar → cleaner water + better soil.

- **Climate Connection:** If you have time, do a quick calculation with the class: "If 1 kg of food waste in a landfill produces ~1.9 kg CO_2-e, and pyrolysis (biochar production) can avoid most of that, how much CO_2 might 50 kg of food waste produce vs. be saved by turning it into biochar?" (50 kg in landfill ≈ 95 kg CO_2-e, whereas biochar could cut that down drastically, plus it avoids methane entirely.) This math ties back to Lesson B and shows a quantitative climate benefit of strategies like biochar.

- **Circular Campus Brainstorm:** Ask students to think of places on campus or in the community where this could be applied. For instance, **could we set up a rain garden with biochar to filter stormwater** by a parking lot? Or use biochar in the school garden's soil to help plants during dry periods? These questions prompt systems thinking, linking waste management with water management and gardening (the food system), and can segue into designing a prototype. Encourage creative ideas: one group might imagine a "biochar filter barrel" that the cafeteria dishwasher runs through; another might pair a compost system with a small biochar kiln to handle woody waste, etc.

Connecting to Next Steps (Systems Thinking):
This activity is a capstone of Module 2's hands-on work. It's a great moment to step back and see the **big picture**: They've done a **waste audit** (HOA1, identifying the problem of waste), tried an **upcycling technique** (HOA2 Bokashi, turning waste into soil amendment), and now **demonstrated a multi-benefit solution** (HOA3 biochar, addressing pollution and climate). Together, these illustrate the power of an integrated, circular approach to waste in food systems. Highlight to students: *By combining solutions, for example, using some food scraps for compost, some for bokashi or biogas, and turning woody waste into biochar, we can drastically reduce landfill waste and improve our environment.* This is exactly how a **circular economy** works, and it's what real sustainable farms and communities are striving for. It also previews Module 3's focus on soil health: biochar and compost both will appear there as ways to regenerate soil, linking modules 2 and 3.

Finally, prompt a reflection: *"How can implementing multiple different waste-to-resource methods in parallel move our whole school closer to a circular system? What challenges might we face, and what would be the next steps to actually make it happen?"* (This echoes the Lesson C **Reflect** question.) Students might mention challenges such as cost, the need for cooperation from many people, and technical know-how. Acknowledge those and encourage them that understanding the science (like they did in these HOAs) is the first step to overcoming such challenges. They are now equipped with knowledge and data to make a strong case for change!

Rubric for assessment

Use the **Data Collection Worksheet** and students' participation to assess understanding. The worksheet responses will show both their observational skills and conceptual grasp. The rubric below provides criteria for evaluating their performance. You may assign point values (for example, 4 = Exemplary, 3 = Proficient, 2 = Developing, 1 = Beginning) for each category, for a total of up to 20 points. This can be used as a formative assessment or part of a lab/activity grade.

Grading Rubric (Short Version)

Use this quick-reference table to evaluate short-response, short-essay, and design-based answers. See page 6 for the detailed rubric.

Criteria	Exemplary (4 pts)	Proficient (3 pts)	Developing (2 pts)	Beginning (1 pt)
Data Collection & Accuracy (pH readings, clarity observations, trial comparisons)	All observations (color clarity + pH) recorded completely and accurately; data organized in neat tables; comparisons clearly noted.	Most observations recorded; data table mostly complete; minor inaccuracies.	Some observations missing or unclear; table incomplete or disorganized.	Minimal data recorded; little evidence of accuracy or organization.
Analysis & Interpretation (Effectiveness of treatments, pollutant removal)	Insightful analysis; clearly identifies which treatment was most effective; connects results to pollutant removal mechanisms with evidence.	Clear analysis; identifies most effective treatment; some explanation of why results occurred.	Limited analysis; treatment effectiveness vaguely described; reasoning incomplete.	Little or no analysis; effectiveness not addressed or incorrect.
Scientific Reasoning (Cause/effect of biochar, soil, and contaminants)	Strong reasoning; explains how biochar and soil interact with pollutants; connects to real-world water purification or soil health.	Reasonable explanation; mentions at least one cause/effect of biochar or soil on contaminants.	Limited reasoning; explanation vague, unclear, or partially incorrect.	No reasoning evident; minimal understanding of biochar or soil roles.
Reflection & Systems Thinking (Environmental connections, applications)	Thoughtful reflection; connects experiment to broader systems (water quality, agriculture, sustainability); strong, clear conclusions.	General reflection; mentions at least one broader impact or connection to environmental issues.	Limited reflection; vague or partial connections to broader systems.	Minimal or no reflection; no evidence of systems thinking.

Communication & Presentation (Clarity, organization, effort)	Work is neat, well-organized, labeled, and easy to follow; strong effort shown.	Work is organized and readable; most labels present; good effort.	Work is somewhat disorganized; some missing labels or explanations; uneven effort.	Work is messy, incomplete, or very difficult to follow; minimal effort.

Rubric Long Version

1. **Data Collection & Observations** (quality of experiment execution and data recorded)

   ○ **Exemplary (4 pts):** All data tables are fully and accurately completed. Student measurements (volume of solution, masses of soil/biochar) are correct and recorded with proper units. Observations are thorough, the student notes detailed descriptions of color and clarity for each cup and includes specific pH readings and qualitative notes (e.g., "Cup C water very light blue, almost clear; pH ~7 (neutral), slight earthy smell"). The data is neatly organized and clearly labeled. It's evident the group followed the procedure closely (e.g., times recorded, etc.) and took care in making observations.

   ○ **Proficient (3 pts):** Data collection is mostly complete. The tables have all the essential entries (final color observations and pH for each cup), with minor omissions or slightly vague notes. Measurements are reasonably accurate (perhaps one small mistake, like not recording an initial pH, or a pH value that seems off). Observations note which cup is clearest and give a basic description ("Cup C clearer than A and B, pH higher than others"), though with less detail. The work is well-organized, and the student made a clear effort to follow the procedure correctly.

   ○ **Developing (2 pts):** Data tables or observations are incomplete or show some errors. Perhaps one of the cups' results is missing, or the student didn't measure pH at all. Descriptions might be minimal or overly general (e.g., "Cup C clearer, Cup A blue" without quantifying or noting pH). It's possible the group deviated from instructions (maybe they didn't wait long enough, resulting in muddled data). The recorded information may be somewhat disorganized or difficult to interpret. The effort in collecting data was inconsistent.

   ○ **Beginning (1 pt):** Little valid data is recorded. Multiple parts of the table are blank or incorrect (e.g., entries in the wrong place, or stating all cups looked "the same" when that's unlikely if the experiment was done correctly). Observations, if any, are very inaccurate or not sensible (e.g., claiming Cup A was clear and Cup C was blue, which would indicate a major mix-up). This level suggests the experiment was not conducted or observed with care.

2. **Reflection & Concept Understanding** (responses to Questions 1–3 about results and biochar's role)

   ○ **Exemplary (4 pts):** Answers to the analysis questions demonstrate excellent understanding. The student identifies Cup C as the clearest and gives a correct, science-based reason (biochar adsorbs the pollutant, removing it from the water). They clearly note any pH changes and correctly interpret them (e.g., recognizing biochar's neutralizing effect). The explanation of biochar's role in water purification is insightful and uses evidence from the experiment ("because the water in Cup C lost a lot of its blue color, it shows the biochar removed much of the copper sulfate"). They use appropriate terminology (adsorption, contaminant, etc., as

introduced in class) and their reasoning is solid. Minor mistakes in wording are okay, but the science is right.

- **Proficient (3 pts):** The student's answers are mostly correct and complete. They correctly pick Cup C as most effective and provide at least one reason (even if simply "biochar absorbs the pollutant better"). They mention pH differences if observed (e.g., "Cup C's pH was higher than Cup A's"), though their explanation might not be deeply detailed ("maybe because of the soil or biochar chemical effect"). Their description of biochar's role captures the general idea that it helps clean the water. There might be slight gaps (for instance, they observe changes but don't fully explain *why* biochar works), but overall comprehension is evident.

- **Developing (2 pts):** The answers show partial understanding. The student might identify the clearest cup correctly but be unsure why ("Cup C was clearest, not sure why, maybe because there was more stuff in it"). They could miss the pH observation or misinterpret it ("we didn't see a change" when in fact there was one, or "Cup A was more acidic because of more copper" without clarity). Their explanation of biochar's role may be vague or slightly off, e.g., "biochar filters the water" (good start, but no elaboration) or a misconception like "biochar chemically reacts to remove color" without further detail. They may focus only on the experiment context and not generalize. In short, they grasp that something happened but can't fully articulate the mechanism or significance.

- **Beginning (1 pt):** Responses are very minimal, confused, or incorrect. The student might pick the wrong cup as clearest or give an irrelevant answer (e.g., "Cup A was best at cleaning" which is opposite of expected). Explanations, if any, are erroneous or nonsensical (like "the biochar added more blue, making it clear" or other misunderstandings). They show little evidence of understanding what biochar did in the experiment or why. Possibly, they guessed or did not engage with the reflection questions meaningfully.

3. **Broader Implications & Systems Thinking** (response to Question 4 and any connection to environmental/circular concepts)

- **Exemplary (4 pts):** The student makes strong connections between the activity and broader concepts. In discussing biochar's other benefits, they correctly mention **at least two** key points (e.g., carbon sequestration and soil enhancement) and explain them. They might write about climate impact: *"Biochar traps carbon that would have become CO_2, so it's helping with climate change,"* and soil health: *"It also helps soil hold nutrients and water, benefiting crops."* They clearly see biochar as part of a circular solution (turning waste into something useful) and may even tie it to what they learned earlier or to sustainability goals (e.g., "This supports the idea of a circular economy because we're using waste to solve problems. It also relates to global goals like reducing pollution and fighting climate change."). Their answer shows insight that goes beyond the cup experiment, indicating a holistic understanding.

- **Proficient (3 pts):** The student identifies at least one major benefit of biochar outside the experiment correctly, and hints at another. For example, they might say, *"Biochar can help with climate change because it stores carbon instead of releasing it,"* or *"Farmers can put biochar in soil to improve plant growth."* The answer is on the right track but may not cover multiple facets. They do recognize that biochar is a positive use of waste, even if they don't use the term "circular economy" explicitly. They demonstrate some systems thinking by linking the activity to either climate or agriculture.

- ○ **Developing (2 pts):** The answer is very surface-level or misses key points. The student might recall one fact (perhaps "biochar is used in soil" or "it can reduce smell" or something minor) but not explain why that's beneficial. They may not mention climate or broader waste management context at all, sticking only to "it cleans water like we saw." This suggests a limited connection to the bigger picture. Or they might mention something irrelevant or incorrect (e.g., "Biochar can be burned for fuel", confusing it with charcoal use, which is not the intended takeaway). Their response shows minimal integration of module concepts.

- ○ **Beginning (1 pt):** No meaningful answer is given about biochar's other uses or benefits. The student might leave it blank, or write something very off-base. They do not show awareness of biochar's role beyond the experiment itself. This could indicate they don't remember or didn't understand the broader context from Lesson A, or they simply did not attempt to connect the dots.

4. **Communication & Presentation** (clarity, organization, and effort in the worksheet/report)

- ○ **Exemplary (4 pts):** The student's work is **clear, well-organized, and shows a high level of effort**. The data tables are neatly filled in with legible writing (or well-formatted if typed). Units and labels are used correctly. The reflection answers are written in complete sentences that articulate thoughts well, using scientific terms learned (like *adsorbent, pH, contaminant,* etc., where appropriate). The flow of their answers is logical and easy to follow. There are few to no spelling or grammatical errors. It looks like they took time to present their findings thoughtfully, possibly even adding a small graph or diagram if especially motivated (not required, but some students do go above and beyond). Overall, it's a pleasure to read.

- ○ **Proficient (3 pts):** The work is generally neat and understandable. Tables are mostly complete and organized, though maybe a number or two is slightly misaligned. Answers are in full sentences and get the point across, even if wording is simple. There might be a few minor writing errors, but nothing that confuses the meaning. The student clearly put in solid effort to address each part of the worksheet. The presentation could be polished a bit more (for instance, more thorough labeling or a bit more detail in explanations), but it meets expectations well.

- ○ **Developing (2 pts):** The work is somewhat disorganized or has sections that are hard to follow. Perhaps the student's handwriting is very messy or they crossed things out a lot, making it a bit of a challenge to decipher their data. Some parts of the tables or questions might be unanswered or only answered in fragments/bullet points when a short explanation was expected. The overall flow is choppy; you might have to re-read sentences to understand their point. It appears the student did the minimum required, and the effort to communicate clearly was moderate at best.

- ○ **Beginning (1 pt):** The work is poorly presented and/or largely incomplete. Many parts of the worksheet are blank, or responses consist of one or two words with no explanation (e.g., just writing "Cup C" as an answer without context). Data might be written in a haphazard way (if at all), and the reflection responses, if present, might be one-word answers or totally off-topic. There was little care in organizing thoughts or making the submission readable. It suggests a lack of effort or severe confusion about the task.

Teacher Assessment Tips:

- Look for **keywords/phrases** in their answers that show understanding. For instance, in reflections: words like "adsorb" or "bind" when talking about biochar, or mention of "carbon" and "climate" in the broader implications question. If a student uses the term *"circular economy"* correctly or references the idea of not wasting waste, that's a sign of a top-tier response.

- It's okay if students didn't recall every detail taught about biochar. Some may focus on one benefit (climate or soil). Give full credit for accurately demonstrating any of the main takeaways. Use follow-up questions in feedback to fill gaps: e.g., if they talked about climate but not soil, you might write a note "Great point about climate benefit! Did you also remember how biochar helps soil? 🙂" to prompt their memory.

- **Common misconception watch:** Some students think that if the water is cleared, the copper "disappeared." Emphasize in discussion (and look for understanding in answers) that the contaminant is now in the biochar/soil sediment. It's removed *from the water*, not gone from the system. That's a nuance of thinking in systems, where did the pollutant go? (If a student mentions this concept, it's a bonus sign of deeper thinking!)

- Encourage students by acknowledging good scientific practices: If a group took neat notes or came up with a creative way to illustrate their results, highlight that. For those who struggled, focus feedback on the process ("Next time, try to record observations immediately and be as specific as possible, that will help your analysis").

- Since this is the last HOA of Module 2, consider having students give a quick presentation or gallery walk of their findings and proposed "next steps" to apply this. **Application mini-pitch:** You might assign an extension where each group shares one idea on how they could implement a waste-to-resource solution for a waste "hotspot" they identified (from Lesson C) and what data support it. This isn't formally graded in the worksheet, but it's a great way to assess their ability to transfer knowledge. Some groups might propose a school garden biochar project, others a compost program, etc. Use the rubric categories of Systems Thinking and Communication to also informally gauge these presentations.

- **Big picture:** Remind both yourself and the students that the ultimate goal is not just to do an experiment for a grade, but to *illuminate possibilities*. This activity shows them a tangible example of innovation, something as simple as charred biomass can clean water. Encourage a class conversation: *What other simple, sustainable innovations might be out there?* By fostering this curiosity, you're helping them transition from learning science to imagining solutions, which is exactly what this curriculum is about! 🎉