

Haunted Swamp Water Filtration STEM Lab

Scientific Method • Variables • Data & Design

✓ **Classroom-Ready**

✓ **Data tables + all instructions included**



Toxic Waste Cleanup Challenge: Haunted Swamp Water Filtration STEM Lab

Story (Read aloud)

A mysterious toxic spill has cursed the Haunted Swamp! Your class of scientists has been summoned to design and build a filtration system that can rescue the swamp's ghostly residents before they die. Each team must engineer, test, and optimize a filter that clears "swamp sludge" (murky dyed water) and low efficiency high.

Driving Question

How can we design a low-cost filtration system that removes visible contaminants from swamp water and to the ecosystem and saving the haunted inhabitants?

Learning Targets

- Plan and carry out an investigation to test and improve a filtration design.
- Collect quantitative data on clarity, flow time, and cost efficiency.
- Explain how physical and chemical filtration processes model real-world water treatment.
- Use evidence and reasoning to justify the best design solution.

Teacher Guide

Materials (per 6-8 teams)

Haunted Swamp Water: Tap water + soil + glitter + green food coloring + a few drops of oil. Recipe teacher copy.

Filtration Supplies (spooky menu):

- Coffee filters – "Ghost Sheets" (\$1)
- Sand (fine) – "Cursed Sand" (\$2)
- Gravel – "Graveyard Gravel" (\$2)
- Activated charcoal – "Witch's Char" (\$3)
- Cotton/felt – "Phantom Padding" (\$1)
- Rubber band – "Binding Ring" (\$1)
- Tape – "Mummy Wrap" (\$1 per 30 cm)
- Bottle funnels / 2 L bottles (free cauldrons)
- Beakers, cups, measuring tools, turbidity chart

Budget: \$10 per team

How the Budget Works

Each team is given \$10 in imaginary budget money to "purchase" filtration materials from the spooky menu. The goal is to design an effective filter while staying within the \$10 limit — just like engineers who work on real-world designs.

Toxic Waste Cleanup Challenge: Haunted Swamp Water Filtration STEM Lab

Names: _____ Period: _____ Date: _____

A toxic spill has cursed the Haunted Swamp. Your team must engineer a filtration system to rescue the swamp by clearing the "sludge" (murky dyed water) while staying under budget.

Driving Question

How can we design a low-cost filtration system that removes visible contaminants from swamp water and restores clarity?

Safety (read & follow)

- Goggles on at all times.
- No tasting; keep liquids away from eyes/skin.
- Handle dyes/charcoal gently—no splashing.
- Dispose of waste water in sink, solids in trash; wash hands.

Criteria for Success

- Clarity: Turbidity ≤ 2 using the card (0 = clear, 5 = opaque).
- Speed: Filter 250 mL in ≤ 3 minutes.
- Budget: Spend $\leq$ \$10 total.
- Stability: No leaks or bypass around layers.

Turbidity Rating (0-5 Visual Scale): Compare the filtered water to the chart below.

Turbidity Level	Description	Visibility
0	Crystal clear	Easily see card lines/text through water
1	Slight haze	Can still see lines clearly
2	Noticeable cloudiness	Lines faint but visible
3	Cloudy	Lines barely visible
4	Very cloudy	Lines invisible but light passes through
5	Opaque	Looks solid green/brown; no light passes through

Materials Store & Budget (you choose within \$10)

Record your purchases below. You may only use items you "buy."

Item	Cost	Qty	Subtotal
Coffee filter (Ghost Sheet)	\$1		
Sand, fine (Cursed Sand)	\$2		
Gravel (Graveyard Gravel)	\$2		
Activated charcoal (Witch's Char)	\$3		
Cotton/Felt (Phantom Padding)	\$1		
Rubber band (Binding Ring)	\$1		
Tape, 30 cm (Mummy Wrap)	\$1		
Bottle funnel / 2 L bottle	Free		
TOTAL SPENT			\$_____ ($\leq$ \$10)

Challenge Overview

The toxic haunt spreads fast—unless you can purify the swamp water! Design, build, and test a gravity-powered filtration device that makes the "sludge" as clear as possible.

Criteria for Success

- Clarity: Turbidity ≤ 2 (use the included **Turbidity chart** (student copy): Rate from 0 (clear) to 5 (opaque).
- Speed: ≤ 3 min per 250 mL filtered.
- Budget: $\leq$ \$10 total.
- Stability: No leaks or structural failures.

Procedure

- Plan – Sketch your filtration tower. Label layers and total your costs. You must keep your total cost $\leq$ \$10.
- Build – Assemble layers in a bottle "cauldron." Wrap with mummy tape and bind with ghost sheets.
- Test – Pour 250 mL of Haunted Swamp Water. Record time, turbidity, and observations.
- Redesign – Modify one element and repeat the test.
- Compare – Which design cleared the most grime for the least cost?
- Analyze – Complete Analysis & CER section.

Analysis & CER

- Which layer(s) trapped the largest particles? Which removed color?
- How did layer order affect performance?
- Why did your second design improve or worsen results?
- CER: Claim which design best rescued the Haunted Swamp, support with quantitative data, and real-world evidence of adsorption and adsorption principles.

Teacher Answer Key

1) Which layer(s) trapped the largest particles? Which removed color?

The gravel (Graveyard Gravel) and sand (Cursed Sand) layers trapped the largest solid particles—soil, glitter, and debris. The activated charcoal (Witch's Char) removed most of the green color and odor by adsorbing dyes and organic material.

2) How did layer order affect performance?
Filters worked best when coarsest particles, and charcoal, were at the bottom, preventing clogging or murky water.

Planning & Design

Sketch your filtration tower (top $\rightarrow$ bottom). Label layer order and thickness; note where you will seal to prevent leaks.

Design Rationale (why did you choose this order?):

Procedure

- Plan: Finalize materials & TOTAL SPENT.
- Build: Assemble layers in your bottle "cauldron." Seal edges to stop leaks.
- Test: Measure 250 mL swamp water. Start timer as you pour. Record time, turbidity, and observations.
- Iterate: Change ONE thing (e.g., layer order, thickness, seal, add or remove materials).
- Compare & Analyze: Answer the Analysis and CER.

Data Tables

Trial Log

Trial	What did you change? (ONE variable)	Time for 250 mL (s)	Turbidity (0-5)
1			
2			

Results Summary

Best turbidity: _____ Best time: _____ s Total spent: \$_____

Met all criteria (clarity, speed, budget, stability)? ☐ Yes ☐ No If No, why? _____

Analysis & CER

- Which layer(s) trapped the largest particles? Which removed color?
- How did layer order affect performance?
- Why did your second design improve or worsen results? Consider design changes and contact time.
- CER – Which design best rescued the Haunted Swamp?

Claim (what you think): _____

Evidence (numbers): Time = _____ s; Turbidity = _____; Cost = \$_____

Reasoning (science): Use filtration (size-based) and adsorption (charcoal)

Haunted Swamp Water Recipe

Materials (for about 2-3 liters, enough for 6-8 teams)

- Tap water: 2-3 L (base of your swamp)
- Soil or potting mix: 2-3 tablespoons — adds realistic murkiness
- Glitter or confetti: small pinch — helps visualize particle trapping
- Green food coloring: 5-8 drops — creates the "swamp" look
- Vegetable oil (optional): 3-5 mL (about a teaspoon) — adds an oil layer for advanced filtration
- Small container or jug with lid (for shaking and storage)

Procedure

- Start with base water: Pour 2-3 liters of tap water into a large pitcher or jug.
- Add "contaminants":
 - Stir in 2-3 tablespoons of soil or potting mix. (Avoid clumps of leaves or sticks.)
 - Sprinkle in a small pinch of glitter for visible particles.
- Add color: Mix in 5-8 drops of green food coloring. Swirl until evenly tinted.
- Optional oil layer: Drizzle in 1 teaspoon of vegetable oil to float on top—represents chemical contamination.
- Mix and settle: Stir or shake briefly, then let sit for 10-15 minutes before distributing to teams.

Teacher Tips

- If it looks too clear, add another spoon of soil or a drop of brown food coloring to make it swampier.
- If it's too opaque, let solids settle a bit and pour from the middle layer.
- Keep a separate jug of "clean" tap water for comparison when students rate turbidity.
- If reusing across periods, let solids settle overnight, then gently stir before each use.
- For a spooky flair, label the jug "Haunted Swamp Sample – Handle with Care!"

Optional Variation (for High School)

Add a small amount of pH indicator (like cabbage juice) to visualize pH shifts or use a few drops of dish soap to simulate surfactant contamination.

Haunted Swamp STEM Challenge – Rubric

Criterion	4 – Exemplary	3 – Proficient	2 – Developing	1 – Beginning
Safety & Setup	Goggles on consistently; station tidy; liquids handled carefully; follows teacher directions without reminders.	Goggles on; minor reminders for spills/organization; generally safe.	Intermittent PPE use; repeated reminders; occasional unsafe placement of materials.	Unsafe behaviors or disregard for directions; station messy or hazardous.
Design Plan & Constraints	Clear sketch with labeled layers (top $\rightarrow$ bottom), thicknesses, seals; budget table complete and $\leq$ \$10; design purposefully addresses criteria (clarity, speed, stability).	Sketch labeled; budget mostly complete and $\leq$ \$10; addresses most criteria.	Rough or incomplete sketch; budget errors or missing items; criteria only partially addressed.	No usable plan; ignores budget/constraints; design unlikely to meet criteria.
Build Quality & Sealing	Layers assembled in logical order; strong seals (no bypass); stable funnel/device; no mixing of layers.	Mostly correct order; minor leaks or small mixing; device stable.	Order has issues (e.g., charcoal on top); noticeable leaks/bypass; unstable build.	Disorganized build; significant leaks or collapse; filtration ineffective.
Measurement & Data Quality	Accurate timing and volume; turbidity documented with scale (or % light) for each trial; notes on leaks/color/odor; iteration log records ONE clear variable change.	Most measurements recorded; turbidity or % light in most trials; iteration noted.	Some missing measurements; unclear turbidity ratings; iteration change vague.	Sparse or unreliable data; no iteration tracking; values lack units or sense.
Performance vs. Criteria	Meets or exceeds all: Turbidity ≤ 2 (or 20% light), ≤ 3 min for 250 mL, $\leq$ \$10, no leaks; includes evidence in summary.	Meets most criteria (3 of 4), minor shortfall documented with data.	Meets some criteria (2 of 4) with limited evidence.	Meets ≤ 1 criterion; lacks evidence or summary.
Iteration & Optimization	Second design shows measurable improvement supported by data (e.g., turbidity 3.5 $\rightarrow$ 1.8; time 150 $\rightarrow$ 110 s); explains which change caused the gain.	Second design improves at least one metric with some explanation.	Change made but effect unclear or not measured; explanation vague.	No iteration or changes made worsen performance without reflection.
Analysis & CER	Claim identifies best design; Evidence cites specific numbers (time, turbidity, cost); Reasoning correctly explains filtration (size exclusion) & adsorption (charcoal) and links sealing/contact time to results.	Claim with relevant evidence; reasoning mostly correct; mentions filtration or adsorption.	Claim vague; evidence limited; reasoning partially incorrect or generic.	Claim absent or contradicts data; no scientific reasoning.

What You Get

- **Special Halloween-Themed Lab Activity with fun connections**
- **Teacher Guide:** Quick setup & safety, pacing/roles, Haunted Swamp Water recipe, success criteria, troubleshooting.
- **Student Handout:** Driving question, roles, \$10 budget menu, sketch/planning page, step-by-step build-test-iterate procedure.
- **Data Tables:** Trial logs for time (s), turbidity (0–5), leaks/notes, and a results summary.
- **Graphing & Scoring Page:** Prompts for Clarity vs. Design Version, optional Cost vs. Clarity, and final score formula.
- **Analysis + Model Answers:** Why layers work (gravel/sand = filtration; charcoal = adsorption), order effects, iteration impacts, exemplar CER.
- **Rubric:** Safety, design/constraints, build & sealing, data quality, performance vs. criteria, iteration, and CER.