

CLEAN WATER FILTRATION STEM STEM INVESTIGATION

**Print-and-go STEM
lab where students
design a low-cost
filtration system that
removes visible
contaminants from
dirty water and
restores clarity?**

Clean Water on a Budget — Filtration Engineering Challenge

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

Learning Targets
Plan and carry out a fair test to design and improve a water filter.
Collect data on clarity (turbidity), flow time, and cost; compare designs.
Explain how physical filtration (size-based) and adsorption (charcoal) model real water treatment.
Use Claim–Evidence–Reasoning (CER) to justify the best design solution.

Materials (per 6–8 teams)

- Dirty Water (recipe below): tap water + soil, a small pinch of glitter/confetti, food coloring; optional: a few mL of vegetable oil
- Coffee filters
- Sand (fine)
- Gravel
- Activated charcoal
- Cotton or felt
- Rubber bands, tape (≈30 cm per team)
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- Cut 2-L bottles or funnels, clear cups/beakers, 250 mL measure
- Stopwatches/phones, turbidity rating card (0–5), markers, scissors

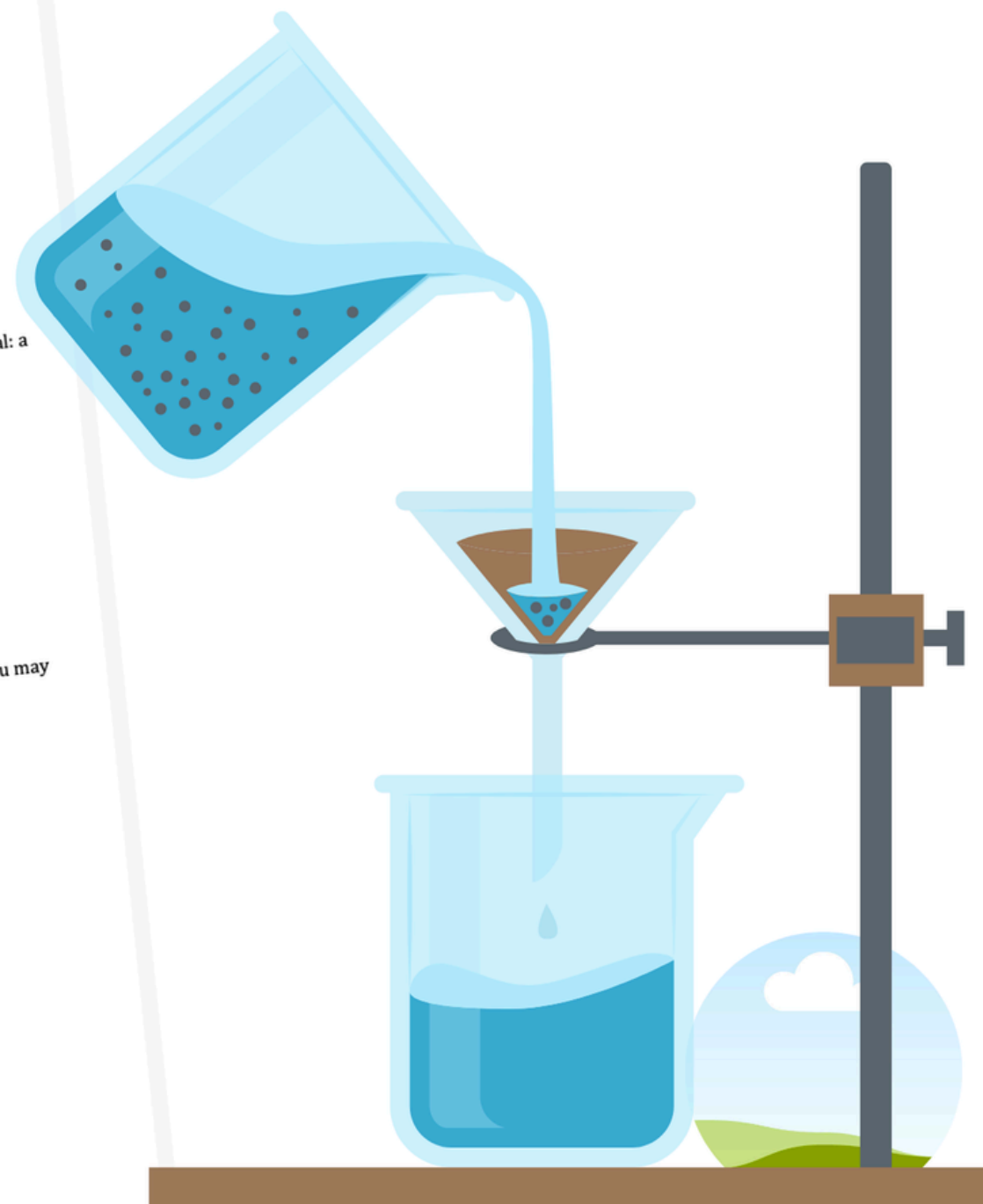
Budget & Materials Store
Each team gets \$10 in pretend money to “buy” materials. Record purchases in the budget table. You may return or exchange items with teacher approval. Use labeled bins to simulate a store.

Safety

- Wear goggles at all times.
- No tasting; keep liquids away from eyes/skin.
- Handle materials gently—no splashing.
- Wipe up spills; put solids in the trash; wash hands.

Teach With Fergy

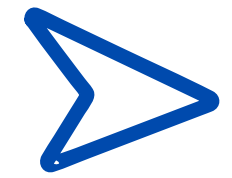
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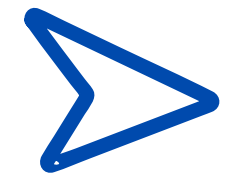
SCROLL
to take a look inside!



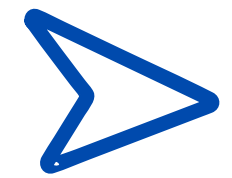
HOW THIS LAB WILL HELP YOU



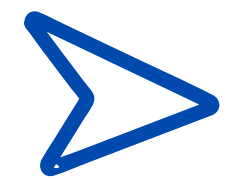
Print-and-go setup



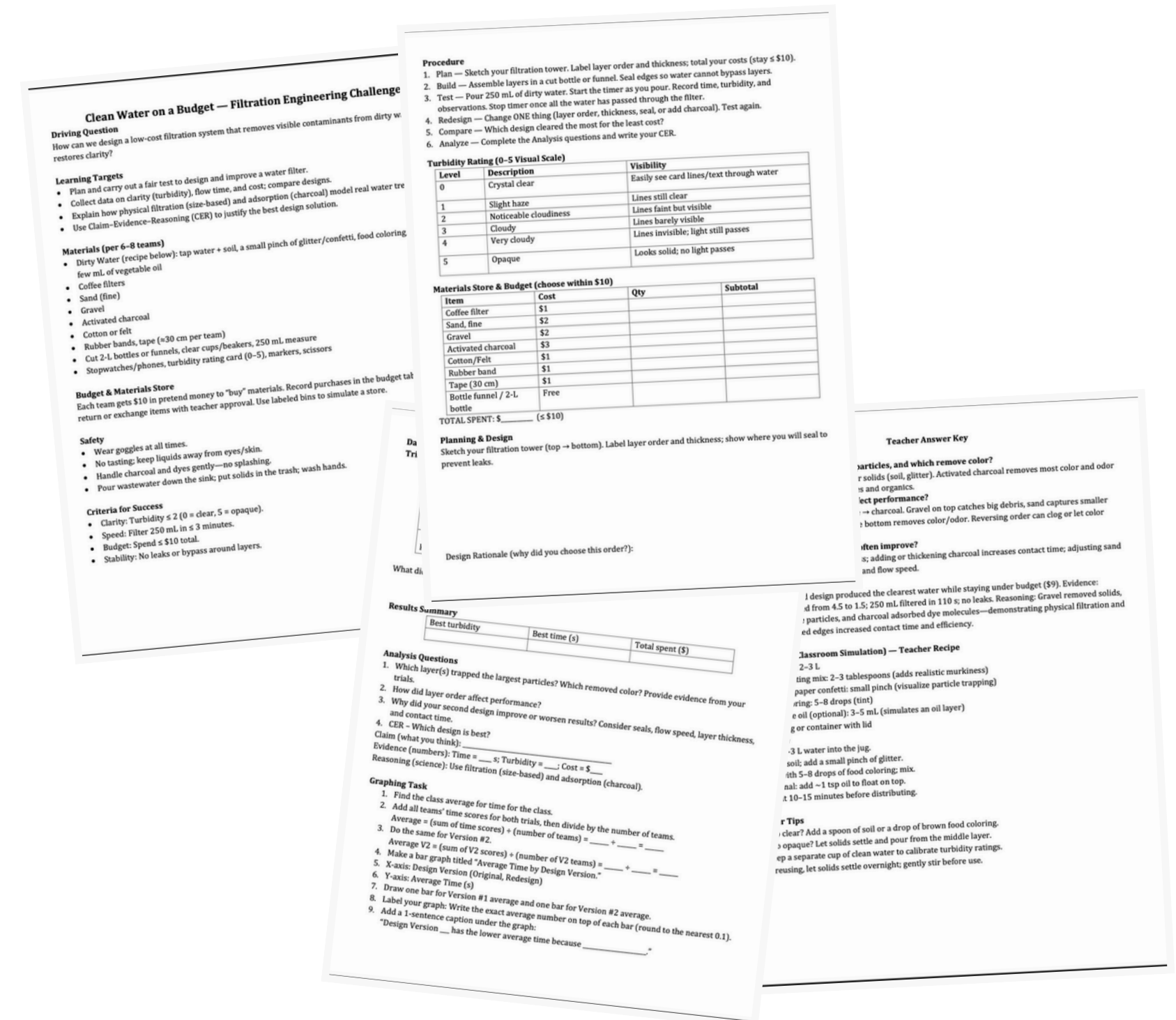
Clear Testing Procedure



Data & math supports



Low-cost & common
materials





Teacher Guide: setup, safety, pacing, and background science.



Student Packet: clear, step-by-step setup and timing instructions with blank data tables.

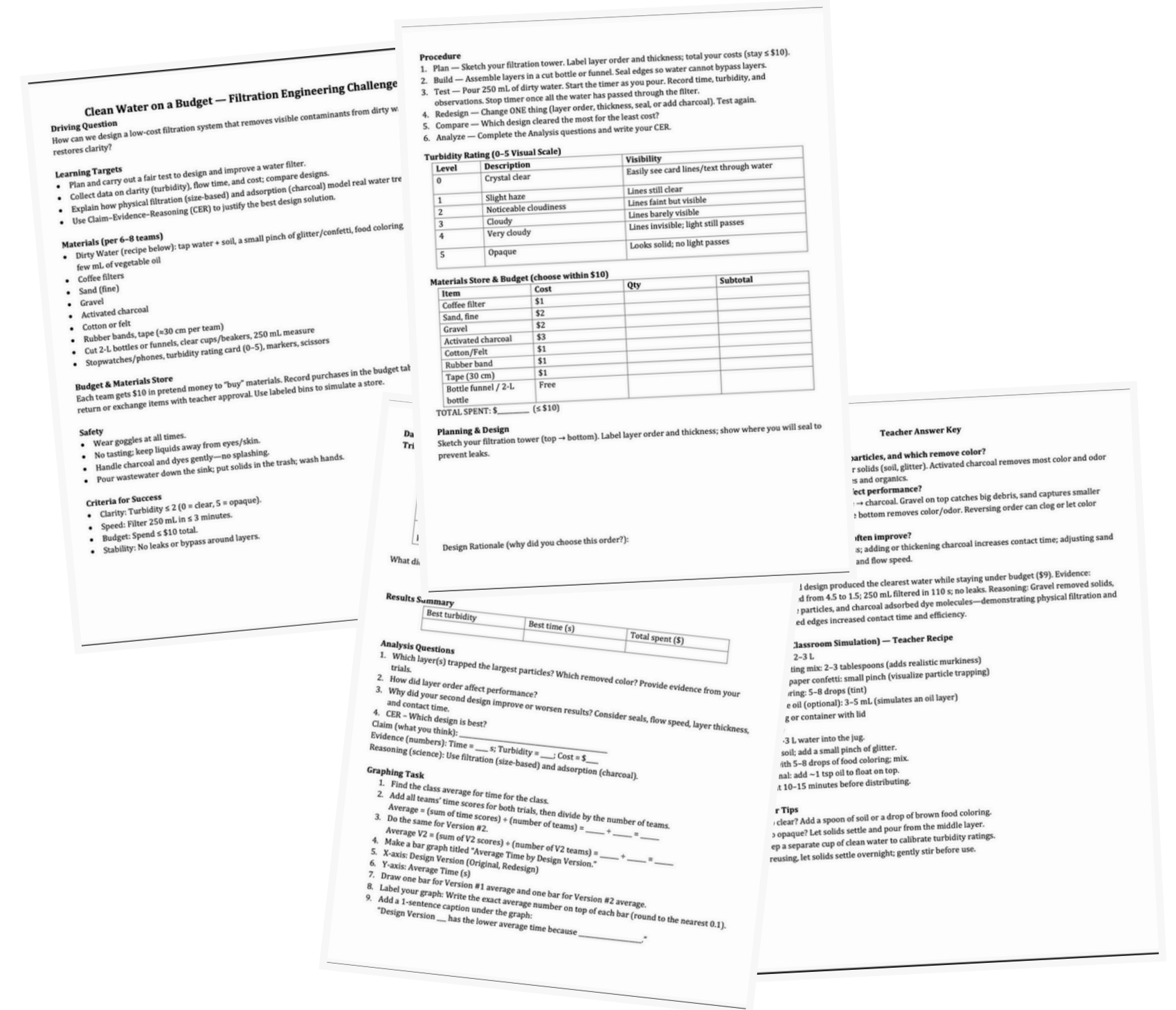


Graphing pages templates and marking rubric.

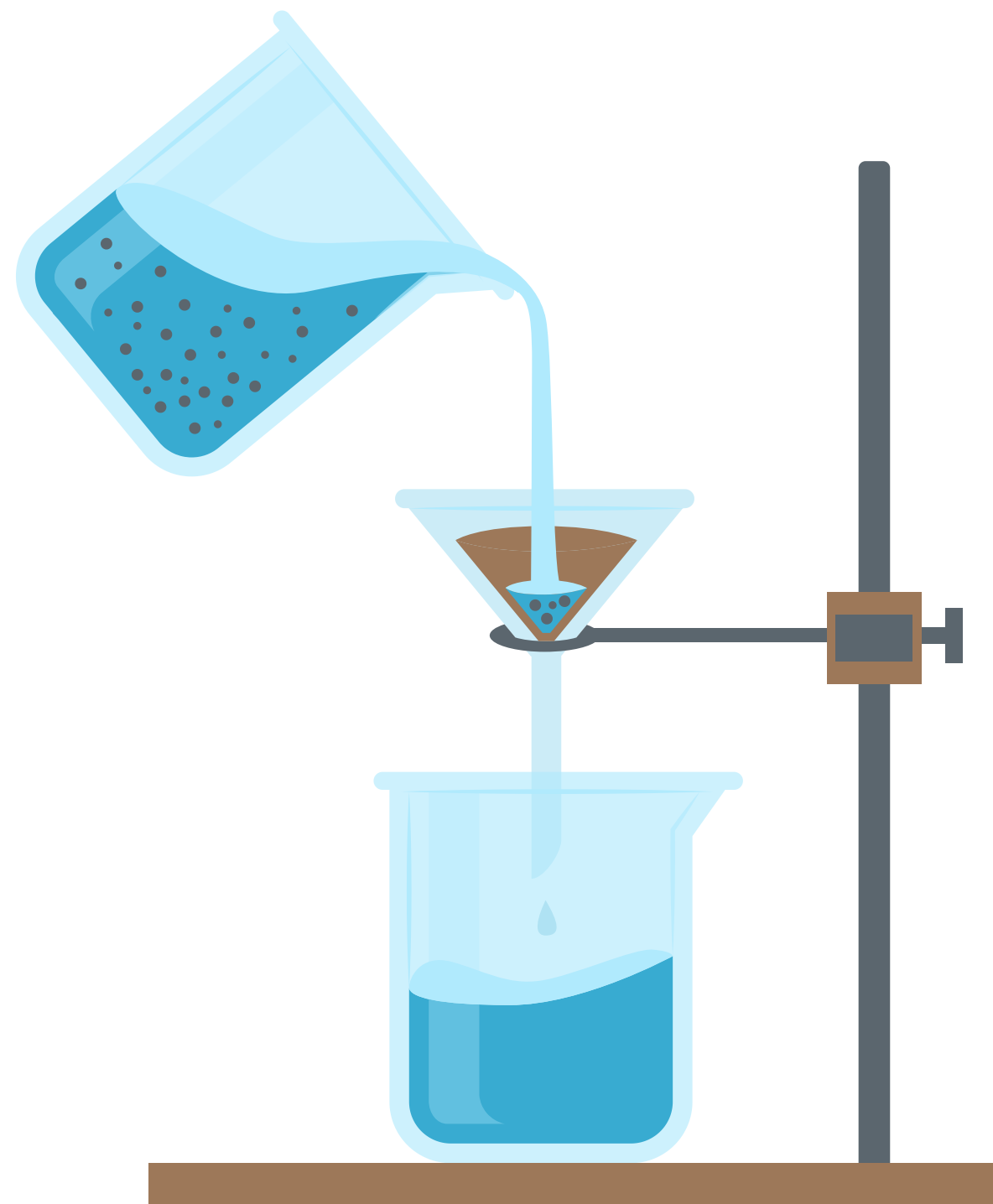


Complete answer key with example data tables.

What you get inside



Skills Your Students Will Learn/Improve



- ✓ Carrying out Controlled Experiments
- ✓ Precise Measurement
- ✓ Design and Redesign
- ✓ Graphing Data
- ✓ Claim–Evidence–Reasoning
- ✓ Analyzing Results

Your Lab

Procedure

1. Plan — Sketch your filtration tower. Label layer order and thickness; total your costs (stay $\leq$ \$10).
2. Build — Assemble layers in a cut bottle or funnel. Seal edges so water cannot bypass layers.
3. Test — Pour 250 mL of dirty water. Start the timer as you pour. Record time, turbidity, and observations. Stop timer once all the water has passed through the filter.
4. Redesign — Change ONE thing (layer order, thickness, seal, or add charcoal). Test again.
5. Compare — Which design cleared the most for the least cost?
6. Analyze — Complete the Analysis questions and write your CER.

Turbidity Rating (0–5 Visual Scale)

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

Materials Store & Budget (choose within \$10)

Item	Cost	Qty	Subtotal
Coffee filter	\$1		
Sand, fine	\$2		
Gravel	\$2		
Activated charcoal	\$3		
Cotton/Felt	\$1		
Rubber band	\$1		
Tape (30 cm)	\$1		
Bottle funnel / 2-L bottle	Free		

TOTAL SPENT: \$_____ ($\leq$ \$10)

Planning & Design

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

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

All steps are clearly outlined and easy to follow

Students collect data in organized charts

Graphing

Students analyze their data and draw conclusions

Data Tables

Trial Log

Trial	Time for 250 mL (s)	Turbidity (0–5)	Leaks? (Y/N)	Notes (color, odor, clogs)
Original Design				
Redesign				

What did you change in your redesign?

Results Summary

Best turbidity	Best time (s)	Total spent (\$)

Analysis Questions

1. Which layer(s) trapped the largest particles? Which removed color? Provide evidence from your trials.
2. How did layer order affect performance?
3. Why did your second design improve or worsen results? Consider seals, flow speed, layer thickness, and contact time.
4. CER – Which design is best?
Claim (what you think): _____
Evidence (numbers): Time = ____ s; Turbidity = ____; Cost = \$____
Reasoning (science): Use filtration (size-based) and adsorption (charcoal).

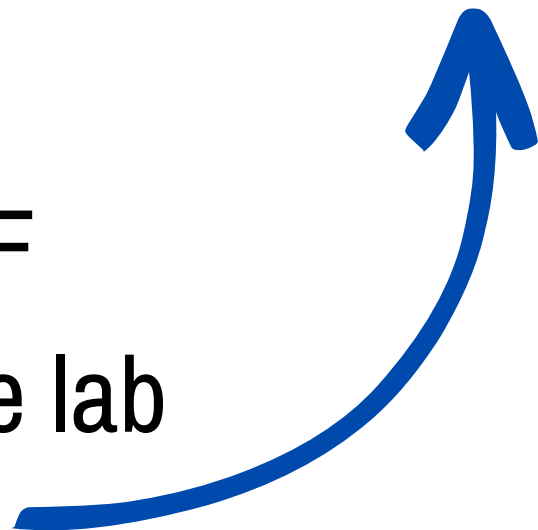
Graphing Task

1. Find the class average for time for the class.
2. Add all teams' time scores for both trials, then divide by the number of teams.
Average = (sum of time scores) $\div$ (number of teams) = ____ $\div$ ____ = ____
3. Do the same for Version #2.
Average V2 = (sum of V2 scores) $\div$ (number of V2 teams) = ____ $\div$ ____ = ____
4. Make a bar graph titled "Average Time by Design Version."
5. X-axis: Design Version (Original, Redesign)
6. Y-axis: Average Time (s)
7. Draw one bar for Version #1 average and one bar for Version #2 average.
8. Label your graph: Write the exact average number on top of each bar (round to the nearest 0.1).
9. Add a 1-sentence caption under the graph:
"Design Version __ has the lower average time because _____."

At School or at Home



Word and PDF
versions of the lab



Fully digital and editable - can be
done in class or through distance
education/homeschool



Ways to Use this Resource



Introduce the Scientific Method



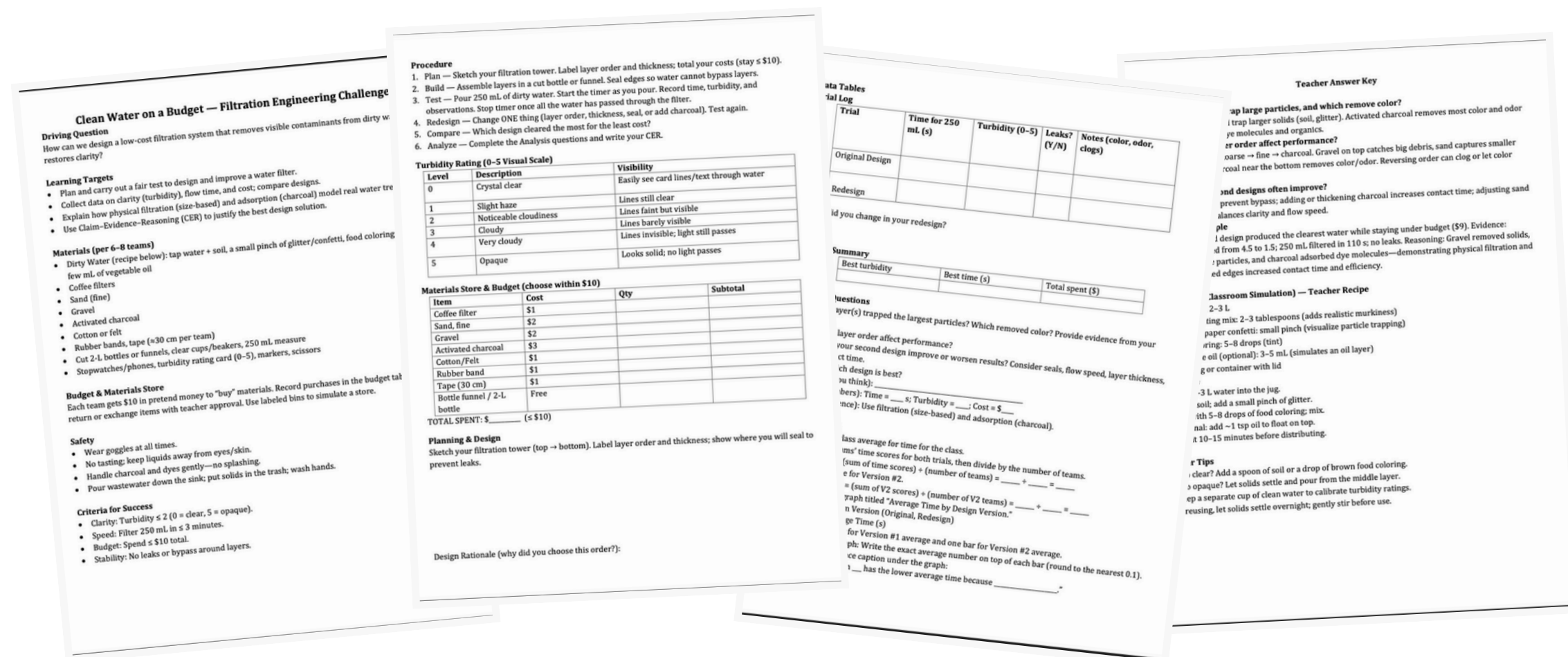
Reinforce key ideas



Teach data analysis and graphing



Formative or Summative Assessment



Download my Angle of Attack STEM Lab FREE
CLICK HERE

Paper Airplane Angle of Attack STEM Lab

Scientific Method • Variables • Data & Graphing

✓ Classroom-Ready

✓ Data tables + bar graph templates included



✓ Teacher guide with setup, safety, background science, pacing

✓ Step-by-step procedure for testing

✓ Analysis questions with model answers and Rubric



Paper Airplane: Angle of Attack STEM Investigation: Scientific Method Activity

Teachers Reference:

Angle of Attack Explained - <https://youtu.be/D1J1oUP-aKA?si=vsnb9a72PajoWnZs>



Purpose

Use a high-engagement paper-airplane challenge to teach experimental design, variables and controls, proportional reasoning, data analysis, and communication of results.

Learning Objectives

- Plan and carry out a controlled investigation with clear independent, dependent, and controlled variables.
- Collect sufficient data (replicates) and compare results across angle conditions.
- Graph distance data to analyze trends and construct evidence-based claims.
- Explain the physical principles (lift, drag, stall) that affect flight distance.

only airplanes; no paper clips or sharp nose cones.
a clear launch lane; stand behind the throw line; throw parallel to the floor.
ing area clear; retrieve planes only after all throws in a round are complete.

- Use a standard 8.5x11 in. — identical for all planes
- Use a standard template (optional, one standard design for all teams)
- Use a protractor (or angle guides) to set release angle relative to horizontal
- Tape for a throw line and distance marks; measuring tape or meter tape
- Data sheets (included), clipboards, pencils

Background Science for the Teacher

Lift vs Angle of Attack (AoA): Lift generally increases with AoA up to a point. Beyond a critical AoA, airflow separates (stall), causing lift to drop and drag to rise, shortening distance.

Drag and Energy: Higher AoA increases frontal area and induced drag; too much drag slows the plane quickly. Moderate AoA balances adequate lift with manageable drag for a longer glide.

Consistency: A single plane design, constant throw force/height, and a clear angle-setting method are key to fair comparisons.

Expected Results Pattern

- Distances typically peak at a moderate AoA (around 10°–15° for a simple dart design).
- Very low AoA (0°–5°) may dive or fail to generate a strong glide; very high AoA (20°+) often stalls or climbs then falls rapidly.
- As throw technique becomes consistent, variation decreases and the distance curve vs angle becomes clearer.

Implementation Notes

- Use one standard airplane design per class for consistency (provide a template or model).
- Assign roles: Thrower, Angle Setter/Checker, Measurer, Recorder. Rotate roles between angles.
- Mark the throw line and measure angle at release using a protractor or an angle card taped to the forearm or launcher guide.

Answer Key and Sample Results

Note: Actual class data will vary. The sample below models typical trends and acceptable analysis quality.

Sample Summary Data

Angle (°)	Average Distance (m)
0	7.8
5	10.6
10	12.9
15	12.1
20	8.9

Interpretation

- Greatest average distance at 10° (=12.9 m) with a close second at 15° (=12.1 m).
- Very low angle (0°) underperformed (dives/low lift). Very high angle (20°) lost distance (near-stall and higher drag).
- The trend supports a moderate-angle optimum due to balance of lift and drag.

Model Responses to Analysis Questions

- Best angle: 10° with an average of ~12.9 m (our class graph shows a peak around 10–15°).
- Consistency: Results were reasonably consistent after the practice round; using the same thrower and angle card reduced variation.
- Controls that mattered most: Plane design and paper type, release height and throw force, indoor/no-draft room, and measuring to first contact.
- Follow-up: Test nose mass with paper clips at the best angle. Hypothesis: Adding a small nose mass (1–2 clips) will increase distance by improving stability without greatly increasing drag.

STEM INVESTIGATION BUNDLE

Build a high-engagement, low-prep STEM program.

- This Bundle includes my best STEM investigations—each one built around true engineering design, fair testing, repeated trials, data tables, graphing, and CER writing.
- STEM develops crucial skills like critical thinking and creativity and prepares students for a changing world and future opportunities.



Tell me and I forget. Teach me and I remember. Involve me and I learn. - Benjamin Franklin



STEM Investigation Growing Bundle

Scientific Method • Variables • Data & Graphing

✓ Classroom-Ready

✓ A Variety of Science Topics Included



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