Name: Date: Class:

Design Sheet Answer Key

Part 1: Plan Your Design

1. What makes a rock good for storing gas?

Good storage rock has pores/spaces that can hold fluids or gas.

2. Why is a cap rock important?

Cap rock prevents gas from escaping, or it acts as a seal/barrier.

3. Sketch Your Model

Bottom: baking soda (gas source)

Middle: porous layer (sand/gravel)

Top: cap rock (clay)

Injection point reaching bottom layer

4. Design Decisions

Design Feature	Your Choice
Porous layer material	Sand, gravel, or combination of sand and gravel
Cap rock material	Clay
Cap rock thickness	2 cm
Injection volume (mL)	15-20 mL

Name: Date: Class:

Part 2: Build & Test

Trial	Porous Material	Cap Rock Material	Cap Rock Thickness (cm)	Injected Solution (mL)	Leak Time (s)	Leak Height (cm)	Spread Width (cm)
1	sand	clay	1.5	15	14	6.0	4.5
2	sand	clay	2.5	15	21	6.8	4.0
3	gravel	clay	1.5	15	9.0	8.5	6.5
4	gravel	clay	2.5	15	15	9.0	6.0
5	1 cm sand and 1 cm gravel	clay	2.0	15	19	7.2	5.2

Part 3: Analyze Your Results

1. Which design lasted the longest before leaking? Why?

   Trial 2 (sand with a 2.5 cm clay cap) lasted the longest before leaking at 21 seconds because the thicker clay cap rock created a stronger seal that slowed the movement of gas and liquid.

2. Which design had the least leakage?

   Trial 2 had the least leakage, as shown by its smaller spread width (4.0 cm) and relatively lower leak height compared to other trials.

3. How did cap rock thickness affect leakage?

   Increasing the cap rock thickness reduced leakage and increased leak time, as seen when comparing Trials 1 and 2 and Trials 3 and 4, where thicker caps led to slower and less extensive leaks.

4. Which material worked best as a cap rock? Why?

   Clay worked best as a cap rock because it is less permeable, which allowed it to effectively block and slow the movement of gas and liquid, reducing leakage across all trials.

Name: Date: Class:

Part 4: Redesign

What ONE change will you make?

Cap thickness

Explanation: Increasing the cap rock thickness would help reduce leakage and increase the time before the gas escapes, as thicker clay caps in Trials 2 and 4 showed better performance compared to thinner caps in Trials 1 and 3.

Part 5: Reflection

1. What trade-offs did you observe between storage and leakage?

Using more porous materials like gravel allowed for more gas storage, but it also caused faster and wider leakage. Thicker or less permeable caps slowed leakage but limited how quickly the gas could be injected or distributed.

2. What are two limitations of this model compared to real underground CO_2 storage?

First, the model does not simulate the high pressures and temperatures found deep underground. Second, it cannot replicate long-term behavior such as rock fractures, chemical reactions, or supercritical CO_2 flow.

3. How might engineers monitor leaks underground?

Engineers could monitor leaks using pressure sensors, soil or air gas detectors, seismic monitoring, or satellite and remote sensing technologies to detect gas escaping from storage sites.