TEACHWITHPORTALS™

## Subject: Math

## Title: *The Broken Rooms*

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**Grade Level: 8th**

**Common Core Standards :**

**8.G**

### Understand congruence and similarity using physical models, transparencies, or geometry software.

1. Verify experimentally the properties of rotations, reflections, and translations.
2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.
3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.
4. Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

### Grade 8 Mathematical Practices Addressed in this Lesson:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others.
6. Attend to precision.
7. Look for and make use of structure.

***Note: If students were to collect data on time spent within each room, number of moves needed to "fix" the room etc., several of the standards for data and statistics for 7th and 8th grade could be met as well.***

APERTURE LABORATORIES

**Time needed for lesson:** Several class periods to construct the rooms, solve the inherent problem in each room and then create their own broken level.

## Overarching Question and Objectives:

What if the actual structure of a room was faulty and therefore made the room unsolvable? Could we find and fix inherent design problems in the game to make the test chamber playable?

## Summary of lesson:

This lesson looks at the game from an entirely different perspective. In this case, students are not trying to "pass" a given test chamber. They are given a test chamber that is flawed in its design. Their goal is to "fix" the chamber, within the editor (Puzzle Maker) given a specific set of constraints in order to make it playable. First, students must use geometric reasoning skills to reconstruct the rooms from screenshots given by their instructor using ideas of congruence, transformations and rotations. Then, when the room has been properly re-constructed in the editor, they are given specific directions for what can and what cannot be changed within the editing platform. Their goal is to (a) figure out what makes the room unplayable (b) come up with ways to fix it within the limits proscribed and (c) make the appropriate changes and defend their reasoning.

## Vocabulary:

Students should be familiar with the concepts of congruence, reflection, rotation, similarity, transformation, dilation and the names of the tools given in the asset panel in the Puzzle Maker.

## Teacher materials needed:

The teacher will need screenshots of broken rooms (several rooms are already provided with this lesson, of course, teachers are encouraged to create their own as well!), preferably a projected version of the software so the entire class can look at a similar room together, and a copy of the attached worksheet for students to work off of.

## Student materials needed:

* The Puzzle Maker

* Student copies of the screenshots

* Student copies of the worksheet

***Note:  This lesson is best used with students who already have some familiarity with *Portal 2* or the Puzzle Maker already.  That way they have experience with the various assets and understand how a test chamber is supposed to work*****

## Lesson Plan:

Begin by having a discussion with students about the game itself.  Ask students, "What is the purpose of *Portal 2?"*  or "What are we trying to achieve within a test chamber?"  Hopefully students will answer with something to the effect of, "We are trying to pass each test chamber."  Or, "We are trying to make it from the entrance to the exit of each room."

Ask students, "Have some of the rooms you've solved been challenging?  If so, what makes them challenging?"  Listen to their responses and try to engage in dialogue about the various choices they have to make within each room about sequence, timing, reasoning about objects and how they are used etc.

Explain that up to this point, their greatest challenges have come from working within rooms, or even in deciding what to put in their own rooms so that their levels are solvable and fun. However, today they are going to start working with a totally different challenge.

Today they are going to explore the concept of a "broken room."  This is a room that has been designed by someone else but is flawed.  It's not solvable the way it is designed.  Therefore, they are going to need to do some investigating to figure out what is wrong and needs to be fixed to in order to make it playable.  However, we are going to make it THAT much more challenging.  We are going to give them certain constraints within each room.  It would be WAY too easy if we let them just change everything in the room to make it playable.  We are going to insist that perhaps they can't use any objects to change the room, or perhaps they can only change the structure of the room to make it playable and so-forth.  The great thing is there may be multiple solutions to the problems. The even greater thing is that fixing a broken room constructed by someone else is even more challenging than designing a room in the first place! It may be helpful to have a conversation with students about limits or constraints to make sure they understand those concepts prior to beginning the lesson.

Explain to students that we are going to start by doing the first one together. Ask a student to define the word “congruent.” Then explain that we are going to build rooms that have congruent shapes, sizes and, in essence, are the exact same room as one another. That is our first challenge.

At this point, have students login to their Puzzle Makers and project the following picture.

Ask students, “What do you notice about this room?” In their responses, make sure they delineate things like there are no portable surfaces, the dimensions of the room itself, 11 x 6, there are no objects in the room, the entrance door is on the very bottom, the exit door is on the very top.

Ask students to recreate the exact same chamber in their Puzzle Maker, and save it as Broken Room #0.

Once all students have created the room and saved it, have them build the room and try to play it. This is an exercise in futility, but have them articulate why. Why is the room broken?

Then, post the following constraints up on the board after they have explained why the room is broken. Tell them they need to "fix" the room in the editor but they cannot change the following things:

### Test Chamber 1

**Rules - Not allowed to:**

**Change portalable surfaces**
**Add Devices, Gels, Panels, Platforms, Switches, Faith Plates or Cubes. (Anything)**

Tell students it is vital that they don't say anything to one another as they work on this room. They all need to try to figure out how to solve the room on their own. Give them a few minutes to try. Once they think they have "fixed" the room, they should play the room to make sure they've got it.

When the majority of students think they have it, ask students to share first what they tried that *did not* work. For instance, students may have tried moving the walls around to build a staircase and then discovered they could not jump on top of it. Then, ask students to share what may have worked for them, for instance, moving the exit across from the entrance. If multiple solutions were found, ask students to judge whether or not those solutions fit the constraints given.

Make sure that students understand the premise behind the broken rooms. Then, pass out the following worksheet. Explain the rooms are in no particular order of difficulty and they may skip around if they chose. Emphasize that there is a great degree of personal satisfaction that comes from really trying to find a solution on one's own, but if they really get stuck, they can speak with a neighbor or ask for a hint. Also, remind them that sometimes with math problems, it is helpful to walk away from one room and then come back after a period of time with a fresh perspective. Also, draw their attention to the end of the packet where there are also some reflection questions they need to fill out.

It is important as students work through the challenges to continually engage in dialogue about their reasoning process, how they are making decisions and how they are learning what does and does not fix a room. Some teachers may choose to have students record their thoughts in a math journal of some sort or spend a few minutes at the end of class discussing these ideas.

One of the key components of this lesson is that we want students to engage in the gamer mentality…we want them coming back again and again and analyzing the problem from a different perspective in order to successfully solve each puzzle.

**Note: Additional pictures of the rooms, notes, and hints to go along with the room are included at the end of the lessons. Please make sure that all cube droppers placed in rooms are set so that a cube does not automatically fall upon entry into the test chamber.**

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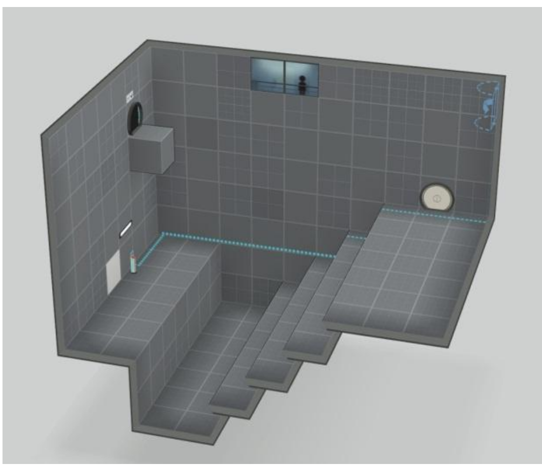
# The Broken Rooms

**The first step in all of the following puzzles is to recreate the room exactly as you see them. Pay attention to the dimensions of the space, the height and number of objects within the test chamber and the volumes of objects within the room.**

**Once the rooms are built, save them.**

**Then, look carefully at the constraints given for each room and experiment to find an effective way to make the test chamber solvable.**

## Test Chamber 1



**Front View**

**Side View**

## Constraints on Chamber 1

**Not allowed to:**

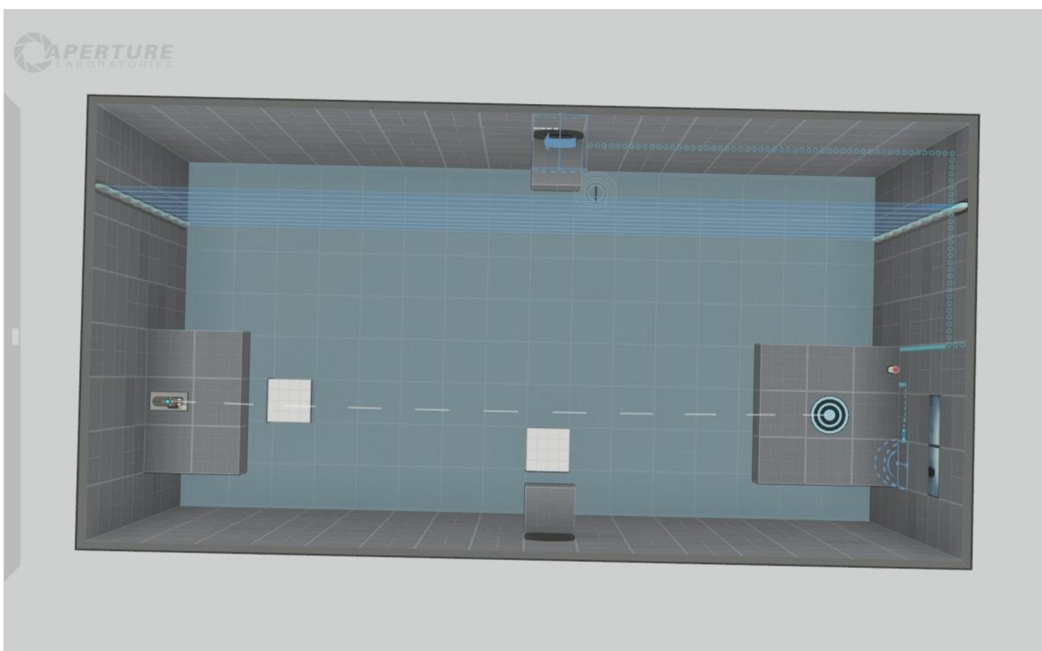
**change portalable surfaces**

**edit the walls**

**add devices, gels, panels, switches, faith plates or cubes**

## Test Chamber 2

Front-side view



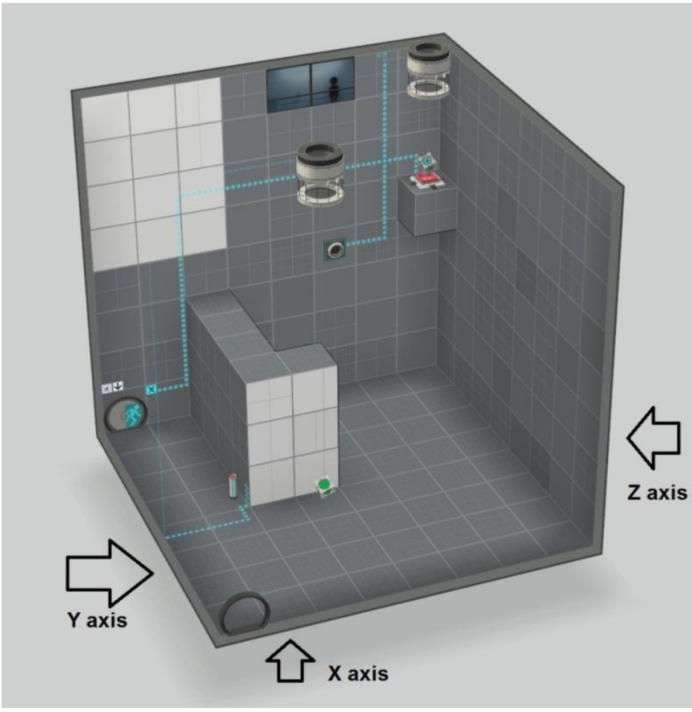
Top View

## Constraints on Chamber 2

**Not allowed to:**

**change portalable surfaces, edit walls or add anything from the asset panel**

**Test Chamber 3**




**Front View**

**Side View**

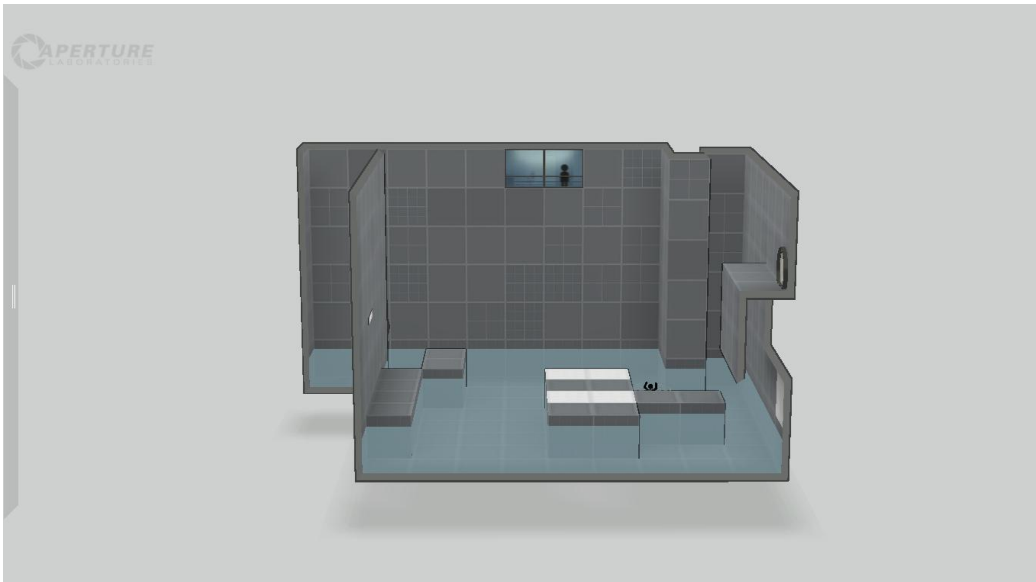
**Constraints on chamber 3**

**Only allowed to edit things within the following coordinates:**

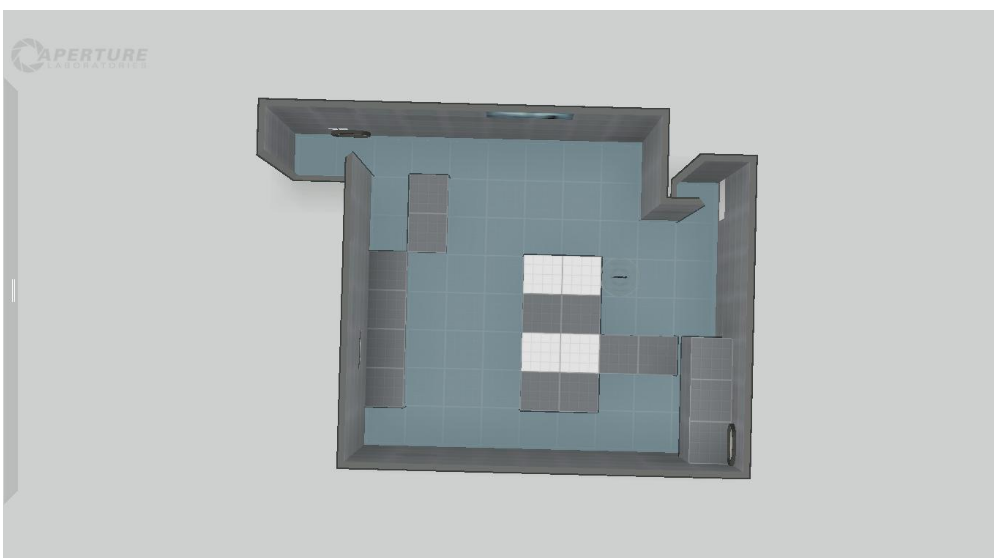
**3-D** OR **2-D**

| | |
|---|---|
| **(3x, 5y, 4z) to (3x, 8y, 4z)** | **(3x, 5y) to (3x, 8y)** |
| **(5x, 5y, 4z) to (5x, 8y, 4z)** | **(5x, 5y) to (3x, 8y)** |

**Test Chamber 4**



**Front View**



**Top View**

**Constraints for Chamber 4**

**Not allowed to:**

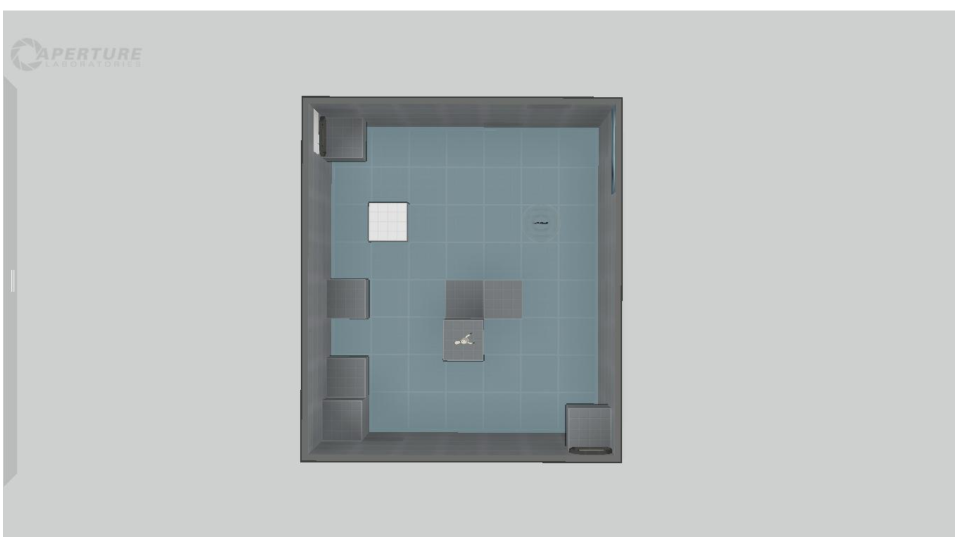
**Move walls or anything in room**

**Change portalable surfaces**

**Add buttons, cubes, faith plates, panels or platforms**

**Chamber 5**


**Front View**




**Top View**

**Constraints for Chamber 5**

**You may modify one wall only**

**You may only add one item to the room**

**You may not: change portalable surfaces, add any beams or panels**

## Final Chamber

**Now it is your turn to create a broken chamber. Design your room, take two screenshots, write up your list of constraints, and then find a partner who is willing to take on the challenge to solve your room.**

**Reflection Questions:**

**(1) Did you find any challenges when trying to recreate the rooms from the screenshots? If so, what were they?**

**(2) What is the difference between "a solution" and "the most efficient solution" for a room?**

**(3) Which room was most challenging for you and why?**

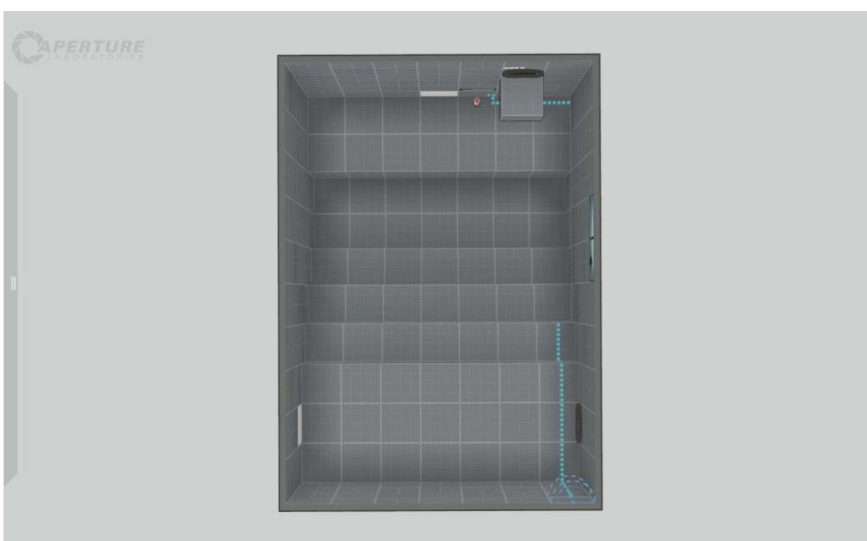
**(4) Which room was least challenging for you and why?**

## (5) How did you create your own "broken test chamber" and did the other person solve it as you expected?

**Additional pictures of rooms and notes.**

**Chamber 1**

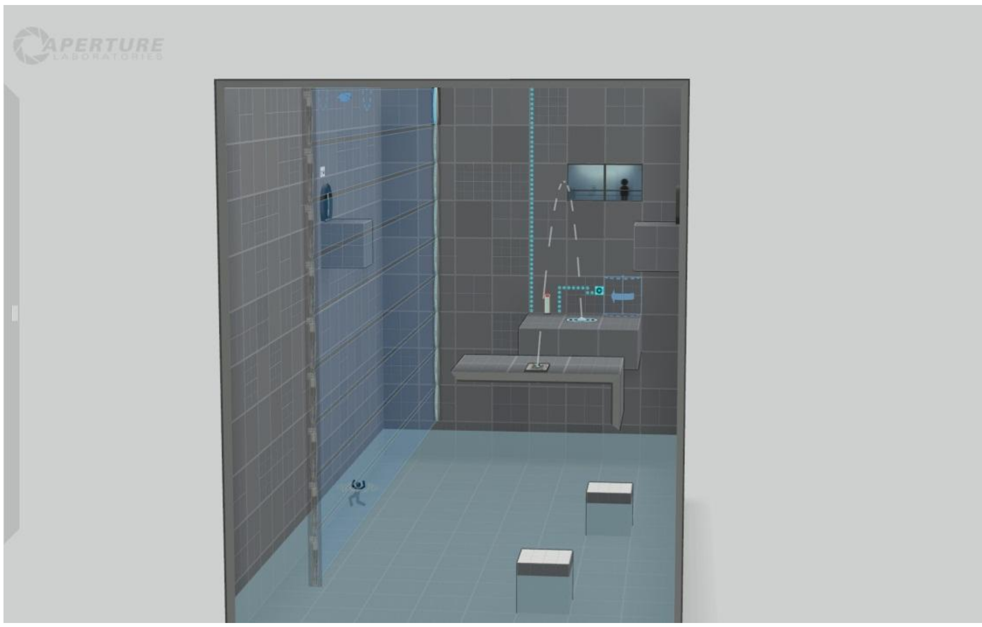
Notice, at the top right corner there is a flip panel.



Hints: There are multiple solutions to this room, some more efficient than others. Have students look at things that are allowed on the asset panel.

Solutions: tractor beams, platforms and track platforms can all be used to access the exit door

**Chamber 2**

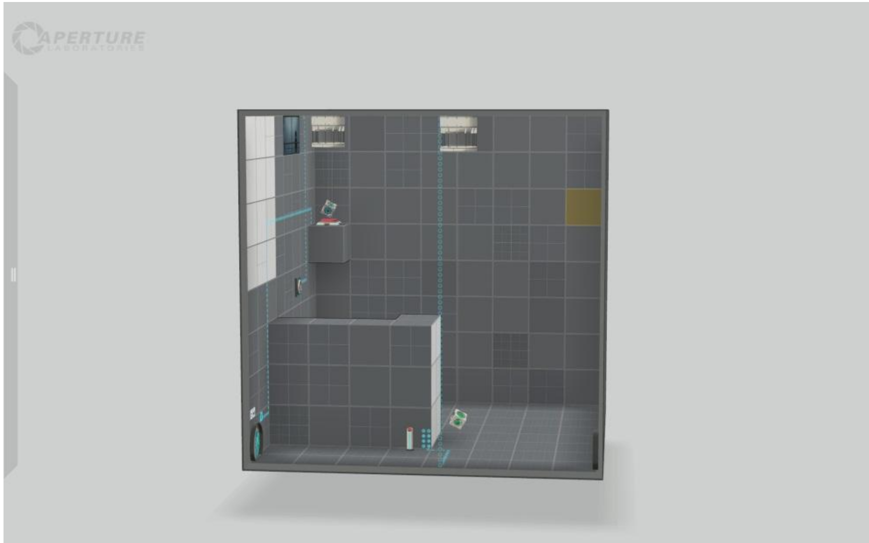


This can be a challenging room to replicate. Really have students explore the room like a 3-D graph…where are things actually located from the various perspectives? Note, they should be able to portal through the two portable surfaces to get to the aerial faithplate and across the goo.

Hint: They should be able to manipulate something already in the room.

Solution: The flip panel near the button just needs to be repositioned.

**Chamber 3**

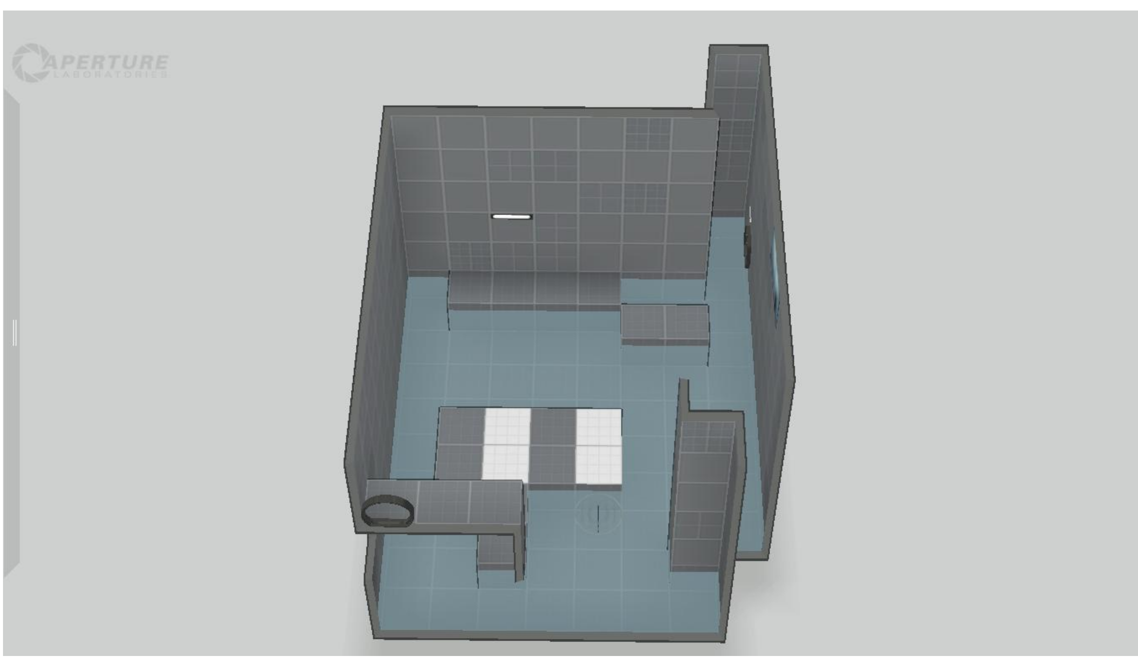


Hints: Make sure the cube droppers are set so that they don't automatically drop cubes down.

Also, there are extraneous items in the room that students don't actually need to use.

One possible solution: Fire a laser through the 3-D portion and use a cube to redirect it.

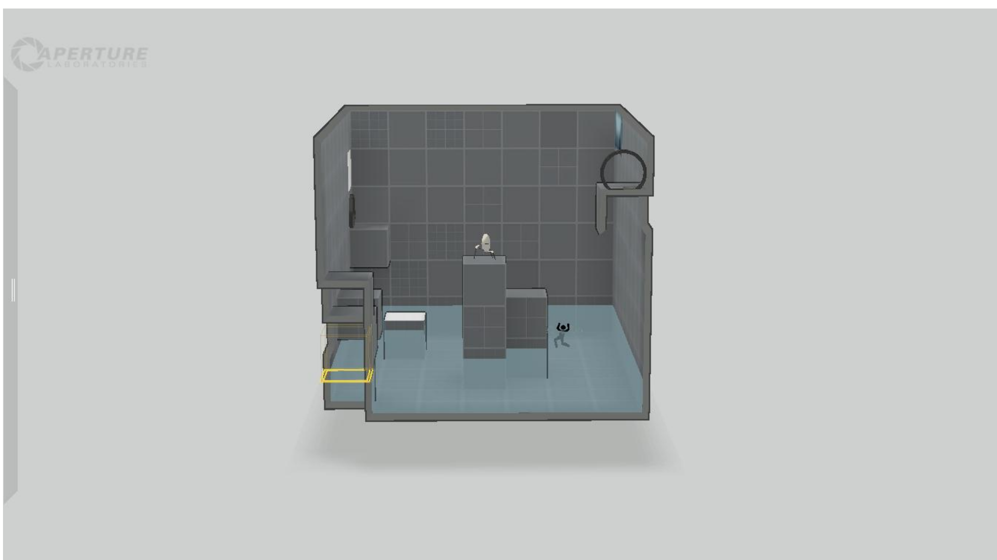
**Chamber 4**



Hint: This room requires the use of some assets we have not yet experienced in any of the other rooms thus far. Multiple types of the asset might need to be used. There are two separate areas that must be manipulated within this room.

One possible solution: Add propulsion and speed gels on the portable island in the middle of the room to get to the far side. Then, add a tractor beam running parallel to the exit.

**Chamber 5**



Hint: There is a tool from the asset panel that allows students to cover some ground, they should add that in one place. The room may need to be altered for that particular pathway to be effective.

One possible solution: Add an aerial faithplate from the entrance to the platform in the corner. The ceiling may need to be raised in order for the parabolic pathway to work properly.