Lesson Plan: Beast Architect's Lair Design Challenge

Materials Needed:

- Computer with internet access
- A free Tinkercad account (autodesk.com/tinkercad)
- Beast Academy Guide & Practice Book 5D, Chapter 12: 3D Solids
- Pencil and paper (or a digital notepad) for calculations
- Calculator (optional, for checking work)

---

1. Learning Objectives (The Goal)

By the end of this lesson, you will be able to:

- Calculate the volume of rectangular prisms and complex 3D shapes made from them (composite solids).
- Apply volume formulas to a creative design project.
- Design a multi-part 3D model in Tinkercad that meets specific mathematical requirements.
- Clearly explain and document the mathematical process behind your creative design.

2. Warm-Up: Volume Refresher (15 minutes)

Let's get our brains warmed up for 3D thinking!

1. **Review the Formulas:** Quickly read through the Beast Academy Guide 5D, Chapter 12 pages on volume. Pay special attention to the formula for the volume of a rectangular prism: **Volume = length × width × height**.
2. **Practice Problem:** On paper, solve Practice 12A, problem #4 from the Beast Academy book. This problem involves finding the volume of a composite solid (a shape made of multiple rectangular prisms). Think about the two main strategies:
   - **Addition:** Breaking the shape into smaller, simpler prisms and adding their volumes together.
   - **Subtraction:** Imagining a larger, complete block and subtracting the volume of the "missing" piece.
3. **Check Your Work:** Confirm your answer in the back of the book. If you got stuck, re-read the examples of the addition and subtraction methods. The goal is to feel confident with these two strategies.

3. Guided Exploration: Tinkercad Basics (20 minutes)

Now, let's move from the page to the digital world. We'll learn the essential tools for a Beast Architect.

1. **Log in to Tinkercad** and create a new "3D Design."
2. **Master the Basics:**
   - **Create a Shape:** Drag a "Box" from the right-hand menu onto the Workplane.
   - **Change Dimensions:** Click on the box. You'll see white and black squares (handles). Click a white corner handle to see the length and width dimensions appear. Click on a number and type a new value (e.g., change it to 40mm long and 30mm wide). The top center handle controls the height. Let's imagine 1mm in Tinkercad = 1 unit from our math problems.

- - **Calculate Volume:** If your box is 40mm x 30mm x 20mm, what is its volume in cubic mm? (*Answer: 40 * 30 * 20 = 24,000 cubic mm*).
    - **Combine Shapes:** Drag a second box onto the workplane and move it so it overlaps with the first. Select both shapes (drag a selection box over them) and click the "Group" button in the top-right menu. You've just created a composite solid!
    - **Create Holes:** Drag a "Hole" box (the striped one) and place it inside your solid shape. Select both and click "Group." You've just used the subtraction method to cut a piece out of your shape!
  3. **Experiment:** Spend a few minutes playing with these tools. Combine shapes, make holes, and change dimensions. Get comfortable building things.

4. Main Activity: The Beast Architect's Design Challenge (60-90 minutes)

Your Mission: The creatures from Beast Academy need a new custom lair, and you've been hired as the lead architect! Your task is to design a lair for a beast of your choice using Tinkercad. However, there are strict building codes you must follow.

The Building Codes (Project Requirements):

1. **Total Volume:** The final lair must have a total volume between **75,000 and 80,000 cubic units (mm³).** You must prove this with your calculations.
2. **Multiple Rooms/Sections:** The lair must be a composite solid, made of **at least 3 different rectangular prisms** joined together. (Think: a main hall, a sleeping area, and a tower).
3. **A Window or Tunnel:** The lair must include **at least one "hole"** created using the subtraction method. This could be a tunnel through a wall or a window.

Your Design Process:

1. **Step 1: Plan on Paper.** Before you build in Tinkercad, sketch a rough design for your lair. Label the different parts (e.g., "Main Hall," "Tower"). Assign target dimensions (length, width, height) to each part.
2. **Step 2: Calculate As You Go.** On your paper, create a "Beast Architect's Report." For each part of your lair, write down its dimensions and calculate its volume.
   Example Report Section:
   - **Main Hall:** 50 x 40 x 20 = 40,000 mm³
   - **Tower:** 20 x 20 x 50 = 20,000 mm³
   - **Entryway:** 15 x 20 x 15 = 4,500 mm³
   - **Sub-Total Volume:** 40,000 + 20,000 + 4,500 = 64,500 mm³
   - **Hole (Tunnel):** - (10 x 10 x 15) = -1,500 mm³
   - **Total Volume:** 64,500 - 1,500 = 63,000 mm³ (*Oops, too small! I need to adjust my design.*)
3. **Step 3: Build in Tinkercad.** Use your plan and calculations to build the lair in Tinkercad. Adjust the dimensions of your shapes digitally to match your plan. Group them together as you go.
4. **Step 4: Refine and Finalize.** This is a creative math puzzle! If your total volume is too high or too low, go back to your design. Do you need to make a wall taller? A room wider? A tunnel bigger? Keep adjusting your plan and your Tinkercad model until you meet the 75,000-80,000 cubic unit requirement.

5. Assessment & Wrap-Up (15 minutes)

To complete your project, present your findings. This is your chance to show off your brilliant design and your sharp math skills!

1. **Final Tinkercad Model:** Make sure your final design is grouped into a single object. Give it a creative name!

2. **Final Architect's Report:** Your paper (or digital doc) should be neat and show the final calculations for each part, the subtracted hole, and the final total volume that meets the requirement.
3. **Show and Tell:** Explain your design.
   - What beast is this lair for? What are the creative features?
   - Walk through your Architect's Report. How did you calculate the volume of each part?
   - What was the biggest challenge? How did you solve it? (e.g., "My first design was too small, so I increased the height of the main hall by 10 units, which added 10,000 cubic units to my total.")

6. Extension & Further Challenges (Optional)

Feeling like a master architect? Try one of these optional challenges:

- **The Paint Job:** Calculate the **surface area** of your lair. This would tell you how much paint you'd need. Research the formula for surface area and add this calculation to your report.
- **Complex Shapes:** Add a new room using a different shape, like a Cylinder or a Wedge. You'll have to research the volume formulas for these shapes!
- **Budget Constraints:** Imagine solid parts cost $2 per cubic unit and empty space (holes) costs $0. Give yourself a budget of $155,000 and try to get as close as you can without going over.