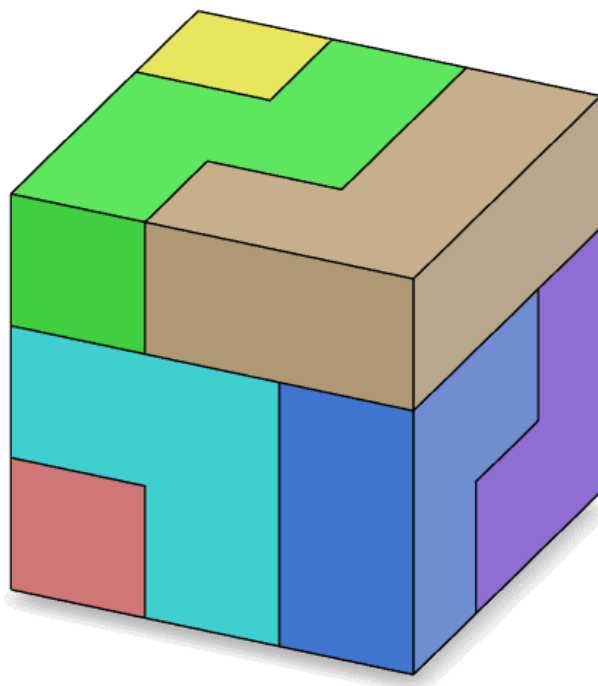


# DESIGN PROJECTS



## PUZZLE CUBE

**GRADE LEVEL**

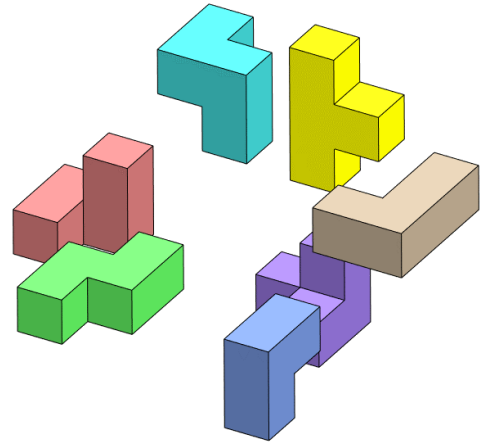
Grades 6–8

**MODELING TIME**

5-10 hours

# MATERIALS

- CAD software (SOLIDWORKS or xDesign)
- 3D printer with filament (Approximately 100g) or wood pieces for fabrication
- Sandpaper, file, or deburring tools
- Adhesive (optional)
- Graph paper (for initial sketches)



# DESIGN OBJECTIVES

- Cube to be 60x60x60mm
- Each side to be broken into 3 equal 20mm segments
- Cube must consist of at least 5 pieces

# DESCRIPTION

Students will design and build a puzzle that can be broken into several geometric shapes. They will focus on geometrical relationships and tolerances while learning about CAD and manufacturing techniques like 3D printing or woodworking.

# EDUCATIONAL CONCEPTS

## MATHEMATICS

- Calculating volume and surface area
- Measuring and understanding tolerances

## ENGINEERING PRINCIPLES

- Understanding material properties
- Exploring snug fits and interlocking mechanics

## TECHNOLOGY

- Using CAD software to model components
- 3D printing or manual cutting techniques

## CREATIVITY AND PROBLEM-SOLVING

- Designing a unique puzzle that challenges spatial reasoning

# HISTORY

Puzzle cubes are inspired by traditional dissection puzzles, which have been used for centuries to teach geometry and problem-solving. Modern versions, like the Soma cube invented in 1933 by Piet Hein, focus on mathematical and spatial challenges.

# LESSON TOPICS

## Phase 1: Brainstorming and Planning

- Think about the end goal: A cube made of interlocking pieces.
- Sketch out different configurations for how the pieces might fit.
- Each piece should occupy specific cubic units that can interlock with others.
- Decide on the number of pieces (e.g., 5–7 pieces) and whether they are symmetrical or irregular.

## Phase 2: CAD Modeling

- **Sketching**
  - Begin with a 2D sketch of a single puzzle piece on a CAD software plane.
  - Add extrusions to turn the 2D sketch into a 3D model.
- **Assembly Simulation:** Test how pieces will fit together virtually using assembly mates.
- **Tolerance Adjustments:** Include small gaps (e.g., 0.2 mm) for 3D printed parts to ensure snug fits without being too tight.

## Phase 3: Prototyping

- **3D Printing/Woodworking:** Print or cut each piece, ensuring dimensional accuracy.
- **Testing:** Assemble the pieces to confirm they fit and stay together. Identify areas needing refinement (e.g., oversized parts, loose fits).
- **Iterating:** Modify CAD designs based on testing feedback and remake as needed.

## Phase 4: Final Assembly and Presentation

- Refine pieces with sandpaper or files.
- Paint or decorate pieces for a polished look.
- Present the finished puzzle to the class, including the design process and challenges faced.

# DISCUSSION STARTERS

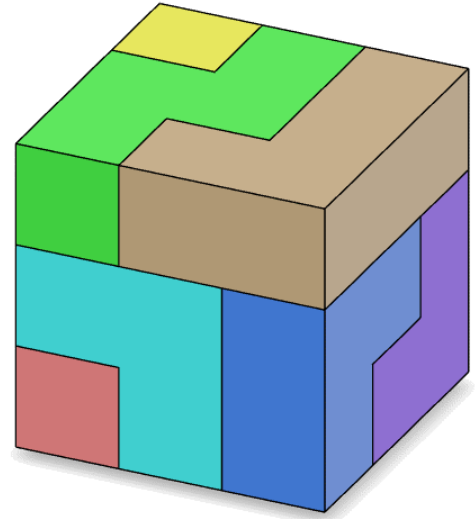
- How does changing the number or shape of pieces affect the difficulty level?
- What are some real-world applications of snug-fitting, interlocking designs (e.g., furniture, manufacturing)?
- How do tolerances vary between 3D printing and other manufacturing methods, and why?

## OPTIONAL CHALLENGES

**Group Activity:** Each team designs a single puzzle piece. Combine them to see if a unified cube can be made.

**Design Twist:** Incorporate negative space or hollow areas into pieces for added complexity.

**Speed Challenge:** Assemble the cube in the fastest time.



## ADVANCED OPTIONS

- **Incorporate Mechanisms:** Add moving parts or rotating components within the puzzle.
- **Algorithmic Design:** Use parametric modeling to create a puzzle that adjusts dimensions based on input values.
- **Design for Manufacturing:** Optimize parts for specific production methods like injection molding.

## ASSESSMENT CRITERIA

- Does the puzzle fit together?
- Do the pieces fit together snugly, but not too tight (appropriate tolerances)?
- Are the individual pieces unique (not just several cubes that stack)?
- Were the pieces sanded/painted/finished for presentation?

## ADDITIONAL RESOURCES

- [LINK TO DOCUMENTS](#)
- [LINK TO YOUTUBE VIDEO](#)
- [LINK TO STEP-BY-STEP](#)

# PUZZLE CUBE IDEAS

