**Case Study: Gaming Tournament Optimization**

**Scenario:**

A gaming tournament is organizing a battle royale competition where players can compete in two types of events: **Solo Matches (x1​)** and **Team Matches (x2​)**. The organizers want to minimize the total setup cost while ensuring enough matches are held to satisfy participant demand.

The cost per Solo Match setup is $4, and the cost per Team Match setup is $6.

The tournament is subject to the following constraints:

1. **Player Demand Constraint:**  
   Each Solo Match satisfies 2 units of player demand, and each Team Match satisfies 1 unit of demand. The tournament must satisfy at least 10 units of player demand.
2. **Arena Time Constraint:**  
   Each Solo Match takes 1 unit of arena time, and each Team Match takes 3 units of arena time. The total arena time allocated must be at least 12 units.
3. **Non-Negativity Constraint:**  
   The number of Solo Matches (x1​) and Team Matches (x2​) cannot be negative.

**Task for Students**

1. **Design the Constraints and Objective Function:**
   * Use the scenario above to derive the mathematical representation of constraints and the objective function.
   * Write the primal optimization problem.
2. **Solve the Problem Using Python:**
   * Use the provided Python template to solve the primal problem.
   * Verify that the solution meets the constraints and minimizes the cost.
3. **Explore Duality:**
   * Derive the dual problem from the primal.
   * Solve the dual problem using Python and interpret the shadow prices (y1​ and y2).