Standard POW write-up:

Aces: Aarushi, Raihan, Saketh

You are expected to address each of the categories listed below, unless otherwise directed.

1. Problem Statement: State the problem clearly in your own words. Your problem statement should be clear enough that someone unfamiliar with the problem could understand what it is that you are being asked to do.

In a two-player game, with player A having a 6 x 6 grid and player B having a 6 x 1 grid, player A goes first and puts letters A and B in the first row of their grid. Player B then puts a letter in the first box of their grid. This keeps going until both grids are fully filled. Player B's goal is to make sure their grid does not match any rows of letters in Player A's grid. Player A's goal is to make one of their rows match Player B's row.

The problem here is to figure out how, or even if, player A can attempt to win this game, and to figure out the strategies each player should use to win.

2. Process: Describe what you did in attempting to solve the problem, using your notes as a reminder. Include things that didn't work out or that seemed like a waste of time. Do this part of the write-up even if you didn't solve the problem. If you get assistance of any kind on the problem, you should indicate what the assistance was and how it helped you.

We started by playing the game a few times to understand how the game worked. After this, we tried exploring different strategies to make Player A win. For example, we tried one strategy where Player A would write the opposite of what they intended to "trick" Player B into writing what Player A originally wanted. However, strategies such as these didn't work out as well as we had imagined. So, we started thinking about why Player B will win every time.

3. Solution: State your solution as clearly as you can. Explain how you know that your solution is correct and complete. (If you obtained only a partial solution, give that. If you were able to generalize the problem, include your general results.) Your explanation should be written in a way that will be convincing to someone else— even someone who initially disagrees with your answer.

If Player B has a 6 x 1 grid and Player A has a 6 x 6 grid, there exists a strategy for the game where Player B will always win. On the nth turn, Player A puts 6 letters on the nth row of his grid. Whatever Player A puts on the nth column of this row, Player B must put the opposite: meaning, if Player A puts "A," Player B must put "B," and vice versa.

This strategy guarantees a win for Player B. On A's 6th turn, B can just put the opposite of A's 6th letter of that turn, meaning A must match B's grid before the 6th turn, having both [the first 5 letters of B's grid] A and [the first 5 letters of B's grid] B. However, whatever first M - letters A puts on turn n, player B could just put the opposite 5th letter. This means that by the 6th turn, player A must have all four combinations of 5th and 6th letters so that B doesn't just negate them. This is impossible of course, since A would have to get the first four letters correct on or before the third turn, while B could just put the opposite third and fourth letters. There aren't enough turns to put all 4 combinations of third and fourth letters down on or before the third turn, meaning B must always win.

4. Extensions: Invent some extensions or variations to the problem. That is, write down some related problems. They can be easier, harder, or about the same level of difficulty as the original problem. (You don't have to solve these additional problems.)

1. **Have Player B write a letter down first while using the same overall model for the grids.**
   - **This would guarantee Player A's win, as they would be able to know all the letters that Player B was writing down ahead of time.**
2. **Adding another row to Player A, and another box to Player B.**
   - **Player B's win would still be guaranteed. On an M x M grid, Player B can just put the opposite of the Mth letter that Player A puts on the last turn. Thus Player A must have all combinations of last two letters by the $(M - 1)^{th}$ turn, while still getting the first (M – 1) letters correct both times. This pattern continues, where Player A must get some letters correct before B even enters this letter, making this game impossible to win for A.**
3. **Give Player A two turns for each turn that Player B gets, and player A has 12 rows instead of 6.**

- **Player A would be able to win. On the last turn Player A can just put [the first 5 letters of B's grid] A and [the first 5 letters of B's grid] B, trapping player B to guarantee a win.**

4. **Having Players A and B unable to see each other's whiteboards, likely increasing the chances of player A winning, but leaving it mostly up to luck.**
   - **This game could go either way. A's grids are independent of B's grids. There are 2^6, or 64 possible boards for B's grid. Player A has 6 chances to guess it. The chances of him NOT guessing it will be**

   (1 – 1/64) * (1 – 1/63) * (1 – 1/62) * (1 – 1/61) * (1 – 1/60) * (1 – 1/59)

     since he eliminates one possible grid each turn. This gives Player A a 9.375% chance of winning. Although this is an unfair game, it's still better than a guaranteed loss.

5. **Have Player A and Player B use colors instead of numbers. The colors are Red, Orange, Yellow, Green, Blue, and Violet. Player A has 6 rows, and Player B has one row, and they cannot see each other's boards. Player B puts down their row and Player A guesses the configuration by putting a row of colors down. Player B tells Player A if any colors are in the correct positions, and Player A puts another row of colors down. This continues until all 6 rows are filled up. Player A wins if they correctly guess the original row of colors put down, Player B wins if Player A is not able to guess the colors that they put down.**
   - **This game is partially chance and partially strategy, with a fair chance for either player to win.**