**NIM Winning Strategy**

Fill in the blanks below so that you have a winning strategy for Nim.

1. Assume you start with **12 sticks** and the other person takes a turn.
   1. If the person took 1 stick, then take \_\_\_\_\_\_ sticks
   2. If the person took 2 sticks, then take \_\_\_\_\_ sticks
   3. If the person took 3 sticks, then take \_\_\_\_\_ stick
2. Now there are \_\_\_\_\_ sticks. The other person takes a turn.
   1. If the person took 1 stick, then take \_\_\_\_\_\_ sticks
   2. If the person took 2 sticks, then take \_\_\_\_\_\_ sticks
   3. If the person took 3 sticks, then take \_\_\_\_\_\_ stick
3. Now there are 4 sticks. The other person takes a turn.
   1. If the person took 1 stick, then take \_\_\_\_\_\_ sticks
   2. If the person took 2 sticks, then take \_\_\_\_\_ sticks
   3. If the person took 3 sticks, then take \_\_\_\_\_\_ stick
4. Now there are no sticks left!

Part 2. Wow, that was too many blanks. See if you can follow the shorter instructions below. Assume you start again with **12 sticks**.

1. Your opponent takes SOME\_NUMBER of sticks.

2. Fill in the blank with a number: You take \_\_\_\_\_\_ - SOME\_NUMBER of sticks.

3. If there are no sticks remaining, you have won! Stop.

4. Go to step 1

Part 3. What if the game is played with some number of sticks that is *not* a multiple of 4. Could you follow the instructions below to win the game? Assume you are the first player.

1. The pile contains NUMBER\_OF\_STICKS

2. Divide NUMBER\_OF\_STICKS by 4. Determine the REMAINDER.

3. Take REMAINDER sticks.

4. Now you can win the game!

a. How many sticks would you need to take if the game starts with 13 sticks? \_\_\_\_\_\_\_\_

b. How many sticks would you need to take if the game starts with 19 sticks? \_\_\_\_\_\_\_\_