

## Nim: A Two Person Game

### Rules:

- 1) Start with three piles of objects with any amount in each pile.

Example:

Pile A 0

Pile B 000

Pile C 00000

- 2) Determine a starting player.
- 3) Alternate turns and on your turn remove as many objects as you want (but at least one) from only one of the remaining piles.
- 4) Whoever takes the last object wins.
- 5) When you teach it, play several games with you always winning until they have the desire to win. (like I did in class)

How to Win

(over)

To win you need to understand bases.

- 1) We use decimal or base 10 commonly in everyday life.

2345 means Two Thousand Three Hundred and Forty Five because its base 10

$$\begin{array}{cccc} 10^3 & 10^2 & 10^1 & 10^0 \\ x & x & x & x \\ 2 & 3 & 4 & 5 \end{array}$$

- 2) Base 10 can only use digits 0-9.

Base 8 can only use digits 0-7 (No 8's or higher)

Base 4 can only use digits 0-3

352 is not a base 4 number because of the 5. 352 is base 6 or higher base.

$$\begin{aligned} \text{Example: } 352 \text{ base } 8 &= 2(8^0) + 5(8^1) + 3(8^2) \\ &= 2(1) + 5(8) + 3(64) \\ &= 234 \end{aligned}$$

So we see 352 base 8 equals 234 base 10.

- 3) For NIM you use Base 2 so only 0's and 1's.

| Base 10 | Base 2 |
|---------|--------|
| 1       | 1      |
| 2       | 10     |
| 3       | 11     |
| 4       | 100    |
| 5       | 101    |
| 6       | 110    |
| 7       | 111    |
| 8       | 1000   |
| 9       | 1001   |
| 10      | 1010   |

Change each pile to base 2 right justified and make sure after you make your move you leave the sum of the columns even.

Example: Separate in your head. Fill 4 first if you have 4, then 2 next if you have 2, and 1 if you have 1.

| Pile   | Contents in piles |                |                | Starting Columns<br>Base 2 | After move<br>(even columns) |
|--------|-------------------|----------------|----------------|----------------------------|------------------------------|
|        | Holds 4 max       | Can hold 2 max | Can hold 1 max |                            |                              |
| Pile A |                   |                | ●              | 1                          | 1                            |
| Pile B |                   | ● ●            | ●              | 1 1                        | 1 1                          |
| Pile C | ● ●<br>● ●        |                | ●              | 1 0 1                      | 1 0                          |

We can see taking 3 out of Pile C is the winning move for this example. If you do so, your opponent cannot keep columns even and a pattern will develop. If two piles are left, take your turn to make them the same amount.

Example: If there two piles with 5 left and 7 left, take 2 from the pile of 7 to leave two piles of 5.

If leaving 1, 2, 3 was a winning move, it will always be a winning move.

Practice – Choose a winning move for each game setup.

| Game Setup | Game 1 | Game 2 | Game 3 |
|------------|--------|--------|--------|
| Pile A     | 3      | 4      | 5      |
| Pile B     | 4      | 5      | 6      |
| Pile C     | 5      | 6      | 7      |

Name \_\_\_\_\_

Comment\_\_\_\_\_

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Name \_\_\_\_\_

Comment\_\_\_\_\_

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