Considering the Connect-4 puzzle shown above, answer the following questions.

1. (1 Mark) How many states did Minimax and Alpha-Beta expand for the starting position provided above?

```
OK
guoshuqi@BiscuitdeMacBook-Air a3 guo 366 % /usr/local/bin/python3.9 "/Users/guoshuqi/Documents/a3 guo 366/testminimax.py"
current state: 0
states expaned by minimax: 17607
.....................
----------------------------------------------------------------------
Ran 21 tests in 1.291s
```

```
guoshuqi@BiscuitdeMacBook-Air a3 guo 366 % /usr/local/bin/python3.9 "/Users/guoshuqi/Documents/a3 guo 366/testalphabeta.py"
************************************
The states that alpha_beta expanded: 1414
************************************
.....................
----------------------------------------------------------------------
Ran 21 tests in 0.114s

OK
```

The state that Minimax expanded is 17607.
The state that alpha-beta expanded is 1414.

2. (1.5 Mark) How can player 'O' win the game from a state such as the one shown above? Note that this is a "how" question.

				O		X
			O	X		O
			O	X		O
X			X	O		X

If X plays sub-optimally, O can possible win the game.

Now we assume the column from left to right and number 0-6.

e.g. If X play col 2, O can play on col 2, then X can play in

any column between 2-6, so O can win by play in col and connect diagonally across cols 1-4.

Also, if X plays optimally, that is hard for O to win the game.

3. (1.5 Mark) Is it possible for Minimax and Alpha-Beta to expand the same number of nodes? Explain why not, or under which conditions this is possible.

Yes. it is possible.

∵ Alpha-beta needs to expand node, all possible moves need to be evaluated to determine which one is best for the player. But in some cases, alpha-beta can't chose the branch. Eg. when in a very small depth, or at the beginning of the game. only a very small number of moves can be used to win.