1. Hex. (i) Draws are not possible. For any positive integer $n$, prove that the empty $n \times n$ board is an $N$-position.

   (ii) Prove that each of these is an $L$-position (so bLack wins as first player and as second player).

```
   B            B B              B B B
W . . W      W . . . W        W  . . . . W
   B          W . . . W        W  . . . . W
                B B             W  . . . . W
                                    B B B
```

2. For each game, for each outcome class $L, R, N, P$, give a position in that class, or explain why there is none:

   nim. hackenbush. green hackenbush. domineering. cram.

   2x2 hex (define any hex position in which any player has already won as a $P$-position).

   2x2 go, komi 1/2. (final net score is black stones+territory − (0.5 + white stones+territory).)

3. Go. are these x-groups unconditionally safe? safe under alternating play? explain.

```
x . x
x . x
```

4. Describe the game $\{ \mid 0, -1 \}$ using only these symbols: { } | ,

5. Draw a 4-cell domineering position whose game notation is $\{ \mid 0, -1 \}$ .

6. For every domineering position with at most 4 cells, give the game notation and draw the game tree.

7. Below is the sum table for the classes $P, L, R, N$. Prove that each entry is correct.

   E.g. for row $P$ and column $L$, you need to prove that if $G$ is a $P$-position and $H$ is an $L$-position, then $G + H$ is an $L$-position. ? means that every outcome class is possible, so for row $L$ and column $R$ you need to do this: prove that if $G$ is an $L$-position and $H$ is an $R$-position, then $G + H$ can be in any of the four classes (so give examples for $G, H$ for each case). $L/N$ means $L$ or $N$.

| | P | L | R | N |
|---|---|---|---|---|
| P | P | L | R | N |
| L | | L | ? | L/N |
| R | | | R | R/N |
| N | | | | ? |