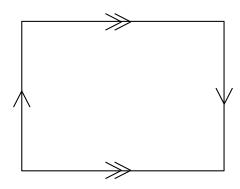# Math Circle - Spring 2012 - Homework 4

A *Klein bottle* can be represented with the following rectangle diagram:

1. (10 points) X goes first in tic-tac-toe on a Klein bottle. Does either **X** or **O** have a winning strategy?

2. (5+5 points) (a) What shape do you get if you cut the Klein bottle above in half along a horizontal line through the middle?
(b) What about if you cut it along a vertical line through the middle?

3. (10 points) Can you draw the following graph on a torus so that none of the edges cross (except at the blue vertices)?