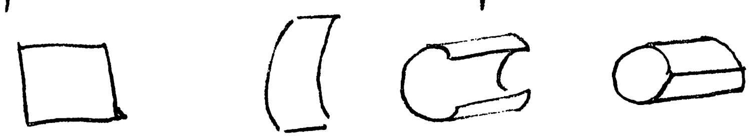
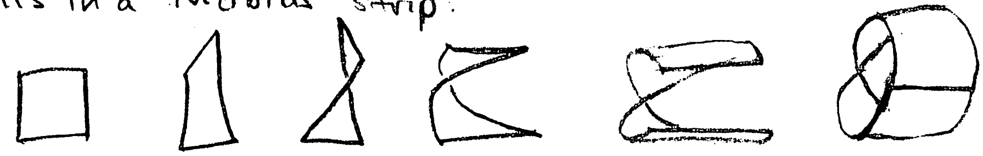
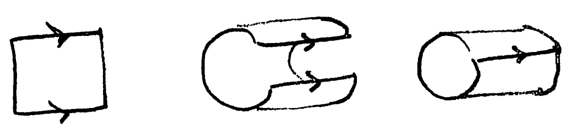
Topology is the branch of mathematics that deals with the shapes of objects made from a flexible, stretchable imaginary material. Topologists often deal with interesting surfaces formed by stretching a square and gluing some of its edges together. For example, here is how to form a cylinder with no end caps:



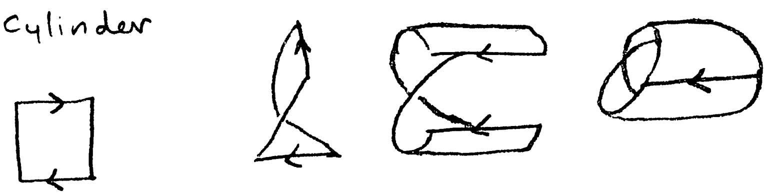
You can also twist the square as you stretch it, which results in a Möbius strip:



Since these figures can be very difficult to draw, topologists sometimes stick to flat pictures, and use arrows to indicate how the edges of the square should be glued together:



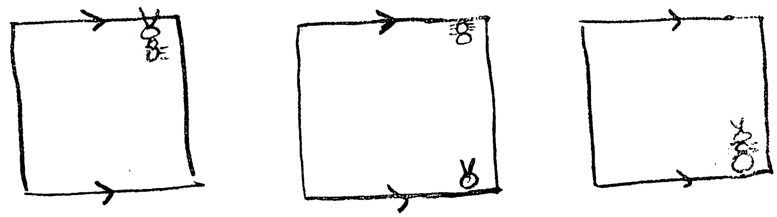
Cylinder



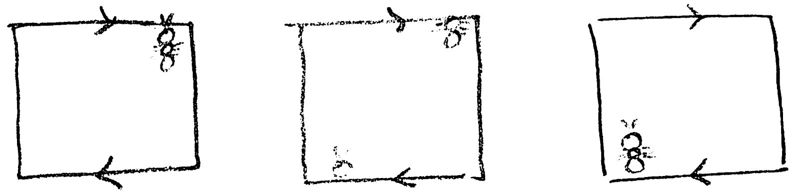
Möbius strip

When you glue the edges together, the arrows have to line up, so you may have to twist the square as you stretch it.

Another way to think of the arrows is by imagining an ant walking across the surface. When it comes to one edge, it magically steps to the other edge. The arrows indicate where it comes out.



Cylinder



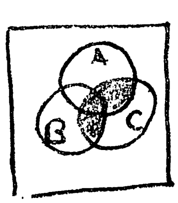
Möbius strip.

You can form other surfaces by gluing two pairs of edges together. Single arrows indicate one pair, double arrows indicate the other:

Torus (surface of a doughnut)

The problems that follow are about Venn diagrams on surfaces constructed like this. Each diagram indicates several regions, all with smooth boundaries and all contiguous. Some of the regions are labeled A, B, C, etc. Your job is to shade the parts of the figure that correspond to the set indicated for the figure. The winner will be selected at random from the most correct entries – so you might win even if you don't know how to do all the problems. Good luck!

Ex

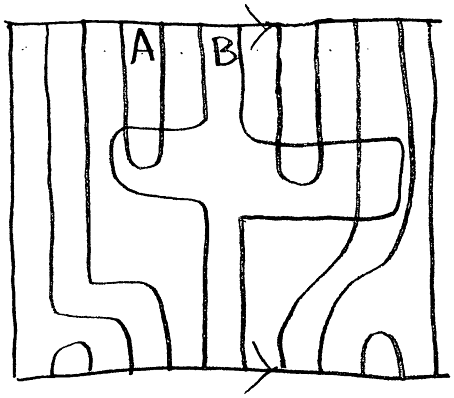


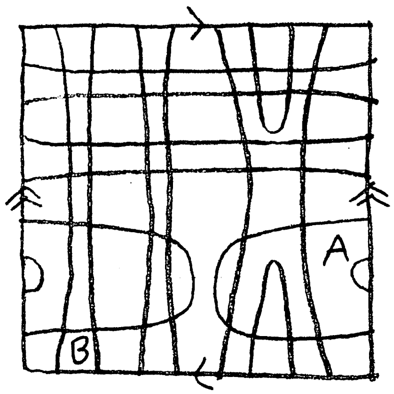
$(A \cup B) \cap C$

$\cup$ means union

$\cap$ means intersection

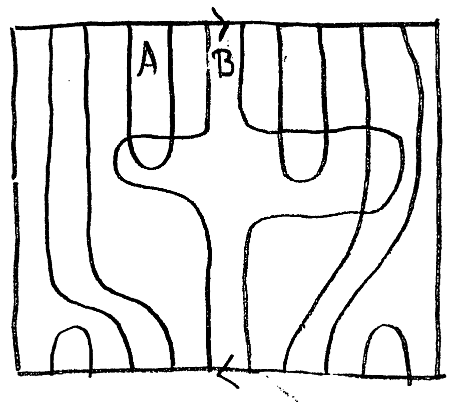
$A \cap B$

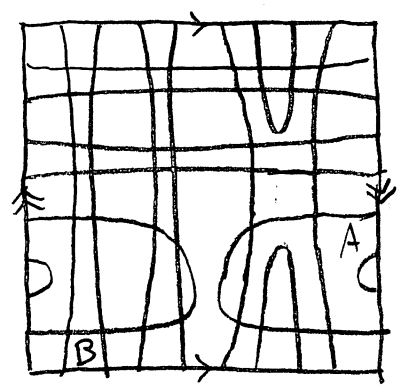




$A \cap B$

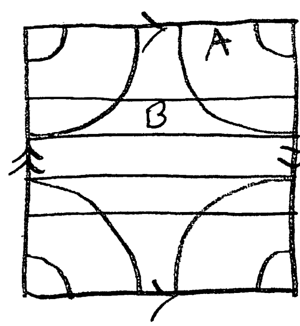
$A \cap B$



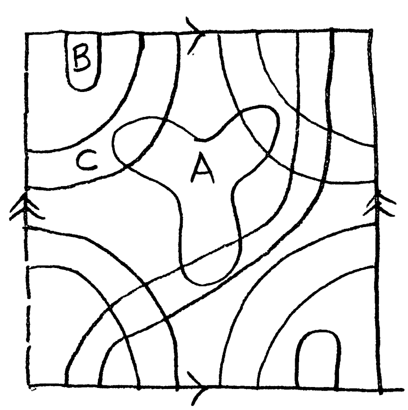


$A \cap B$

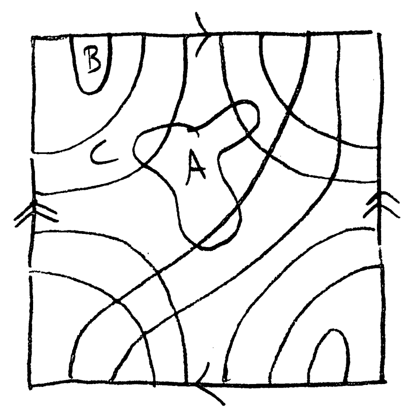
$A \cap B$



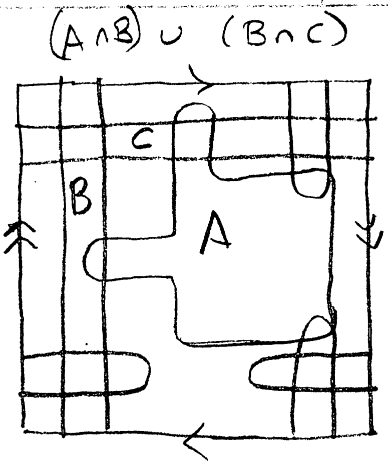
Careful! Some of these diagrams are the same except for the arrows on the edges!

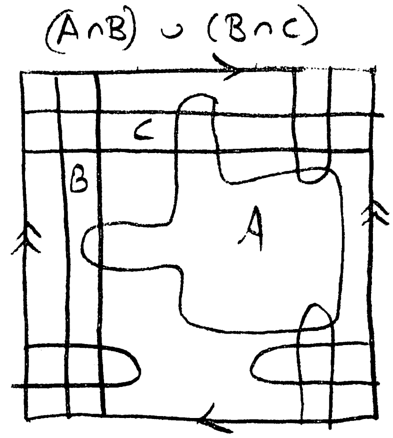


$B \cup (C \cap A)$



$B \cup (C \cap A)$





These are slight variations: By excluding the corners, the stretching and gluing of the edges yields a surface with handles