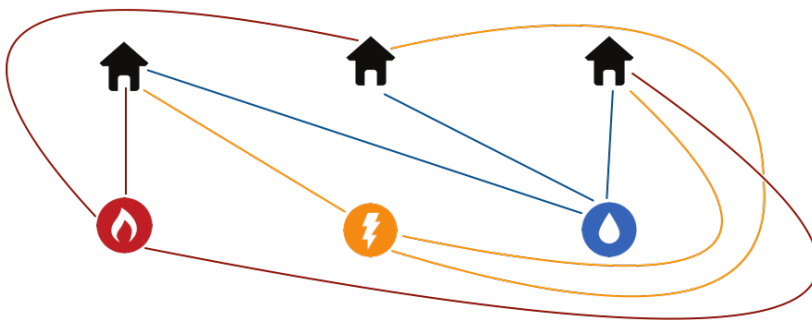




# MUG SOLUTIONS

**Utilities Puzzle ( $K_{3,3}$ ):** The Utilities Puzzle cannot be solved on a flat surface – the graph  $K_{3,3}$  is non-planar.

- 1) Below is almost a solution. Circle where the edges cross over.

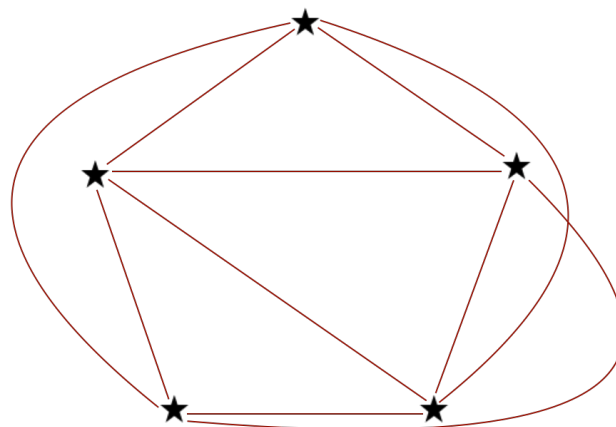


At the crossing point, if the edge that is on top could go over a 'bridge', and the edge underneath go under the 'bridge', this would solve the problem. For this reason, the Utilities Puzzle can be solved on mug, where the handle acts as the bridge.

- 2) Can you use the almost-solution above to help you solve it on a mug?

**$K_5$  Puzzle:** The  $K_5$  Puzzle cannot be solved on flat paper - the graph  $K_5$  is non-planar.

- 1) Below is almost a solution. Circle where the edges cross over.



- 2) The  $K_5$  puzzle can be solved on the surface of a mug. Can you work out how to do it?