

1. Draw a series of pictures (stages of a deformation) to prove that a punctured torus (a torus with a small open disk removed) is isotopic to the surface drawn in part (a) below (you may find this difficult). Then give an argument to prove that a punctured torus is not homeomorphic to the surface drawn in part (b) below.



(a)

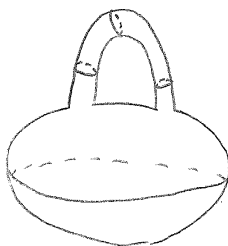


(b)

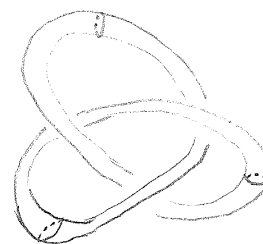
2. (i) Separate the following surfaces into groups such that two surfaces are in the same group iff they are homeomorphic. Give arguments or draw pictures to explain why any two surfaces are or are not homeomorphic.
- (ii) Separate the following surfaces into groups such that two surfaces are in the same group iff they are isotopic. Give arguments or draw pictures to explain why any two surfaces are or are not isotopic.



(a)



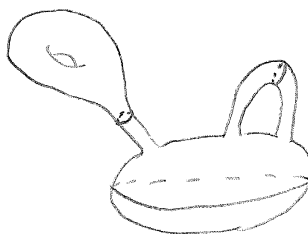
(b)



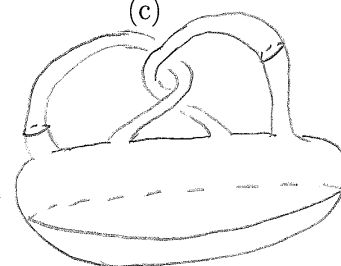
(c)



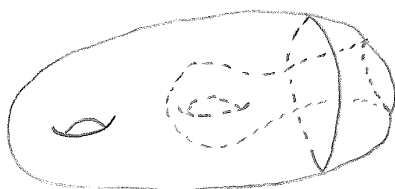
(d)



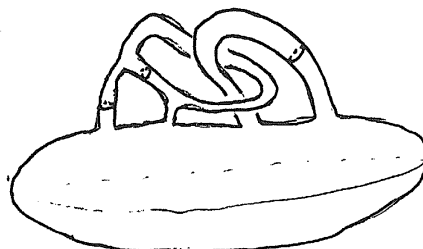
(e)



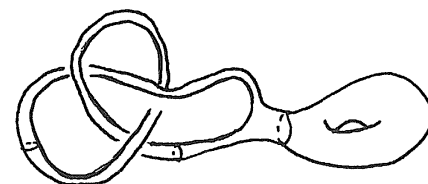
(f)



(g)



(h)



(i)

3. Prove the following theorem:  $S^1$  cannot be embedded in  $\mathbb{R}$ .