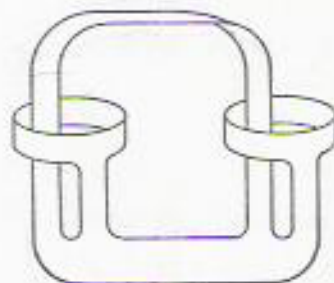


Question 9

Redraw each of the following surfaces in a simpler form, labelling clearly any cutting and glueing operations. Hence write down χ and β for each surface, and whether or not each is orientable.

- (i) (thin paper)



[6]

- (ii) (tubular)



[5]

Question 10

- (i) Write down the conditions that a closed surface, subdivided into F heptagons (7-sided polygons), has k faces meeting at each vertex. (The number of edges and vertices are E and V respectively.) [3]
- (ii) Show that no surface of Euler characteristic $\chi = -2$ can be subdivided as in (i) if $k = 8$. [4]
- (iii) Show that no surface of Euler characteristic $\chi = -2$ can be subdivided as in (i) unless $k = 3$, $F = 12$. [4]

Question 11

Reduce each of the following systems of edge equations to canonical form. Justify your working. Hence calculate χ and β for the surfaces they represent.

- (i) $ab = 1; bc = 1; cd = 1$. [3]
- (ii) $abacbdcd = 1$. [4]
- (iii) $aba^{-1}b^{-1}cc = 1$. [4]