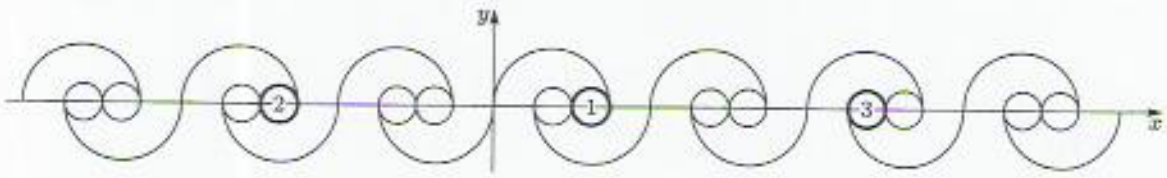
Question 3 (*Unit IB3*)

This question concerns the following two frieze patterns:

$\mathcal{F}_1$

$\mathcal{F}_2$

The question also concerns the three circular parts of each pattern drawn in bold and labelled 1, 2 and 3 in the diagram below. (This diagram also indicates x- and y-axes — note that these axes are *not* part of the frieze patterns.)



$\mathcal{F}_1$

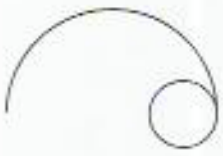
$\mathcal{F}_2$

(a) For each pattern, give a geometric description of the symmetry of the pattern that maps circle 1 to circle 2, and of that which maps circle 1 to circle 3. [6]

(b) (i) Use the algorithm given in Section 4 of *Unit IB3* to determine the type of each pattern. State clearly how you have used each step that applies. [9]

(ii) Express each of the four symmetries that you found in part (a) in the standard form for its pattern type as identified in part (b)(i). In each case, take as origin the intersection of the x- and y-axes indicated. [5]

(c) Patterns 1 and 2 are created from the basic shape, consisting of a semicircle and a circle, shown below.



Both patterns can be fitted in a frieze whose height is the diameter of the larger circle. Trace this shape and, without increasing the frieze height, create frieze patterns of *two* types other than those you have identified in part (b)(i), using copies of this shape. Sketch and identify these frieze patterns. [5]