Question 4 (*Unit GE2*)

Parts (a) to (e) of this question are concerned with tiling IH3, a portion of which is depicted on Side 1 of Tiling Card 10. (A smaller portion is depicted on Side 1 of Tiling Card 5, where the incidence symbol is given.) We shall denote this tiling by $\mathcal{T}$.

(a) Write down the number $n_t(\mathcal{T})$ of translational tile orbits. 2 [1]

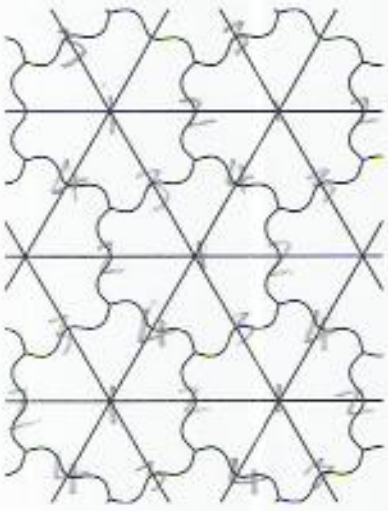
(b) Use an appropriate theorem in Section 3 of *Unit GE2* to calculate $n_e(\mathcal{T})$. 6 [3]

(c) On the *first* of the two magnified portions of $\mathcal{T}$ on the back of this booklet, indicate the translational tile and edge orbits. (That is, place circled numbers at the centres of tiles to distinguish translational tile orbits, and uncircled numbers alongside the edges to distinguish translational edge orbits.) [5]

(d) Draw the tile–edge diagram for $\mathcal{T}$. [4]

(e) Construct the edge side orbits of $\mathcal{T}$ under the action of the *full* symmetry group $\Gamma(\mathcal{T})$, using the *second* of the two magnified portions of $\mathcal{T}$ on the back page of this booklet. ('Edge side orbits' are discussed in Subsection 5.1 of *Unit GE2*.) [4]

(f) Let $\mathcal{S}$ be the tiling IH30, depicted below, which has six translational tile orbits. Use an appropriate theorem in Section 3 of *Unit GE2* to calculate $n_v(\mathcal{S})$. [3]



4 4 6

$6\left(\frac{1}{4}+\frac{1}{4}+\frac{1}{6}\right)$

(g) A periodic tiling $\mathcal{U}$ has one translational tile orbit of tile type $[3,4,3,4,3,4,3,4]$ and four of tile type $[3,4,3,4]$. Determine $n_v(\mathcal{U})$. (You will find it helpful to refer to the *proof* of one of the theorems in Section 3 of *Unit GE2*.) [5]

$\left(\frac{4}{3}+1\right)+4\left(\frac{2}{3}+\frac{1}{2}\right)=\frac{7}{3}+\frac{14}{3}=7$

$\left(\frac{4}{3}+1\right)+4\left(\frac{2}{3}+\frac{1}{2}\right)$