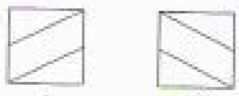
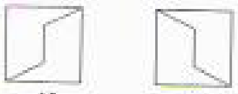
Question 4 (*Unit GE2*)

In Question 1 of TMA 01, we constructed a tiling $\mathcal{T}_1$ by alternately subdividing the squares of $\mathcal{R}_4$ as A and B:



A $\qquad$ B

A transitive tiling $\mathcal{T}$ can be obtained in a similar manner by modifying A to A^* and B to B^*, where these new subdivisions are as follows:



A^* $\qquad$ B^*

Two magnified portions of $\mathcal{T}$ are drawn on the back of this booklet.

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

(b) Calculate $n_e(\mathcal{T})$ with the help of an appropriate theorem from Section 3 of *Unit GE2*. [2]

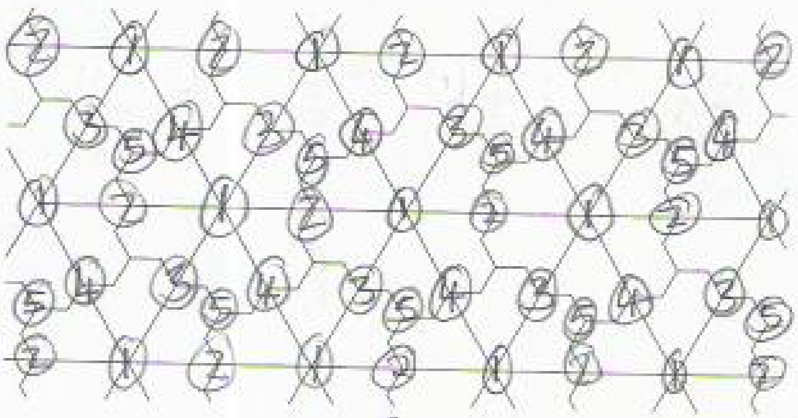
(c) Using the *first* portion of $\mathcal{T}$ on the back of this booklet, write *circled* numbers at the centres of the tiles to distinguish translational tile orbits, and *uncircled* numbers alongside the edges to distinguish translational edge orbits of $\mathcal{T}$. [5]

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

(e) Section 5.1 of *Unit GE2* discusses 'edge side orbits'.

Using the *second* portion of $\mathcal{T}$ on the back of this booklet, construct the edge side orbits of $\mathcal{T}$ under the action of the *full* symmetry group of $\mathcal{T}$. [5]

(f) Let $\mathcal{S}$ be the transitive tiling depicted below, which has six translational tile orbits.



$\mathcal{S}$

Use an appropriate theorem from Section 3 of *Unit GE2* to calculate $n_v(\mathcal{S})$. [3]

(g) The tiling $\mathcal{T}_1$ of Question 1 of TMA 01 has six translational tile orbits (three corresponding to each of the subdivisions A and B). Two of these tile orbits correspond to one of the tile types found there, and the other four to the other. Use the *proof* of Theorem 3.2 of *Unit GE2*, together with the information on tile types from your answer to TMA 01, to determine $n_v(\mathcal{T}_1)$. [5]

(REMEMBER TO DETACH OR PHOTOCOPY THE BACK PAGE OF THIS BOOKLET AND SUBMIT IT WITH YOUR ASSIGNMENT.)