The following are wallpaper patterns. On each one, indicate the following with colored ink:

- Shortest translations, \( \tau_v \) and \( \tau_w \), in two different directions, that preserve the pattern and form the boundary of a fundamental region \( R \) for \( T \).
- All \( n \)-centers for each possible \( n \).
- All lines of symmetry.
- If there are glide reflections but no reflections, give the axes for the glide reflections.
- A fundamental region, \( R \), for \( T \). If \( W \) is a \( W_3 \)-group that contains lines of symmetry, base it at a 3-center on a line of symmetry. Otherwise base it at an \( n \)-center for the largest possible \( n \).
- A fundamental region, \( S \) for \( W \).

1. (a) How many \( T \)-orbits are there of \( n \)-centers for each possible \( n \) and what is their isotropy?
   (b) Which wallpaper group is \( W \)?
2. (a) How many $\mathcal{T}$-orbits are there of $n$-centers for each possible $n$ and what is their isotropy?
(b) Which wallpaper group is $W$?

3. (a) How many $\mathcal{T}$-orbits are there of $n$-centers for each possible $n$ and what is their isotropy?
(b) Which wallpaper group is $W$?
4. (a) How many $T$-orbits are there of $n$-centers for each possible $n$ and what is their isotropy?
(b) Which wallpaper group is $W$?

5. (a) How many $T$-orbits are there of $n$-centers for each possible $n$ and what is their isotropy?
(b) Which wallpaper group is $W$?
6. Extra credit:
   (a) Describe the orbit space for Problem 2 in terms of identifications made on $S$. Draw the picture and indicate the identifications with arrow heads and also describe the orbit space in words.

   (b) Describe the orbit space for Problem 3 in terms of identifications made on $S$. Draw the picture and indicate the identifications with arrow heads and also describe the orbit space in words.