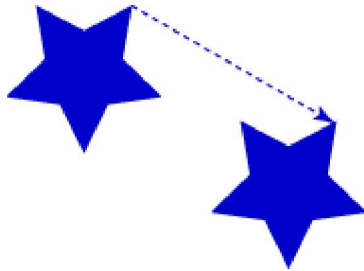


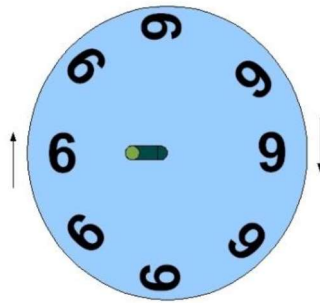
Theoretical Part

We have discussed 3 types of symmetries:

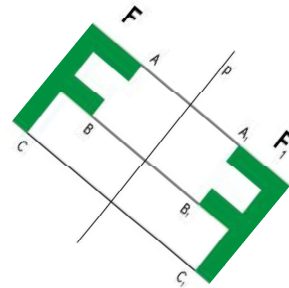
Translational



Rotational

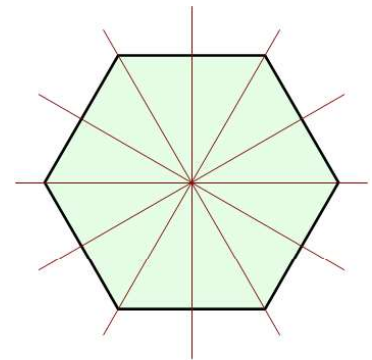


mirror/reflection



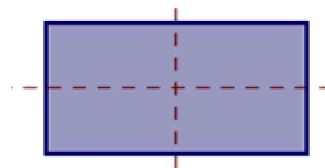
These translations or combination of this translations make up **congruent** objects. Two objects are **congruent** if they have the **same dimensions and shape**.

Many figures we see in geometry and in real life have many symmetries. For example, the hexagon shown to the right is symmetric under 60° rotations around the point O (that is to say, if we rotate it by 60° , we get the exact same hexagon – as if we didn't rotate at all) and also under 120° , 180° , . . . rotations. It is also symmetric under many reflections: these reflection lines are also shown.

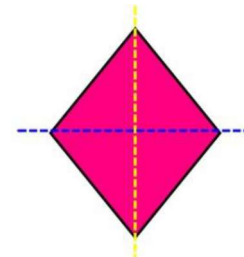


Special quadrilaterals.

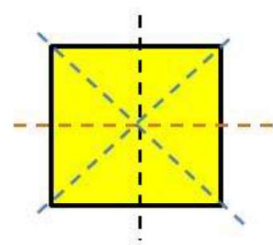
Rectangle. All four angles are 90° . It has any symmetries: two reflection symmetries and a 180° rotation.



Rhombus. All four sides are equal. In this case, it also has two lines of symmetry and in addition 180° rotation symmetry.

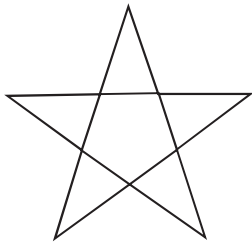


Square. All angles are 90° and all four sides are equal. Thus, it is both a special kind of a rectangle and also a special case of a rhombus; so it has all symmetries of rectangle and also all symmetries of a rhombus. In addition, it has 90° , 180° , 270° rotation symmetry.

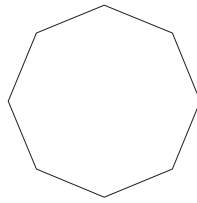


MATH 4: HOMEWORK 20
MARCH 22, 2020

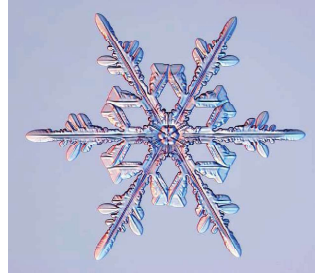
1. Find the symmetries of the figures below. Draw the lines of symmetries in blue on the figure; if there are any rotational symmetries, mark the center of rotation as black dot and write the rotation angle (or angles) next to it.



(a) star



(b) octagon



(c) a snowflake

2. The figure below is an ancient Chinese symbol (usually referred to as Yin and Yang).



- (a) Does it have any symmetries (ignoring the colors)? If so, mark them on the figure in the same way as in the previous problem.
(b) Can you draw a line (not necessarily a straight line — it can be curved) which would divide both red and blue pieces into two identical parts.

3. The figure to the right shows a pattern found in one of Egyptian tombs. Can you find all symmetries of this pattern? Namely,

- Mark on the figure all symmetry lines (in blue)
- Mark all centers of 90° rotations by black dots (make the dots large enough so that I can see them).
- Mark all centers of 180° rotations by green dots.



- *4. Can you find all possible rotational symmetries of a **cube**?

For example, it is easy to see that if we draw a perpendicular line through the center of one of the sides (faces) of the cube, then the cube is symmetric under 0° , 90° , 180° , 270° rotations. Are there any other possible rotations?

