

Materials:

- *Ninja Clans* activity's cards

Activity

-Ninja Clans-

The goal

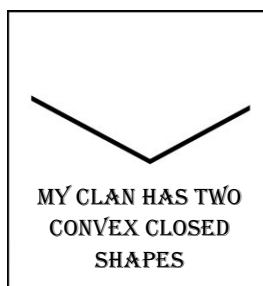
GOAL: Place each ninja (card) in his clan (his team).

EXPLANATIONS: Ninjas are Japanese spies that must remain incognito in order to do their job properly. In this activity, the ninjas work in clans that must recognize each other with a secret code. So, each ninja has a logo associated to a statement. This statement describes certain characteristics of plane figures that are valid for all the clan's logos.

Example:



These three ninjas together cannot form a complete clan. Although the first ninja indicates that the clan must have two right angles and that this requirement is met, the other two statements are not. Indeed, there is only one obtuse angle among these three ninjas and no open shape.



However, by adding the card above, we get a complete clan. We have two right angles (in the right triangles), exactly two obtuse angles (the quadrilateral's exterior angle and the open shape's interior angle), one open shape and two convex closed shapes (the right triangles).

So, each team of students must manage to gather every card (or every ninja) in the right clan. There is only one possible solution.



Solution

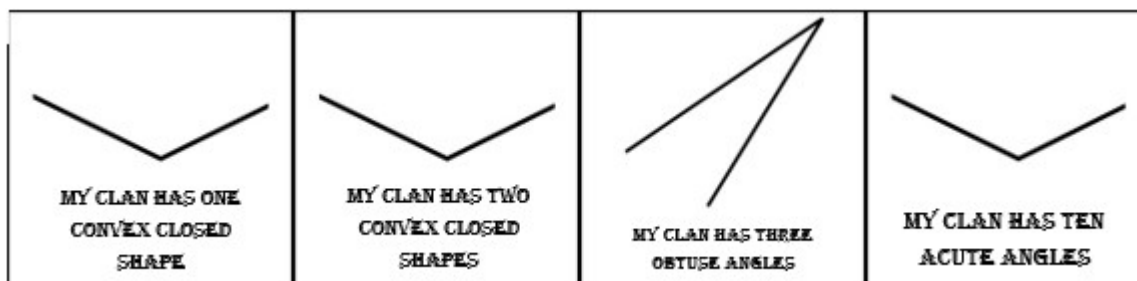


Careful: The explanations seem long and the logical reasoning complex. However, it is rare that the students follow this reasoning exactly. Most of the time, the students who accomplish this activity do it by discussing with their team mates and by adjusting their work after their observations. So, this Explanation Sheet presents one of the many ways to solve the problem.

Detailed Explanations of the Solution:



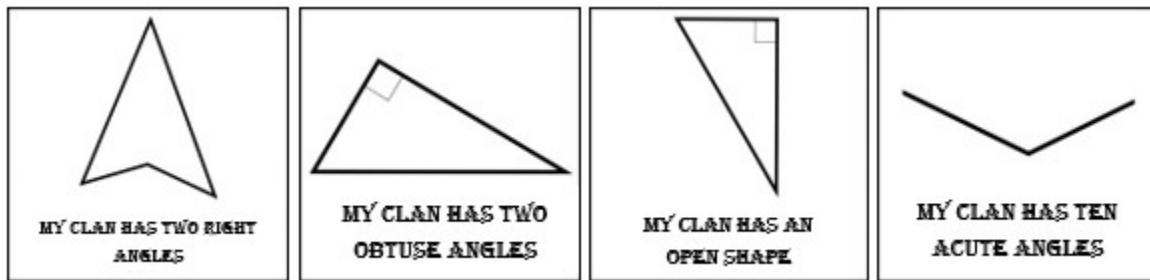
Let's begin with these three ninjas. Since the first ninja says that there are two right angles in his clan and that the only two right angles in the game are on the other two cards presented above, these three cards must be grouped together. But, this clan is not complete because the other two statements are not respected. So, let's focus on the ninja "my clan has an open shape". Four ninjas meet this criterion. Here they are:



Among these four ninjas, only the first one absolutely cannot join the clan above because it already has two convex closed shapes. So, we must set it aside. Among the other three ninjas, one of them has a particular statement: "my clan has ten acute angles". It is a rather high number. The clan presented above already has 7 acute angles. So, we are only missing 3 to respect the ninja's statement: "my clan has ten acute angles". Plus, by looking at all the other ninjas in the game, we can notice that it is impossible to gather enough ninjas in a new clan to have 10 acute angles while respecting each statement. So, we will add this ninja to our first clan.



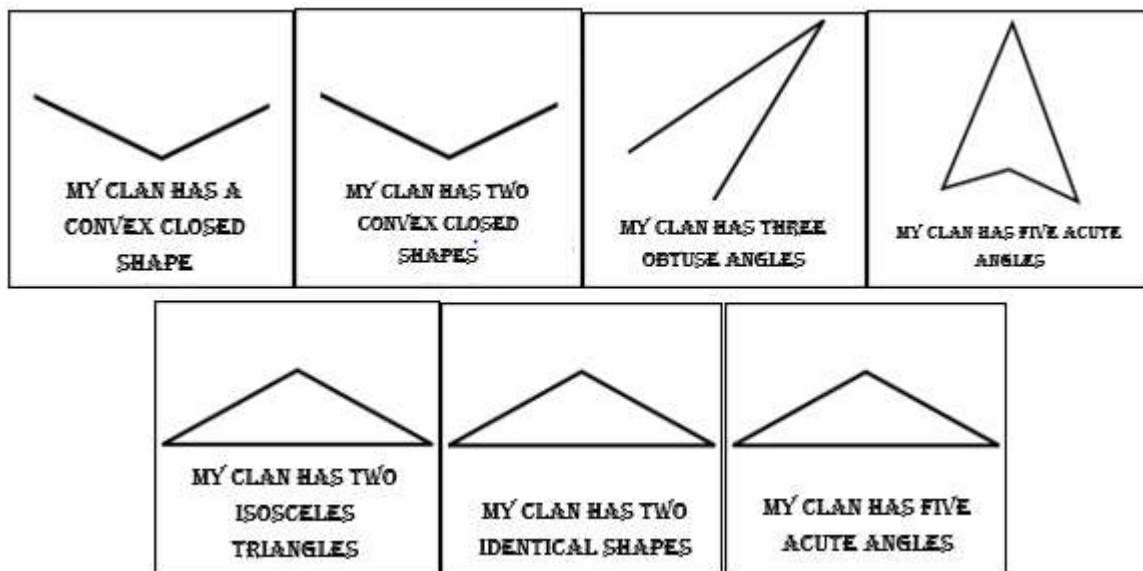
So, here is what the first clan currently looks like:



Let's notice that to complete this clan there is now only 3 acute angles missing, all the other statements being respected. There are several ninjas that could be added to this clan, but only one allows to complete it. It is the only shape left that has three acute angles and respects all the other statements, including its own:

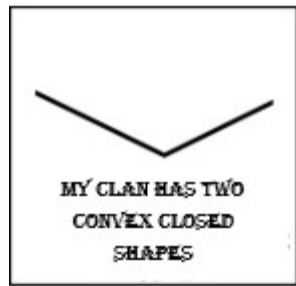


So, we formed a clan of 5 ninjas. There are then 7 cards left in the game:

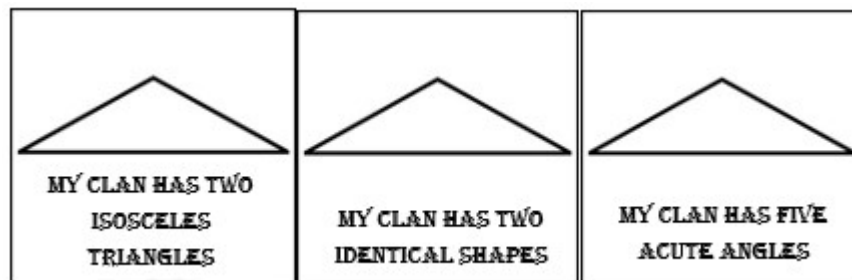


The first ninja in this group says that he is part of a clan that has only 1 convex shape while the second one says that his has 2. So, we understand that they will be part of two separate clans.

Let's begin with this ninja:

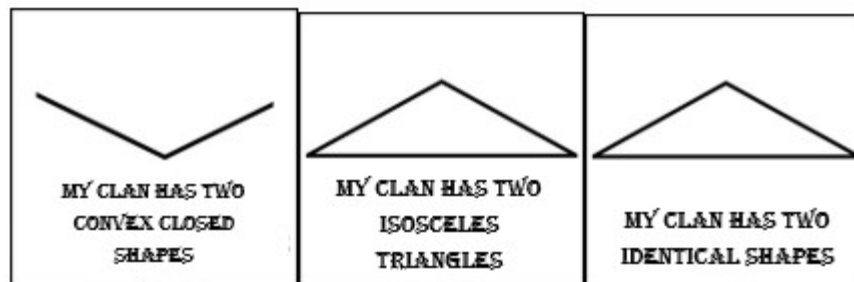


Among all the ninjas left, there are only 3 convex closed shapes. They are three identical shapes. They are isosceles triangles:

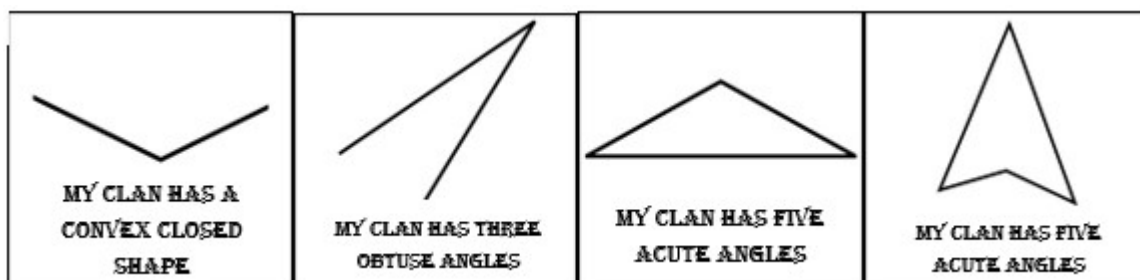


By looking at these three ninjas, we can observe that two of them have statements that complete each other. Indeed, the two identical shapes are also the two isosceles triangles. So, they form a pair and can join the clan with the ninja "my clan has two convex closed shapes", since they also complete this statement.

So, here is what this second clan looks like:



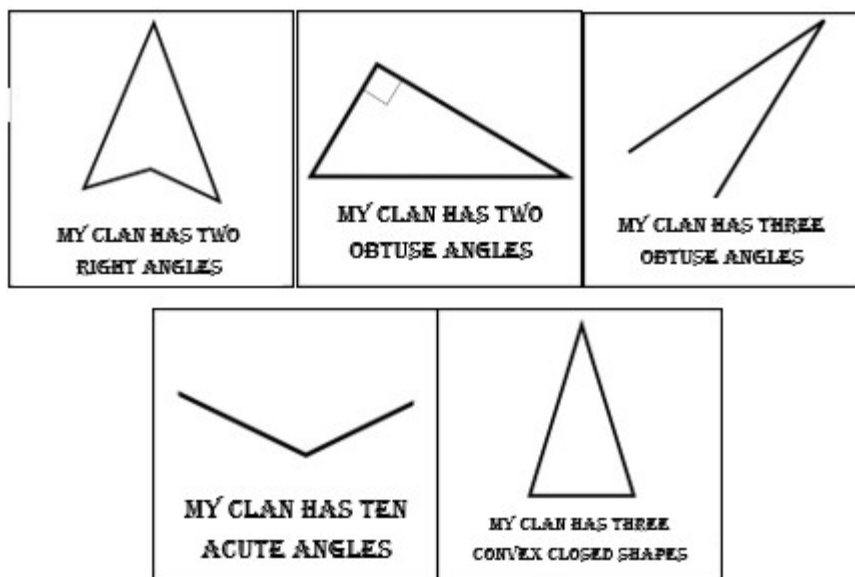
We now have two clans that can be considered complete. Now, let's look at the ninjas that are left:



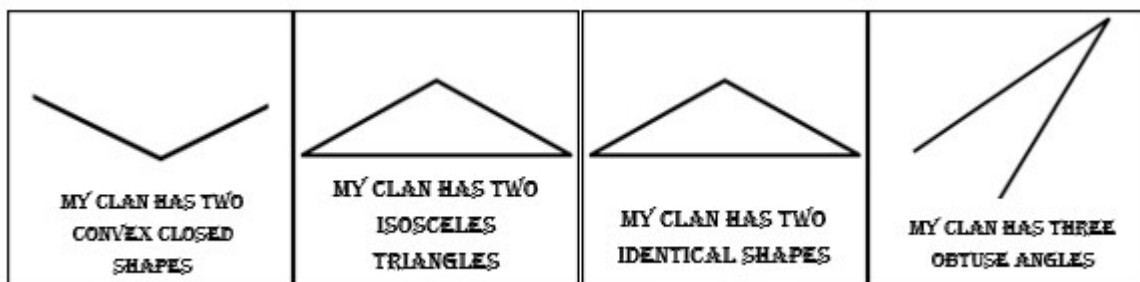
Since the second clan has 3 obtuse angles, as the cards left, the ninja describing this characteristic can move from one clan to the other without invalidating his own statement. By leaving him with the remaining ninjas, this group then has 6 acute angles while two of these ninjas require 5. So, it is not a valid clan. However, by moving him in the second clan, it allows the remaining ninjas to create a valid clan and thus solve the problem. Indeed, the third clan then has only one convex closed shape (the triangle) and five acute angles (three in the non-convex closed shape and two in the triangle).

So, here are our three final clans:

First clan:



Second clan:



Third clan:

