## Properties of objects and SET game.

## Properties cards.

We have some 12 cards on the board. Each one of them describe a certain value of certain property. How can we divide these properties into separate groups? Do we get 4 separate groups?

- Colors: red, purple and green,
- Shapes: oval, diamond and squiggle,
- Shadings: solid, striped and open,
- And numbers: 1, 2 and 3.


Who knows which game we will be playing today? Does everyone know the SET? But we will look at the SET in a very different way today. If we choose 4 property values, one for each property, say 3 red open ovals, how many SET cards can we find matching them all? How many SET cards with 2 red solid squiggles can we find? How about 3 purple striped ovals or 2 green open diamonds?

- There is only one card that satisfies all 4 properties at the same time!


Let us now find how many cards satisfy 3 of these 4 properties: 3 red open? We now can have any of the 3 shapes, since we don't require any specific shape.

- 3 red open ovals, 3 red open squiggles and 3 red open diamonds satisfy the 3 properties! Total of 3 cards.
What if we removed another condition/property and left only " 3 items" and "red" properties? Our 3 red open squiggles can now become:
- 3 red solid squiggles, 3 red striped squiggles and 3 red open squiggles.

Each of the cards got multiplied into 3 distinct cards, when we removed the "open" property! And since we had 3 cards satisfying three properties to begin with, we get $3 \times 3=9$ cards. Let us do it one more time. What happens to our 3 solid red squiggles card if we remove the " 3 items" property?

- 1 solid red squiggle, 2 solid red squiggles and 3 solid red squiggles!

All our cards again got multiplied into 3 distinct and the total number of cards multiplied by 3 to give us 27 in total. We now have a tree-like picture when cards are arranged going down as we remove properties.
Now we can answer the ultimate question of life, the universe, and everything: many cards are there in SET in total? This time we need to remove the "red" property, and include all 3 colors in our collection of cards: that is $3 \times 27=81$ cards in total! And we found the number without ever having to count more than 3.


A SET includes three cards with common features: shape, color, shade or number of symbols.
However, three completely different cards also can comprise a SET -- their common feature being that they have nothing in common.
For example, the following are 'Sets':
All three cards are red; all are ovals; all have two symbols; and all have different shadings.

All have different colors; all have different symbols; all have different numbers of symbols; and all have the same shading.


All have different colors; all have different symbols; all have different numbers of symbols, and all have different
 shadings.

The following are NOT 'Sets':
All have different colors; all are diamonds; all have one symbol; however, two are open and one is not.


All are squiggles; all have different shadings; all have two symbols; however, two are red and one is not.


## SET?



YES!

SET?


NOT really.....

SET?


YES!

If we pick two random cards from our pile of 81 SET game cards, can we always find the third one among the other 79 that will make a SET? Or is it sometimes impossible? Let's look at an example: we have 3 green striped ovals (1st row below) and 3 green open diamonds (2nd row below). What are their properties?

- Green, 3, oval, stripes
- Green, 3 diamond, open

Now let us find the would-be properties of the missing card:

- two greens are the same, and give us a green,
- two 3s are the same, and give us a 3,
- oval and diamond are different, and give us a squiggle,
- striped and open are different, and give us a solid.

Putting the "calculated" properties together, we get: 3 green solid squiggles! Does a card with these 4 properties exists? Of course it does! But how many? Let's go back to our tree, how many cards are there at the top, where all properties are given? A single card! Then for a random pair of cards, there is always one and only one card that completes a SET.


Now it is time to play the real SET game! In this SET we have only 3 different properties (shape, number and shading).
To pick up a set of 3 cards from the 9 on the field, we have to have some properties the same for all cards and the rest of properties different for all cards. For example, for the 9 cards below we can find 4 sets that look like the vertical columns below.


Now we know how to play! Let us find 6 SETs by yourself and then we will check it on the board. Everyone has six copy of the same SET game to find and mark all 6 SETs on it.

Everyone is busy looking for SETs.


The first SET is found, we have 5 more SETs to find. Vanya found the last one!


