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as part of the ASISTM Project.

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Introduction

SET® is a game to develop mathematical reasoning skills. It also encourages students to discuss their logic and to solve problems involving combinations and permutations.

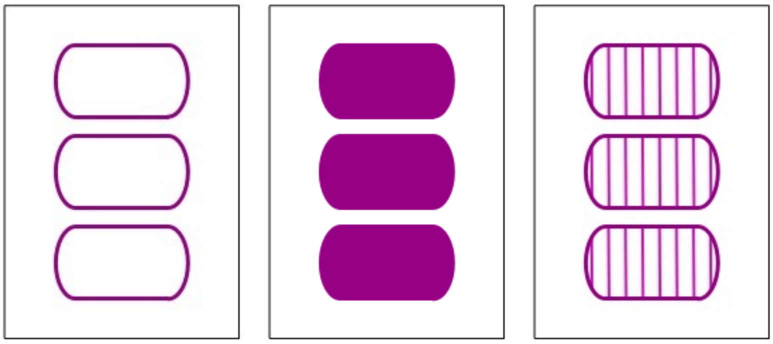
There are four features (or *attributes*) of a SET® card: colour, shape, number and shading. The cards provided for this module have the following attributes:

- **Colour** – purple, green, red.
- **Shape** – triangle, oval, squiggle.
- **Number** – one, two, three.
- **Shading** – empty, filled, striped.

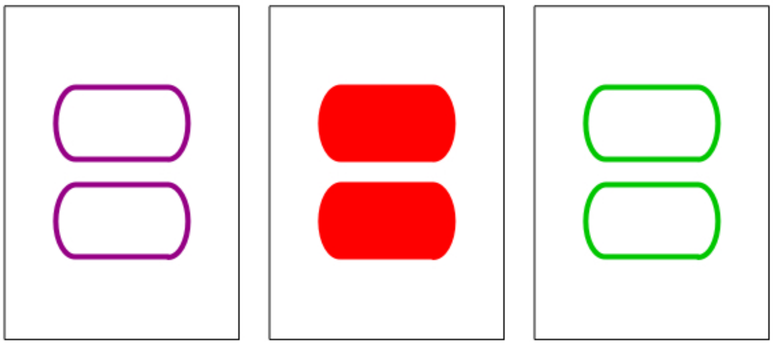
A *set* consists of three cards where each feature is EITHER the same on all three cards OR different on all three cards. For example, the following cards form a set as: all three cards are purple; all are ovals; all have three symbols; all have different shadings.

NOTE

Find the popular game of SET® at www.setgame.com.



The following example is not a set. The set meets the conditions for colour, shape and number (all three cards are different colours; all are ovals; all have two symbols) but does not meet the condition for shading as two are empty and one is filled.



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SACSA Learning Outcomes

Number Strand (Outcome 6)

- **Standard 2**: Represents and compares rational numbers in a variety of ways, describing relationships among them.
- **Standard 3**: Represents and analyses relationships amongst number concepts and uses these to make sense of, and represent the world.
- **Standard 4**: Represents and analyses relationships amongst integers and rational numbers and commonly encountered irrational numbers.
- **Standard 5**: Uses numbers, relationships among numbers and number systems and represents and discusses these understandings with others.

Preparation

Obtain a copy of a deck of cards (81 cards) for each group of students.

Topics

These topics should be completed in order.

- The SET® Cards
- Making Sets
- Playing SET®

Additional Resources

Teacher Created Resources

The following resources have been developed from the modules by teachers to use in the classroom. Feel free to use these or help us expand the resources by creating your own.

- Class worksheet (developed by Michael Bowen).
- Class examples (for use with a data/overhead projector).

Teacher Comments

The following comments and suggestions are from teachers using the resources in the classroom. Please send us your experiences.

- 'Demonstrating examples of sets to the whole class was important in conveying the concept. The use of non-examples improved understanding further.'
- 'Having the card game to play was a great motivator for students, and the competitive nature seemed to enhance engagement in how to find sets.'

Other Resources

- Math Workbook – Developing mathematical reasoning using attribute games.
- Quarto – Another attribute based game which may be played using SET® cards.
- SET at wikipedia.

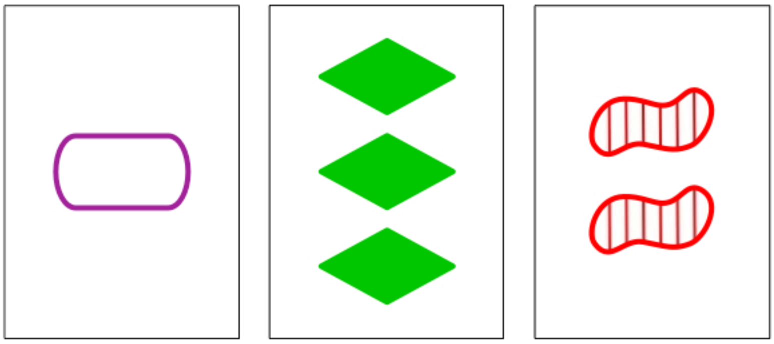
The SET® Cards

NOTE

The examples in this section (and more) may be found in the ‘Class Examples’ under ‘Resources’ on page 2.

Describing the Attributes

Show the students the following example and explain that it contains all the different attributes for the game. Ask them to describe them to you.



☞ Colour (purple, green, red); shape (oval, diamond, squiggle); number (one, two, three); shading (empty, filled, striped).

Counting the Number of Cards

Tell the students that a SET® deck contains exactly one card of every possible combination. Ask the students to work out how many cards are in a complete deck without counting them. This can be done using the basic counting principle of mathematics – the *multiplication principle*. The Multiplication Principle may be illustrated in many ways such as with the School Uniform Example.

The Multiplication Principle

If one event can occur in *m* ways and a second can occur independently in *n* ways, then the two can occur in *m* x *n* ways.

In SET®, each card has four attributes. The first attribute, colour, can occur in three different ways (purple, green, red). Similarly, the remaining three attributes can also occur in three different ways. Hence, there are 3 x 3 x 3 x 3 = 81 different cards.

Test this concept by asking different questions such as ‘How many cards are possible if we add a fourth colour such as blue?’

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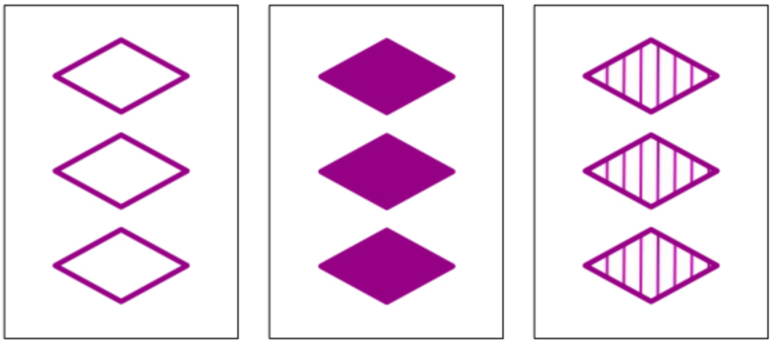
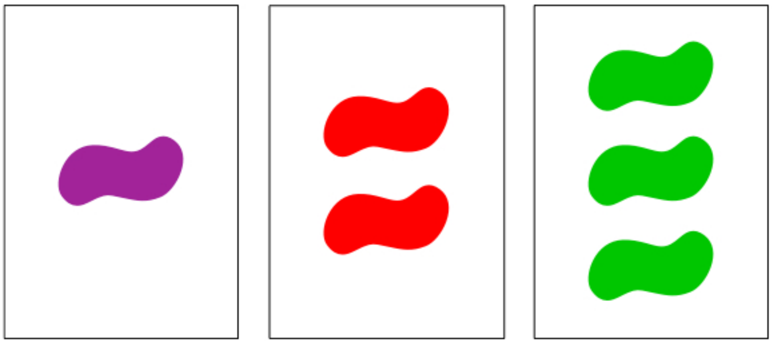
Making Sets

Introduce the rules of making a set. Then, show the students the following examples (found in the Class Examples) and ask them to explain why each set of three cards makes a set. For example, in Example 1, the colour, shape and number is the same across all three cards (purple, diamond, three) but the shading is different across all three cards.

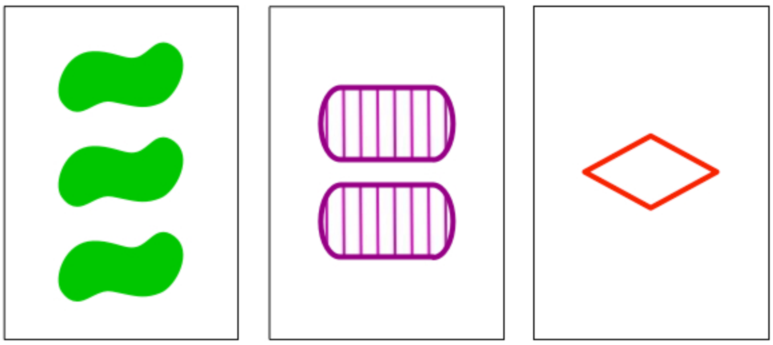
Example 1



Example 2



Example 3



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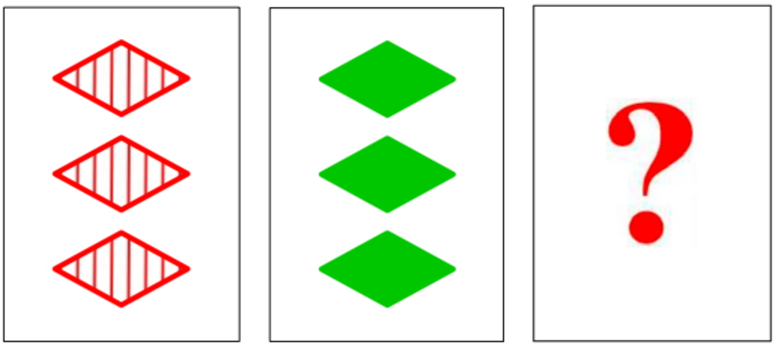
You may also like to show examples that are not sets to illustrate how to form a set.

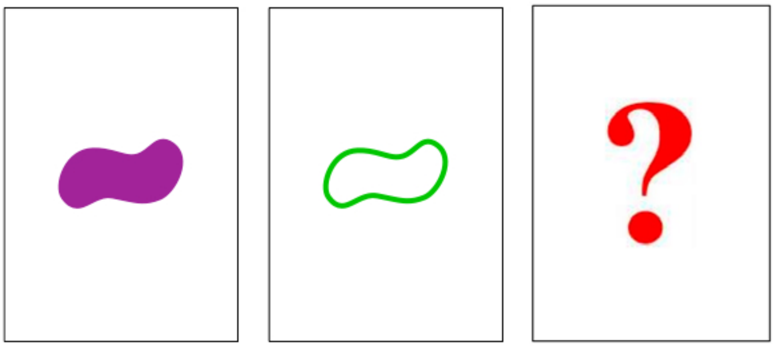
Now ask the students what is the third card to complete each set?

Example 1



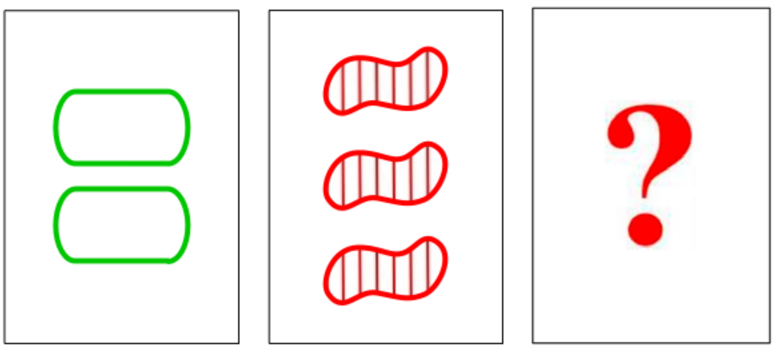
☞ A card with three purple empty diamonds.

Example 2



☞ A card with one red striped squiggle.

Example 3



☞ A card with one purple filled diamond.

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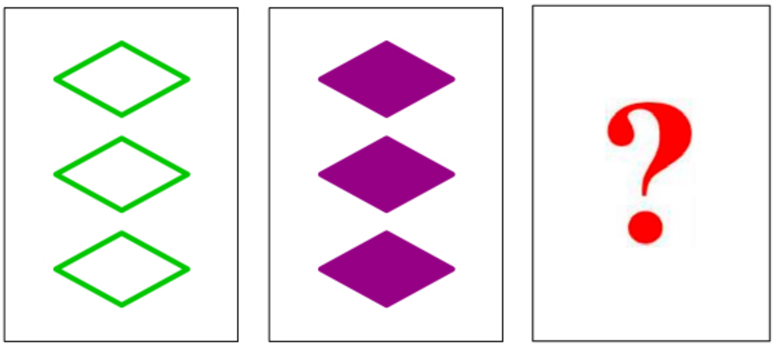
See if the students can work out why there is only one possibility to complete each set when two cards are selected. For example, consider the two cards shown below:



Since the cards are different in colour (green, purple), the remaining card must be red. Since the cards are different in shading (empty, full), the remaining card must be striped. Since the cards are the same in number (three), the remaining card must have three symbols. Since the cards are the same in shape (diamond), the remaining card must be a diamond. This defines a single card – a card with three red striped diamonds.

How many sets are possible?

This illustrates the concepts of *combinations* and *permutations*.

To calculate how many sets are possible, the logic proceeds as follows. We could choose any of 81 cards as the first card, then, any of the remaining 80 cards as the second card. We have just shown that there is only one card that completes the set. Therefore, according to the Multiplication Principle, there are 81 x 80 x 1 = 6480 possibilities (or combinations).

However! The order in which the cards are placed does not matter. Have the students show that there are six different orderings (or permutations). For example, if the cards are labelled A, B and C then the six different orderings are ABC, ACB, BAC, BCA, CAB, CBA.

Therefore, we have counted each set six times so we divide by 6. Hence, there are 6480/6 = 1080 possible sets in the whole deck.

Extension Grids

There are six sets in Extension Grid 1 and Extension Grid 2. Find them!
(Extension Grid 1 Solutions, Extension Grid 2 Solutions.)

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Playing SET®

SET Rules (from www.setgame.com)
The dealer shuffles the cards and lays twelve cards (in a rectangle) face up on the table so that they can be seen by all players. The players remove a 'Set' of three cards as they are seen. Each 'Set' is checked by the other players. If correct, the 'Set' is kept by the player and the dealer replaces the three cards with three from the deck. Players do not take turns but pick up 'Sets' as soon as they see them. A player must call 'Set' before picking up the cards. After a player has called 'Set', no other player can pick up cards until the first player is finished. If a player calls 'Set' and does not have one, the player loses one point. The three cards are returned to the table. If all players agree that there is no 'Set' in the twelve cards showing, three more cards (making a total of fifteen) are laid face up. These cards are not replaced when the next 'Set' is picked up, reducing the number to twelve again. If solitaire is being played, the player loses at this point. The play continues until the deck is depleted. At the end of the play there may be six or nine cards which do not form a 'Set'. The number of 'Sets' held by each player are then counted, one point is given for each and added to their score. The deal then passes to the person on the dealer's left and the play resumes with the deck being reshuffled. When all players have dealt, the game ends; the highest score wins.

It is the most fun to play without penalising for calling an incorrect set.

Instead of playing SET, another group activity is to lay out all 81 cards and let the students work together to remove sets.

What is the best strategy when looking for sets?

There are four different types of sets we might make, depending on how many attributes are the same or are different. These are four different/none same, three different/one same, two different/two same and one different/three same. (Why isn't zero different/four same possible? The answer is because each card would be identical to the other two.)

We will work out how many sets are possible if our set is to contain cards where three attributes are different and one is the same across all three cards.

There are 81 choices for the first card. Suppose the common attribute is colour. Then, the second card must be the same colour as the first card, but must differ on the other three

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attributes. For each differing attribute, there are two other choices. So there are 1 x 2 x 2 x 2 = 8 possible choices for the second card. As before, there is only one card that will complete the set. So, if the common attribute is colour, there are 81 x 8 x 1 = 648 different combinations. However! As we showed on Page 7, we must divide by 6 because the order in which the cards are placed does not matter. This gives 108 different sets where the common attribute is colour and every other attribute is different across all three cards.

What if the common attribute was something other than colour? There are three other attributes: shape, number and shading. Because there are four choices of attributes, there are a total of 108 x 4 = 432 different sets where three attributes are different and one is the same across all three cards.

The other possibilities may be worked out in the same way. The table below shows the number and the percentage of sets possible for each different type. This shows that the best strategy is to look for sets with three different/one same attribute.

# Diff	# Same	# Sets	Percentage
4	0	216	20%
3	1	432	40%
2	2	324	30%
1	3	108	10%
		1080	**100%**

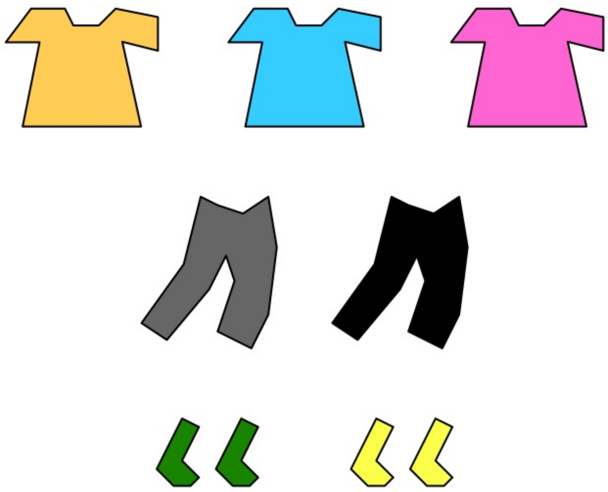
The Multiplication Principle

The Multiplication Principle

If one event can occur in m ways and a second can occur independently in n ways, then the two can occur in m x n ways.

The School Uniform Example

When Bob gets dressed in the morning, he has a choice of which clothes to wear. There are three different coloured shirts, two different coloured pants and two different coloured pairs of socks. How many different possibilities of outfits are there?



We could list out all of the possibilities as shown below. To apply the multiplication principle, we notice that Bob has three independent choices to make (events to occur): 1. Choose a shirt, 2. Choose a pair of pants, 3. Choose a pair of socks. There are 3 choices for his shirt, 2 choices for his pants and 2 choices for his socks. Therefore, there are 3 x 2 x 2 = 12 different outfits to choose from.

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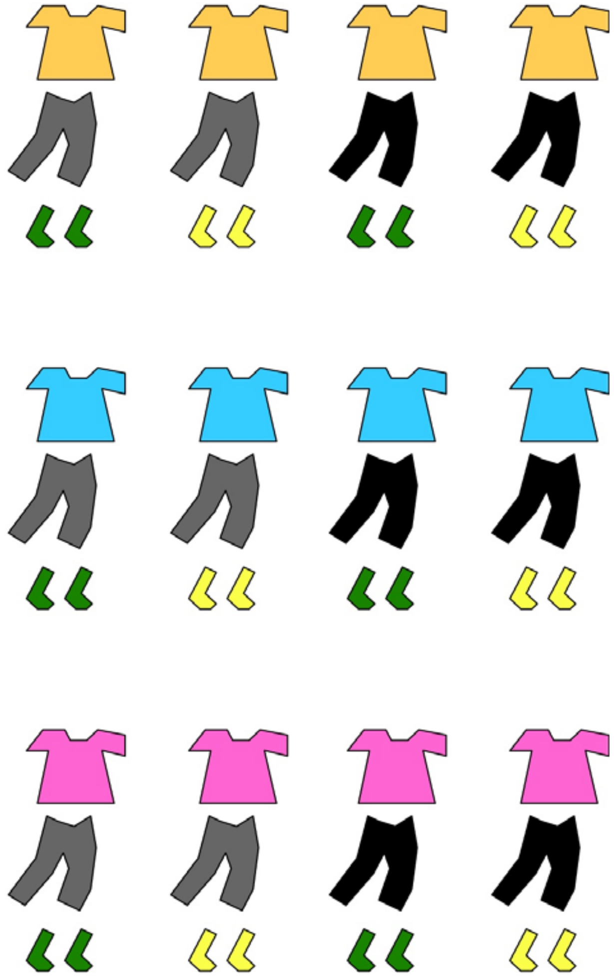

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