Three game modes
BASIC, INTERMEDIATE, ADVANCED
From 8 to 99 years old

MATHEMATICUS®

The game of mathematics

Have fun with numbers

Test and improve your mathematical knowledge

Instructions

MATICUS
The game of mathematics

Al-Khwarizmi

Gauss

Turing

CHALLENGE

BAJ GAMES

Mathematicus can be played in three different modes: basic, intermediate and advanced. In addition, it can also be played in "simplified" mode using only the cards without the game board.

All of the modes of play use the same game board but with different instruments specific to each mode such as specific dice, tokens, cards and tools. The basic play mode rules are simpler than those for the other two modes.

One of the fundamental characteristics of *Mathematicus* is its modularity. This means that it is possible to play in basic mode, but also gradually adopt elements from the intermediate mode.

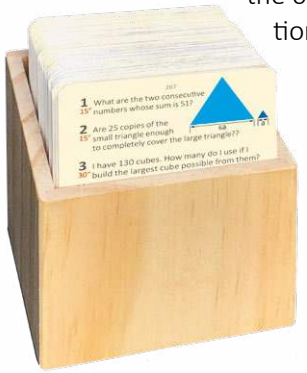
Similarly, when played in intermediate mode, one or more of the 10 elements from the advanced mode can be integrated. In other words, the game can be calibrated to accommodate a wide variety of different levels depending on the age and knowledge of the players, and also on their desire to learn new things.

Another interesting aspect of *Mathematicus* is that it can be played simultaneously at different levels or using different modes with each player following his/her individual rules answering questions appropriate for the chosen level of knowledge. After playing a few times, the suitable mode and level of play for each player becomes clear.

In the basic and intermediate game modes, players advance by answering yellow card questions which offer four different levels of difficulty, while the advanced game mode also uses blue cards in addition to level 4 yellow cards. Finally, *Mathematicus* can be played in "custom" mode, thanks to question preparation by the players themselves, at any level from the most basic to the most specialized. For this purpose, the publisher provides packs of blank writable cards on request.

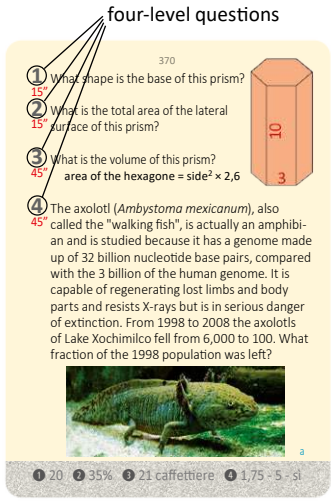
Basic game mode

Before playing *Mathematicus* for the first time, unpack the cards, remove the 001 card (the top card with a summary of the instructions) and place the cards in the case.



The structure of *Mathematicus* is based on a "snakes & ladders" type board game, entailing rolling dice to follow a path and land on squares, each of which requires players to execute certain actions, be granted benefits or pay penalties.

Mathematicus uses two different dice, a four-sided tetrahedral die and a twelve-sided dodecahedral die, which the player is free to choose from time to time. If the target square is within 4 squares then

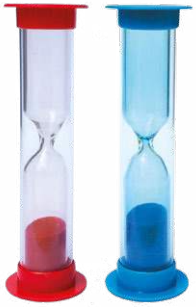


the tetrahedral die gives a 25% probability of landing on it, compared to 8.3% with the dodecahedral die. Conversely, if the target square lies further away, then the dodecahedral die gives a greater probability of landing on it or getting closer.

Players move around the board by successfully answering questions from the cards selected when they arrive on the square bearing a yellow card symbol. If the question is answered incorrectly, then the player whose turn it is returns to the departure square.

Questions must be answered within the given deadline, usually 15 or 30 seconds which can be timed using the hourglasses provided.

Should the response time be longer, for example 45 seconds or a minute, both hourglasses are required.



15" 30" hourglasses.

Players can decide to adopt an agreed tolerance threshold regarding response times, meaning that slightly delayed responses can be still be considered after the stated expiry time. This could be particularly helpful in the presence of very young or inexperienced players.

Each card has 4 questions with varying levels of difficulty. The appropriate question level for each player is decided together by all players at the start of the game. It can be changed however, by joint agreement, if it becomes obvious that the chosen level is either too simple (rise to the next level) or too difficult (go down to the lower level).

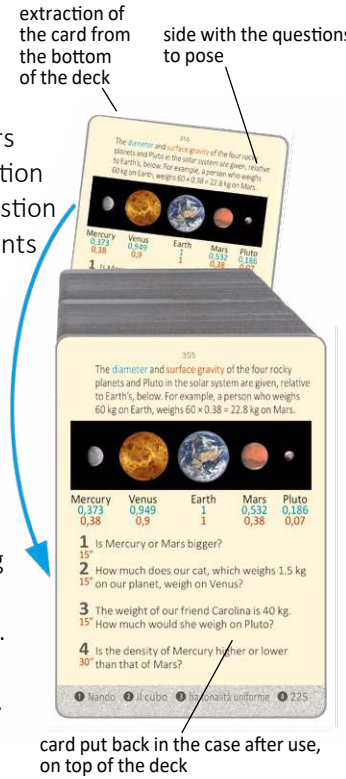
Some questions require rolling one of the included dice whereas others involve answering questions consulting the reverse side of the Slide Rule, which shows a table containing data

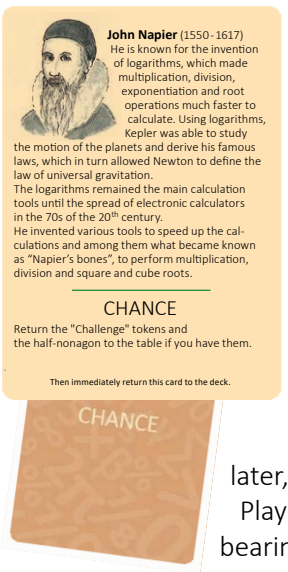
on regular polygons of up to 14 sides, regular solids, circles and spheres.

Yellow card question answers can be found in the footer section of the reverse side of each question card. After the player gives an answer, the opponents check if it is correct. The card is then returned to the case.

During a standard game, there will usually be enough cards; however, should the cards run out, then simply turn the block of cards in the case and continue the game by reading the new questions on the reverse side of each card.

It is preferable to draw cards from the bottom of the deck and place them on top without turning after each turn, so that questions and answers are not visible to players when the cards are in the case. Another advantage of this method is that the cards are already sorted if it is necessary to turn the deck. The player holds the card viewing the side containing the question to ask so as to avoid looking at the answer on the reverse side.





The small blue letters (a, b, ...) are insignificant to game play as they contain references to photographs which can be found in the final pages of the booklet.

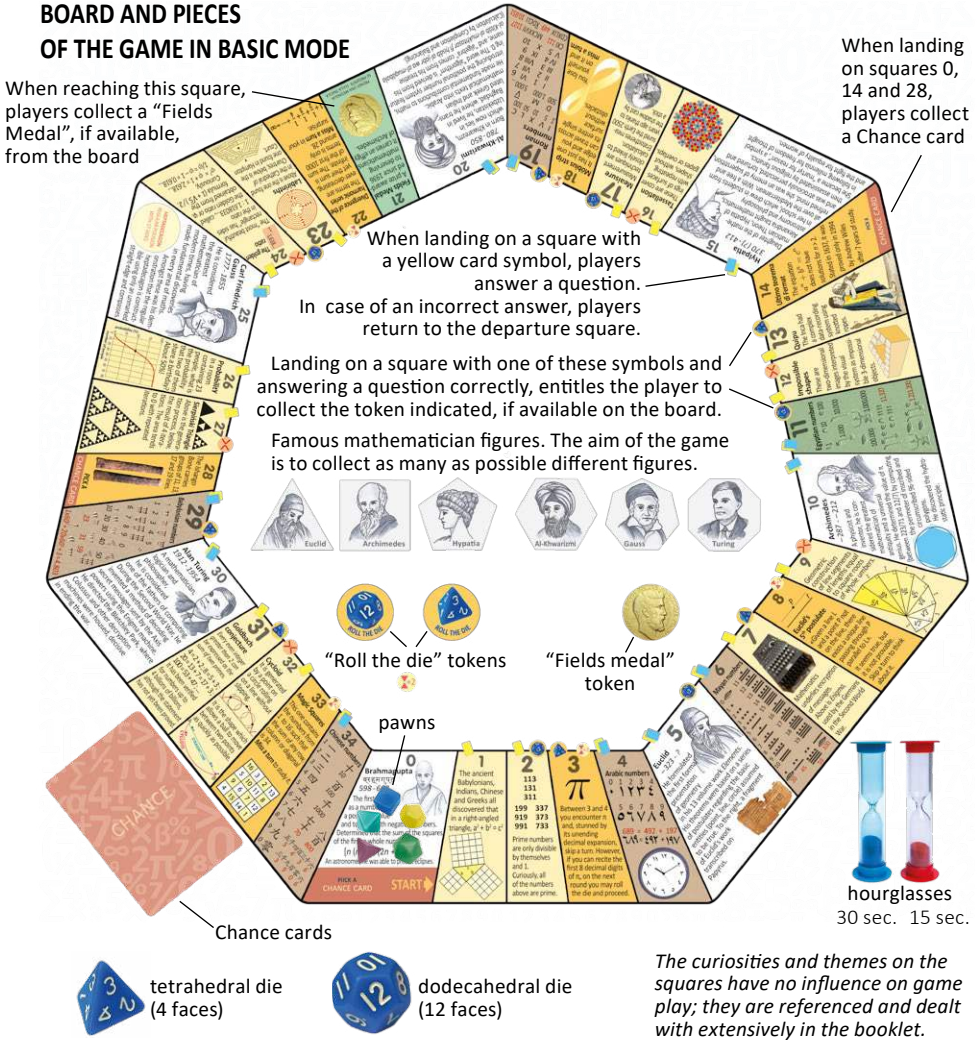
Squares 3, 8, 18, 22 and 33 are penalty squares, meaning that the player skips a turn, however square 3 is slightly different as a gimmick can be used to avoid being penalized.

As a general rule, penalties can also be avoided by trading in a "Roll the die" token .

Squares 0, 14 and 28 instruct players to draw a Chance card, which features different kinds of benefits or penalties. Some Chance cards require immediate action while others can be kept and traded in later, when a player considers it opportune.

Players collect "Roll the die" tokens by landing on a square bearing the same symbol provided they are available on

BOARD AND PIECES OF THE GAME IN BASIC MODE



tetrahedral die (4 faces)

dodecahedral die (12 faces)

The curiosities and themes on the squares have no influence on game play; they are referenced and dealt with extensively in the booklet.

the board. Players can "trade in" these tokens to make an additional roll, upon their turn, or continue the game normally and "trade it in" later when landing on a square that requires you to skip a turn.

When you land on a square featuring a famous mathematician figure, the corresponding token, if available, is collected from the board.

"Roll the die" tokens and famous mathematician figures can only be taken if a question is answered correctly.

Conversely, the Fields Medal, if available on the board, is gained without answering any question, when landing on square 21. Players can choose to use

Famous mathematician figures.


The Fields Medal.

it upon their turn in exchange for a famous mathematician figure on the board. Should the figure of the mathematician desired by the player be unavailable then the player can use the Fields Medal to poach it from another player.

When a "Roll the die" token or a Fields Medal is "traded in", it is placed back on the board.

Rules

Starting the game. Unfold the game board and position the Chance cards, pawns, dice and the hourglasses. Shuffle the cards and place them in the case. Next, lay out the three "Field Medals" and the other tokens and figures on the table as shown below. Then, each player receives a dodecahedral "Roll the die" token and a tetrahedral "Roll the die" token required to start the game.
After placing the pawns on the "0" start square, players roll the dodecahedral die. Whoever scores the highest number or is the first to score 12 starts the game. Each player selects their pawn during the first round of play.

Game rounds. When a player rolls the dice and moves his/her pawn, this status is considered "in turn" or "active".

The game proceeds in a counterclockwise direction by passing the die to the next player. Practically, the dice are handed to the player located on their right.

If a player decides, after rolling the dice, that advancing to the square indicated by the score is less opportune than staying on the same square, it is possible to "skip" a turn, even though the die has already been thrown.

The "Dealer". The role of Dealer is alternated between players for either an agreed number of rounds or a set time, e.g. 30 minutes. This should be decided prior to starting play. Alternatively, if a player volunteers to be the Dealer for the duration of the game and receives unanimous approval there can alternatively be a fixed dealer.

The Dealer's tasks include removing the cards and handing them to the players when landing on a yellow card square.

The player reads the question, but is not allowed to turn the question card over where the answers are located.

The Dealer also has the task of monitoring response times using the hourglasses and checking the accuracy of the answers.

The Dealer is the only player who may use an electronic calculator and this for the sole purpose of checking other players' answers.

PIECES ON THE BOARD
AT THE BEGINNING OF THE GAME

2 players	3	3
3 players	4	4
4 players	5	5
5 players	5	5

2 players	1 series of 6 figures
3 players	2 series of 6 figures
4 players	3 series of 6 figures
5 players	4 series of 6 figures

Aim of the game. To collect the maximum number of famous mathematician figures possible, including the possibility of poaching them from other players or by using the "Fields Medal". In addition, Chance cards also allow players to acquire famous mathematician figures.

Warning: it is not possible to own two identical figures of the same mathematician. If you land on the square corresponding to a famous mathematician whose figure is already in your possession, your pawn must be left on the square without any action.

End of the game and winner. The game ends:

1 - when a player has collected the six different famous mathematician figures;
2 - when the last famous mathematician figure has been removed from the board. The player with the highest number of figures is then declared the winner;
3 - after a set time: the player who, at the expiry of the set time has the greatest number of famous mathematician figures, is the winner.

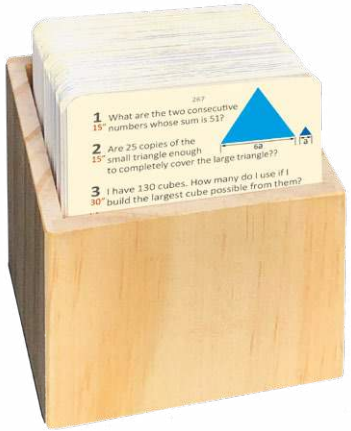
With reference to scenarios 2 and 3 above, should two or more players have an equal number of famous mathematician figures, they proceed by drawing cards in turn and answering questions, as occurs in the simplified game mode which only uses cards (see p. 8).

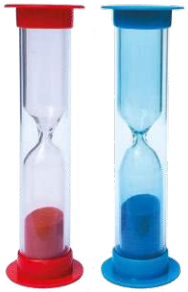
Players are progressively eliminated on the basis of incorrect answers and the final remaining player wins. At the start of the elimination challenge each player rolls the dice; whoever scores the lowest number draws the first card with the other players then following suit in counterclockwise mode.

Checking answers. The Dealer checks the answers by reading them from the reverse side of the card. In the event that an active player's answer is contested by another player, the Dealer's opinion is final.

Basic game mode (cards only)

THE GAME PIECES





15" 30"
hourglasses

tetrahedral die
(4 faces)

dodecahedral die
(12 faces)

Reverse side
of the Slide Rule

The dice and the reverse side of the Slide Rule are used to answer some of the game questions.

Mathematicus can also be played in a "simplified" version, which consists of only using the cards, and some additional accessories.
The number of players is unlimited when playing in this mode, while in other modes it is limited to a maximum of 5 players.
Remove the top card from the deck of cards, which is the 001 card and provides a summary of the instructions. The cards numbered from 296 to 301 and those from 405 onwards are also removed as they are only used in the board game. Nonetheless, should one or more of the cards to be removed remain in the deck by mistake, they can simply be extracted when drawn during the game; in this case, the player draws another card.
The cards should be shuffled taking care not to damage them, and then placed in the case.
When it is a player's turn, he/she draws a card and answers the question corresponding to one of four levels of difficulty decided prior to play.
The advantage of *Mathematicus*, as already mentioned, is that players of all levels can play together.
The appropriate level of question for each player to answer is decided at the beginning of the game. This can be modified, however, if all players agree that a particular player's level is obviously either too simple (move to a higher level) or too difficult (move to a lower level).
Questions must be answered within a given time frame, most often either 15 or 30 seconds. In excess of this, for example 45 seconds or one minute, a combination of the two hourglasses is used.

With reference to the response time, players can decide to adopt an agreed tolerance threshold, meaning that slightly delayed responses can still be considered after the stated deadline. This is particularly helpful when there are very young or inexperienced players.

Upon a player's turn, he/she draws a card and reads the question aloud keeping his/her gaze on the front of the card. The card should not be turned over as the answers are located in the grey footer section on the reverse side.

Some questions necessitate rolling one of the included dice, whereas other questions are answered by consulting the reverse side of the Slide Rule, which is a table containing data on regular polygons of up to 14 sides, regular solids, a circle and a sphere.

After giving the answer, the player and the opponents check if it is correct. The card is then placed back in the case.

There should be sufficient cards to play a standard game, however should the cards run out, simply turn the block of cards in the case and continue the game by reading the new questions on the reverse side of each card.

Drawing cards from the bottom of the deck is recommended and then placing them back on top without turning after use. In this way, the questions and answers are not visible to the players when the cards are in the case, and in addition the cards are already sorted if it is necessary to turn the deck (see figure above on p. 4).

The player holds the card looking at the question side only . The small blue letters (a, b, ...) are insignificant to game play as they contain photographic references referred to in the final pages of the booklet.

Players draw cards in turn either in a clockwise or counterclockwise direction which is decided in advance and then fixed.

When a player gives a wrong answer no action is taken and the card is placed back in the case and play continues with the next player.

When a player answers a question correctly, a point is recorded on a sheet of paper acting as a score card for all players.

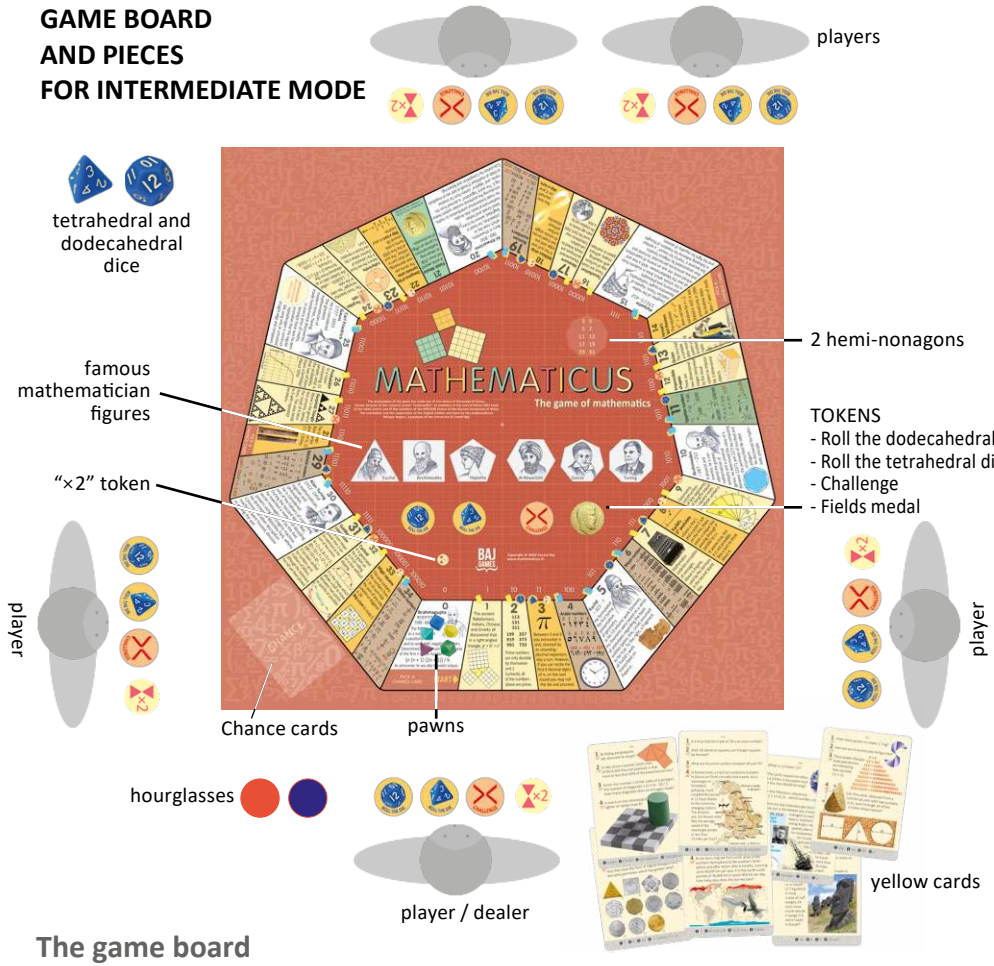
Players can decide to keep correctly answered question cards as it is easier to quickly determine the number of correct answers at any given time, but especially at the end of the game.

Prior to starting the game, players decide whether to either play against the clock, meaning that the player with the greatest number of correct answers at the expiry time wins, or alternatively to set a fixed number of correct answers, for example 19 or 31 or indeed any other agreed target number.

In case of a tie at the expiry point of a timed game, those players having the same number of correct answers proceed to a gradual elimination challenge after each wrong answer. If there is a tie between two players, which is most often the case, the first to make a mistake is eliminated thereby declaring the other player the winner.

Intermediate game mode

GAME BOARD AND PIECES FOR INTERMEDIATE MODE

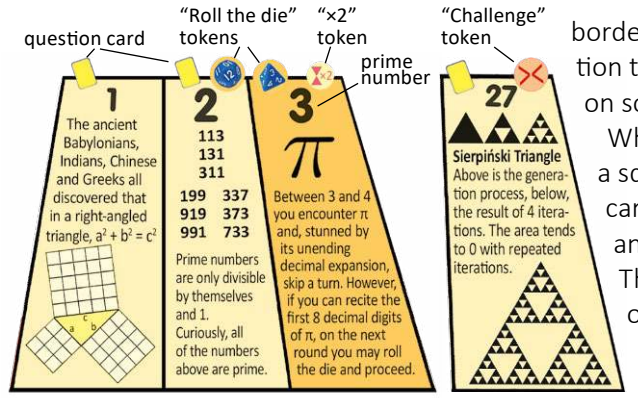


The game board

The game board has a heptagonal shape containing 35 squares numbered from 0 to 34. The prime numbers, considered as the "building blocks of the numeric system", appear in larger font. As a reminder, prime numbers are natural numbers other than 0 and 1 that are only divisible by themselves and by the number 1.

With the exception of a few squares on the board, the text found on the squares has no influence on game play; it merely presents mathematical curiosities provided to stimulate players' imaginations. In-depth information on these themes can be found in the book included in the game box, and is intended to illustrate just how diverse and inquisitive mathematics is.

The influential elements of the game are the symbols visible on the upper

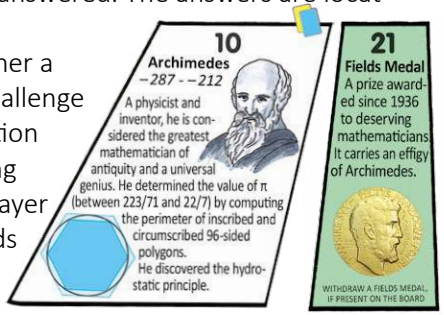


border of each square in addition to the instructions found on some squares.

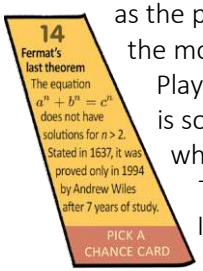
When the player lands on a square with the yellow card symbol, he must answer a question. The answers are on the other side of the card.

When a player lands on a square with a yellow card symbol, it means a question must be answered. The answers are located on the reverse side of the cards.

When a player lands on a square with either a dodecahedral die, a tetrahedral die or a challenge symbol, and subsequently answers a question correctly, he/she collects the corresponding token, if available on the board. When a player lands on square 21, he/she collects a "Fields Medal" from the board, if available, without answering a question.



When landing on a square featuring a famous mathematician from the past, players who answer a question correctly can collect the corresponding figure of that mathematician, if available on the board. These are important figures as the player who has collected all 6 different figures, or the one with the most at the end of the game, is the winner.



Players landing on square 0, 14 or 28 draw a Chance card which is sometimes used immediately and other times retained for use when deemed appropriate.

The 0 square is the start square and features an important Indian mathematician, included in honour of India's precious contribution to the development of mathematics. However, this is not a collectible figure and a Chance card is drawn instead.

Squares 3, 8, 18, 22 and 33 contain penalties that oblige players to skip a turn. As a consolation, players can collect a "×2" token, if available on the board.

The board has six squares featuring content regarding ancient or exotic mathematics. When playing in intermediate mode, these are considered normal squares.

The binary numbers on the board are used in the advanced game mode and therefore of no consideration in intermediate game mode.

Pawns

The pawns take the shape of the 5 platonic solids: tetrahedron, cube, octahedron, dodecahedron and icosahedron, with 4, 6, 8, 12 and 20 sides respectively. Each player chooses a pawn and places it on the start square before rolling the dice.

Dice

In intermediate mode, only the tetrahedral and dodecahedral dice are used.

Hourglasses

The hourglasses measure time intervals of 15 and 30 seconds. The response time is indicated next to each question and is mostly either 15 or 30 seconds. When the response time is longer, it is necessary to turn the 30 seconds hourglass over (1 minute) or use the two hourglasses in sequence (45 seconds), or an appropriate combination to measure the required response time.

Famous mathematician figures

These pieces are to be placed on the board at the start of the game; the number of figures depends on the number of players. They are of great significance as holding them ensures victory. The figures must be visible to all players and are therefore placed in front of each player.

"Challenge tokens"

Each player receives one "challenge" token at the start of the game. Any remaining tokens are placed on the board in the quantities indicated opposite and can be collected by players when landing on a square with the same symbol. Challenge tokens are placed back on the board after use.

ON THE BOARD AT THE BEGINNING OF THE GAME

2 players	1 series of 6 figures
3 players	2 series of 6 figures
4 players	3 series of 6 figures
5 players	4 series of 6 figures

"Roll the die tokens"

Each player receives one of each type at the beginning of the game. Any leftover tokens are placed on the board in the quantity indicated below and can be collected by any player landing on the square bearing the same symbol. When a player decides to use a "roll the die" token for an additional turn, it is placed back on the board.

2 players	3	3	3	8
3 players	4	4	4	7
4 players	5	5	5	6
5 players	5	5	5	5

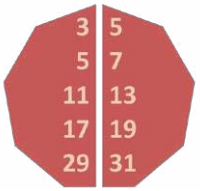
"×2 tokens"

These tokens double the question response time and are placed back on the board after use.

"Fields Medal tokens"

At the start of the game all 3 tokens are placed on the board. When a player lands on square 21, he/she collects a "Fields Medal" token. The token is placed back on the board when it is used in exchange for a famous mathematician figure or for a "Challenge" token.

The nonagon



The hemi-nonagons

In fact, it is more correct to say two hemi-nonagons given that it is divided into two equal symmetrical parts. They feature the twin prime numbers included on the board ("twin" primes are separated by a single number, which of course is an even number).
The player collects a hemi-nonagon when landing on the square bearing a twin prime number. irrespective of answering the question.
The aim is to acquire the other half in order to create a whole nonagon.

Chance cards

Chance cards are drawn when landing on squares 0, 14 and 28 and indicate opportunities, benefits or penalties.

Question cards

There are 208 double-sided question cards featuring questions on arithmetic and geometry or related issues. Each set of questions has 4 levels of difficulty making a total of about 1,600 questions when taking into account both sides. The answers can be found in the footer section of the reverse side of each question card.

When a player lands on a yellow card square, the Dealer draws a card and hands it to the player who then reads the question aloud without turning the card over where the answers are located.

Once an answer is given, the Dealer checks whether it is correct. In case the question cards run out on one side, simply turn the deck of cards around in the display case and use the questions on the reverse side.

When there are players of different ages or mathematical knowledge, the difficulty level can be adjusted for each player. For example, level 1 players will always be asked questions at level 1 while level 3 players will always answer level 3 questions.

The difficulty level of the questions is decided prior to commencing play. Nonetheless, if during the course of the game the level of one or more players appears inadequate, it can be changed by unanimous decision.

Rules

Starting the game. Unfold the game board and position the Chance cards, pawns, dice and the hourglasses. Shuffle the cards and place them in the case provided.

Each player receives a dodecahedral "Roll the Die" token, a tetrahedral "Roll the Die" token, a "Challenge" token, and a "×2" token.

Next, the three "Fields Medals" and the hemi-nonagons are placed on the board alongside the other tokens and famous mathematician figures, in the quantity specified in the description section of the game booklet.

After placing the pawns on the starting "0" square, players roll the dodecahedral die. Whoever scores the highest number or is the first to score 12 starts the game. During the first round, each player selects their pawn.

End of the game and declaring the winner. The game ends:
1 - when a player has collected the six different famous mathematician figures;
2 - when the last famous mathematician figure has been removed from the board. The player with the highest number of figures is then declared the winner;
3 - after a set time: the player who, at the expiry of the set time has the highest number of famous mathematician figures, wins.

With reference to scenarios 2 and 3 above, should two or more players have an equal number of famous mathematician figures, there is an elimination challenge between the players concerned. They proceed by drawing cards and answering questions in turn; an incorrect answer by a player leads to their elimination. Whoever scores the lowest number with the dodecahedral die begins the challenge. The last remaining player is the winner.

Attention: notwithstanding that the aim of the game is to collect the famous mathematician figures, no single player can possess more than one figure of the same mathematician. In other words, duplicate figures cannot be retained to prevent other players from taking them. When a player lands on a famous mathematician square whose token he/she already owns, the token is simply left on that square.

Game rounds. When a player rolls the dice and moves his/her pawn, he/she is deemed to be "in turn" or "active" . The dice are passed to the next player at the end of each turn. Play proceeds in a counterclockwise direction, i.e. to the player on the right.

The "Dealer". The role of Dealer is alternated between players for either a number of rounds or a set time, for example for 30 minutes. This should be decided prior to commencing play. Alternatively, if a player volunteers to be the Dealer for the duration of the game and receives unanimous approval, there may also be a fixed dealer.

The Dealer's tasks include drawing a card and handing it to the player whose turn it is when he/she lands on a yellow card square. The player reads the question out loud, but cannot turn it over to view the answers located on the reverse side.

The Dealer also has the task of monitoring response times with the aid of the hourglasses as well as checking the accuracy of the answers. The Dealer is the only player who may use an electronic calculator and only when checking another player's answer.

Rolling the dice and moving pawns. The player whose turn it is chooses to either roll the dodecahedral (1-12) or the tetrahedral (1-4) die and advances to the square equal to the score indicated by the die. At the start of the game, the pawn moves in a counterclockwise direction from the starting square (in the direction of the arrow). Players can also choose to move in a clockwise direction, but only when a prime number (2, 3, 5, 7 or 11) is rolled and only for the turn in question.

Players can also decide to "pass" either before or after the roll of the die deciding not to move their pawn. In this case, the pawn remains on the same square without answering a question.

Landing on a square. When a player lands on a square, the actions foreseen are carried out. When landing on a yellow card square, the Dealer draws a question card and hands it to the player whose turn it is. The player reads the card aloud, as previously mentioned without looking at the reverse side, where the answers are located. The response time for each question is indicated on the card and is either communicated by the Dealer or read by the player holding the card. The response time starts when the Dealer or active player has finished reading the question.

If the player responds correctly, he/she leaves the pawn on the arrival square and receives any associated benefits, namely a token or, in the case of famous mathematician squares, a valuable figure of the mathematician featured on that square, providing it is available on the board.

If the player responds incorrectly, the pawn remains on the departure square of the previous turn without benefiting from any of the actions provided on the arrival square. In a nutshell, players advance by answering questions correctly and receiving the associated benefits; wrong answers generate a status quo with no advancement.

"Roll the dice" tokens. At the beginning of the game each player receives two tokens; one dodecahedral die token and one tetrahedral die token.

Players landing on prime number squares, the foundation blocks of arithmetic, and who correctly answer a question, withdraw the apposite token if available from the board.

The token can be traded in by the player holding it during their turn (even the current one), and generates an additional roll with the specific die represented on the token. After use, the token is placed back on the same symbol location, ready to be collected later either by the same player or other players.

The token can also be traded in when a player lands on a square with the instruction to “skip a turn”. In this case the player can use the token to take his/her turn normally.

The token cannot however be used if the player answers a question incorrectly.

Players are not obliged to use tokens and can use them at their own discretion.

“Challenge tokens”. At the start of the game each player receives a token bearing a challenge symbol. Players can collect an additional token upon landing on a square with a challenge symbol, if available on the board, provided that the question is answered correctly.

This token can be used at any time to challenge another player. As soon as an opponent lands on a square, the player with the token says “challenge” and places the challenge symbol token back on the board.

The challenge can only occur before the Dealer reads the question. If two players wish to challenge, the one who says “Challenge” first is selected.

The Dealer can now proceed by reading the question to the challenged player. A correct answer signifies that the challenged player has won and the challenger has lost his/her “Challenge” token. The winner is then entitled to reap the benefits featured on the target square. If the challenged player provides either an incorrect answer or one which is out of time then his/her pawn remains on the square occupied previous to the challenge, i.e. no move. In this case, the Dealer draws a new card and proceeds to ask the question to the challenger. Should the challenger give either an incorrect answer or one which is out of time, then the challenge terminates without any action, with the challenger losing the token and leaving his/her pawn where it is. On the other hand, if the challenger responds correctly thereby winning the challenge, he/she jumps to the target square and reaps the associated benefits.

Obviously, challenges are particularly interesting when they occur on one of the famous mathematician squares, where a valuable token can be collected or even poached by a challenger.

There is another important scenario that can give rise to a challenge. Should a player holding a “Challenge” token land on a famous mathematician square whose token he/she does not yet have and no tokens of this specific mathematician are available on the board, he/she may challenge a player who has it. This is done by saying the word “Challenge” followed by the player’s name.

The Dealer then reads the question to the challenged player and the challenge proceeds as described above. If the challenged player responds correctly, he/she wins without moving his/her pawn and the challenger gives up his/her token.

If instead the challenger wins, he/she collects the challenged player’s figure and places his/her pawn on the square of the famous mathematician whose figure he/she has just acquired.

“Fields Medal” tokens. This token is a reproduction of a medal awarded to the most prestigious mathematicians and the three replicas provided are positioned on the board at the corresponding symbol at the start of the game.

Players landing on square 21 collect a “Fields Medal” token which can be used in exchange for any of the famous mathematician figures available on the board. Players in possession of this token can use it at their discretion provided the decision is communicated prior to rolling the dice on their turn. The “Fields Medal” token is placed back on the board after use when the chosen famous mathematician figure has been collected.

If no “Fields Medal” tokens are available on the board when a player lands on square 21, he/she can challenge a player who has at least one of them. In case of a successful challenge, he/she wins the precious token, and if unsuccessful his/her pawn stays on square 21 with no action.

“Fields Medals” can also be used as “Challenge” tokens at the player’s discretion.

The nonagon. Each time a player lands on a twin prime number square and answers the question correctly, he/she collects a hemi-nonagon bearing that number, if available, from the board. The objective is to acquire the other half to then complete the nonagon. This is achieved by landing on a square with one of the numbers shown on the hemi-nonagon to be acquired and answering the question correctly. Players in possession of a complete nonagon can poach a famous mathematician figure from any another player, or collect one from the board if none of the other players has one.

Players should try to acquire two hemi-nonagons as quickly as possible. Players in possession of one hemi-nonagon endeavour to land on a square bearing a number featured on the other half as soon as possible. Indeed, if another player acquires the second half of the nonagon required by the first player to complete it, the latter is forced to relinquish his/her half and place it back on the board. Thus, only one player can hold a hemi-nonagon at any one time until the nonagon is either completed or collected by another player. The completed nonagon is used immediately in exchange for a famous mathematician figure after which the two parts are placed back on the board.

“×2” tokens. These tokens are collected, if available on the board, when landing on a square with the same symbol. They double the question response time and are placed back on the board after use.

Strategy. The number of sets of famous mathematicians available on the board is less than the number of players. The first player with a complete set of famous mathematician figures or the one with the highest number of them at the end of the game wins. In view of this, it is in the interest of each player to actively use challenges and complete nonagons so as to poach figures from other players and try to get “Fields Medals”.

We have seen that the game includes offers various random elements regarding the possession of figures which is heightened by the Chance cards. The decision to launch a challenge or use a “Fields Medal” should be taken in function of the most opportune moment to do so.

Checking for answers. The Dealer is responsible for checking the answer by reading it on the reverse side of the card.

Answers resulting from arithmetic operations can be expressed in different formats. For example, 1/4 can also be expressed as 0.25, 64 as 8^2, $0.\overline{3}$ (i.e. 0.3 periodic) as 1/3, and 0.015 as 1.5%. Answers with a correct value are considered correct even if they are expressed in a different format.

Objections to answers. In the event that a player contests another player’s answer, the Dealer’s opinion is final.

Variants. *Mathematicus* is a modular game whose rules provide for some flexibility; however, any variation to the game rules requires unanimous consent by all players.

Example of gaming in different modes and at different levels. When players have diverse knowledge, the situation described hereafter as an example is a possible alternative and if adopted is noted by the Dealer at the start of the game. Player A plays in basic mode, answering level 2 questions and also using “×2” tokens and hemi-nonagons. Player B plays in normal mode answering level 3 questions, but also answers advanced mode questions that require the use of the Slide Rule and calculations in Arabic and Chinese numerical systems. Player C plays at advanced level, answering level 4 yellow card questions as well as blue card questions, with the exclusion of questions requiring calculations in the Mayan, Babylonian, and binary systems.

Permitted equipment. Players can use pen and paper, as well as the Slide Rule if they know how to use it, to answer questions, make calculations and review data concerning geometric figures, that are the subject of some questions.

Advanced game mode

The basic rules are the same as those applied to the intermediate mode. All the information required to play in advanced mode, as well as various examples of issue resolution are laid out in the initial section of the booklet. As a result, only equipment and specific rules regarding advanced play are presented hereafter.

Dice

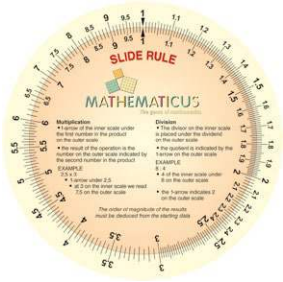
In addition to the tetrahedral and dodecahedral dice, the icosahedral and the binary dice can also be used in advanced mode.

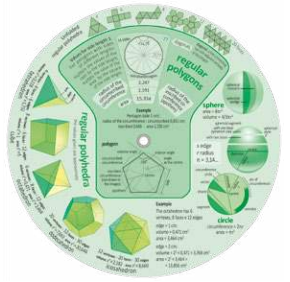
Binary numbers

The corresponding binary number is located above each square from 0 (0) to 34 (100010).

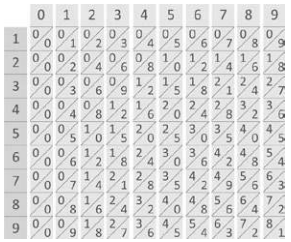
Rules

Playing in advanced mode allows players to familiarize themselves with ancient calculation tools, namely Napier’s Bones and the Slide Rule, and also with interesting numeric systems used by various former civilizations. Binary calculation, an essential tool in today’s world of electronics and information technology, is also used. The advanced game also foresees making basic mental calculations, according to the techniques illustrated in the book.





Above: the Slide Rule. On the back, information on plane figures and solids. Below: Napier’s Bones.



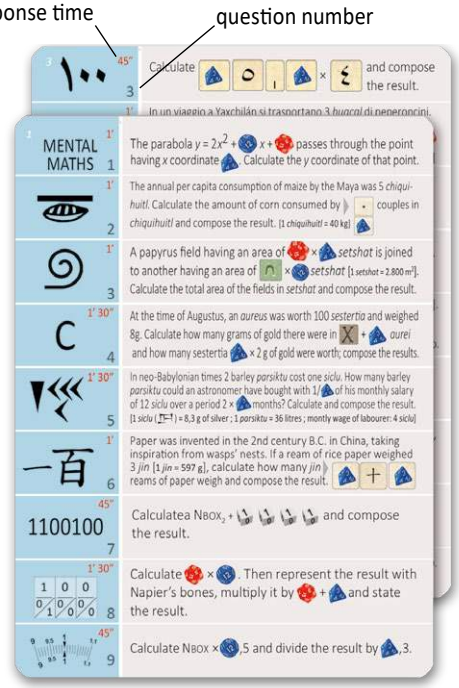
In the advanced game mode, players landing on yellow card squares answer level 4 questions, as well as advanced blue card questions when landing on a blue card square. The calculation resulting from the various numeric systems is composed using the small symbol tiles that feature the numbers used in those systems (to be placed neatly on the board at the start of the game). The response time counts down from the moment the player rolls the dice required for the calculation or, in the use of Napier’s Bones, from the time they are placed on the table for calculation.

All calculations using digits from the various numeric systems give results that never exceed the number 240. To verify an answer, the Dealer or a player can consult the table provided at the end of the booklet which lists all the numbers from 1 to 240 expressed in the various numeric systems.

The Dealer can alternatively use an electronic calculator to verify the correctness of answers relative to mental calculations and those made with the Slide Rule and Napier’s Bones. Binary calculation results can be verified using the the tables available at the end of the book or using binary calculation applications available for smartphones.

Answers calculated using the Slide Rule are considered exact if the deviation is within 5% of the correct one (allowed to compensate for small set-up inaccuracies or instrumental errors).

ADVANCED CARD



The symbols represent the number 100 in the various numeral systems

With regard to the various ancient or exotic numeric systems, the necessary numbers are visible in squares 4, 6, 11, 19, 29 and 34, and can easily be consulted to help find the answer.

Advanced question cards

These are used in the advanced mode game when the player whose turn it is lands on one of the blue card squares (squares featuring the various ancient or exotic numerical systems and famous mathematician squares). Each advanced question card presents problems to be resolved using either mental calculation or the Slide Rule or Napier's Bones, or special cards featuring numbers from the various numerical systems to represent the numbers.

The calculation numbers are not predetermined and are obtained by rolling the indicated dice. The number shown in the Indo - Arabic (NSQ) or binary digits (NSQ2) square on which the player has landed can also be used in the calculation. For example, the calculation to be resolved using Napier's Bones shown in this extract, requires multiplying the score obtained by throwing the icosahedric and dodecahedric dice, using Napier's Bones to represent the result, and then finally, still using Napier's Bones, multiplying it by the sum of the numbers obtained from the roll of the two indicated dice and announcing the result.

Another example is the binary calculation question shown opposite which requires composing the binary number obtained by adding together the binary numbers shown in the square occupied by the pawn using small tokens (e.g. square 25 would be expressed as 11001) and the digits of the binary numbers obtained from 4 successive rolls of the binary die. If the roll numbers were to be 1011 then the answer would be the the sum of 11001 + 1011. Should the first digit or digits resulting from the die be zeros, then only the successive ones commencing with the initial 1 obtained are considered. If all throws produce zeros, then the sum coincides with the binary number of the square.

The cards have different numbers (from 1 to 9) for the same type of calculation and are concealed by the Dealer. When a player whose turn it is lands on a blue card square, the Dealer draws an advanced card and, without revealing it, asks the player to give a number between 1 and 9 to represent the chosen question to be asked. This is done to ensure randomness in the questions asked to players. Once the player has answered, the Dealer reveals the card and lets the player keep it.

Whenever an advanced card is used, the Dealer shuffles the deck and places it face down, so that players are not able to determine the next card to be drawn.

Intermediate game mode rules apply to all other aspects of the game.

Nature is a book written in the language of mathematics.

Galileo Galilei

Go down deep enough into anything and you will find mathematics.

Dean Schlicter

Mathematics knows no races or geographical boundaries; for mathematics, the cultural world is one country.

David Hilbert

To those who do not know mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty, of nature.

R. P. Feynman

Mathematics seems to endow one with something like a new sense.

Charles Darwin

[How to]... teach young people the elements of geometry ... go back to the sources and follow the path of our discoveries and the needs that have produced them.

Voltaire quoting Alexis Clairaut

A GAME FOR EVERYONE

In order to play *Mathematicus* and appreciate the contents of the attached book, we need the knowledge of elementary mathematics that we all learned in the first didactic cycles and that are listed below:

- Knowledge of the four operations: addition (+), subtraction (–), multiplication (×) and division (: or ÷). For the division sign the symbol /is also used. Therefore 6:4 can also be written as 6/4. The multiplication is indicated by the sign ×, but in the case where a number is represented by a letter the symbol can be omitted; for example $2 \times a$ is also *written* as $2a$.
- Knowledge of the meaning of equal (=), greater than... (>), less than... (<), percentage (%).
- Knowledge of the operation of exponentiation. The notation n^2 means that the number n is raised to the second power or square, that is multiplied by itself; $n^2 = n \times n$. The notation n^3 means that the number n is raised to the third power; $n^3 = n \times n \times n$. And so on.
  Examples: $3^2 = 3 \times 3 = 9$; $3^3 = 3 \times 3 \times 3 = 27$; $3^4 = 3 \times 3 \times 3 \times 3 = 81$.
- Knowledge of the root operation, understood as the inverse operation of the elevation to power. Finding the square root of the number n means finding the number that is squared by n. The square root of 9 is 3 because $3^2 = 9$; in symbols: $\sqrt{9} = 3$. Similarly for the cubic root, fourth, etc. The cubic root of 27 is 3 because $3^3 = 3 \times 3 \times 3 = 27$; in symbols: $\sqrt[3]{27} = 3$.
- Knowledge of the arithmetic mean or average between two numbers. The arithmetic mean between two or more numbers is obtained by summing the numbers and dividing the result by the number of the values considered.
  For example, the average of the numbers 7, 18, 3 and 40 is: (7+18+3+40)/4=17.
  The average of the numbers 4 and 5 is (4+5)/2 = 4.5.
- Knowledge of the concept of reciprocal or inverse. The reciprocal of the number a is $1/a$, that is the number that multiplied by a gives as a result 1. Examples: 1/4 is the reciprocal of 4 (in fact 1/4×4=1); the reciprocal of 20 is 1/20=0.05.
- Knowledge of the "factorial" symbol. The factorial of a natural number n, denoted by $n!$, is the product of positive integers less than or equal to that number. Example $5! = 5 \times 4 \times 3 \times 2 \times 1$.
- Round and square brackets are used in the game. The calculations are made first within the brackets and the determined value is used in the continuation of the calculation with the values outside the brackets. Example: 3+[50/2–(3×4)]: you run before 3×4; then 25–12; then 3+13=16. The order of the operations to be performed when there are no brackets is: 1) elevation to power and root; 2) division and multiplication; 3) addition and subtraction. In the example above, when you get to 50/2–12, you first do the 50/2=25 division and then the 25 – 12 = 13 subtraction. Sometimes brackets are used in game documentation even when they are unnecessary to highlight the operations to be performed first.

  In the game commas in numbers separate thousands and decimals are separated by points. We notice that in the non-Anglo-Saxon world they behave in the opposite way. What in England, the USA or China is written 52,318.74 in Italy or France is written 52.318,74.

Mathematical curiosities are presented in the squares and in the book that sometimes imply more complex concepts, the understanding of which is not necessary for the game.
These concepts are in any case explained starting from the basic notions set out in these pages.

Abbreviations and symbols

min	minute	m	metre	ft	foot /feet	l	litre
sec	second	g	gram	°C	Celsius degree	HP	horsepower
h	hour	t	ton	°F	Fahrenheit degree	b.c.e.	before the common era

Recurring terms

absolute value It is the value of a number regardless of the sign. It is indicated by placing the number between two vertical dashes; Thus $|a|$is theabsolute value of a and $-a$.
Example: |4| represents the absolute value of 4 and -4.
complement The complement a of a number n with respect to the number m (greater than n) is the number to such that $n + a = m$.
Examples: 2 is the complement of 8 to 10;
21 is the complement of 79 to 100.
natural number Null or positive integer: 0, 1, 2, ...
negative number Number less than 0.
numerical root The numerical root of a number is the result of the sum of its digits, repeated until a monocifre value is obtained, then between 0 and 9. The numerical root of 358 is 7. In fact 3 + 5 + 8 = 16 and then 1 + 6 = 7.
palindrome number A number that has the same value if the digits are read from the left or right. Examples: 1331; 5678765.
pandigital number A number that includes at least once all digits from 0 to 9.
periodic decimal number Number that after the comma has a string of digits that repeat to infinity. This string is called the period. Many periodic numbers have a finite string of digits before the period, called antiperiode.
The period is indicated by a continuous line superimposed on its figures. Examples: 4.333... is represented with $4.\overline{3}$; 8.43555... with $8.43\overline{5}$.
positive number Number greater than 0.
Prime number Natural number other than 0 and 1 that has only itself and the unit as dividers. Two prime numbers that appear in pairs, separated by a single even number, are called prime twins. Examples: 5 and 7; 17 and 19. Semiprime is a number that is the product of two prime numbers, not necessarily distinct Examples: 4 = 2×2; 21 = 7×3.
A reversible prime or emirp (prime written backwards) is a prime number whose digits, written in reverse order, give rise to another prime number. Example: 157 and 751 are prime and emirp.
whole number Zero or positive number (natural number) or negative number: ... -3, -2, -.1, 0, 1, 2, 3, ...

NOTE

The cards show numeric information about many facts and phenomena. In some cases these figures have been slightly rounded to limit the number of significant figures in the calculations to be made.

In the game the dates before the common era are indicated with the words b.c.e. (*before the Common Era*) or sometimes with the sign –. Remember that the commonly used Gregorian calendar does not cover the year 0.

The publisher and the author are grateful to players, schools and associations who wish to share proposals for new card content, with or without illustrations, which can possibly be adopted for future editions of the game.

The author

Cesare Baj dedicated his life to the diffusion of science. He has collaborated with many publishing houses and has written works of astronomy and aviation. He founded and directed the science magazine for young adults *Newton*.
As an expert in analog computing, he designed hundreds of slide rules.

The preparation of the game has made use of the advice of Simonetta Di Sieno, former director of the research centre "matematita", of members of the Unit of Milan-Città Studi of the same centre and of the members of the PRISTEM Centre of the Bocconi University of Milan.

The translation and the supervision of the English edition was done by the mathematician Morgan Rogers, a graduate of the University of Cambridge, during his doctoral studies in mathematics at Università dell'Insubria in Como, Italy. He has since gone on to post-doctoral research at LIPN in Paris, France.
The translation of the Instruction booklet was done by Victoria Finch.

For more information : **www.mathematicus.it**

SAFETY INFORMATION

Recommended age: 8 years and up.
ATTENTION! Not suitable for children under 3 years of age.
It contains small parts that could be swallowed causing suffocation.
To be used by children under the direct supervision of an adult and to be stored in places inaccessible to them.
The use of the game takes place under the complete responsibility of the buyer.
For safety information contact the manufacturer:

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Via Raimondi 8 - 22041 Colverde (Co)
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This booklet is an integral part of the MATHEMATICUS® board game

Designed in Italy
Printed in China

The game is designed in accordance with principles of respect for the environment and recyclability of materials and is produced in compliance with the regulations in force.