

National Aeronautics and
Space Administration

Langley Research Center
Hampton, VA 23681-2199

Educational Product

Educators

Grades 6-8

EG-2003-01-01-LARC

NASA CONNECT™

Special Edition: World Space Congress 2002: The New Face of Space

An Educator Guide with Activities in Mathematics, Science, and Technology





Special Edition: World Space Congress 2002: The New Face of Space is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address:

<http://spacelink.nasa.gov/products>

A PDF version of the educator guide for NASA CONNECT™ can be found at the NASA CONNECT™ web site: **<http://connect.larc.nasa.gov>**

NASA CONNECT™ is produced by the NASA Center for Distance Learning, a component of the Office of Education at NASA's Langley Research Center, Hampton, VA, and is a collaborative endeavor of NASA with the following organization. The NASA Center for Distance Learning is operated under cooperative agreement NCC-1-02039 with Christopher Newport University, Newport News, VA.



***Special Edition: World Space
Congress 2002:
The New Face of Space***

An Educator Guide with Activities in Mathematics, Science, and Technology

Program Overview

Summary and Objectives 5
 Student Involvement 5
 Hands-On Activity 5
 Resources 5

Hands-On Activity


Background 6
 National Standards 6
 Instructional Objectives 7
 Vocabulary 7
 Preparing for the Activity 7
 Student Materials 7
 Time 7
 Advance Preparation 7
 The Activity 8

Student Worksheets

Tivot Game Pieces 14
 Student Score Sheet 1 17
 Student Score Sheet 2 18
 Game Sheets 19

Resources

Web Sites 27

 Registered users of NASA CONNECT™ may request an American Institute of Aeronautics and Astronautics (AIAA) classroom mentor. For more information or to request a mentor, e-mail nasaconnect@aiaa.org.

 Captioning provided by NEC Foundation of America

Acknowledgments: Special thanks to TIVY Inc., Steve Scully, Chris Giersch, Bill Williams, and The National Council of Teachers of Mathematics (NCTM).



Program Overview

SUMMARY AND OBJECTIVES

In *Special Edition: World Space Congress 2002: The New Face of Space*, students will learn how space offers continually expanding resources for commerce, science, technology, and education. From the discovery of distant planets to medical advancements, from geological exploration to urban

planning, from water on Mars to energy sources in developing nations, students will find it all here. Students will also have an unprecedented look at how advances in space can and do improve life on Earth.

STUDENT INVOLVEMENT

Hands-On Activity



The hands-on activity, developed by TIVY, Inc. in cooperation with NASA, is aligned with the National Council of Teachers of Mathematics (NCTM) standards. Students will play an exciting mathematics-based strategy and critical thinking game that will enhance their basic mathematics skills of addition, subtraction, multiplication, and

division by using decimals, fractions, percentages, integers, square roots, and exponents.

RESOURCES

Teacher and student resources (p. 27) support, enhance, and extend the NASA CONNECT™ program. Books, periodicals, pamphlets, and web sites provide teachers and students with background information and extensions. In addition to the resources listed in the educator guide, the NASA CONNECT™ web site, <<http://connect.larc.nasa.gov>> offers online resources for teachers, students, and parents.

Hands-On Activity

BACKGROUND

TIVY, is a unique, competitive mathematics game designed to motivate students in grades 4-8, particularly those that have never taken an interest in mathematics before, to improve both mathematics and critical thinking skills. TIVY, Inc. introduced Baseball TIVY with the support of the Major League Baseball (MLB) team, the New York Yankees, to New York schools in the Bronx in 1997. Baseball TIVY popularity has expanded nationwide. In an effort to expand the program, games have been distributed to date to schools in Los Angeles, San Diego, Anaheim, New York, Arlington, Dallas, Ft. Worth, Detroit, Orlando, and Tampa. This expansion has been made possible because of the teachers and the support of MLB teams such as the Los Angeles Dodgers, the Anaheim Angels, the San Diego Padres, the Yankees, the Texas Rangers, the Detroit Tigers, and the Tampa Bay Devil Rays.

TIVY features five important elements to promote the success of mathematics education. The following are the five elements, with an explanation of each element regarding to the game.

1. Strategy – planning moves to create the highest scoring mathematic problems while incorporating blocks, traps, and forced moves against the opponent.
2. Critical Thinking – thinking ahead and changing strategy according to an opponent’s moves.
3. Responsibility – proofing and approving the accuracy of an opponent’s mathematic scores and compliance with the rules.
4. Attitude – maintaining a good attitude by completing the game like a winner, even if losing becomes apparent.
5. Mathematics Accuracy – creating and solving mathematic problems to determine the highest possible score.

TIVY, Inc. in cooperation with NASA, has developed a Space TIVY game for students in grades 6-8. This game incorporates the NASA CONNECT™ characters, Norbert and Zot.

NATIONAL STANDARDS

Mathematics (NCTM) Standards

- Work flexibly with fractions, decimals and percents to solve problems.
- Develop an understanding of large numbers and recognize and appropriately use exponential, scientific, and calculator notation.
- Understand the meaning and effects of arithmetic operations with fractions, decimals, and integers.
- Understand and use the inverse relationships of addition, subtraction, multiplication, and division, and of squaring and finding square roots to simplify computations and solve problems.
- Select appropriate methods and tools for computing with fractions and decimals from among mental computation, estimation, and paper and pencil, depending on the situation. Apply the selected methods.
- Recognize reasoning and proof as fundamental aspects of mathematics.
- Analyze and evaluate the mathematical thinking strategies of others.



INSTRUCTIONAL OBJECTIVES

The student will

- improve and enhance arithmetic skills by using fractions, decimals, integers, exponents, and square roots through a fun and challenging game.

VOCABULARY

tivot – the moveable playing piece

PREPARING FOR THE ACTIVITY

Student Materials (2 per student group)

tivot game pieces (p. 15)
Student Score Sheet 1 (p. 17)
Student Score Sheet 2 (p. 18)
game sheets (p. 19)
pencil

Time

Discussion of the activity 15 minutes
Preparing for the activity 5 minutes
Conducting the activity 30 minutes (per game)

Advance Preparation

For each group:

1. Copy and cut out all the tivot pieces and organize them by color. You may want to laminate the tivots to avoid any tearing or bending.
2. Copy the game board and assemble using clear tape.

THE ACTIVITY

Step 1: Introducing the game

- A. Organize students into groups of two.
- B. Distribute a game board and the necessary materials for each group.
- C. Announce the objective of the game. "Move your tivot from your home base across the asteroid field to capture score goals in Norbert's home world that will give you the highest point score."

Example: When using the tivot symbol with the following numbers, both players must play with the same symbol and numbers:



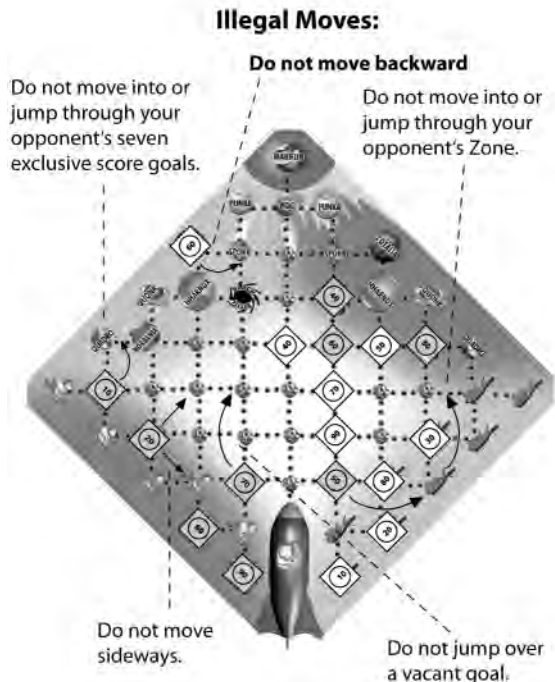
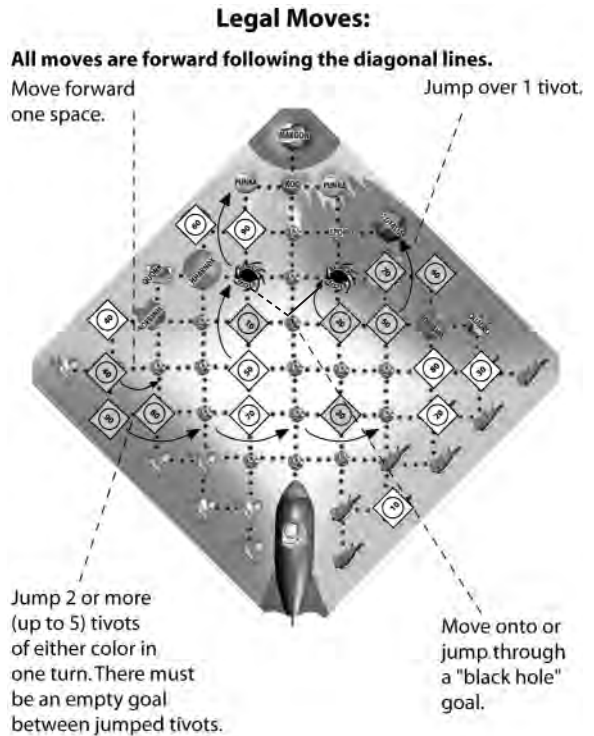
On Game Sheet #1, the score goal values are



Note: Each player has **seven exclusive identical** score goals in Norbert's home world. The two score goals in the center of Norbert's home world are "**common**" score goals and are first-come, first-score.

Your highest tivot value, 60, should capture the best score goal \square_{x7} to give you a high score of $60 \times 7 = 420$. Your next highest tivot value is 50, and you should capture the next best score, which would be \square_{x3} to give you a score of $50 \times 3 = 150$, etc.

The following are legal moves and illegal moves:



Step 2: Playing the game

A. To select the pivot color of each player, one player holds a different color pivot in each hand. The other player chooses a hand and plays with the color chosen.

Note: The white pivot player moves first. The gray pivot player gets the last move if a legal move is available. There is no advantage in moving first.


B. Choose the game sheet the students want to play. There are six different game sheets to choose from, totaling 36 different games.

Note: Three games are provided in this educator guide. Three remaining game sheets and a blank sheet can be found at <http://connect.larc.nasa.gov>.

C. Choose the pivot symbol and numbers students want to use with the game sheet chosen. For example:


Example:
 Use these pivot sets for answers without remainders.

POSSIBLE REMAINDERS, NO NEGATIVES



Using these pivots may have answers with remainders or you can play with the whole number rounding.

POSSIBLE REMAINDERS

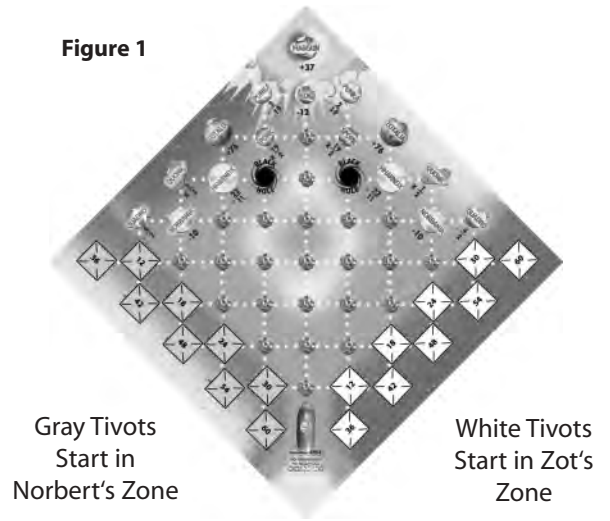


D. Have each player fill out the top part of the score sheet above the score grids.

Note: If the teacher decides to have students play the game with no remainder, decimal, or fraction answers or to have whole number rounded answers, students need to use Score Sheet 1. If the teacher decides to have students play the game with remainders, decimals, and fractions, students need to use Score Sheet 2.

E. Have the students place the pivots on the start goals (Norberts and Zots) in any order, with the chosen symbol and numbers facing up. See Figure 1.

Figure 1



F. To start the game, the white pivot moves first. The gray pivot gets the last move if a legal move is available.

G. Tivots only move or jump forward, following the diagonal lines.

H. Jump either color pivot. Multiple jumps in one turn are legal if you can jump one pivot, land on an empty goal, then jump another pivot, etc. Do not let go of the pivot until the move is final.

I. The student cannot pass a move if the student has a legal move available, even if it means moving from one score goal to another. However, if the student is trapped or blocked and has no legal move available, the student must pass his or her move to the opponent, provided he or she has a legal move. The same player could therefore make several moves in a row. The student must move again when a legal move becomes available.

J. When neither player has all the tivots on score goals, the game is not over until all legal moves are made, even if a pivot must move from one score goal to another of less value.

K. The game is over when one player captures all seven "exclusive" score goals and the two "common" score goals are captured, or when neither player has a forward legal move. See figures 2 – 5.

Note: Refer to page 10 for figures 2 – 5

1. when a player has all nine tivots on score goals, or

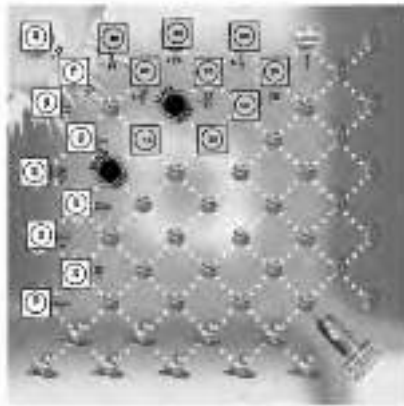


Figure 2

2. when a player has captured his seven exclusive score goals and his opponent has captured the two 'common' goals, or

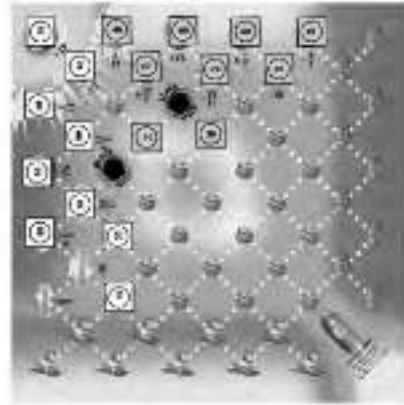


Figure 3

3. when a player has captured all seven exclusive score goals, one 'common' score goal, and his opponent has captured the other 'common' score goal, or

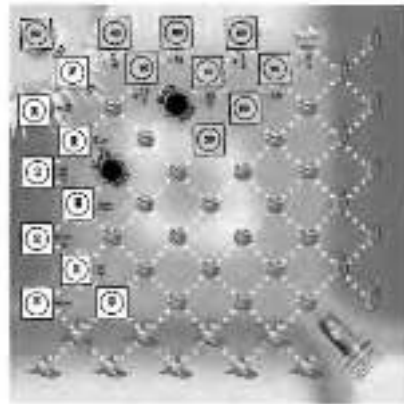


Figure 4

4. when neither player has a forward legal move remaining.

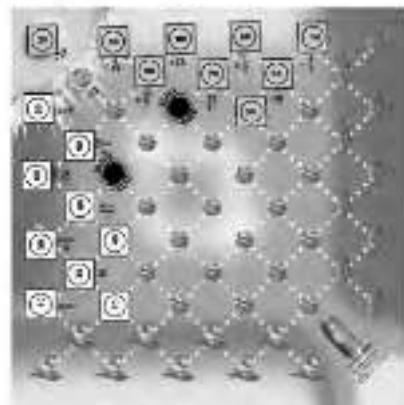
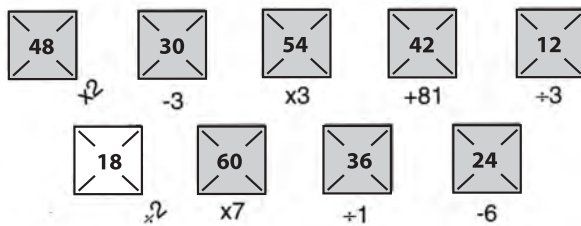


Figure 5

SCORING



All players fill out the MY SCORE guide on their score sheets as shown in the example for the gray player (captured goals are shown above; note that white captured one of the "common" goals).

After writing in all the tivot values and their captured score goal values (and mathematic operations), solve the problems and write the answers in the proper place-value columns, as shown.

After completing all your problems, add down for your total score.

MY SCORE						
Double-check your answers BEFORE giving to opponent!						
TIVOT VALUE	MATH OPERATION	GOAL VALUE	10,000's	1,000's	100's	TENS ONES
48	x	2			2	3
30	-	3				9 6
54	x	3			1	6 2
42	+	81			1	3 3
12	÷	3				4
60	x	7			4	2 0
36	÷	1				3 6
24	-	6				1 8
—	÷	2				
TOTAL SCORE					8	9 6



PROOF SCORES:

DOUBLE CHECK your ANSWERS! Then swap score sheets with your opponent and check his/her score sheet to be sure the pivot values, math operations, and goal values are written correctly. Then check for wrong problem answers. In center grid write OK for correct answers or write the correct answer if the opponent's answer is wrong.

MY SCORE						
Double-check your answers BEFORE giving to opponent!						
TIVOT VALUE	MATH OPERATION	GOAL VALUE	100/1000	1000/100	1000/1000	1000/1000
48	X	2 =				9 6
30	-	3 =				2 7
54	X	3 =		1	6	2
42	+	81 =		1	3	3
12	+	3 =				4
60	X	7 =		4	2	0
36	÷	1 =			3	6
24	-	6 =			1	8
-	÷	2 =				
TOTAL SCORE						8 0 6

OPPONENT			OPPONENT			
Check & write OK or correct answer			List correct answers or 0 for those incorrect			
						2 3
						9 6
						2 7
						1 6 2
						0
						4
						4 2 0
						3 6
						1 8
						7 6 3

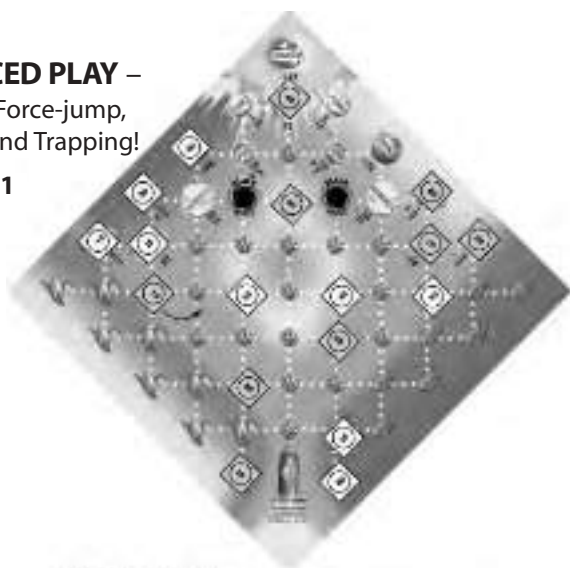
CHALLENGE your opponent if he/she says you have a wrong answer.

Make them prove it. If you both do not agree, call your coach or teacher. Circle the agreed upon final score.

ADVANCED PLAY –

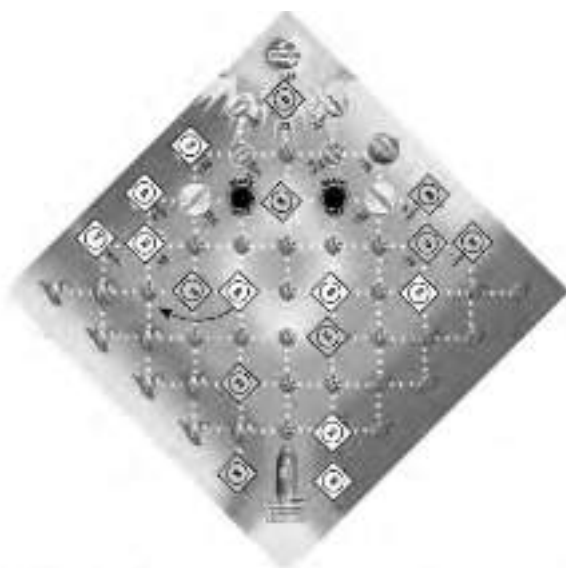
using the Force-jump, Blocking and Trapping!

EXAMPLE 1



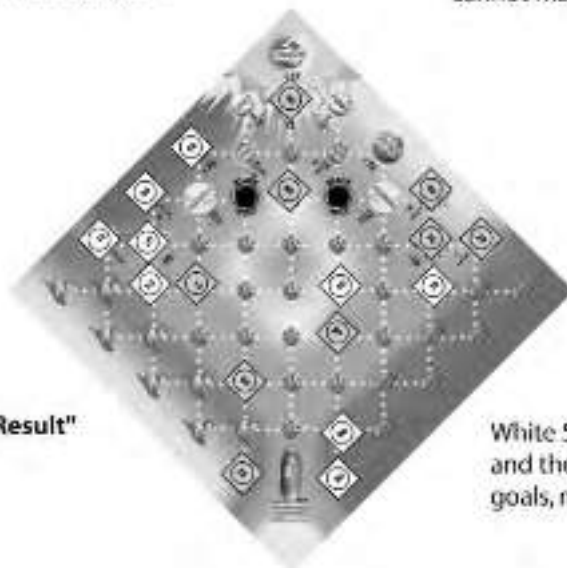
"The Set-up"

Above, move your gray pivot 10 to the open goal directly in front of white 50. Call "Force-jump, white 50 over gray 10."



"The Force-jump"

Above, white 50 must jump exactly as you direct. After jumping, white 50 is effectively trapped and cannot make further moves.



"The Result"

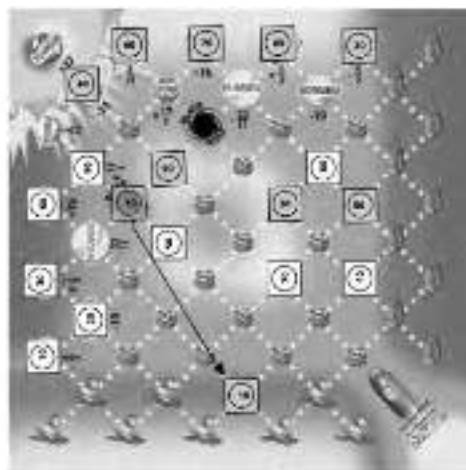
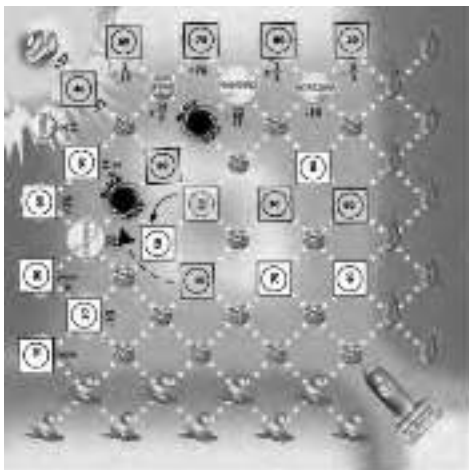
White 50 cannot go backwards or sideways and therefore cannot capture any score goals, much less the best score goal, x7!



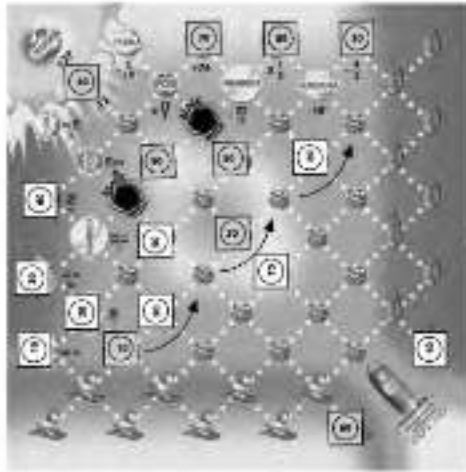
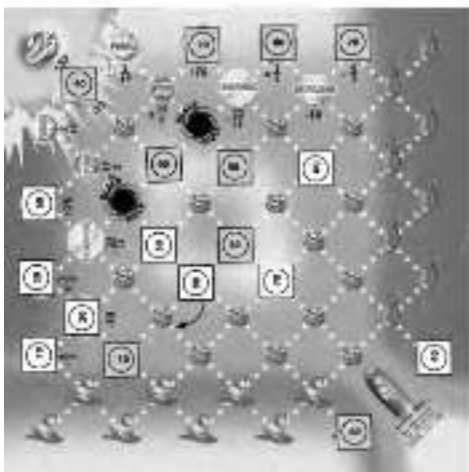
EXAMPLE 2 (force-jump onto a “fly-out” goal)

In the example below, White moves white 50 to an empty goal directly in front of the Gray 10 and says “Force-jump, your 10 over my 50.” Gray jumps as directed.

Since the gray 10 has been force-jumped onto a “blackhole” goal, gray must return the tivot to a start goal of his/her choice in his/her dugout.



MULTIPLE FORCE-JUMPS are also legal – You still must move your tivot to an open goal directly in front of the tivot that you are force-jumping. Also, the first and last tivots you force your opponent to jump in one turn **must** be your tivots.



As always, you must move your tivot into an open goal directly in front of the tivot you are forcing to jump. Then call “multiple force-jump” and tell your opponent which tivots can jump.

White can force gray to jump over his own gray tivot as long as the *first* and *last* tivots are white.

When your opponent forces you to jump, it counts as your turn and then becomes your opponent's turn again: UNLESS at the end of the force-jump there are other tivot, either color, that you wish to jump before you let go of your tivot. See figures 1 and 2 below.

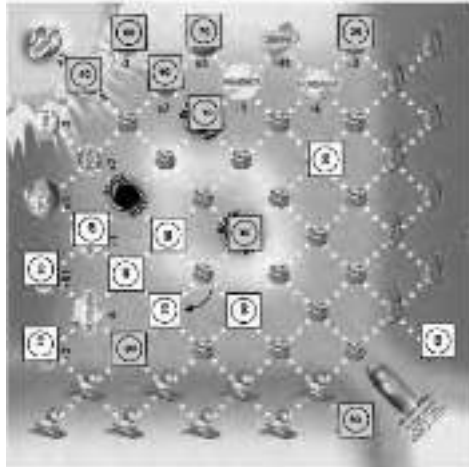


Figure 1

Above, white sets up a force-jump over white ONLY calls "force-jump, gray 30 over white 70." Gray must then jump white 70 with gray 30 .

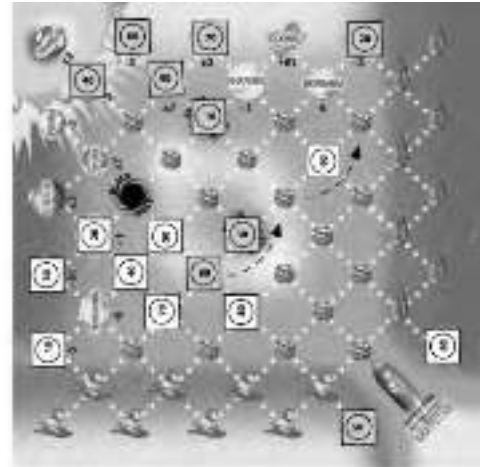
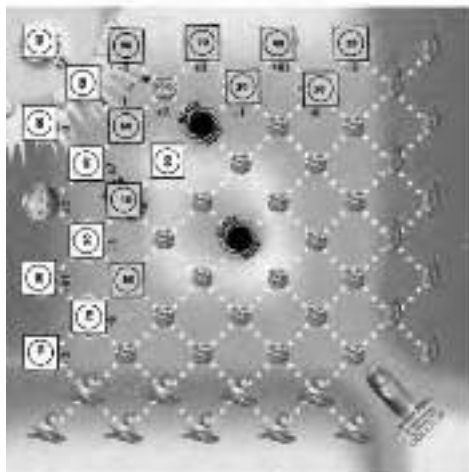


Figure 2

Above, gray can then choose to continue if legal jumps are available. By jumping gray 30 and white 90, gray 30 is four goals closer to a score goal. Remember, do not let go of your tivot until your move is finished.

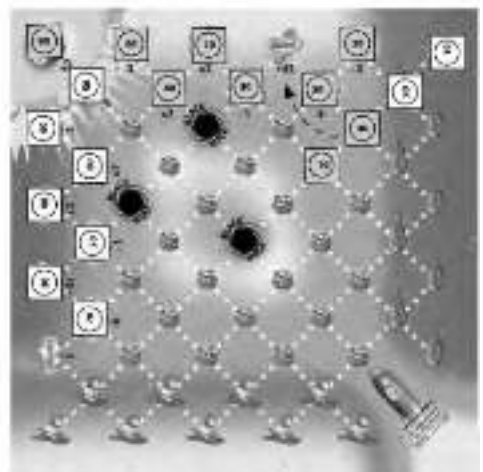
BLOCKING AND TRAPPING

Blocking and trapping, used carefully in combination with other strategies, can be effective.



Block

Above, gray has set up a block to keep white from capturing the x3 score goal. Gray's last move, gray 60 onto the x7, will end the game. Gray's final score is 806 to white's 733. If White had been allowed to capture the x3, white would have won with 895.



Trap

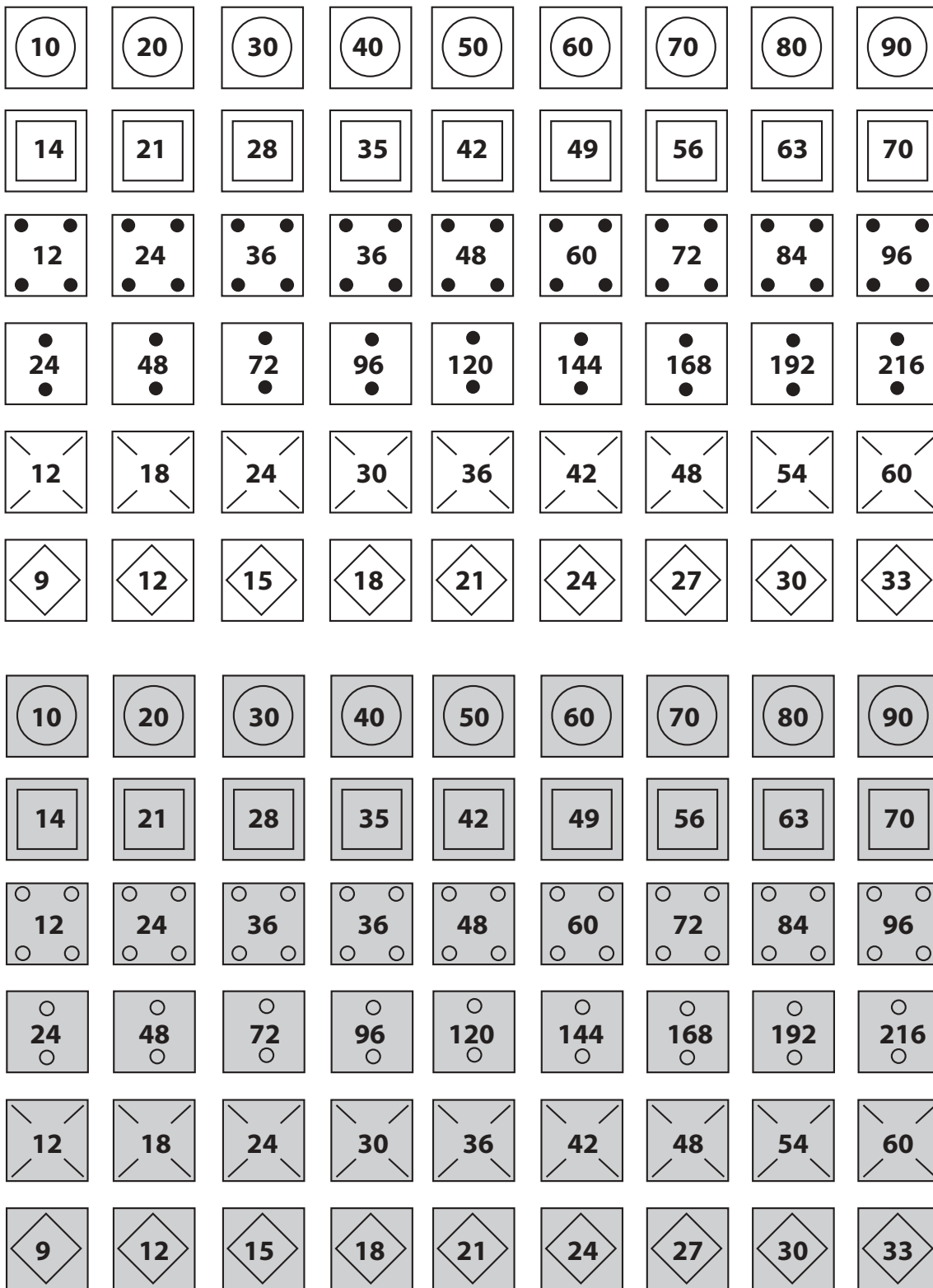
Above, gray has trapped white 90 and 10 is in Zot's zone (start goals). Gray's next move (gray 40 to the +81) will end the game. Gray wins with a score of 870 to White's score of 777. Traps must be used carefully; some are effective; some are not. Generally, a player must sacrifice at least 1 tivot to trap an opponent. In this case gray sacrificed only the 10, the lowest value tivot.

Instructions:

Cut out tivot game pieces (p. 15) and tivot game sheets (p.19-26). Game sheets should be front and back. Two sheets make up one board.



Tivot Game Pieces





Student Score Sheet 1

Use with gamesheets that have no remainder, decimal, or fraction answers or for whole, rounded answers.

"CIRCLE" TIVOT

USED THIS GAME

"CHECK" IF USING: Whole Number Rounding

My Name _____

Date _____ My Tivot Color _____ (WHITE MOVES FIRST) Gamesheet # _____

My School _____ My Grade _____

Opponent's Name _____

Scoring Incorrcet problem answers are given a 0 in the final score column. Once score sheet is given to opponent to check, you cannot change your answers. If you and your opponent disagree on answers, a teacher, coach or judge shall decide.

Rules:

- If Tivots, Math Symbols and Goal Values are not written correctly on Score Sheet, that problem gets **0**.

MY SCORE						
Double-check your answers BEFORE giving to opponent!						
TIVOT VALUE	MATH OPERATION	GOAL VALUE	1000's	100's	10's	ONE's
•	•	•				
•	•	=				
•	•	=				
•	•	=				
•	•	=				
•	•	=				
•	•	=				
•	•	=				
•	•	=				
•	•	=				
TOTAL SCORE						

OPONENT	OPONENT	OPONENT
Check & write OK or correct answer	List correct answers or 0 for those incorrect	Opponent's final check

FIGURING SPACE:

Student Score Sheet 2

Use with gamesheets that have
Remainders, Decimals, and Fractions.
Round decimals to the nearest
hundredth (100th).
Convert fractions to decimals.

"CIRCLE" TIVOT
USED THIS GAME

My Name _____ My Tivot Color _____ Gamesheet # _____
Date _____ (WHITE MOVES FIRST) My Grade _____
My School _____
Opponent's Name _____

Scoring Incorrect problem answers are given a 0 in the final score column. Once score sheet is given to opponent to check, you cannot change your answers. If you and your opponent disagree on answers, a teacher, coach or judge shall decide.

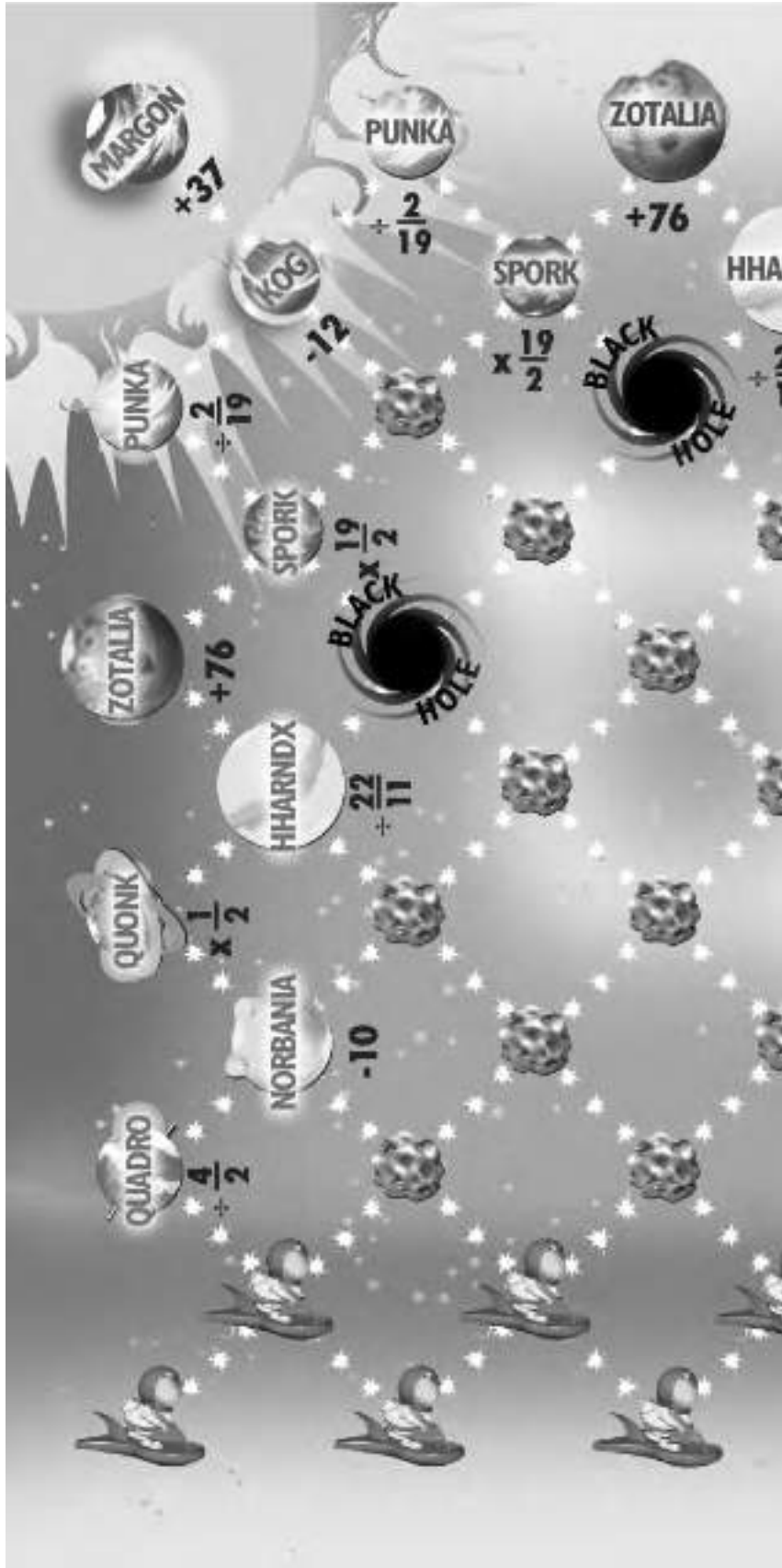
Rules:

- If Tivots, Math Symbols and Goal Values are not written correctly on Score Sheet, that problem gets 0.

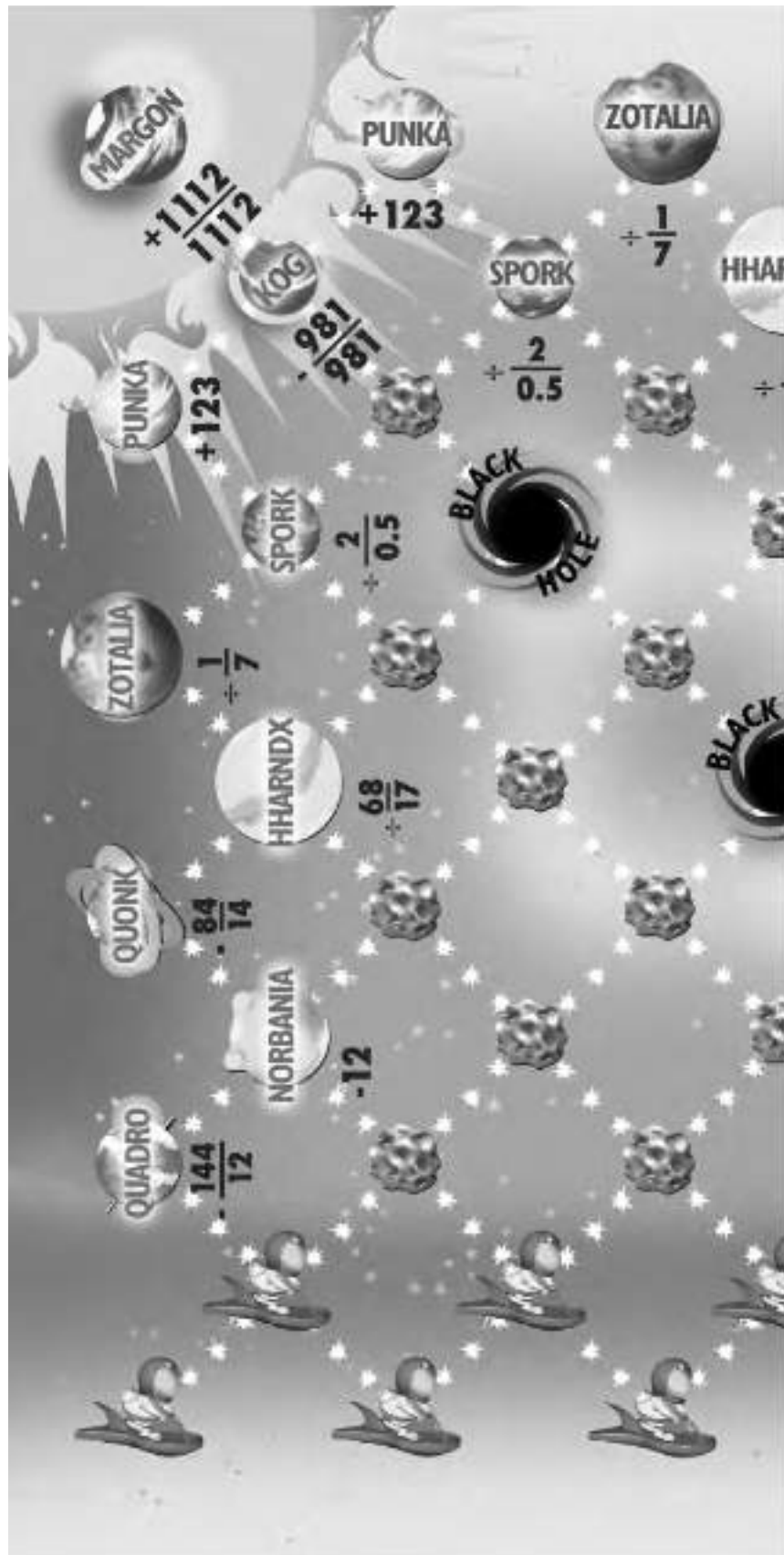
		MY SCORE							Opponent's final check
		Double-check your answers BEFORE giving to opponent!	Problem	Points	Goal	Math	Symbol	Operation	
TIVOT VALUE	MATH OPERATION VALUE	GOAL VALUE	Points	Goal	Math	Symbol	Operation	Opponent's final check	
•	•	•							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
•	•	=							
TOTAL SCORE									

FIGURING SPACE:
↑ Decimal Point

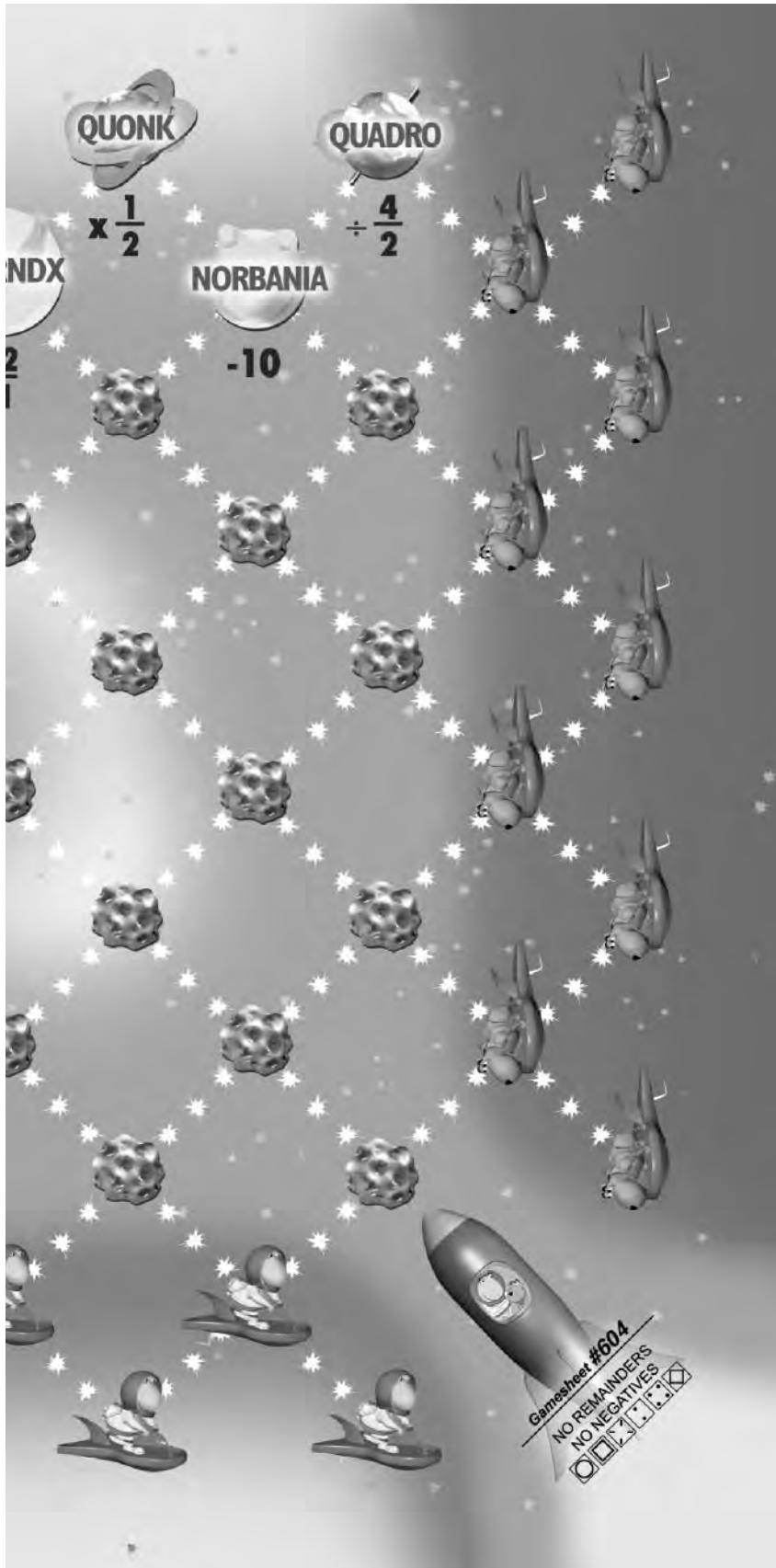
Game Sheet 604 (1)



Game Sheet 704 (1)

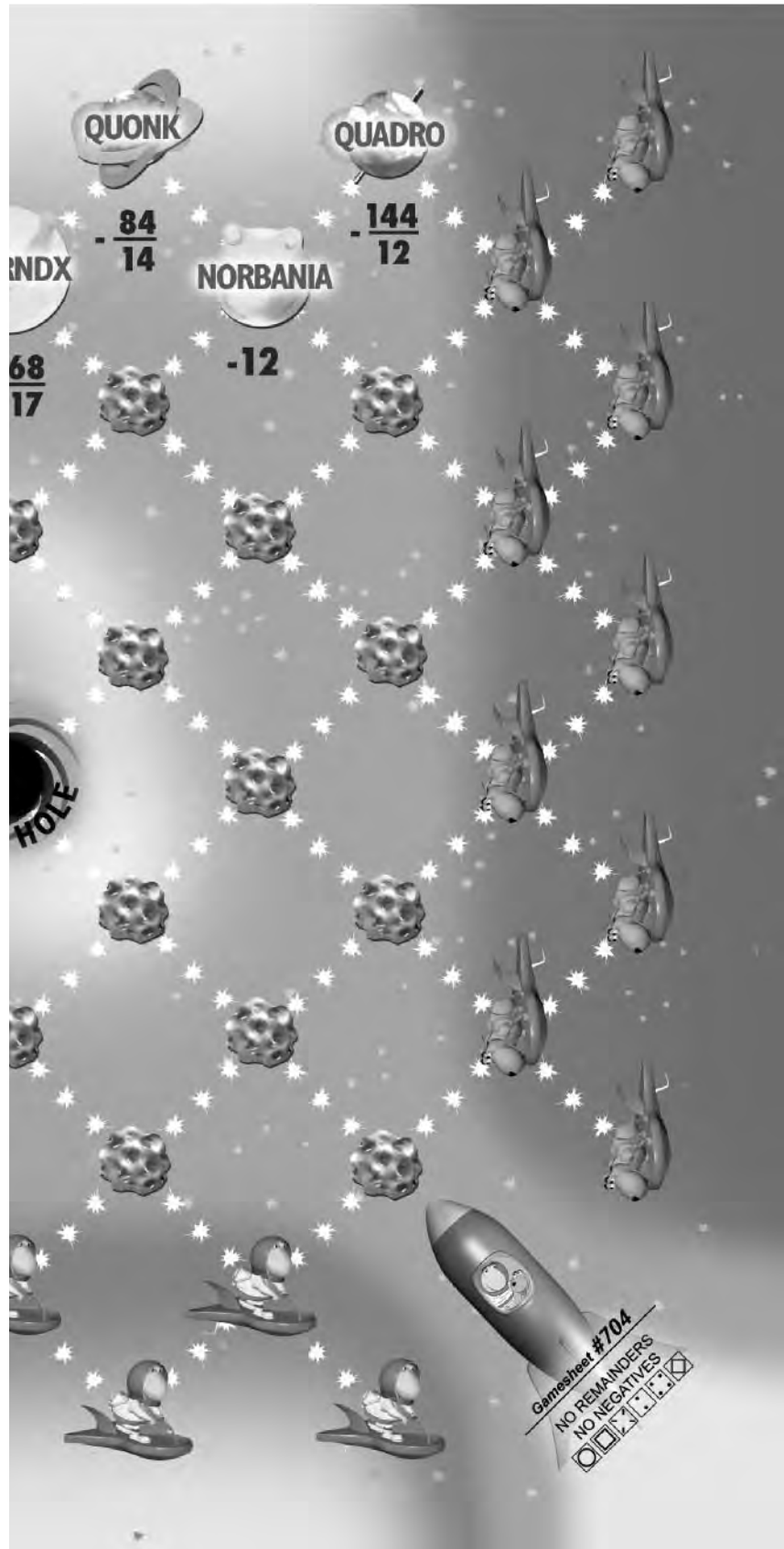


Game Sheet 604 (2)

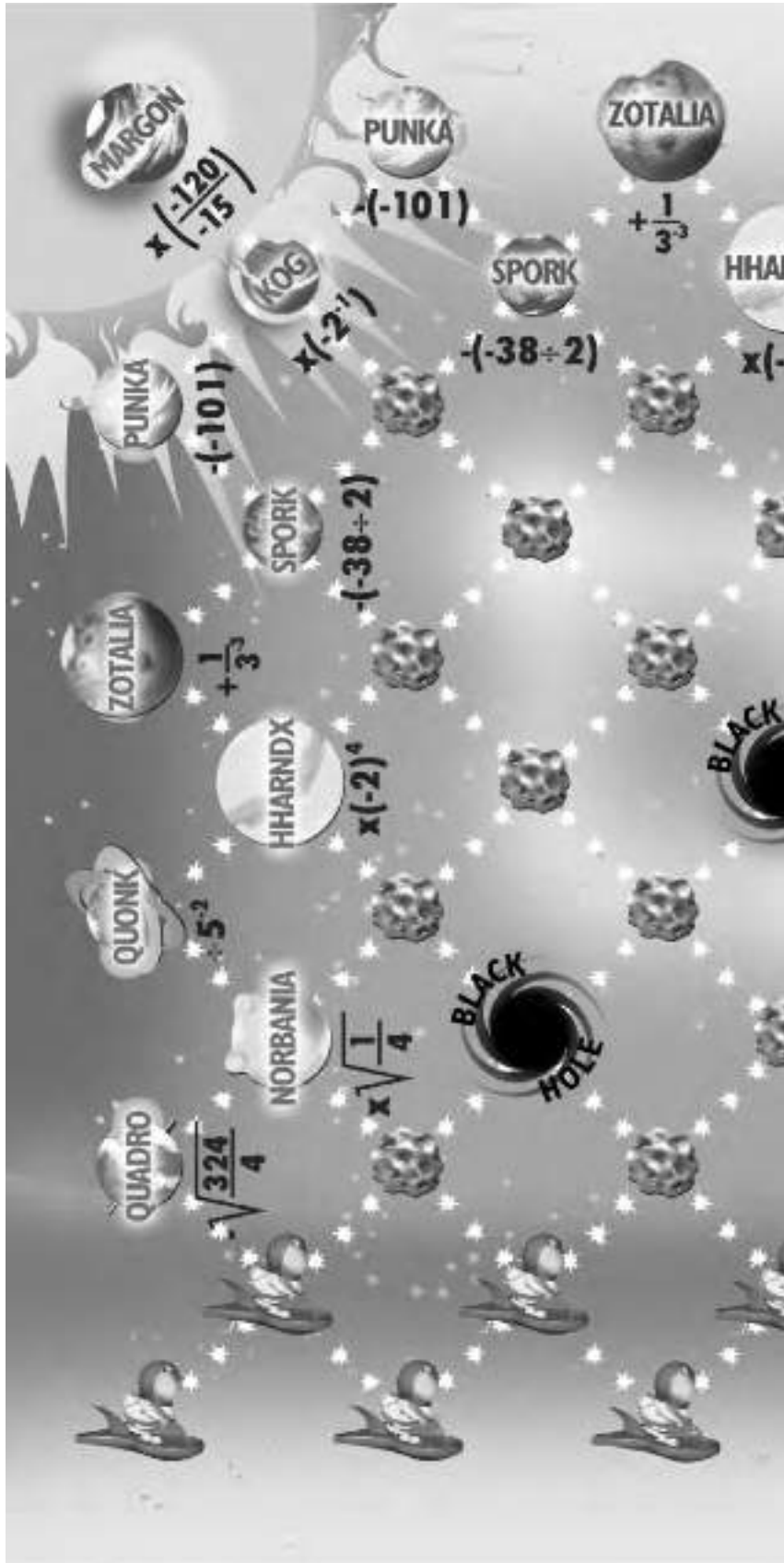




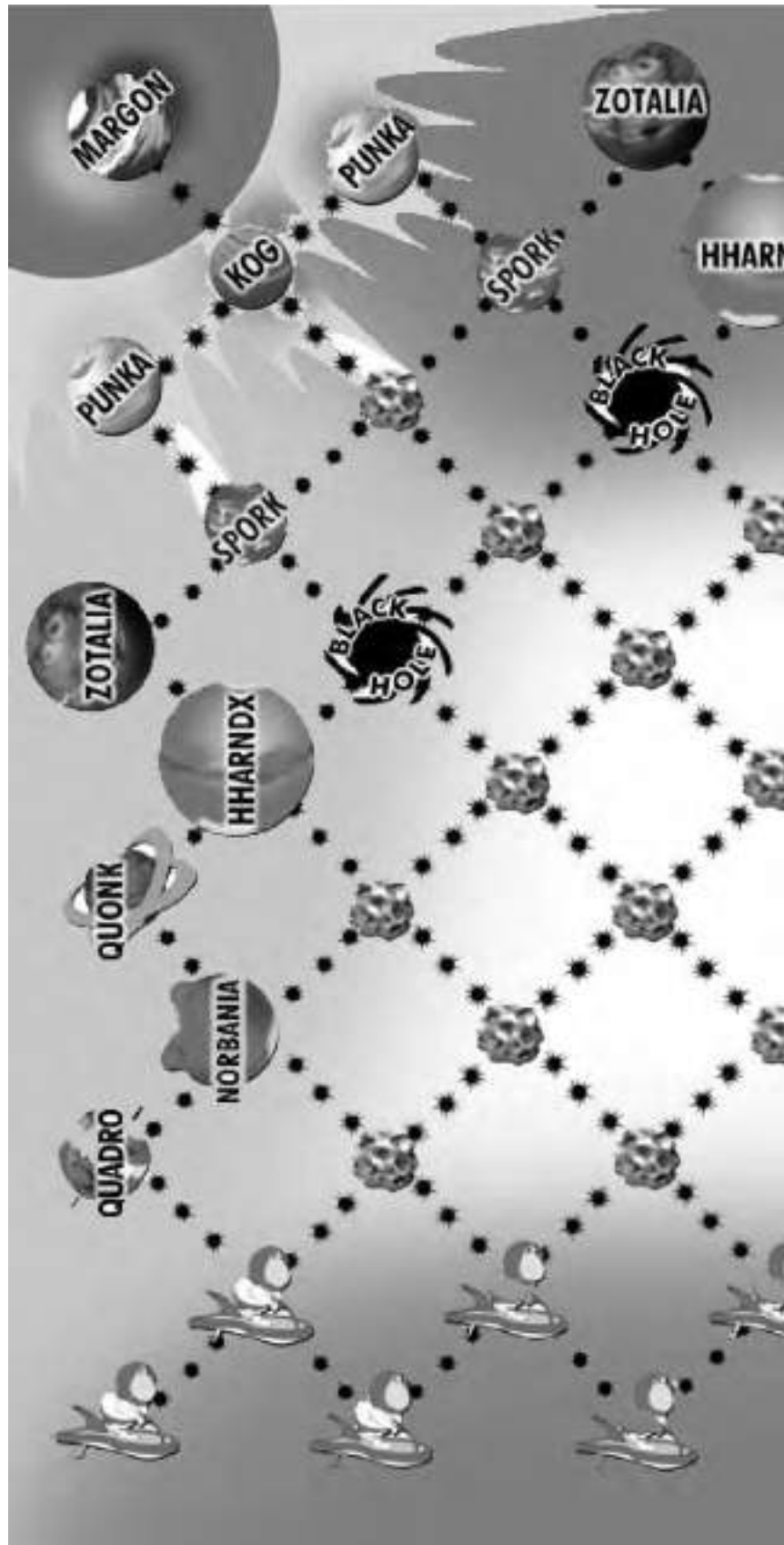
Game Sheet 704 (2)



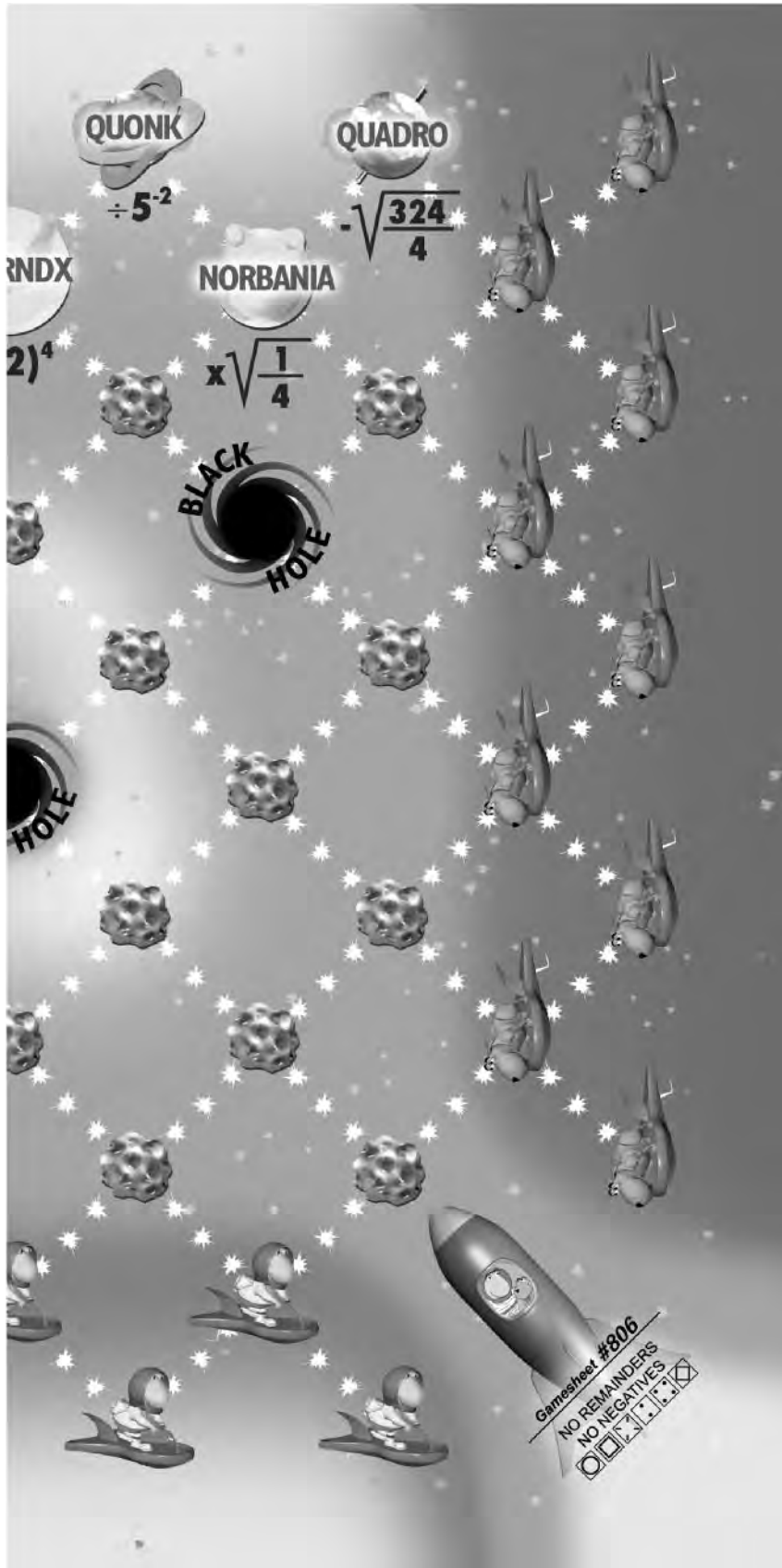
Game Sheet 804 (1)



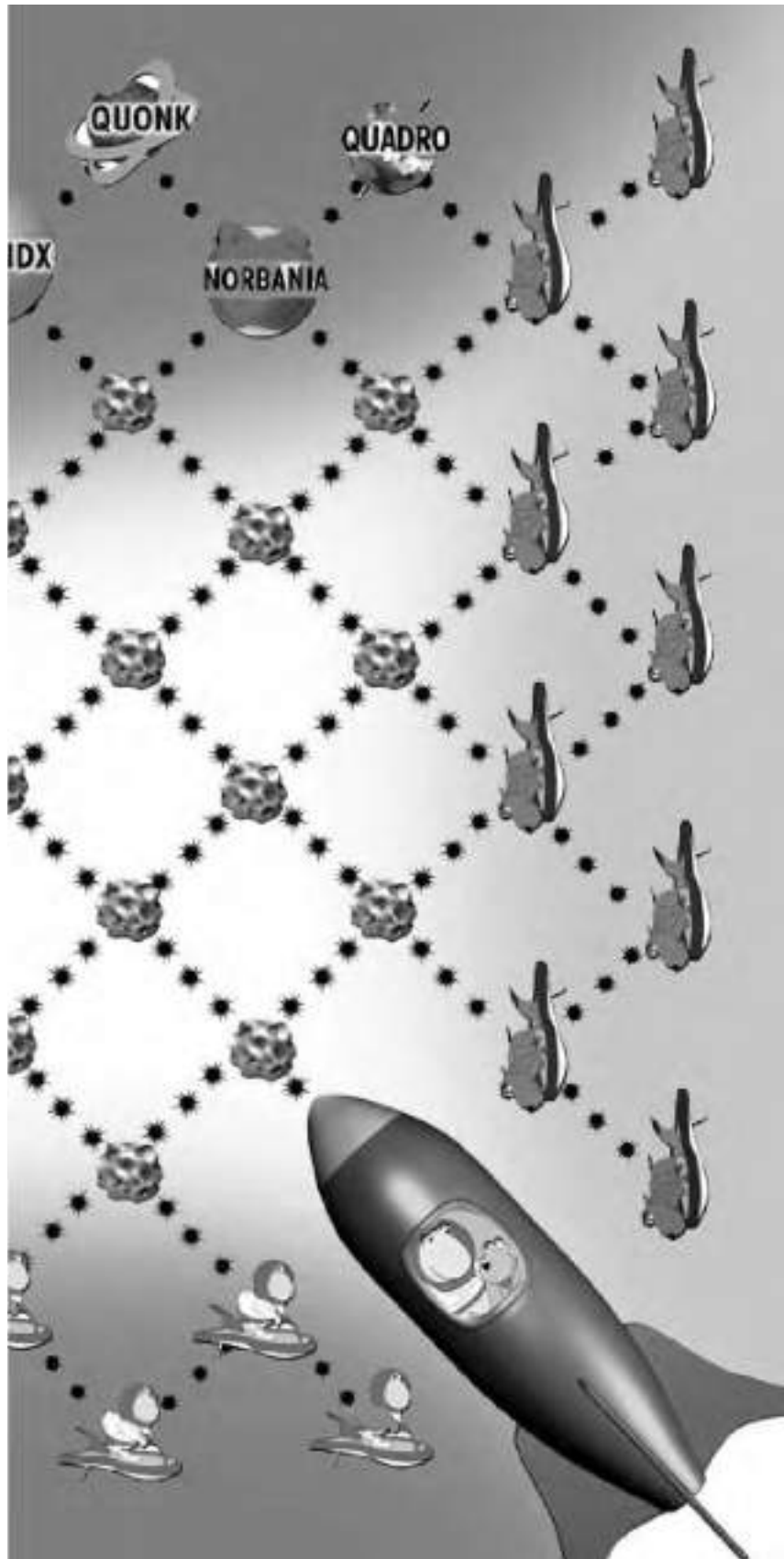
Game Sheet Blank (1)



Game Sheet 804 (2)



Game Sheet Blank (2)



Resources

WEB SITES

Mathematics Games

<http://www.funbrain.com>
<http://www.aplusmath.com/Games/index.html>
<http://www.aaamath.com/index.html>

Educator Links

Air-Breathing Rockets

http://www.nasaexplores.com/lessons/01-047/5-8_index.html

Building Blocks to Space

http://www.nasaexplores.com/lessons/01-043/5-8_index.html

Designing Tomorrow's Space Ships Today

http://www.nasaexplores.com/lessons/02-007/5-8_index.html

Destination Mars

http://www.nasaexplores.com/lessons/01-060/5-8_index.html

Escape Velocity: Fun and Games

http://www.nasaexplores.com/lessons/01-049/5-8_index.html

Liftoff to Learning: The Mathematics of Space Rendezvous

[<http://quest.arc.nasa.gov:80/space/teachers/liftoff/math.html>]

Mega-Magnetism

http://www.nasaexplores.com/lessons/01-055/5-8_index.html

Slingshot to Space

http://www.nasaexplores.com/lessons/01-027/5-8_index.html

Slow and Steady Wins the Race...to Distant Space

http://www.nasaexplores.com/lessons/01-069/5-8_index.html

The Space Elevator

http://www.nasaexplores.com/lessons/01-015/5-8_index.html

Figure This

Offers mathematics challenges that middle school students can do at home with their families to emphasize the importance of a high-quality mathematics education for all.

<http://www.figurethis.org>

Engineer Girl

Part of the National Academy of Engineering's Celebrations of Women in the Engineering project. The project brings national attention to the opportunity that engineering presents to people of all ages, but particularly to women and girls.

<http://www.engineergirl.org>

National Council Teachers of Mathematics

<http://www.nctm.org>