The King's Rule:
Mathematics and Discovery

Apple

Commodore 64

IBM PC/PC Jr.

TRS-80 Model III, 4

SUNBURST
COMMUNICATIONS

SOFTWARE REVIEWS

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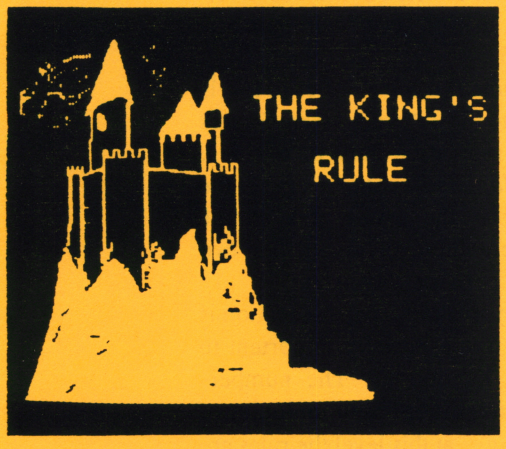


THE KING'S RULE: Mathematics and Discovery

Category: Hypotheses formation and deductive reasoning, mathematics
Educational Level: Grade 4—Adult
Systems: Apple II Plus and IIe (48K) with disk drive (color monitor recommended).
Package: Includes one disk, backup disk, and a 21-page teacher's manual; $55.
Publisher: Sunburst Communications, Inc., 39 Washington Ave., Pleasantville, NY 10570; (800) 431-1934.

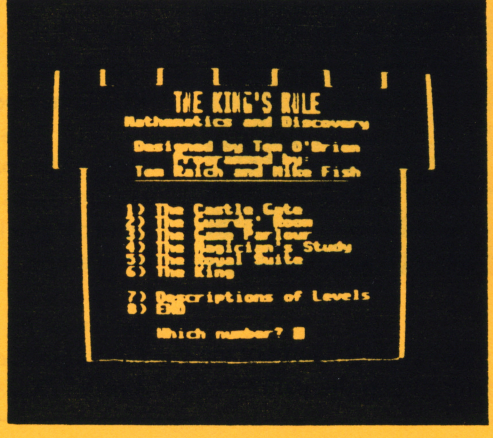
THE KING'S RULE is an interactive reasoning skills program based on work by Peter C. Wason at the Jerome Bruner Center for Cognitive Studies. Wason was puzzled by his findings on the reluctance of college students to change initial hypotheses they formed to explain simple phenomena. Subjects were given three number such as "2, 4, 6" and asked to form a hypothesis as to what pattern determined the numbers. Most subjects jumped to the conclusion that the pattern was "consecutive even integers." When told that this was not the pattern (which was any three integers in ascending order), most students refused to test alternate hypotheses and returned doggedly to their original hypothesis.

The formation and systematic testing of hypotheses is at the heart of science and mathematics. Every scientist and mathematician must learn to question initial assumptions and explore alternative models that might also explain observed phenomena. The shortage of time, facilities and teacher patience can combine to make it quite difficult to help young science and math students learn to form and explore hypotheses. Now this package, THE KING'S RULE, from Sunburst Communications creates an interactive environment to assist upper-elementary students to look for hidden patterns and explore alternate explanations for observed behaviors of a system.

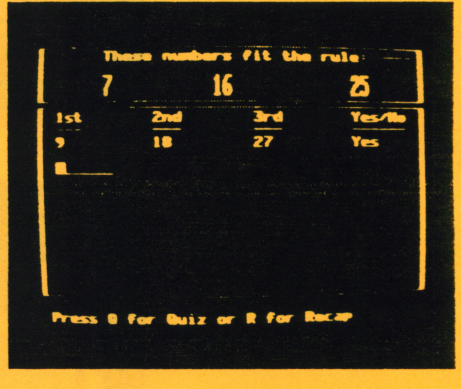
Objectives of the program include:

- practice in forming and testing hypotheses;
- training in recognition of numerical patterns and relationships;
- development of skills in critical thinking and problem solving;
- practice in addition, subtraction, multiplication and division; and development of strategies, especially useful in groups.

The six levels of THE KING'S RULE provide a game format in which the object is to acquire tokens at each level to be used for admission to new areas of the castle and higher levels of difficulty. This encourages mastery of lower-level thinking and reasoning skills before may students advance. Colorful figures guard each of the castle gates and present riddles which the student must answer using deductions tested prior to confronting the guard.

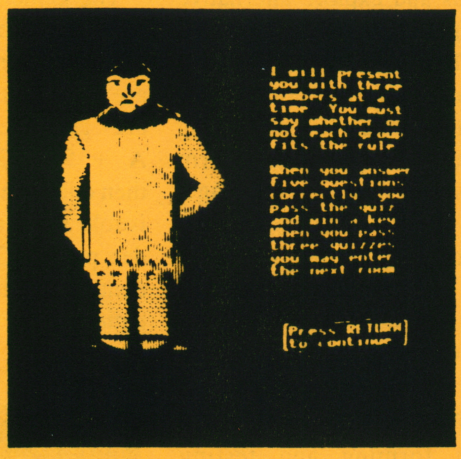


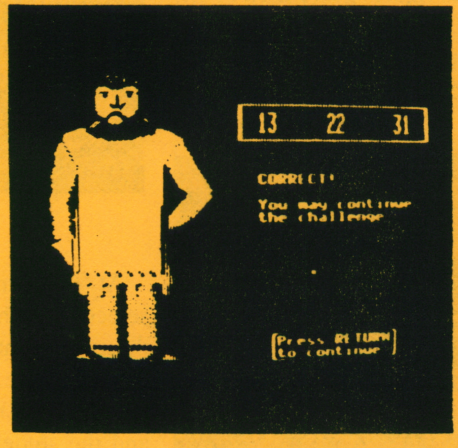
The game is deceptively simple. Each level has two modes. In the first mode, three numbers (under columns A, B, C) are presented on the screen. The numbers are generated using a rule such as A + 5 = B; B + 5 = C. The student then enters three numbers of her own and is told whether these numbers fit the hidden pattern. This continues until the student is confident she knows the hidden pattern.



At that time, the "Quiz" mode is selected. In this mode, the guard presents three different numbers and asks if they fit the same rule. If the student answers correctly, three more numbers are provided and the student is again asked if they fit the rule. This continues until the user either answers correctly five consecutive times or misses one set. A miss results in a screen menu asking if the student wants (1) the same riddle again with different

numbers. (2) a different riddle at the same level, or (3) a riddle at a lower level. Upon acquiring three tokens (keys, shields, magic notebooks, etc.) the student may move to a higher level.





The six levels and general nature of the rules used in determining the pattern of numbers in each are:

1. *The Castle Gate:* small upward or downward jumps of a constant change, with all numbers lying between 1 and 30.
2. *The Guard's Room:* constant multiplication of division by numbers between 1 and 9, using "seed" numbers between 1 and 5.
3. *The Game Parlour:* rules of levels 1 and 2 plus ten less "transparent" rules such as right-most digit must be a 9, etc.
4. *The Magician's Study:* here the third number is the result of a simple arithmetic operation involving the first two numbers and perhaps a constant.
5. *The Royal Suite:* here deception is practiced, so it is especially important to test alternate hypotheses. The numbers 100-200-300 might represent multiples of
6. *The King:* at this level the rules are simple, but may apply to only one or two of the three numbers, such as 64-66-68 where the rule is that the second number is even.

The package comes with two disks and a 21-page teacher's manual. The manual contains all the instructions for using the program in a classroom environment. It provides a key to many of the hidden rules, although higher-level patterns are set by the computer's random number generator. The teacher has the option of turning off the program's sound and limiting access to specific difficulty levels. Small groups of two or three working together cooperatively seem to work quite well, since individuals are likely to be "stumped" by middle and upper level rules. Repeated attempts to cause the program to 'crash' by entering unexpected values failed. On a single level the program will operate without the disk in the drive, but movement to higher or lower levels requires disk access.

It is easy to see why THE KING'S RULE has been placed high on several software lists for use at the elementary level. The package has been carefully crafted by its designers to fill an important role in elementary science and math software.

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THE KING'S RULE: MATHEMATICS AND DISCOVERY

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THE KING'S RULE: MATHEMATICS AND DISCOVERY

Introduction

by Thomas C. O'Brien

THE KING'S RULE: MATHEMATICS AND DISCOVERY uses a captivating fantasy format to address skills at the very heart of scientific and mathematical reasoning: the generation and testing of hypotheses.

Let's take a simple example. Suppose someone says to you "1-2-3." Then the same person says "8-9-10." Next comes "34-35-36."

What's happening here? It might occur to you that the person is giving you three consecutive numbers. You have formed a hypothesis. How would you test this hypothesis? You might ask whether 5-6-7 fits the "rule" that person is using. If you were told "Yes, 5-6-7 does fit," you'd feel more secure about your hunch.

But 5-6-7, or even 8-9-10 and 34-35-36, have other common properties besides being three consecutive numbers. They are also three numbers with a constant jump (in this case, 1). Therefore, the numbers 104-108-112 (with a constant jump of 4) would also fit the rule.

So, you could ask whether 5-6-7 fits and you would increase your confidence in the hypothesis "three consecutive numbers." But if you had several hypotheses in mind, and if you sought both confirming and disconfirming evidence, you'd be much more likely to discover the correct rule.

Indeed, all of science, if not all of intelligent life, depends upon the generation and testing of hypotheses. We must not allow ourselves to be sold on the first idea that comes to mind. (Imagine a physician who considers one symptom, say a fever, and jumps to a diagnosis -- cholera -- without further inquiry. You wouldn't take your Pet Rock to such a person.)

Despite the importance of hypothesis generating and testing in science, mathematics, and other fields, it receives very little attention in our school curriculum.

THE KING'S RULE fills this void, providing rich experiences through which students develop critical thinking skills. The program is diverse enough to engage elementary students as well as adults.

It does so through a series of number riddles at six levels

of difficulty. Although the thinking at higher levels can get quite complex, the mathematical knowledge required of players does not exceed that of sixth grade math. In each game, players are given three numbers related by a "secret" rule. Players are then invited to try three numbers of their own to see whether or not the numbers fit the rule. Players can do this as long as they want. When they are satisfied that they have made a correct diagnosis, they can test their conclusions with a five-question quiz.

The program is based on the research of Professor P.C. Wason of the University of London. He researched a single rule ("three numbers in increasing order") with Harvard University students at Jerome Bruner's Center for Cognitive Studies. Wason used the numbers 2-4-6, and he cautioned students to gather as much evidence as possible before announcing the rule.

Given 2-4-6, students almost always asked questions of the type, "Does 4-6-8 fit the rule?" Of course the answer was yes. After a number of other such questions (e.g. 10-12-14), students commonly guessed the rule to be "three consecutive even numbers."

When told that it was not the rule (The rule was "three numbers in ascending order.") and given a second chance, students persevered with the 8-10-12 sort of question and "altered" their original hypothesis to "The first number is even, the second is two more, and the third is two more again."

In general, Wason found that these highly educated students failed to truly test their hypotheses by trying such samples as 2-4-5, 6-4-2, or 4-8-12. In publishing the research, he chose the title "On the Failure to Eliminate Hypotheses."

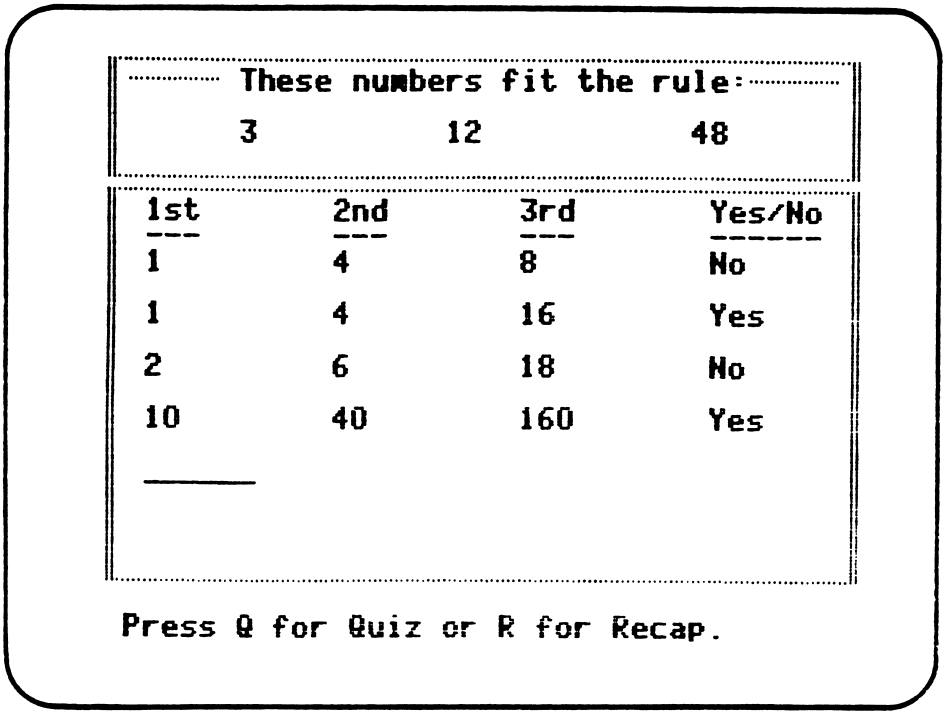
THE KING'S RULE thus helps students to build abilities which are 1) at the heart of scientific thinking, 2) not systematically attended to by present curricula, and 3) widely unavailable even to "well-educated" students.

The program helps its users learn to test alternate hypotheses in an attempt to find the truth. One or two initial quiz failures will quickly and brightly illuminate the benefits of that process:

"Gee, I thought I had the rule! But. . .if that's not it, then what else could it be . . . and how can I weed out the incorrect hunches in order to find the one that will work?"

Best of all, THE KING'S RULE is fun to play. It's even better in groups!

THE KING'S RULE: MATHEMATICS AND DISCOVERY



Skills: Recognizing numerical patterns and relationships
Addition, subtraction, multiplication, and division
Forming and testing hypotheses
Problem solving
Developing and using strategies

Grade Level: 6 - adult

Reading Level: 4th grade (Fry)

Time Required: 10 - 20 minutes for each level

Objectives:
1. To train students to form and test hypotheses.
2. To build skills in recognizing numerical patterns and relationships.
3. To develop skills in critical thinking and problem solving.

Program Overview

Students playing THE KING'S RULE solve number riddles -- guessing the rules that apply to sets of three numbers -- as they move from room to room inside a king's castle. The rooms correspond to difficulty levels. Students are allowed entrance into each room after they have solved three riddles at that level. Their ultimate objective is to come face-to-face with the King, deep within the fortress, where each player is challenged to solve a final series of riddles. To meet the King may take many sittings, even for a very able player.

The program has six levels of difficulty that correspond to five castle rooms and the challenge of the King. They are

Level 1: The Castle Gate
Level 2: The Guards' Room
Level 3: The Game Parlour
Level 4: The Magician's Study
Level 5: The Royal Suite
Level 6: The King

On each level, students are shown three numbers that correspond to a secret rule. They must generate their own hypotheses about the rule, and then test those hypotheses by entering their own sets of three numbers for the computer to check against the rule. The computer will respond "Yes" to those sets that conform to the rule, and "No" to those that don't. When students feel confident that they know the rule, they can take a quiz that tests their conclusions.

Students can enter the program on any level left open to them by the teacher (see the change option on page 5). After solving three consecutive riddles on Levels 1-3, or a total of three riddles on Levels 4-6, students are returned to the main menu, where they can choose to go to a higher (or lower) level.

If students fail a quiz by answering any of its questions incorrectly, they are given the choice of

1) again trying the same level/same rule,
2) trying the same level/different rule, or
3) returning to the main menu.

For more information on playing sequence, see page 16.

Students must press the RETURN key [Apple/Commodore], the key [IBM], or the ENTER key [TRS-80] for all inputs except for the student options listed in the next section.

Student Options

The following playing options are available to students during the program:

Recap Notepad

Students testing hypotheses may receive a recap of their previous guesses by pressing the R key when the computer asks for a number input.

Quiz Request

Students finished testing hypotheses may request a quiz by pressing the Q key when the computer asks for a number input.

Exiting the Program

Students may exit the program at any time by simultaneously holding the CONTROL and E keys (the SHIFT, down-arrow and E keys on the TRS-80) at any input.

Teacher Options

Two teacher options are provided to enrich your use of THE KING'S RULE.

The Change Option: Sound and Level Availability

By simultaneously pressing the T key with the CONTROL [Apple/IBM], SHIFT and down-arrow [TRS-80] or C: [Commodore] keys during the menu screen, you can

* turn ON or OFF the program's sound (not available on TRS-80), or
* open or close higher difficulty levels.

When the sound option is on, the program will emit "yes" or "no" tones along with displayed answers during the hypothesis testing segment of the program. In situations where the sounds would be distractive, the computer can be muted. The computer will remain in either mode until you use the option again. On the IBM, if the sound is turned ON, students will be able to toggle between having sound or not by holding down the CONTROL (CTRL) key and pressing S at any input. This extra student control of sound is only available when the Sound Option is turned ON.

The same option allows you to limit the level at which students can enter the program by selectively closing off higher difficulty levels. If you decide that Level 4 is the highest at which students should be allowed to enter, you may specify so during the option and students will see only Levels 1-4 on the main menu. Students playing in this mode would still be able to advance to Level 5 by solving a total of three riddles at Level 4. They could choose to go back to the menu and would then see Levels 1-5 displayed. Likewise, students failing a quiz at Level 3, and then going back to the menu, would see only Levels 1-3 displayed.

Display the Rule Option

In Levels 3-6, you may press CONTROL and T [Apple/IBM], SHIFT, down-arrow and T [TRS-80] or C= and T [Commodore] during any hypothesis test screen in order to see the rule under which the program is currently operating. Two numbers will appear in the lower right-hand corner of the screen. The first number is the level; the second is the current rule being tested. You can then find that number and its corresponding rule in the rules section of this guide (page 7).

Difficulty Levels

Following are descriptions of each difficulty level, including the specific rules with examples. Although students may enter the program at any level left open by the teacher (see the change options on page 5), they should first be encouraged to work through the first three levels sequentially. Sequential play is not so important in Levels 4, 5 and 6, where rules, example sets, and strategies interact in entirely new ways. Students should be allowed free reign there.

Level 1: The Castle Gate

DESCRIPTION:

Rules in Level 1 involve small upward or downward jumps, from 1 to 10 inclusive, from the first number to the second to the third. All sets presented by the program in Level 1 are transparent. That is, they clearly suggest the rules that govern them.

EXAMPLES:

If the rule is "increasing jumps of 2," and the beginning number is 10, the resulting set would be

10 12 14.

A typical rule might also be "decreasing jumps of 2," with a beginning number of 14, in which case the same three numbers could be presented in descending order:

14 12 10.

If the rule is "decreasing jumps of 5," the program might present the set,

29 24 19.

Level 2: The Guards' Room

DESCRIPTION:

Rules found in Level 2 involve constant multiplication or division jumps of numbers between 1 and 9 inclusive. They are multiplied or divided by numbers between 1 and 5 inclusive. The sets presented by the program in Level 2 are also transparent: They clearly represent the rules that govern them.

EXAMPLES:

A "seed" value is chosen, such as 4. That number is then multiplied by a factor between 1 and 5 -- in this case, 2. The resulting product is then multiplied by the same factor again. The result is:

4 8 16.

This relationship might also be displayed in descending order (representing a different rule -- that of numbers divided by 2):

16 8 4.

If the rule is "numbers multiplied by 5 -- ascending," the numerical example presented by the program could be:

2 10 50

(the seed number, 2, then that number times the multiple, 5, then that product times the multiple). Students testing hypotheses of this rule could get acceptance on submissions such as 7-35-175 or 1-5-25. Submissions of 125-25-5 or 50-10-2 would not be accepted since they involve division by 5.

The following set indicates the rule "divide each succeeding number by 4":

48 12 3

(48 divided by four, then the resulting quotient divided by four, yielding 3). Students testing hypotheses for this rule could get acceptance for the submissions 64-16-4, 16-4-1, or several others.

Level 3: The Game Parlour

DESCRIPTION:

The rules in Level 3 include all of those used in Levels 1 and 2, with the addition of ten new rules. Again, each set presented by the program clearly suggests its rule. The ten new rules used in Level 3, along with a numerical example of each, are presented below:

1. Rule: All numbers end in 9.
   Example: 9 29 19

2. Rule: The third number is the sum of the first two.
   Example: 17 8 25

3. Rule: The third number is the product of the first two.
   Example: 6 8 48

4. Rule: All numbers are divisible by 5.
   Example: 25 10 25

5. Rule: All numbers are divisible by 3.
   Example: 12 6 18

6. Rule: All numbers are divisible by 10.
   Example: 70 100 20

7. Rule: The second number is larger than the first, but smaller than the third.
   Example: 1 2 6

8. Rule: The first number minus the second equals the third.
   Example: 18 12 6

9. Rule: All of the numbers are odd.
   Example: 13 17 7

10. Rule: The numbers have a common divisor ranging from 1 to 10.

    Example: 56 96 32 (divisor is 8)
    130 70 190 (divisor is 10)

NOTE: In addition to rules 1-10, a CONTROL-T rule check on this level might indicate

"3-11" (meaning a Level 1 / ascending rule),
"3-12" (meaning a Level 1 / descending rule),
"3-13" (meaning a Level 2 / ascending rule), or
"3-14" (meaning a Level 2 / descending rule).

Level 4: The Magician's Study

DESCRIPTION:

Level 4 calls for deep thinking. Here, the third number is the result of an operation --addition, subtraction, multiplication, or division -- involving the first two numbers, and in some cases, a constant. The following list of eighteen formulas shows how the rules are calculated:

A: random value from 1 to 9
B: random value from 1 to 9
C: a value ranging from 1 to 5, staying constant throughout study of the rule

The program uses INT (Integer) to mean ignore fractional parts.

(INT 4.3 = 4)

ABS (Absolute value) means ignore the negative sign.

(ABS -4 = 4)

Rule	First Number	Second Number	Third Number
1	A	B	A*B
2	A	B	A-B
3	A	B	A*A-1
4	A	B	B-A
5	A	B	A
6	A	B	A*A
7	A	B	(A-B)*(A-B)
8	A	B	INT (A+B/2)
9	A	B	(A+B)*(A+B)
10	A	B	ABS (A^2 - B^2)
11	A	B	-(A+B)
12	A	B	(A+1)*(B+1)
13	A	B	A+B+C

Level 4 (Continued)

Rule	First Number	Second Number	Third Number
14	A	B	(A*B)-C
15	A	B	(A+B)*C
16	A	B	(A*B)+C
17	A	B	100-A-B
18	A	B	(A+B)*10

EXAMPLES:

The program may present the set

2 4 8,

based on the rule, "multiply the first number by the second."

For the rule (A+B)*10, an example would be

2 3 50.

Level 5: The Royal Suite

Level 5 differs significantly from previous levels. Here, the example sets given by the computer may be deceiving in regard to the rules they represent. Therefore, it is especially important to critically test several different hypotheses. If the student is presented with the set 100-200-300, the rule may not be the obvious ("multiples of 100" or "jumps of 100"), but something not so obvious, such as "multiples of 2" or "multiples of 5."

Suppose the example set, 100-200-300, represents the latter rule "multiples of 5." Many players are likely to assume that the rule could be "multiples of 100," and may start the testing process by submitting other multiples of 100, such as 300-400-500. Since these numbers are also multiples of 5, the test sets would be approved. When presented with the quiz, players might then be asked to approve or reject the numbers 100-200-45. They might think "those numbers are not multiples of 100," and accordingly reject the set. Such an answer would be incorrect, and the players would fail the quiz. A better strategy would have been to test for the rules "multiples of 10," "multiples of 5,""multiples of 2," and others. In Level 5, students must be constantly on guard against being misled, although the computer will always tell the truth.

Following are the guidelines for each "disguised" example given by the program, and the actual rule each represents:

1. Example: Three consecutive even numbers
   Rule: The second number is greater than the first, but less than the third.

2. Example: Three consecutive even numbers
   Rule: The three numbers are even.

3. Example: Three consecutive odd numbers
   Rule: Any constant difference between the three numbers

4. Example: Three consecutive numbers
   Rule: The sum of the numbers is divisible by 3.

5. Example: Three consecutive multiples of 5
   Rule: Numbers in upward jumps of five (e.g. 2-7-12)

6. Example: The third number is 10 minus the sum of the first two numbers.
   Rule: Same as example

7. Example: Three multiples of 100
   Rule: Each number is divisible by 5.

Level 5 (Continued)

8. Example: Three consecutive multiples of 10
   Rule: The sum of the numbers is divisible by 10 (e.g. 8-3-9).

9. Example: The second number is five times the first. The third number is five times the second.
   Rule: Any three ascending or descending numbers

10. Example: The first and second numbers are multiples of 10. The third number is the sum of the first two.
    Rule: The third number is the sum of the first two.

11. Example: The second number equals the third. The first number is the second number times the third.
    Rule: At least two of the three numbers are equal.

12. Example: The first number is a multiple of three. The second number is the first plus 2. The third is the second plus 2.
    Rule: The sum of the numbers is divisible by 3.

13. Example: The first number ends with a 9; the second with an 8; the third with a 7.
    Rule: Same as example

14. Example: The first number is even. The second number is even. The third number is the first times the second.
    Rule: The third number is divisible by the first two.

15. Example: The first number is even. The second is twice the first. The third is three times the first.
    Rule: The second number is greater than the first but less than the third.

16. Example: The first number is a multiple of 3. The second number is the first plus 3. The third is the second plus 3.
    Rule: Any constant upward or downward jump

17. Example: The third number is the first number squared plus the second number squared.
    Rule: Same as example

18. Example: The three numbers are all even.
    Rule: The sum of the numbers is even.

19. Example: The second number is two times the first. The third number is two times the second.
    Rule: The numbers are in ascending order.

Level 6: The King

Level 6 uses very simple rules, but is extremely challenging because the rules may apply to only one or two of the numbers presented by the computer. For example, the program may present 64-66-68 and the rule would be "the second number is even."

Following are the guidelines for each "disguised" example given by the program, and the actual rule each represents:

1. Example: The first number is a multiple of 100 plus 1. The second number is the first plus 1, and the third is the second plus 1.
   Rule: Only one number is even.

2. Example: The first number is a multiple of 100. The second number is the first plus 1. The third is the second plus 1.
   Rule: Exactly one number can be evenly divided by 5.

3. Example: The first two numbers add up to 10.
   Rule: Same as example

4. Example: The second number is 1. The third is the same as the first.
   Rule: The second number is a square.

5. Example: The first number ends with a 3; the second with a 4; the third with a 5.
   Rule: At least one of the numbers ends with a 3.

6. Example: The third number is a constant ranging from 1 to 20 less the sum of the first two.
   Rule: Same as example

7. Example: The first number is a multiple of 4. The second number is the first plus 1. The third is the second plus 1.
   Rule: At least one number is divisible by 4.

8. Example: The first number ends with a 9, the second with a 0, the third with a 1.
   Rule: At least one number ends in nine.

9. Example: The first and third numbers are the same. The second number is the first plus 1.
   Rule: At least two of the numbers are equal.

Level 6 (Continued)

10. Example: The second number equals the first. The third number is the first times the second.
    Rule: All three numbers are either even or odd.

11. Example: The third number is the square of the sum of the first two.
    Rule: The third number is the largest.

12. Example: The first number is even. The second number is the first plus 1. The third is the second plus 1.
    Rule: At least one number is even.

13. Example: The first number is a multiple of 1000. The second number is the first plus 1. The third is the second plus 1.
    Rule: Only one of the numbers is divisible by 10.

14. Example: All three numbers are equal.
    Rule: The third number is the average of the first two.

15. Example: Each of the three numbers has the form ABC,ABC (typical sets presented by the computer would be 947,947 - 345,345 - 169,169 or 12,012 - 321,321 - 2,002).
    Rule: At least one number is divisible by 13.

16. Example: The third number is the square of the sum of the first two.
    Rule: Same as example

17. Example: The first number is the square of an even number. The second is the first plus 2; the third is the second plus 2.
    Rule: The second number is even.

18. Example: The third number is the square of the first.
    Rule: The third number is the largest.

19. Example: The first number is a multiple of 4. The second is the first minus 1. The third is the second minus 1.
    Rule: The first number is the largest.

20. Example: The first number is a square of an even number. The second is a square of an even number. The third is the average of the first two.
    Rule: The first number is a square.

Background on Playing

The program begins with an illustration of the castle. A menu then appears, and students choose the difficulty level (castle room) on which to begin. If the teacher has used the option of closing off higher levels (see page 5), only those levels eligible for play will appear on the menu.

As students work through the castle, they are met at the entrance to each room by a guard. Students are presented with the message, "Halt! I am the guardian of the ... room. To pass, you must successfully solve three number riddles." Students are then given a set of numbers that fit the secret rule, and may then form and test various hypotheses by submitting an unlimited number of sets for the computer to check against the rule.

Based upon the program's responses ("Yes [Those numbers fit the rule.]" or "No [Those numbers do not fit the rule.]"), the students test hypotheses until they feel ready for the quiz. At any time, students can get a recap of previous submissions by pressing the R key. Students having difficulty in successfully selecting numbers that fit the rule (three to six "No"s) will be given a hint in the form of another set that also fits the rule.

Students can call for a quiz by pressing the Q key at any input during the hypotheses-testing activity. They are then presented with five sets, and must say whether or not each one fits the rule. In Level 4, The Magician's Study, students taking the quiz are given two numbers that fit the rule -- they must enter the third.

After correctly answering all five quiz questions, students pass the quiz and, depending upon the level, the screen displays one of the following objects:

The Castle Gate (Level 1)	--	Key
The Guards' Room (Level 2)	--	Shield
The Game Parlour (Level 3)	--	Chess Piece
The Magician's Study (Level 4)	--	Magic Book
The Royal Suite (Level 5)	--	Flag

After passing three consecutive quizzes on Levels 1-3, or a total of three quizzes on Levels 4-6, students are granted passage into the room (or, on Level 6, win the game). They then are returned to the main menu, where they can select a higher (if applicable) or lower level. Students failing a quiz may choose to try the same riddle again, try another riddle at the same level, or return to the menu.

In this way, students progress toward the ultimate goal, solving a riddle at the highest level of difficulty -- The King. There an illustration of the witty and powerful monarch accompanies the climactic "Guess My Rule!" challenge. Each time students win a quiz, they are presented with a royal crown. When they win three crowns, they win the game.

Classroom Use

THE KING'S RULE: MATHEMATICS AND DISCOVERY is designed so that students can enter the program at any difficulty level. First-time users should, of course, begin at The Castle Gate (the simplest level) in order to become familiar with the program's rules and format. They can then work into higher difficulty levels according to individual ability. Students can subsequently choose to enter the program at higher levels, avoiding the waste of time that could result from dealing with the less-challenging riddles. Again, it is wise to remember that levels 4-6 are much more difficult than Levels 1-3.

Teachers can selectively close off higher difficulty levels, customizing the program according to individual classroom needs (see page 5). However, students solving three consecutive riddles at the highest level allowed by the teacher can then progress to the next level. Likewise, students failing a quiz at any level cannot progress to a higher level regardless of the upward limit set by the teacher. For this reason, it is essential that the program be started over (using the "End" option on the menu) after each student has finished.

It is most important that the teacher emphasize to students the value of generating and testing alternate hypotheses when attempting to determine rules, especially at Levels 4-6. You should note that one particular set of numbers could represent several possible rules.

For example, suppose a student playing on Level 5 is given the set 14-16-18. The obvious rule might be "jumps of 2." It might also be "numbers divisible by two," "constant jumps," all even numbers," or even "ascending numbers."

Suppose the student decides to concentrate on the more obvious possibilities, and enters 2-4-6 for acceptance. The computer gives a "Yes" response. However, that set could fit any of the obvious rules. Another more selective submission is needed. The student needs to check for constant jumps that are not jumps of two. Upon entering 6-10-14 (jumps of 4), he or she gets a "Yes" response, and is able to eliminate the "jumps of 2" hypothesis.

Now suppose the student enters 3-5-7 and gets a "No" from the computer. Since the set 3-5-7 represents ascending numbers and constant jumps, those hypotheses can also be eliminated. That leaves "all even numbers" and "numbers divisible by 2." Since both rules define the same numbers, the student may have solved the riddle, although there is no guarantee. In brief,

alternate hypotheses and attention to both confirming and disconfirming evidence are the keys to success with THE KING'S RULE.

Students should be encouraged to play in groups as well as individually. Several students collaborating on one rule will generate many more alternate hypotheses than a single student.

Competition among groups or individual class members is another way to increase classroom successes with THE KING'S RULE. Individual players or group members can have contests to see who can generate the most hypotheses to fit a single set of numbers. Since the program itself makes use of many unorthodox rules, students should be encouraged to be as creative as possible in hypotheses generation.

Class members can also take part in an ongoing tournament for mastery of the program. A bulletin board could show the relative heights attained by individuals or teams in their attempts to beat the King.

APPLE: WORKING WITH THE COMPUTER

TURNING ON THE COMPUTER

1. Turn on the television monitor.

2. Insert the diskette into the disk drive with the label facing up and on the right.

3. Close the door to the disk drive.

4. Turn on the Apple. (The on-off switch is on the back left side of the computer.)

5. You will see a red light on the disk drive turn on. If the disk drive does not turn on in about ten seconds, turn the Apple off and make sure your diskette is placed correctly in the disk drive.

6. SUNBURST will appear on the screen.

7. Follow directions given in the program.

8. If at any time during the program you want to stop, hold down the CONTROL (CTRL) key and press the E key.

TURNING OFF THE COMPUTER

1. Remove the diskette from the disk drive and return it to its place of storage.

2. Turn off the Apple.

3. Turn off the television or monitor.

COMMODORE 64: WORKING WITH THE COMPUTER

TURNING ON THE COMPUTER

1. Turn on the television or monitor.

2. The disk drive must be turned on before the computer. Turn on the disk drive (the switch is located at the back right side of the drive).

3. Open the door of the drive by pressing in on the door. Insert the diskette with the exposed oval window inserted first and the label up.

4. Close the door on the disk drive.

5. Turn on the computer. You will see the words--

```
     *****COMMODORE 64 BASIC V2*****
64K RAM SYSTEM 38911 BASIC BYTES FREE
READY.
```

6. Type LOAD "0:*",8 and press the Return Key. The red light on the disk drive will come on. The computer will print--

```
"Searching for 0"
LOADING
READY.
```

7. Type RUN and press the RETURN key.

8. If any time during the program you want to stop, hold the CTRL (Control) key and press the E key.

TURNING OFF THE COMPUTER

1. Remove the diskette.

2. Turn off the disk drive, computer and television.

IBM: WORKING WITH THE COMPUTER

TURNING ON THE COMPUTER

1. Place the diskette in the computer's disk drive with the label facing up and on the right. (If there are two disk drives, place the diskette in the one on the left.) Close the door of the disk drive.

2. Turn on the graphics monitor.

3. Turn on the computer. In several seconds, you will see the red light on the disk drive light up, and you will hear the disk drive spinning.

4. The SUNBURST logo will appear on the screen, followed by a menu of the program. Select the section you want and press the RETURN key.

5. Follow the instructions in the program.

6. If at any time during the program you want to stop, hold down the CONTROL (CTRL) key and press the E key.

TURNING OFF THE COMPUTER

1. Remove the diskette from the drive and put it in a safe place.

2. Turn off the computer.

3. Turn off the graphics monitor.

TRS-80: WORKING WITH THE COMPUTER (Diskette)

TURNING ON THE COMPUTER

1. Insert the diskette into the disk drive with the label facing up and on the right.

2. Close the door to the drive.

3. Turn on the computer.

4. You will see a red light on the disk drive light up. If the disk drive does not turn off in about 25 seconds, turn off the TRS-80and make sure the diskette is placed correctly in the disk drive.

5. SUNBURST will appear on the screen, followed by a menu of program.

6. Select the program you want from the menu.

7. If, at any time during the program, you want to stop, hold down the SHIFT key and the down-arrow key and press the E key.

TURNING OFF THE COMPUTER

1. Remove the diskette from the disk drive and return it to its place of storage.

2. Turn off the TRS-80.

WHAT HAPPENS IF...?" -- SUNBURST COURSEWARE AND WARRANTY

1. What happens if a program will not load or run?

   Call us on our toll-free number and we will send you a new tape or diskette.

2. What if I find an error in the program?

   We have thoroughly tested the programs that SUNBURST carries so we hope this does not happen. But if you find an error, please note what you did before the error occurred. Also, if a message appears on the screen, please write the message down. Then fill out the evaluation form and call us with the information. We will correct the error and send you a new diskette.

3. What happens if the courseware is accidently destroyed?

   SUNBURST has a lifetime guarantee on its courseware. Send us the product that was damaged and we will send you a new one.

4. How do I stop the program in the middle to go on to something new?

   A program can be ended at any time by holding the CONTROL (CTRL) key and pressing the E key. On the TRS-80, hold down the SHIFT and down-arrow keys and press the E key.

5. Can I copy this diskette?

   The material on the diskette is copyrighted. You should not copy the courseware.

6. Can I remove the diskette while using the program?

   No. Throughout the program the computer accesses the diskette for information.

Sunburst Lifetime Warranty Registration Form

Congratulations on your purchase of quality SUNBURST courseware! To register ownership and protect your lifetime warranty, please complete and return this card. The SUNBURST warranty—unlike any other—guarantees replacement of any program component that becomes lost or damaged during normal use. This warranty applies as long as the program is offered for sale.

USER NAME

TITLE

SCHOOL OR BUSINESS NAME

ADDRESS

CITY STATE ZIP

GRADE LEVEL OF SCHOOL

PRODUCT NAME COMPUTER SYSTEM

PRODUCT NO. DATE PURCHASED

MAY WE SEND A CATALOG TO A FRIEND?

NAME

ADDRESS

CITY STATE ZIP

I learned about SUNBURST products through:

- ☐ a SUNBURST catalog
- ☐ another catalog
- ☐ sales person
- ☐ a computer store
- ☐ computer conference
- ☐ friend's recommendation
- ☐ magazine advertisement.
  Name of magazine: _____
- ☐ magazine article.
  Name of magazine: _____

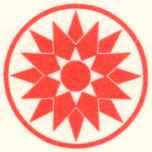
The education or computer magazine I read most is: _____

The three most important factors influencing my purchase decision are:

- ☐ classroom tested
- ☐ preview policy
- ☐ subject matter
- ☐ reputation of publisher
- ☐ program's use of graphics and sound
- ☐ instructional quality
- ☐ price
- ☐ options to edit
- ☐ guide and support material
- ☐ ease of use
- ☐ other: _____

We hope you enjoy your SUNBURST product!

Please help us serve you better by filling out and returning the enclosed evaluation form. . . . We're waiting to hear from you!



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