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# THE ROYAL RULES

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## THE ROYAL RULES

### Introduction

by Thomas C. O'Brien

The Royal Rules is a sequel to The King's Rule, winner of the 1984 Classroom Computer Learning Software of the Year Award. The Royal Rules differs from The King's Rule in two respects. First, it gives players new and challenging rules to investigate. Second, and more important, it gives players (and teachers) the opportunity to enter rules of THEIR OWN for anyone to play against. It is possible for players to create hundreds, even thousands of rules of their own, to save them on diskettes, and then to challenge others to discover these rules. In fact, in The Royal Rules, creation of rules (and of disguises on Levels 3 and 4) is at least as thought provoking and challenging as the solution of rules.

The Royal Rules uses a captivating fantasy format to engage children (and adults) in the very heart of scientific and mathematical reasoning: the generation and testing of hypotheses. The activities are accessible to players as young as 10, yet the higher levels can fruitfully engage a highly intelligent adult.

Let's look at a simple example of hypothesis generating and testing in mathematical reasoning. Suppose someone says to you "1,3,5." Next the same person says "9,11,13," and then "41,43,45."

What's happening here? It might occur to you that the person is giving you three consecutive odd numbers. You have formed a hypothesis. How would you test this hypothesis? You might ask whether "15,17,19" fits the rule that is used by that person. If you were told "Yes," you'd feel more secure about your hunch.

But "1,3,5," or even "9,11,13," and "41,43,45" have other common properties besides being three consecutive odd numbers. They are also three numbers with a constant jump (in this case, 2). Therefore, the numbers "104,108,112" (with a constant jump of 4) might also fit the rule. Furthermore, they could be three ascending numbers, and so "1,45,179" might get a "Yes" answer as well.

So, you could ask whether "15,17,19" fits to increase your confidence in the hypothesis "three consecutive odd 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. Therefore, "104,108,112" and "1,45,179" would be good numbers to test, and so would "179,45,1."

Indeed, all of science, if not all of intelligent life, depends upon the generation and testing of hypotheses. In other words, 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 without further inquiry.) Yet, despite its importance in science, mathematics, and other fields, hypothesis generating and testing receives very little attention in our school curriculum.

## THE ROYAL RULES

The Royal Rules fills this void as did The King's Rule, providing rich experiences through which students develop critical thinking skills.

It does so through a series of activities at four 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 new twist, aside from new and interesting rules provided on the diskette, is that players can enter their own rules after they have passed three quizzes. And at any time, by using the Change Options, teachers and parents can add rules of their own.

The program is based on the research of Professor P.C. Wason of the University of London. He tested 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 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 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 they "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 test their hypotheses by trying such samples as "2,4,5, and 6,4,2, or 4,8,12." In publishing the research, he chose the title "On the Failure to Eliminate Hypotheses."

The Royal Rules helps students 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, as Professor Wason found out.

## THE ROYAL RULES

The program helps students 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 the 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 Royal Rules is fun to play. It's even better in groups!

THE ROYAL RULES

Program Objectives

**TOM's rule challenges you....**  
**These numbers fit the rule.**

**63                  23                  203**

<b>1st</b>	<b>2nd</b>	<b>3rd</b>	<b>Yes/No</b>
<b>2</b>	<b>3</b>	<b>2</b>	<b>No</b>
<b>2</b>	<b>3</b>	<b>4</b>	<b>No</b>
<b>1</b>	<b>3</b>	<b>5</b>	<b>Yes</b>
<b>-1</b>	<b>-3</b>	<b>-5</b>	<b>Yes</b>

**H for help, R for recap, Q for quiz.**

**Skills:** Recognizing number patterns and relationships  
Adding, subtracting, multiplying, and dividing  
Forming and testing hypotheses  
Problem solving  
Developing and using complex classification strategies

**Grade Level:** 6 - adult

**Reading Level:** 4th grade (Fry)

**Time Required:** 10-20 minutes for each level

- Objectives:**
1. To enable players to form and test hypotheses.
  2. To help players build skills in recognizing numerical patterns and relationships.
  3. To help players develop skills in critical thinking and problem solving.

# THE ROYAL RULES

## Program Overview

The Royal Rules includes a Program Diskette and a Data Diskette. On the Program Diskette, players solve number problems--guessing the rules that apply to sets of three numbers--at four levels of difficulty. After they have discovered three rules on a chosen level, players are allowed to solve new rules or to enter rules of their own which are then saved onto the Data Diskette. The ultimate objective for players is to come face-to-face with the Queen, at which time each player is challenged to solve a final series of problems. To finish the game at this level may require many tries, even for a very able player.

The program has four levels of difficulty:

- Level 1: The City
- Level 2: The Duchy
- Level 3: The Province
- Level 4: The Kingdom

At each level, players can choose to play against the Sunburst Rules provided on the Program Diskette, the Player Rules entered on the Data Diskette by previous players, or a combination of both.

On each level, players 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 to be checked against the rule. Players will receive a "Yes" answer to those sets that conform to the rule, and a "No" answer to those that do not. When players feel confident that they know the rule, they can take a quiz that tests their hypothesis.

If players fail a quiz by answering any of its questions incorrectly, they may try the same rule again. They can also choose a new rule. But they cannot enter a rule of their own for others to play against until they have passed three quizzes on one level.

THE ROYAL RULES  
Program Description

Starting the Program

Students start with the Program Diskette and choose a level from the main menu, as shown below:

**THE ROYAL RULES**  
Designed by Tom O'Brien  
Programmed by Raoul Watson

---

**The City**  
The Duchy  
The Province  
The Kingdom  
Descriptions of Levels  
End

---

Use the   keys, then press RETURN.

On each level, players can choose Sunburst Rules, Player Rules, or Combination of Both, as shown below:

**THE ROYAL RULES**  
Designed by Tom O'Brien  
Programmed by Raoul Watson

---

Which do you want to play with?  
**Sunburst Rules**  
Player Rules  
Combination of Both

---

Use the   keys, then press RETURN.

Players who select Player Rules or Combination of Both will need the Data Diskette. If the Data Diskette is empty (as when it is used for the first time), players will be informed that there are no Player Rules available.

THE ROYAL RULES

Testing Hypotheses

On each level, players are shown three numbers corresponding to a secret rule, as in the following example:

<b>Your challenge....</b>			
<b>These numbers fit the rule.</b>			
<b>12</b>	<b>6</b>	<b>3</b>	
<b>1st</b>	<b>2nd</b>	<b>3rd</b>	<b>Yes/No</b>
<b>█</b>			
<b>H for help, R for recap, Q for quiz.</b>			

Players must then generate their own hypotheses by entering their own sets of three numbers to be checked against the rule. They will receive a "Yes" answer to those sets that conform to the rule, and a "No" answer to those that do not, as in the following example:

<b>Your challenge....</b>			
<b>These numbers fit the rule.</b>			
<b>20</b>	<b>120</b>	<b>160</b>	
<b>1st</b>	<b>2nd</b>	<b>3rd</b>	<b>Yes/No</b>
<b>40</b>	<b>140</b>	<b>180</b>	<b>Yes</b>
<b>10</b>	<b>110</b>	<b>120</b>	<b>No</b>
<b>40</b>	<b>180</b>	<b>200</b>	<b>Yes</b>
<b>20</b>	<b>200</b>	<b>400</b>	<b>Yes</b>
<b>█</b>			
<b>H for help, R for recap, Q for quiz.</b>			

## THE ROYAL RULES

The goal is for players to test as many hypotheses as possible until they feel they know the rule and are ready to take a quiz.

Players can enter as many hypotheses as they wish. When they have filled the entire screen with their guesses, the first line is automatically deleted but not lost (see Recap below), allowing more entries at the bottom of the screen.

### Player Options

At any time while testing their hypotheses, students can use the following options:

- o Help - Players may press the H key to receive a new set of three numbers which also fit the rule, as in the following example:

<b>Shhh..our secret..</b>			
<b>these numbers also fit the rule:</b>			
	<b>180</b>	<b>160</b>	<b>20</b>
<b>1st</b>	<b>2nd</b>	<b>3rd</b>	<b>Yes/No</b>
<b>40</b>	<b>140</b>	<b>180</b>	<b>Yes</b>
<b>10</b>	<b>110</b>	<b>120</b>	<b>No</b>
<b>40</b>	<b>180</b>	<b>200</b>	<b>Yes</b>
<b>20</b>	<b>200</b>	<b>400</b>	<b>Yes</b>

**Press RETURN to continue.**

- o Recap - Players who have entered more hypotheses than can fit on one screen may receive a recap of their previous guesses by pressing the R key at any number input.
- o Quiz Request - Players can call for a quiz by pressing the Q key at any input during the hypothesis-testing activity. They will then be asked to answer five questions that will vary depending on the chosen level.

THE ROYAL RULES

On levels 1 (The City), 3 (The Province), and 4 (The Kingdom), players are presented with five sets of three numbers, and they must state whether or not each set fits the rule, as in the following example:

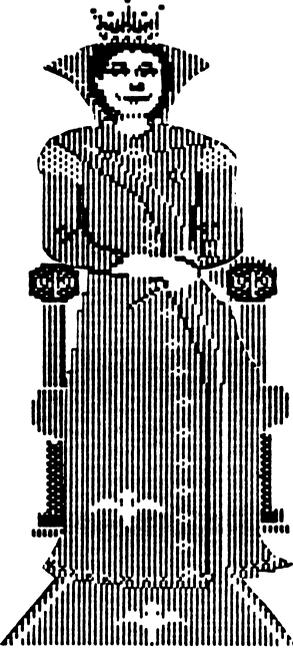
Do these numbers  
fit the rule?

6 9 13

Yes    No

**CORRECT! You  
may continue  
the challenge.**

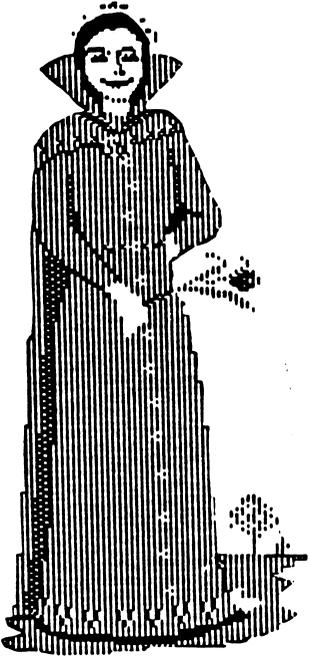
Press RETURN  
to continue.



On level 2 (The Duchy), players taking the quiz are given two numbers, they must supply a third number which will fit the rule, as shown below:

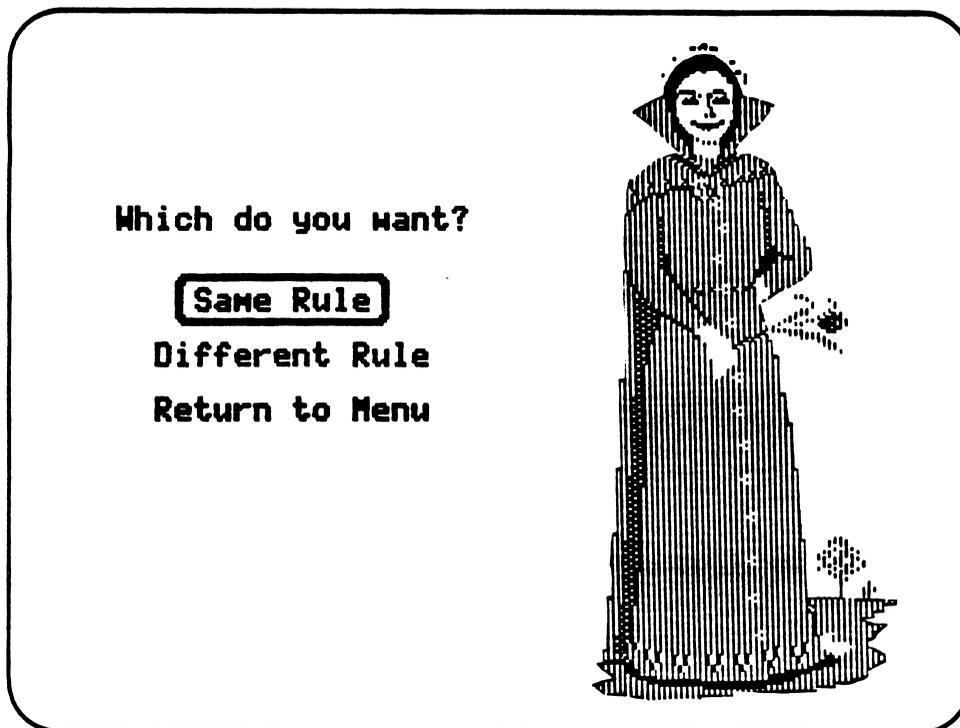
Please enter the  
third number.

52 29 █



## THE ROYAL RULES

To complete a quiz successfully, players must answer each of the five questions correctly. Students who fail the quiz are given the following options:



Players who have passed the quiz are awarded an object which varies according to the chosen level. The objects displayed are the following:

- Level 1: The City -- Magic Book
- Level 2: The Duchy -- Royal Crest
- Level 3: The Province -- Goblet
- Level 4: The Kingdom -- Crown

Players who have passed three quizzes at any level are given the choice to enter their own rules (see Creating Rules page 19) provided the teacher has permitted this option (see Change Options page 27). Players who do not wish to enter their own rules are returned to the main menu. They can then select a different level and play the game again.

### Exiting the Program

Players can exit the program at any time by holding down the CONTROL (CTRL) key and pressing the E key. If they choose to exit the game during the hypothesis-testing or the quiz activities of the program, they will be given the option to choose the same rules, to choose a different rule, or to return to the main menu.

Please Note: Students who have won one quiz and return to the main menu before completing the next two quizzes will lose that first quiz object.

THE ROYAL RULES

Difficulty Levels

Each difficulty level in this program offers students a different set of rules. This section of the guide contains a list of the rules for each level. Teachers will need to refer to this list whenever they wish to check the current rule under which the program is operating.

Rule Display

At any levels while players are generating and testing hypotheses, teachers may see the current rule under which the program is operating. They may do so by holding the CONTROL (CTRL) key and pressing the T key. A message will then be displayed as follows:

- o If the current rule is a Sunburst Rule: The Sunburst Rule number is displayed as listed in this section of the guide for a particular level. The level is also displayed, as shown below:

<b>Your challenge....</b>			
<b>These numbers fit the rule.</b>			
<b>28</b>	<b>33</b>	<b>38</b>	
<b>1st</b>	<b>2nd</b>	<b>3rd</b>	<b>Yes/No</b>
<b>Sunburst 7 (The Kingdom)</b>			
<b>Press RETURN to continue.</b>			

- o If the current rule is a Player Rule: The number of the player who entered the rule is displayed, followed by the level. To view the rule, teachers need to select View Rules through the Change Options (see pages 27-28).

## THE ROYAL RULES

Following are the descriptions of the rules of each level of difficulty. Although players may enter the program at any level, they should all be encouraged to work through the first level. Sequential play is not so important on Levels 2, 3, and 4.

### Level 1: The City

Rules in Level 1 are transparent. That is, the three numbers given at the start clearly suggest the rule that governs them.

If the rule is "upward jumps of 2," an example might be:

10                      12                      14

Another typical rule might also be "downward jumps of 2."

14                      12                      10

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

29                      24                      19

Here is a list of the Sunburst Rules provided on the Program Diskette for Level 1:

1. Three perfect squares
2. All numbers are divisible by 20
3. All numbers end in 99
4. All numbers are odd
5. Numbers in ascending order
6. Upward jumps of 11
7. Downward jumps of 7
8. The second number is half of the first and the third number is half the second number
9. Upward jumps of 101
10. The third number equals the first number times the second

Here are the types of rules allowed when players formulate and add their own rules:

1. Ends in a particular number
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd

## THE ROYAL RULES

### Level 2: The Duchy

Level 2 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.

Sunburst Rule 1, for example, is "The third number is double the sum of the first two numbers," or:

$$2(A+B)=C$$

If A (randomly chosen) = 3, and B (randomly chosen) = 0, then C=6 and the number trio is:

$$3, 0, 6.$$

What is the third number for 1, 10, ( )? The answer is 22.

Does 1,1,5 fit the rule? No, it doesn't, but 1,1,4 does fit the rule.

Sunburst Rule 2 is:

$$(A+B)^2=C$$

The number trio 0,0,0 fits the rule, and so does 1,5,36.

Does 4,1,2 fit the rule? No, but 4,1,25 does because:

$$(4+1)^2=25$$

Some of the rules displayed in this guide include the terms INT and MOD. INT is used to mean integer part, in other words, "ignore fractional parts" (for example: INT 4.3=4 and INT 7/2=3); MOD is used to mean "the remainder of a division" (for example: 29 MOD 3=2).

Here are the Sunburst Rules for Level 2:

1.  $2(A+B)=C$
2.  $(A+B)^2=C$
3.  $(A-B)^2=C$
4.  $(A)(B)(10)=C$
5.  $\text{INT}((A+B)/2)=C$
6.  $A^2-B=C$
7.  $7A+B=C$
8.  $\text{INT}(A/B)=C$
9.  $A \text{ MOD } B = C$
10.  $A^2+B^2=C$

## THE ROYAL RULES

The Player Rules for Level 2 are based on the formula:

$$AX+BY+K=C$$

For example, a possible rule may be "The third number is twice the first number plus twice the second number, plus three," or:

$$\begin{aligned} 2A+2B+3=C \\ \text{if } A=5, \text{ and } B=0, \\ \text{then } (2 \times 5) + (2 \times 0) + 3 = 13. \end{aligned}$$

Consequently, the number trio is: 5,0,13.

And what about 1,4,2? Does it fit the rule? No, it doesn't.

But 1,4,13 does fit the rule because:

$$(2 \times 1) + (2 \times 4) + 3 = 13.$$

In the Player Rules for The Duchy (Level 2), the following formats are available:

1.  $A + B + K = C$
2.  $A - B - K = C$
3.  $A + B - K = C$
4.  $A - B + K = C$
5.  $AX + BY + K = C$
6.  $AX - BY - K = C$
7.  $AX + BY - K = C$
8.  $AX - BY + K = C$

After selecting a format (such as  $AX + BY + K = C$ ), players are asked to choose a multiplier for the first number A, a multiplier for the second number B, and a constant, K. In each case, the choices range from -10 to 10. Suppose a player chooses, respectively, 0, 0, and 3. Then the rule is 0 times the first number, plus 0 times the second number, plus 3. The trios 4,5,3, or 9,24,3, and 7,1,3 all fit the rule, but 1,1,4 does not. If the constant K is not desired, one simply can enter 0. Zero can also be used for the multipliers X and Y.

### Level 3: The Province

Level 3 differs from previous levels in that the example trios may disguise the rules they represent. Therefore, it is especially important to test several different hypotheses. If the student is presented with the set 100,200,300, the rule may not be as simple as it first appears. Rather than the obvious "multiples of 100" or "jumps of 100," the rule may be more subtle, such as "multiples of 2" or "multiples of 5."

If a player chooses a rule such as "multiples" (and other such rules needing further information), a follow-up question asks for the specific information, for example: "multiples of \_\_," which the player must fill in with a number.

## THE ROYAL RULES

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 300,400,900. Since these numbers are also multiples of 5, the test sets do fit the rule. When presented with the quiz, players might then be asked to approve or reject the numbers 100,200,45. They might think that 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 the rules "multiples of 10," "multiples of 5," and "multiples of 2," and others. In Level 3, players must be constantly on guard against being misled by the examples disguised.

Following are the disguised examples provided on the Program Diskette, and the actual Sunburst Rule each represents:

1. Disguise: Constant upward jumps  
Rule: Any constant upward OR downward jumps
2. Disguise: Upward jumps of  $n$  ( $n$  divisible by 3)  
Rule: Constant upward or downward jumps which are divisible by 3
3. Disguise: Constant upward or downward jumps  
Rule: The second number = (the first + the third) divided by 2
4. Disguise: Three consecutive numbers  
Rule: Any constant jumps
5. Disguise: The third number equals the first times the second  
Rule: The third number is divisible by BOTH the first and second
6. Disguise: The third number equals the first plus the second  
Rule: The third number equals the first plus the second
7. Disguise: Upward jumps of 2  
Rule: All even numbers OR all odd numbers
8. Disguise: The third number equals the first times the second  
Rule: The third number is divisible by the first
9. Disguise: Multiples of 100  
Rule: Multiples of 5
10. Disguise: Constant upward jumps  
Rule: The difference of the first number and the third is even

## THE ROYAL RULES

Listed below are the types of rules allowed when teachers and players formulate their own rules for Level 3:

1. Ends in a particular digit
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd
9. Ascending numbers
10. Descending numbers

The same list is given both for the rule and for the disguise. Players may choose to create a rule first or a disguise first (see Creating Rules page 19). Even though the list is the same for rules and disguises, the match-ups are incredibly rich and complex. Here are some possible situations teachers and players can construct:

Disguise: Ends in 1  
Rule: All numbers are odd

Disguise: Ends in 0  
Rule: Multiples of 2

Disguise: Multiples of 8  
Rule: Multiples of 1

Disguise: Constant multiples of 5 (for example, 2,10,50)  
Rule: Ascending numbers

Disguise: Multiples of 9  
Rule: Multiples of 3

### Level 4: The Kingdom

Level 4 uses very simple rules, but is extremely challenging because the rules may apply to only one, at least one, or all three of the numbers presented. For example, the program may present 64,66,68 and the rule could be "At least one number is a perfect square."

## THE ROYAL RULES

Following are "disguised" examples given by the Sunburst program, and the actual rule each represents:

1. Disguise: Upward jumps of  $n$   
Rule: Numbers in ascending order
2. Disguise: Multiples of 100  
Rule: Multiples of 4
3. Disguise: Multiples of 100  
Rule: The sum of the numbers is divisible by 4
4. Disguise: Three ascending squares  
Rule: All numbers are squares
5. Disguise: Constant upward jumps  
Rule: The first number is the smallest
6. Disguise: Three multiples of  $n$   
Rule: At least one number is a multiple of  $n$
7. Disguise: Upward jumps of  $n$  ( $n$  is odd)  
Rule: At least one number is even
8. Disguise: Three consecutive even numbers  
Rule: Ascending OR descending numbers
9. Disguise: Three numbers greater than one where the third number equals the first times the second  
Rule: The third number is the largest
10. Disguise: Three positive numbers where the third number is the first minus the second  
Rule: The first number is the largest

In constructing Player Rules (and disguises) for Level 4, teachers and players are asked whether they want their rule to apply to:

All of the numbers  
At least one of the numbers  
Only one of the numbers.

They are then asked for a disguise and a rule. For rules involving only one of the numbers, no disguise is used as the situations are difficult enough as presented.

## THE ROYAL RULES

If the rule applies to all of the numbers, the rule and the disguise are chosen from the following list:

1. Ends in a particular digit
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd
9. Ascending numbers
10. Descending numbers
11. Consecutive even numbers
12. Consecutive odd numbers

If the rule applies to at least one of the numbers, the choices listed above are available for disguises, while the choices listed below are available for rules:

1. Ends in digit
2. Multiple
3. Odd number
4. Even number

And if the rule applies to only one of the numbers, the rule must be selected from the following choices:

1. Ends in digit
2. Multiple
3. Odd number
4. Even number
5. Square
6. Smallest
7. Largest

In this manner, a wealth of situations can be created, as shown in the following examples:

Disguise: Consecutive even numbers  
Rule: Multiples of 2

Disguise: Constant upward jumps of 1  
Rule: At least one number is odd

Disguise: Ends in 0  
Rule: At least one number is even

Disguise: Constant downward jumps of 2  
Rule: Descending numbers

Disguise: (Not necessary since the rule pertains to only one number)  
Rule: Third number is a square

## THE ROYAL RULES

### Creating Rules

Teachers can enter rules through the Change Options (see page 29). Through the Change Options, teachers can also allow students to enter their own rules (see Rule Option page 27).

When teachers or players add a rule of their own, the rule is saved on the Data Diskette so that others may play against it. If one disk drive is used, a message will be displayed whenever the diskettes must be exchanged. If a two-disk drive system is used, the computer will automatically switch back and forth between the two diskettes.

On Level 1, teachers or players are prompted for a rule by choosing from a list of available rules as shown below.

### Create Player Rules (The City)

1. Ends in a particular digit
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd
9. Exit

Which rule do you want? \_

In some cases (for example, constant multiples), players are asked to choose a number within a given range of numbers.

THE ROYAL RULES

Finally, the player must enter a sample trio depicting the rule. If the sample does not fit the rule, the teachers or players are given the chance to try again, as in the following example:

**Create Player Rules (The City)**

---

**RULE: Constant multiples of 5.**

Please enter a 3 number set that will fit the rule.

1st	2nd	3rd
5	10	15

Those numbers don't fit the rule.

Do you want to try again?

Yes      No

After a correct set of numbers has been entered, teachers or players are shown a list of possible sets which fit the rule. They are then asked whether they are satisfied with the results displayed, as in the example shown below:

**Create Player Rules (The City)**

---

**RULE: Constant multiples of 5.**

Based on this rule, the following random sets could be generated:

9,45,225	12,60,300
11,55,275	5,25,125
10,50,250	4,20,100

Is this what you want?

Yes      No

## THE ROYAL RULES

If they are not satisfied with the results, they get another chance at entering a rule. Once a player is satisfied with the rule, the player's name is requested and the rule is saved under that name on the Data Diskette. Players or teachers then have the option of entering another rule or returning to the menu.

Players and teachers can enter as many rules as desired. To do so, players must first pass three quizzes, while teachers can choose Create Player Rules from the Change Option menu (see Change Options page 27). It is possible for one player to fill an entire Data Diskette with rules for others to play against.

On Level 2, the same procedure as on Level 1 is used to enter rules, but the format chosen to define the rule is different, as shown below:

### Create Player Rules (The Duchy)

1.	A+B+K=C
2.	A-B-K=C
3.	A+B-K=C
4.	A-B+K=C
5.	AX+BY+K=C
6.	AX-BY-K=C
7.	AX+BY-K=C
8.	AX-BY+K=C
9.	Exit

Which format do you want? 5\_

## THE ROYAL RULES

Players or teachers must define X,Y,K, as the program will generate A and B randomly:

### Create Player Rules (The Duchy)

**FORMAT:  $AX+BY+K=C$ .**

In the game, the program will generate A and B randomly.

You should supply X, Y, and K.

Enter number for X (-10 to 10): 2  
Enter number for Y (-10 to 10): 1  
Enter number for K (-10 to 10): 4\_

Here again, a sample of the rule is requested in which the first, second, and third number of the set must be entered.

### Create Player Rules (The Duchy)

**FORMAT:  $AX+BY+K=C$ .**  
**(X=2, Y=1, K=4)**

Please enter a 3 number set that will fit the rule.

A	B	C
0	0	4_

THE ROYAL RULES

Number trios are then generated, and teachers or players are asked whether they are satisfied with the results displayed.

On Levels 3 and 4, teachers or players must create a rule and a disguise for the rule. They may choose the order in which they wish to proceed, as shown below:

**Create Player Rules (The Province)**

Which do you want to do first?

Enter a Rule

**Disguise a Rule**

When choosing Disguise a Rule, teachers or players choose a disguise, in this case, "Ends in a particular digit" from a list of available disguises, as shown below:

**Create Player Rules (The Province)**

Enter your DISGUISE.

1. Ends in a particular digit
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd
9. Ascending numbers
10. Descending numbers
11. Exit

Which disguise do you want? 1\_

## THE ROYAL RULES

After selecting the particular number needed for the disguise (for example 1), players are asked to provide a number trio which fits the disguise. If the three numbers fit the disguise, players are then shown other number trios, randomly generated as in the example below:

### Create Player Rules (The Province)

All numbers end in 1.

Based on this disguise, the following random sets could be generated:

71,71,191	71,101,51
11,101,51	101,71,191
71,81,91	31,31,191

Is this what you want?

Yes       No

If they have created a disguise first, teachers or players must then enter a rule. They do so by choosing, as in the other levels, from a list of available rules, as shown below:

### Create Player Rules (The Province)

All numbers end in 1.

Enter your RULE for your disguise.

1. Ends in a particular digit
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd
9. Ascending numbers
10. Descending numbers
11. Exit

Which rule do you want? 8\_

THE ROYAL RULES

Suppose a player chooses "All numbers are odd," for the rule (the disguise is still "All numbers end in 1"). A display similar to the one below will then be shown:

**Create Player Rules (The Province)**

**RULE: All numbers are odd.**

**Please enter a 3 number set that will fit the rule.**

1st	2nd	3rd
<input type="text" value="-"/>		

All possible examples of the disguise (in this case 91,111,131, and 11,71,121, and so forth) must fit the rule. A consistency check is then performed on randomly selected examples of the disguise to see if they fit the rule, as shown below:

**Create Player Rules (The Province)**

**Disguise:**  
All numbers end in 1.

**Rule:**  
All numbers are odd.

**The program found no inconsistencies.  
Your disguise and rule are accepted.**

**Press RETURN to continue.**

## THE ROYAL RULES

If no inconsistencies are found, the players are then asked to enter their names. The rule and the disguise are then saved on the Data Diskette under the player's name.

If a disguise and a rule fail the consistency check, the player is given a message as follows:

**Create Player Rules (The Province)**

---

**Disguise:**  
Constant upward jumps of 2.

**Rule:**  
All numbers are even.

47,49,51	17,19,21	43,45,47
47,49,51	5,7,9	41,43,45

These numbers fit the disguise but do not fit the rule.

Press RETURN to continue.

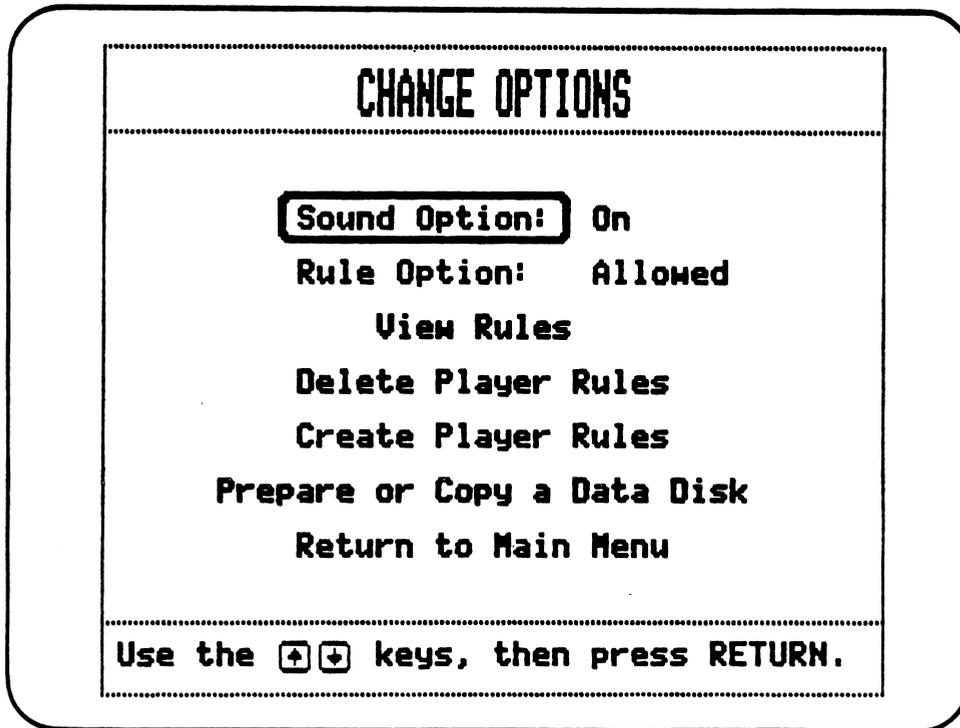
The player would then be given the opportunity to change either the rule or the disguise or to start over.

After selecting the disguise in Level 4, players may choose to have the rule apply to all the numbers, or at least one of the numbers. If the rule is entered first, the players may also choose to make the rule apply to only one of the numbers. When applying the rule to only one of the numbers, no disguise will be needed.

## THE ROYAL RULES

### Change Options

Several change options are provided to enrich the use of The Royal Rules and to give teachers control of the learning situation. By holding down the CONTROL (CTRL) key and T key at the main menu, teachers can make important decisions on behalf of the players, as shown below:



#### Sound Option

This option allows the teacher to choose whether the sound will be on or off during the program. Answering the question "Do you want sound?" will allow the teacher to turn the sound off or on. The sound will then remain in the mode selected until the Sound Option is used again.

During the game, when the sound is turned on players can then toggle at their discretion between sound on or off by holding down the CONTROL (CTRL) key and pressing:

- S on the Apple and IBM.
- A on the Tandy 1000.

#### Rule Option

This option allows teachers to turn the Rule Option on or off. When the Rule Option is turned on, players who have successfully completed three quizzes, at any one level, will be given the option of entering their own rules. Since teachers may wish to focus the players' attention on certain types of rules, they can turn the Rule Option off, thus preventing new rules from being added by players. Once the option has been turned off (or on), it will remain in the mode selected until this option is used again.

THE ROYAL RULES

View Rules

This option allows teachers to view the rules created by the players. Teachers first choose the level (for example: The Province), then the particular rule(s) to be viewed. The rules are listed by the names of the players who entered them. Here's a look at how the players' names are listed for a chosen level (The Province):

**View Rules (The Province)**

---

1	TOM
2	EDWARD
3	KRIS
4	MARK
5	JANE

Which number to view? 1\_

(Enter 0 to return to the menu).

After choosing the name of the player whose rule will be viewed, the teacher is then given information as shown below:

**View Rules (The Province)**

---

**Rule creator: TOM**

**Rule:**  
Numbers in ascending order.

**Disguise:**  
Constant upward jumps of 2.

**Press RETURN to continue.**

## THE ROYAL RULES

Teachers may get a printout of Player Rules at each of the four levels. To obtain this printout with any type of printer, they need to hold down the CONTROL (CTRL) key and press the P key when asked "Which number to view?" All the Player Rules in that level will be sent to the printer.

- Before printing on the Apple, teachers are asked to specify the location of the computer card as the question, "Which slot is your printer card in?" is displayed (on the Apple IIc: "Which port is your printer attached to?"). The printer card is usually in slot 1 (on the Apple IIc, printer attached to port 1).

- On the IBM and Tandy 1000, teachers are not asked to specify the location of the printer card.

### Delete Player Rules

This option allows teachers to delete some of the Player Rules (because of redundancy), or all of the Player Rules. After choosing the level, teachers are asked the following question:

**Delete Player Rules (The Province)**

Do you want to delete  
some of the rules or  
all of them?

**Some**     **All**

Use the   keys, then press RETURN.

To delete some of the rules, teachers choose from a list of names under which these rules were entered. If they choose to delete all of the rules, teachers will be given the opportunity to change their mind.

### Create Player Rules

Perhaps most important, teachers can add rules of their own--as many as they want--and at any level of the program. (See Creating Rules page 19.)

## THE ROYAL RULES

### Prepare or Copy a Data Disk

This option allows teachers to make a copy of the Data Diskette or to prepare a blank diskette so that it can be used as a Data Diskette. Once a Data Diskette has been prepared, it can be used to store the rules created by the students or teachers. Through a repeated use of this option, teachers may prepare as many Data Diskettes and as many copies as needed in the classroom.

Note: IBM 3.5" DISK ONLY.

Since the 3.5" disk allows for added disk space, teachers may prepare a data disk that is playable without having to reinsert the program disk into the disk drive. To do this, an IBM with 2 drives (A: & B:) is needed. Select "Prepare or Copy a Data Disk" from the Change Options Menu. When this is completed exit the program to the DOS prompt (see End Option below). With the original Royal Rules program disk in drive A:, at the A > type: PLAYDISK and press ENTER (↵). The necessary files will be copied to the data disk. Now you can boot the original program disk and at the Main Menu you may replace it with the playable data disk to continue the program.

### Return to Main Menu

This last option allows teachers to exit the Change Options and return to the menu.

### End Option (Main Menu)

Selecting "End" will allow you to boot another program disk. You may also return to the DOS prompt by answering "No" to "Do you want to use another disk?" and then pressing SHIFT-ALT-SPACEBAR. The DOS prompt (A >) will then be displayed.

## THE ROYAL RULES

### Classroom Use

The Royal Rules is designed so that students can enter the program at any difficulty level. Students using the program for the first time should begin at The City, Level 1 (the simplest level), in order to become familiar with the program's format and procedures. 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 problems. Again, it is wise to remember that Levels 2-4 are much more difficult than Level 1.

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 2-4. One particular set of numbers could represent several possible rules. For example, suppose a student playing on Level 3 is given the set 14,16,18. The obvious rule might be "jumps of 2." It might also be "constant jumps," "all even numbers," or even "ascending numbers." In brief, generating alternate hypotheses and attending both to confirming and disconfirming evidence are the keys to success.

Creating new rules for others to solve is a special feature of The Royal Rules. In Levels 1 and 2, the task is relatively straight-forward. But in Levels 3 and 4, the creating of rules (and disguises) is an extremely complex task which will certainly cause much growth and enjoyment among students.

The critical issue in creating rules and disguises in Levels 3 and 4 is that all possible manifestations of the disguise must fit the rule. At the same time, the disguise should not reveal the rule. Students (and possibly teachers as well), are likely to struggle in coordinating rules and disguises. For example, is "constant upward jumps of 2" a good disguise for the rule "all even numbers?" No, because a possible number trio for the disguise "constant upward jumps of 2" is 23,25,27, where no number is even.

In solving the problems in The Royal Rules, and in creating rules to be stored on the Data Diskette, students should be encouraged to work in groups of 2 to 4. In general, students tend to construct ideas best in small group situations.

## THE ROYAL RULES

### Observations from Field Testing

A final word: What about evaluation? The Royal Rules is concerned with students' construction of ideas. The best evaluation is in terms of the quality of players' thinking, not the quantity of right or wrong responses. To assess students' efforts--and to learn a great deal more about their construction of complex ideas--the program was subjected to field-testing. The following observations and conclusions were made during the experiment:

1. Students who aren't used to solving problems through original thinking--in other words, students who have been taught to rely mostly on memorized facts and formulas--tend to race through the programs. They will move within minutes to the higher levels (2-4) without having understood the rules on Level 1. As thoughtful examination of a problem requires time, it is recommended that students playing the Royal Rules should not be allowed to move to the higher levels until they have completed successfully Level 1.
2. Students show amazing capacity for thinking on the higher levels (2-4), especially when encouraged to play the Royal Rules in groups of 3-4. Generally, they tend to play the game cooperatively and work harmoniously in groups of 3-4.
3. Typical low achievers tend to attain great success with the Royal Rules. This confirms the idea that students who fail at memorizing facts and formulas can be very creative when given a chance to think for themselves. In fact, it is not uncommon for "failing" students to surpass "straight A" students in originality, as "straight A" students may have succeeded on the strength of memory alone.
4. Students love to make up rules to challenge others. But if entering rules at Level 1 is easy, the making of rules on Levels 3 and 4 is a difficult task. To be successful, students must find a disguise which fits the rule without revealing it to the player. (For example, "End in 0" is a good disguise for "Divisible by 2," but upward Jumps of 2" is not a good disguise, since the trio, 3,5,7 (upward jumps of 2) doesn't fit the rule.)
5. The coordination of the rule with a disguise is a very complex activity which can give students unparalleled experience applicable to data management (from the organization of information in a composition outline, to the management of information in a complex data base).

In conclusion, the Royal Rules doesn't require that students store information in their memory; rather, it encourages them to gather and organize information, construct complex arguments, and make original judgments based on their own thinking. Quite a rich experience for school children, and an eye-opener for many teachers!

## APPLE: WORKING WITH THE COMPUTER

1. Turn on the television or monitor.
2. Insert the diskette into the disk drive with the label facing up and on the right.
3. Close the door of the disk drive.
4. Turn on the computer (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 light does not turn off in about 20 seconds, turn the Apple off and make sure your diskette is placed correctly in the disk drive.
6. The SUNBURST logo will appear, followed by the opening screen.
7. Follow the instructions 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 System

1. Remove the diskette from the disk drive and return it to its place of storage.
2. Turn off the computer.
3. Turn off the television or monitor.

## Apple IGS: Control Panel Settings

To allow your Apple IGS to work properly with Sunburst software, certain Control Panel settings should be selected. The Apple IGS retains these settings even after the power is turned off.

### To Use the Control Panel:

- Turn on the Apple IGS and monitor.
- Enter the Control Panel main menu by holding down the CONTROL and OPTION keys, and then press RESET (the rectangular key located above the number keys). If your Apple IGS is in an Apple //e case, use the closed-apple (🍏) key instead of OPTION.
- Press the 1 key to enter the Control Panel.
- Use ↓ and ↑ to highlight the feature you want to change and press RETURN. Again use ↓ and ↑ to highlight a specific option and change it by using the ← and → keys.
- After you have finished making changes, select Quit to use the Apple IGS.

### To Change the Display:

- Highlight **Display** and press RETURN.
- Set **Type** to **Color**.
- Set **Columns** to 40.
- Set **Text** to **White**.
- Set **Background** to **Black**.
- Set **Border** to **Black**.
- Press RETURN to save the changes and to go back to the Control Panel.

### To Change the System Speed:

- Highlight **System Speed** and press RETURN.
- Set **System Speed** to **Normal**.
- Press RETURN to go back to the Control Panel.

### To Change the Slots:

- Highlight **Slots** and press RETURN.
- Set **Slot 1** to **Printer Port**. If you are using a printer card, select the slot number your printer card is in.
- Set **Slot 6** to **Disk Port**, if you use a 5.25 - inch drive connected to the disk drive port.
- Set **Slot 6** to **Your Card**, if you use a 5.25 - inch drive connected to a controller card in Slot 6.
- Set **Startup Slot** to **Scan**.
- Press RETURN to go back to the Control Panel.

## IBM: WORKING WITH THE COMPUTER

For use with the:

IBM PC with 128K and a graphics monitor  
IBM PC/PCjr with 128K and a graphics monitor  
IBM PS/2 Models 25 and 30.

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.)
2. Turn on the computer and graphics monitor.
3. The SUNBURST logo will appear, followed by the opening screen.
4. Follow the instructions in the program.
5. If at any time during the program you want to stop, hold down the CTRL (Control) key and press the E key.

### Turning Off the System

1. Remove the diskette from the disk drive and return it to its place of storage.
2. Turn off the computer and graphics monitor.

## TANDY 1000: WORKING WITH 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 bottom.) Close the door of the disk drive.
2. Turn on the 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, followed by the opening screen.
5. Follow the instructions in the program.
6. If at any time during the program you want to stop, hold down the CTRL (Control) key and press the E key.

### Turning Off the System

1. Remove the diskette from the disk drive and return it to its place of storage.
2. Turn off the computer.
3. Turn off the monitor.

"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 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 or call us with the information. We will correct the error and send you a new diskette.
  
3. What happens if the courseware is accidentally 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 in the middle to go on to something new?  
A program can be ended at any input by holding down the CONTROL (CTRL) key and pressing the E key.
  
5. May I copy this diskette?  
The material on the diskette is copyrighted. You should not copy the diskette. You can copy the Data Diskette.
  
6. Can I take this diskette out of the computer after the program has loaded and put it into another computer?  
Once the players are on a particular level, the Program Diskette is no longer needed until the players decide to return to the main menu. The Data Diskette may be needed if playing with Player Rules or Creating Player Rules.