Warm-Up

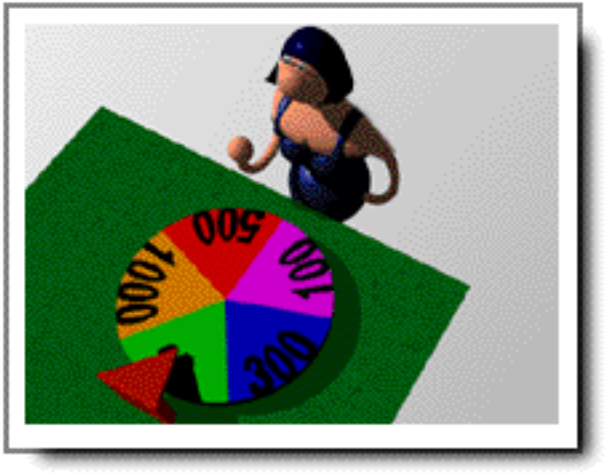
Spin the color wheel 20 times and note the relative frequency of red. Spin the wheel several more times and note the value of the relative frequency of red in the spreadsheet each time.

What is the maximum value of the relative frequency of red that you observed?

0.8

ACTIVITY CENTRAL

SCREEN 1 OF 4



Values	A	B
	Rel. Freq.	
a		
	0.750	
	0.250	
Sum:	1	

Warm-Up

Now repeat the experiment several more times and observe the value of the relative frequency of red each time.
What is the minimum value that you observed?

0.2

ACTIVITY CENTRAL

SCREEN 2 OF 4

Values	A	B
a	Rel. Freq.	
	0.800	
	0.200	
Sum:	1	

Warm-Up

Without seeing what the actual color wheel of this model looks like, what can you conclude about the probability of red turning up whenever you spin the wheel?

The probability of red turning up is equal to or greater than the minimum relative frequency and less than or equal to the maximum relative frequency.

ACTIVITY CENTRAL

SCREEN 3 OF 4

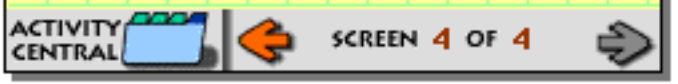
Values	A	B
a	Rel. Freq.	
	0.800	
	0.200	
Sum:	1	

Warm-Up

You have completed this activity.
Now you can choose another activity from this subsection:

Exploration
Problem

You may click the Activity Central icon below to return to Activity Central.



Exploration

The wheel in this model is divided into 8 regions of equal area. Assume that this is a fair wheel: when it is spun, each region has an equal chance of turning up. What is the probability that the wheel will stop in a red region? In other words, what is P(red)?

3/8 or 0.375

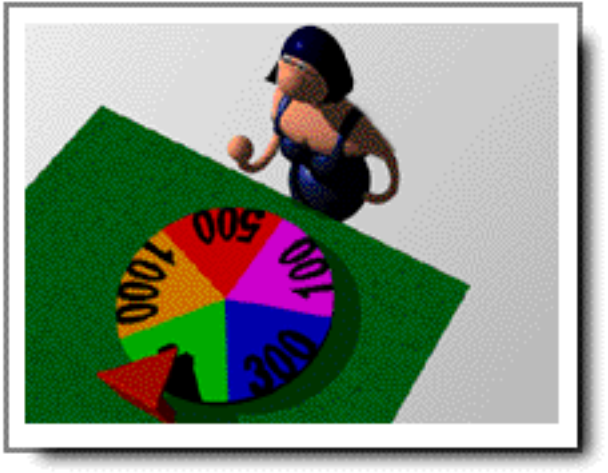
ACTIVITY CENTRAL

SCREEN 1 OF 14

Probability

The probability of an outcome is its long-term relative frequency, that is, the value of the relative frequency as the number of tries gets larger and larger.

Close



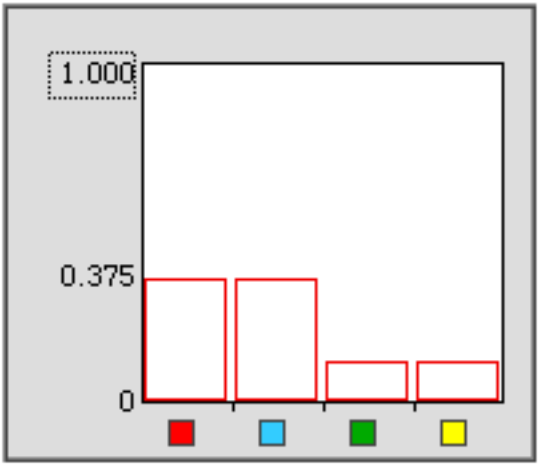
Exploration

The first column of the spreadsheet contains the probability that each color will turn up when the wheel is spun. These data can also be displayed on a bar graph. Explain what the height of each bar represents.

The height of each bar represents the approximate probability of each color turning up, as reported in the spreadsheet.

ACTIVITY CENTRAL

SCREEN 2 OF 14



	A	B	C
	Prob.	Rel. Freq.	
a			
	0.375	0.000	
	0.375	0.000	
	0.125	0.000	
	0.125	0.000	
Sum:	1	0	

Exploration

Spin the wheel 10 times.

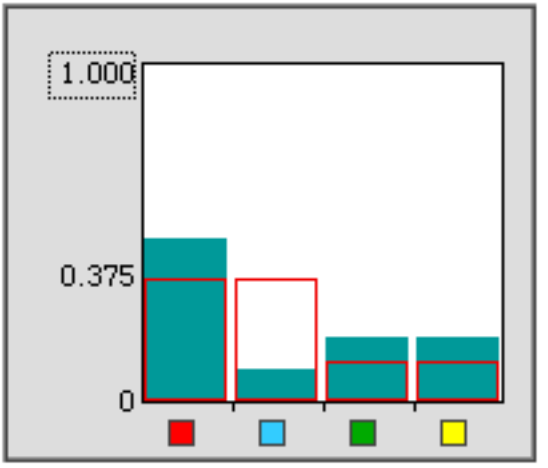
(You may close the Model Animation panel to speed up the process.)

The relative frequency of each outcome is displayed in the bar graph and in the second column of the spreadsheet. Compare the results of the experiment and the probability of each outcome. Are the results the same?

In most cases, the experimental results are not the same as the corresponding probabilities.

ACTIVITY CENTRAL

SCREEN 3 OF 14



	A	B	C
a	Prob.	Rel. Freq.	
	0.375	0.500	
	0.375	0.100	
	0.125	0.200	
	0.125	0.200	
Sum:	1	1	

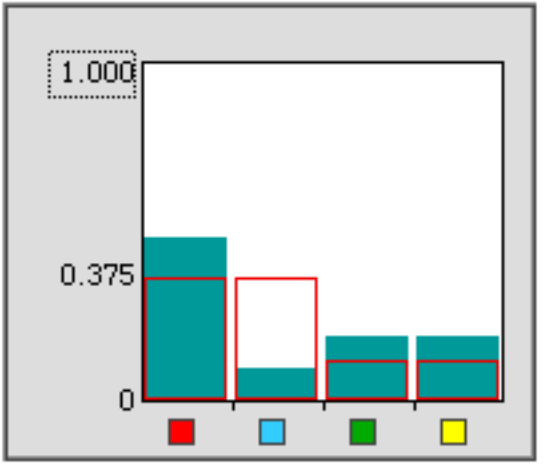
Exploration

The third column of the spreadsheet displays the absolute value of the difference between the probability and relative frequency of each color. (ABS is the abbreviation for absolute value.) What is the non-negative difference between the probability of red and the relative frequency of red for this experiment?

0.125

ACTIVITY CENTRAL

SCREEN 4 OF 14



	A	B	C	D
a	Prob.	Rel. Freq.	ABS(A-B)	
	0.375	0.500	0.125	
	0.375	0.100	0.275	
	0.125	0.200	0.075	
	0.125	0.200	0.075	
Sum:	1	1	0.55	

Exploration

Repeat the experiment as many times as necessary until the absolute value of the difference between P(red) and the relative frequency of red in the spreadsheet is less than 0.1. When you find this value, enter it into the first row of the table on the right.

ACTIVITY CENTRAL

SCREEN 5 OF 14

|P(red) - Relative Frequency of Red| Less Than...	Number of Tries	|P(Red) - Rel. Freq. (Red)|
0.1	10	0.025
0.03		
0.01		

	A	B	C
a	Prob.	Rel. Freq.	ABS(A-B)
	0.375	0.400	0.025
	0.375	0.300	0.075
	0.125	0.000	0.125
	0.125	0.300	0.175
Sum:	1	1	0.4

Exploration

With the number of tries still set to 10, repeat the experiment until the non-negative difference between the probability of red and the relative frequency of red is less than 0.03. If you have difficulty achieving this result, increase the number of tries and try again. When you succeed, record the number of tries you needed and the value of the difference in the second row of the table.

ACTIVITY CENTRAL

SCREEN 6 OF 14

|P(red) - Relative Frequency of Red| Less Than...	Number of Tries	|P(Red) - Rel. Freq. (Red)|
0.1	10	0.025
0.03	10	0.025
0.01		

	A	B	C	D
a	Prob.	Rel. Freq.	ABS(A-B)	
	0.375	0.400	0.025	
	0.375	0.500	0.125	
	0.125	0.000	0.125	
	0.125	0.100	0.025	
Sum:	1	1	0.3	

Exploration

Repeat the experiment until the non-negative difference between the probability of red and the relative frequency of red is less than 0.01. (Again, you may need to increase the number of tries. You may speed up the process by closing the Model Outcome panel.)

When you succeed, record the number of tries you needed and the value of the difference in the third row of the table.

ACTIVITY CENTRAL SCREEN 7 OF 14

|P(red) - Relative Frequency of Red| Less Than...	Number of Tries	|P(Red) - Rel. Freq. (Red)|
0.1	10	0.025
0.03	10	0.025
0.01	100	0.005

	A	B	C
	Prob.	Rel. Freq.	ABS(A-B)
	0.375	0.380	0.005
	0.375	0.420	0.045
	0.125	0.130	0.005
	0.125	0.070	0.055
Sum:	1	1	0.11

Exploration

Examine the data in the third column of the table. In each case the positive difference between the probability and the relative frequency of red was less than 0.1, 0.03, and 0.01 respectively. Do you think that these differences can be made even smaller? What can you do to obtain an even smaller difference in an experiment?

To make the difference even smaller, one should increase the number of tries.

ACTIVITY CENTRAL SCREEN 8 OF 14

|P(red) - Relative Frequency of Red| Less Than...	Number of Tries	|P(Red) - Rel. Freq. (Red)|
0.1	10	0.025
0.03	10	0.025
0.01	100	0.005

	A	B	C
	Prob.	Rel. Freq.	ABS(A-B)
a			
	0.375	0.380	0.005
	0.375	0.420	0.045
	0.125	0.130	0.005
	0.125	0.070	0.055
Sum:	1	1	0.11

Exploration

The probability of red is now set to 1.
Run the animation several times.
What can you say about the relative frequency of red in any experiment in this model?

The relative frequency of red is also 1.

What does it mean if the probability of an outcome in an experiment is 1?

It means that this is the only possible outcome for the experiment.

ACTIVITY CENTRAL

SCREEN 9 OF 14

	A	B	C	D
	Prob.	Rel. Freq.		
a				
Sum:	1	1		

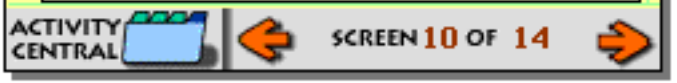
Exploration

Suppose that the probability of an outcome in an experiment is 0. What can you say about the relative frequency of this outcome in the experiment?

The relative frequency of that outcome is always 0.

What does it mean if the probability of an outcome is 0?

It means that the outcome will never occur.



Exploration

The data in the spreadsheet reflect the original model in this activity. Examine the probabilities of the four colors in the wheel. What is the relationship among the four values?

The four values add up to 1. That is,
P(blue) + P(red) +P(yellow) + P(green) = 1.

ACTIVITY CENTRAL

SCREEN 11 OF 14

	A	B	C
a	Prob.	Rel. Freq.	
	0.375	0.000	
	0.375	0.000	
	0.125	0.000	
	0.125	0.000	
Sum:	1	0	

Exploration

Open the Modify Model dialog window and change the probabilities to any set of new values. Click Apply, close the dialog window, and examine the relationship among the probabilities of the colors in the spreadsheet. What conjecture seems to be true about the probabilities of all the outcomes in an experiment?

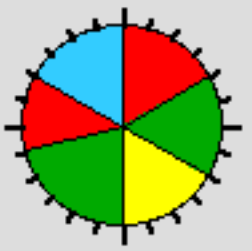
The sum of the probabilities of the outcomes in an experiment is always equal to 1.

ACTIVITY CENTRAL

SCREEN 12 OF 14

Change the Division of Colors in the Wheel.

	0.29
	0.17
	0.38
	0.17



1 Wheels spun

Apply

	A	B	C
a	Prob.	Rel. Freq.	
	0.292	0.000	
	0.167	0.000	
	0.375	0.000	
	0.167	0.000	
Sum:	1	0	

Exploration

What can you say about the probability of any outcome in an experiment? (What kind of number is it? What values are not possible?)

The probability of any outcome in an experiment is a number between 0 and 1, including 0 or 1. That is, $0 \le P(\text{outcome}) \le 1$.

ACTIVITY CENTRAL

SCREEN 13 OF 14

	A	B	C
a	Prob.	Rel. Freq.	
	0.292	0.000	
	0.167	0.000	
	0.375	0.000	
	0.167	0.000	
Sum:	1	0	

Exploration

You have completed this activity.
Now you can choose another activity from this subsection:

Warm-up
Problem

You may click the Activity Central icon below to return to Activity Central.

ACTIVITY CENTRAL

SCREEN 14 OF 14

Boy
Girl
Girl
Boy
Girl
Boy
Girl
Girl
Girl
Girl

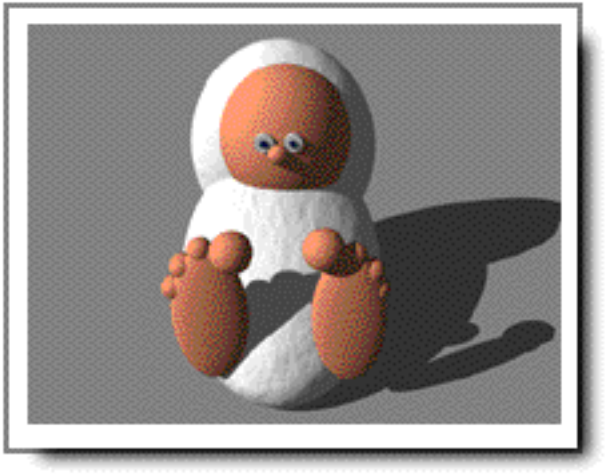
Problem

This model is based on actual Census Bureau data about the gender of babies born in the United States. Run a few experiments that simulate the birth of 10 babies and observe the frequencies of boys and girls in the spreadsheet. Based on these experiments, can you accurately predict if the next baby born will be a boy or a girl?

No. It is not possible to make any prediction.

ACTIVITY CENTRAL

SCREEN 1 OF 5



	A	B	C
a	Freq.		
Boy	3		
Girl	7		
Sum:	10		

Boy
Boy
Boy
Girl
Girl
Boy
Boy
Boy
Girl
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Girl
Boy
Girl
Girl
Boy
Girl
Girl

Problem

Run a few experiments that simulate the birth of 100 babies and observe the frequencies of boys and girls in the spreadsheet. Based on these experiments, can you accurately predict if the next baby born will be a boy or a girl?

No, it is impossible to predict if the next baby born will be a boy or a girl.

SCREEN 2 OF 5

	A	B	C
a	Freq.		
Boy	52		
Girl	48		
Sum:	100		

Boy
Boy
Boy
Girl
Girl
Boy
Boy
Boy
Girl
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Girl
Boy
Girl
Girl
Boy
Girl
Girl

Problem

It is a fact that there are more boys than girls born in the United States (and in the entire world) each year.
You can detect this fact by examining a very large number of births.
Increase the number of tries in an experiment until the results of an experiment always produce a greater number of boys. How many tries did you use?

? To speed up the experiment, close the Model Outcome panel.

Answers will vary.

ACTIVITY CENTRAL

SCREEN 3 OF 5

	A	B	C
a	Freq.		
Boy	52		
Girl	48		
Sum:	100		

Boy
Boy
Boy
Girl
Girl
Boy
Boy
Boy
Girl
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Girl
Boy
Girl
Girl
Boy
Girl
Girl

Problem

Add another column to the spreadsheet to see the actual probabilities of each gender.
Record each probability as a percentage.
How can you explain the fact that the world population contains more females (over 51%) than males?

Boys tend to die more often than girls.

P(boy) = 51.3%

P(girl) = 48.7%

ACTIVITY CENTRAL

SCREEN 4 OF 5

	A	B	C
a	Freq.	Prob.	
Boy	52	51.3%	
Girl	48	48.7%	
Sum:	100	100%	

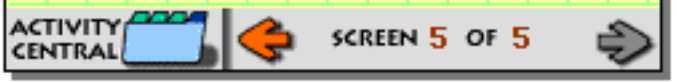
Boy
Boy
Boy
Girl
Girl
Boy
Boy
Boy
Girl
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Boy
Girl
Boy
Girl
Girl
Boy
Girl
Girl

Problem

You have completed this activity.
Now you can choose another activity from this subsection:

Warm-up
Exploration

You may click the Activity Central icon below to return to Activity Central.



Printing *Probability Constructor*

This CD includes material to help you prepare your use of *Probability Constructor* activities in the classroom.

You can access information about Installation, Logon, or the product itself by clicking the chapter name below.

For each activity listed at right there are: pictures of the on-screen activities including the text, the Model Window, any displays used in the activity, and the suggested answers.

- **To print a file,** click the chapter or activity name.

  Then choose Print from the File menu.

- **To reaccess this list,** click the "Last Page" icon  in the toolbar above.

Installation

Logon

About *Probability Constructor*

Frequency

Frequency of Heads and Tails
Frequency and Dice
Frequency of Colors in Turning Wheels

Relative Frequency

Exploring Relative Frequency with Marbles
Displaying Relative Frequency
Relative Frequency and Area

Probability

Calculating Probability
Properties of Probability
Geometric Probability
Probability Trees