

3. What is the probability that a player will roll the die six times on a turn without rolling a 1?
4. A player decides that she will roll the die three times on each turn, unless she rolls a 1 on the first or second roll of the turn. What is the probability that she will score more than 0 points on the turn?
5. Is the strategy of the player in (4) a winning strategy? Explain.

Rolling the Dice

Using Probability

“When am I ever going to use this?”
Using the concepts in this worksheet, you will be able to predict how likely it is you will score points when playing a game of dice.

Dice games have been around for centuries. The game of Pig is a dice game with simple rules. Each turn a player rolls a die repeatedly until a 1 is rolled or the player decides to end his turn. After each roll, the player may choose to roll again or to end his turn. If the player decides to end his turn, he adds up the face values of each roll and adds the result to his total score. If the player rolls a 1, his turn ends and he scores 0 points for that turn.

For example, Marisol gets a 3 on her first roll, a 6 on her second roll, and a 5 on her third roll. She decides to end her turn and adds up her points. Since $3 + 6 + 5 = 14$, she scores 14 points on that turn.

Alex goes next and rolls a 4, 5, 3, and 1, in that order. Since he rolled a 1, his turn ends and he scores 0 points on that turn.

The first player to 100 points wins the game.

1. What is the probability of scoring 0 points on the first dice roll of a turn?

There are 6 possible outcomes: {1,2,3,4,5,6}. The only way to earn 0 points is to roll a 1.

$$P(1) = \frac{1}{6}$$
$$\approx 16.7\%$$

There is a 16.7% probability that the player scores 0 points on his first turn.

2. A player rolls the die twice and then chooses to end her turn. Given that she didn't roll a 1 on either turn, what is the probability that she scored exactly 7 points on the turn?

We list the possible outcomes as two digit numbers with the first digit being the value of the first roll and the second digit being the value of the second roll.

$$\left. \begin{array}{l} 22 \ 23 \ 24 \ 25 \ 26 \\ 32 \ 33 \ 34 \ 35 \ 36 \\ 42 \ 43 \ 44 \ 45 \ 46 \\ 52 \ 53 \ 54 \ 55 \ 56 \\ 62 \ 63 \ 64 \ 65 \ 66 \end{array} \right\}$$

There are 25 outcomes. To score 7 points, she must roll 25, 34, 43, or 52.

$$P(\text{scores 7 points}) = \frac{4}{25}$$
$$= 16\%$$

There is a 16% probability that she scored 7 points on the turn.

3. What is the probability that a player will roll the die six times on a turn without rolling a 1?

$$\begin{aligned}P(\text{no 1 for six rolls}) &= \left(\frac{5}{6}\right)\left(\frac{5}{6}\right)\left(\frac{5}{6}\right)\left(\frac{5}{6}\right)\left(\frac{5}{6}\right)\left(\frac{5}{6}\right) \\ &= \frac{15,625}{46,656} \\ &\approx 33.5\%\end{aligned}$$

There is a 33.5% probability that a player will roll the die six times in a row without getting a 1.

4. A player decides that she will roll the die three times on each turn, unless she rolls a 1 on the first or second roll of the turn. What is the probability that she will score more than 0 points on the turn?

The probability she will score 0 points on the first roll is $\frac{1}{6} \approx 16.7\%$.

To have a second roll, she has to roll something other than 1 on the first roll. To score 0 on the second roll, she has to roll a 1. So the probability that she will score 0 on the second roll is

$$\begin{aligned}P(1 \text{ on second roll}) &= P(\text{not 1 on first roll}) \cdot P(1 \text{ on second roll}) \\ &= \frac{5}{6} \left(\frac{1}{6}\right) \\ &= \frac{5}{36} \\ &\approx 13.9\%\end{aligned}$$

To have a third roll, she has to roll something other than a 1 on the first two rolls. To score a 0 on the third roll, she has to roll a 1. So the probability she will score a 0 on the third roll is

$$\begin{aligned}P(1 \text{ on third roll}) &= P(\text{not 1 on first roll}) \cdot P(\text{not 1 on second roll}) \cdot P(1 \text{ on third roll}) \\ &= \left(\frac{5}{6}\right)\left(\frac{5}{6}\right)\left(\frac{1}{6}\right) \\ &= \frac{25}{216} \\ &\approx 11.6\%\end{aligned}$$

We add up the individual probabilities

$$\begin{aligned}\frac{1}{6} + \frac{5}{36} + \frac{25}{216} &= \frac{91}{216} \\ &\approx 42.1\%\end{aligned}$$

The probability of the person scoring 0 is 42.1%. Therefore, the probability of scoring more than 0 is 57.9%.

5. Is the strategy of the player in (4) a winning strategy? Explain.

Yes. The player will score more than 0 points 57.9% of the time. In the long run, the player will score points more often than not.

<i>Worksheet Title</i>	Rolling the Dice: Using Probability				<i>Filename:</i>	m1009
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<i>NCTM Standard</i>		Content Standards				Process Standards
	X	Number and Operations			X	Problem Solving
		Algebra				Reasoning and Proof
		Geometry				Communication
		Measurement			X	Connections
	X	Data Analysis and Probability			X	Representations
<i>Grade Band</i>		PreK – 2				
		3 – 5				
	X	6 – 8				
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<i>Data Type</i>	Words					

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