**Theoretical Probability**

Performing experiments to estimate a probability can be very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, depending on the accessories that are needed. Often it is possible to calculate an exact probability by using mathematical theory.

Consider the act of flipping a coin three times. What are the possible outcomes?

For the number of outcomes, we could use our brains and think about them:

Or, we can use a tool like a tree diagram:

Now these eight outcomes can be grouped in to specific events we might be looking for:

Event A: three tails # outcomes: \_\_\_\_\_\_\_\_\_\_

Event B: two tails # outcomes: \_\_\_\_\_\_\_\_\_\_

Event C: one tails # outcomes: \_\_\_\_\_\_\_\_\_\_

Event D: no tails # outcomes: \_\_\_\_\_\_\_\_\_\_

Listing the outcomes and the events as shown above gives a more clear indication of your chances of having a particular event occur. In this case, you can calculate the \_\_\_\_\_\_\_\_\_\_\_\_ probability of each of the events:

**Theoretical Probability**

$$P\left(E\right)=\frac{\# times event occurs}{\# of possible equally likely events}$$

Determine the probabilities of events A, B, C and D as fractions, decimals and percents.

A.

B.

C.

D.

Probability Scale

0 0.5 1.0

|  |  |
| --- | --- |
|  |  |
|  |  |

Example 1: In the experiment of rolling a die, what is the probability of the following events? Express each as a fraction, decimal and percent.

1. P(rolling a three) Possible Outcomes:
2. P(rolling an odd #) Possible Outcomes:
3. P(rolling an 8) Possible Outcomes:

Example 2: Given a bag containing 4 red marbles and 1 white marble, what is the probability of selecting a red marble?

Example 3: Two coins are tossed. What is the probability of getting two heads?

Example 4: In the experiment of selecting a card from a standard deck of 52 cards (not including jokers), what is the probability of:

a) selecting a 5 b) selecting a face card c) selecting a club

Many board games involve tossing dice (six-sided number cubes). Suppose you are playing a game where two dice are tossed and the values of the faces of the cubes are added together. The possible outcomes in this game consist of the possible sums of the two faces.

It will be helpful in this activity to list all possible combinations of the sum of faces of two dice:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sum** | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** |  |  |  |  |  |  |
| **2** |  |  |  |  |  |  |
| **3** |  |  |  |  |  |  |
| **4** |  |  |  |  |  |  |
| **5** |  |  |  |  |  |  |
| **6** |  |  |  |  |  |  |

There are \_\_\_\_\_\_\_\_\_\_\_\_\_ possible outcomes when the faces of two dice are added together, but only \_\_\_\_\_\_\_\_\_\_\_unique (different) outcomes.

Complete the table by calculating the probability of each possible sum.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sum** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| **Prob.** |  |  |  |  |  |  |  |  |  |  |  |

Using the table above, determine the probability of each event listed below.

a) P(sum = 4) b) P(sum > 9)

c) P(sum is even) d) P(sum = 5 or 6 or 7)

Suppose that you observed a sum of 8 on the last three tosses.

What is the probability that your next toss will also yield a sum of 8? Justify your answer.