List the outcomes of rolling a pair of dice by complete the dice chart below.

	⚀	⚁	⚂	⚃	⚄	⚅
⚀	2	3	4	5	6	7
⚁	3	4	5	6	7	8
⚂	4	5	6	7	8	9
⚃	5	6	7	8	9	10
⚄	6	7	8	9	10	11
⚅	7	8	9	10	11	12

EXAMPLE 1 Testing Your Intuition About Probability

Find the probability of each of the following events.

(a) Tossing a head on one toss of a fair coin. $\frac{1}{2} = 0.5$

(b) Tossing two heads in a row on two tosses of a fair coin. $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$

(c) Drawing a queen from a standard deck of 52 cards. $\frac{4}{52} = \frac{1}{13}$

(d) Rolling a sum of 4 on a single roll of two fair dice. $\frac{3}{36} = \frac{1}{12}$

(e) Guessing all 6 numbers in a state lottery that requires you to pick 6 numbers between 1 and 46, inclusive.

$$\frac{1}{{}_{46}C_6} = \frac{1}{9,366,819}$$

Notice that in each of these cases we first counted the number of possible outcomes of the experiment in question. The set of all possible outcomes of an experiment is the **sample space** of the experiment. An **event** is a subset of the sample space. Each of our sample spaces consisted of a finite number of **equally likely outcomes**, which enabled us to find the probability of an event by counting.

Probability of an Event (Equally Likely Outcomes)

If E is an event in a finite, nonempty sample space S of equally likely outcomes, then the **probability** of the event E is

$$P(E) = \frac{\text{the number of outcomes in } E}{\text{the number of outcomes in } S}.$$

$$\frac{{}_{46}C_5}{{}_{46}C_6}$$

EXAMPLE 2 Rolling the Dice

Find the probability of rolling a sum divisible by 3 on a single roll of two fair dice.

3 6 9 12

$$\frac{2}{36} + \frac{5}{36} + \frac{4}{36} + \frac{1}{36}$$

$$\frac{12}{36} = \boxed{\frac{1}{3}}$$

DEFINITION **Probability Function**

A **probability function** is a function P that assigns a real number to each outcome in a sample space S subject to the following conditions:

1. $0 \leq P(O) \leq 1$ for every outcome O;
2. the sum of the probabilities of all outcomes in S is 1;
3. $P(\varnothing) = 0$.

probability of rolling a number <u>NOT</u> divisible

$1 - 1/3 = \frac{2}{3}$

EXAMPLE 4 Choosing Chocolates, Sample Space I

Sal opens a box of a dozen chocolate cremes and generously offers two of them to Val. Val likes vanilla cremes the best, but all the chocolates look alike on the outside. If four of the twelve cremes are vanilla, what is the probability that both of Val's picks turn out to be vanilla?

Combinations:

$$\frac{E}{S} = \frac{{}_4C_2}{{}_{12}C_2}$$

EXAMPLE 5 Choosing Chocolates, Sample Space II

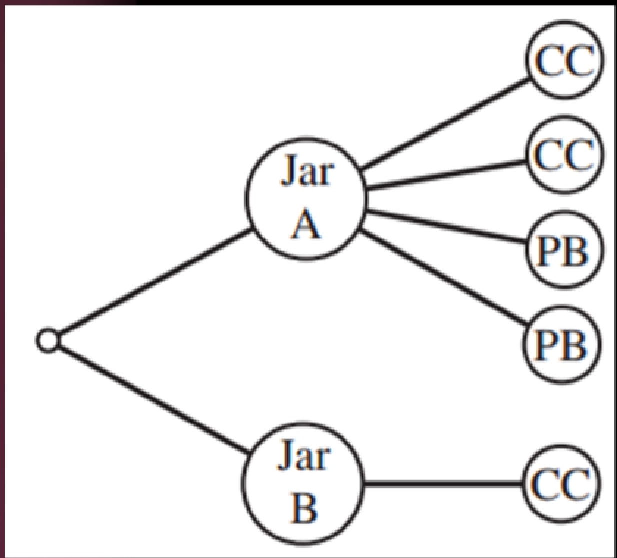
Sal opens a box of a dozen chocolate cremes and generously offers two of them to Val. Val likes vanilla cremes the best, but all the chocolates look alike on the outside. If four of the twelve cremes are vanilla, what is the probability that both of Val's picks turn out to be vanilla?

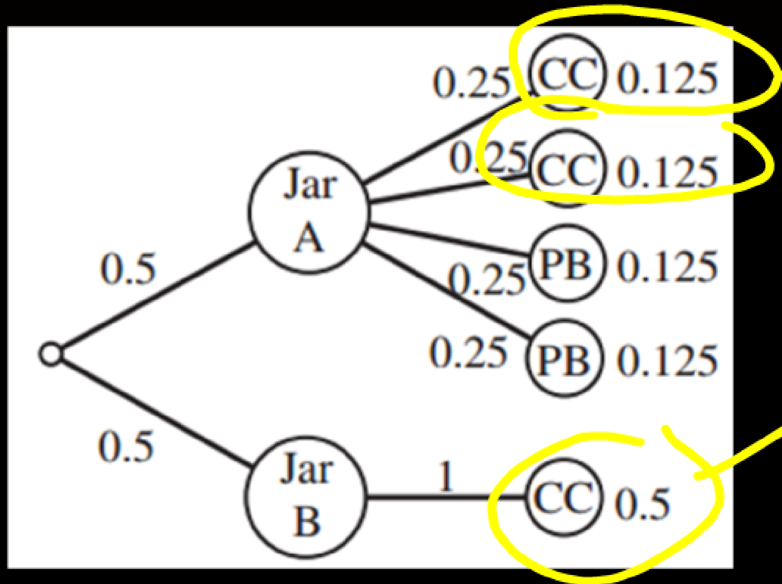
Multiplying Probabilities:

$$\frac{4}{12} \cdot \frac{3}{11} = \frac{1}{11}$$

EXAMPLE 7 Using a Tree Diagram

Two identical cookie jars are on a counter. Jar *A* contains 2 chocolate chip and 2 peanut butter cookies, while jar *B* contains 1 chocolate chip cookie. We select a cookie at random. What is the probability that it is a chocolate chip cookie?





add

0.75

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