

# Chapter 12

## Probability

12.1 Sample Spaces and Probability

12.2 Independent and Dependent Events

12.3 Two-Way Tables and Probability

**12.4 Probability of Disjoint and Overlapping Events**

12.5 Permutations and Combinations

12.6 Binomial Distributions



## 12.4 Probability of Disjoint and Overlapping Events

### Compound Events

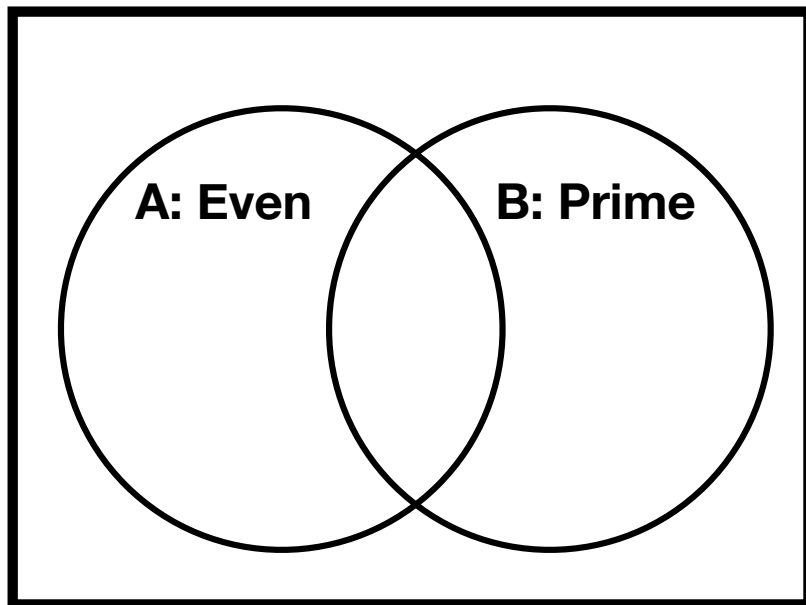
Roll a 6-side die. The table shows the numbered side of the die and the number of trials the number appeared.



**Event A: The result is an even number.**

**Event B: The result is a prime number**

Fill in the table and diagram.



Side Num	1	2	3	4	5	6	Total
# Trials	16	13	21	18	12	20	100

	Even	Odd	Total
Prime			
Not Prime			
Total			

## 12.4 Probability of Disjoint and Overlapping Events

### Compound Events

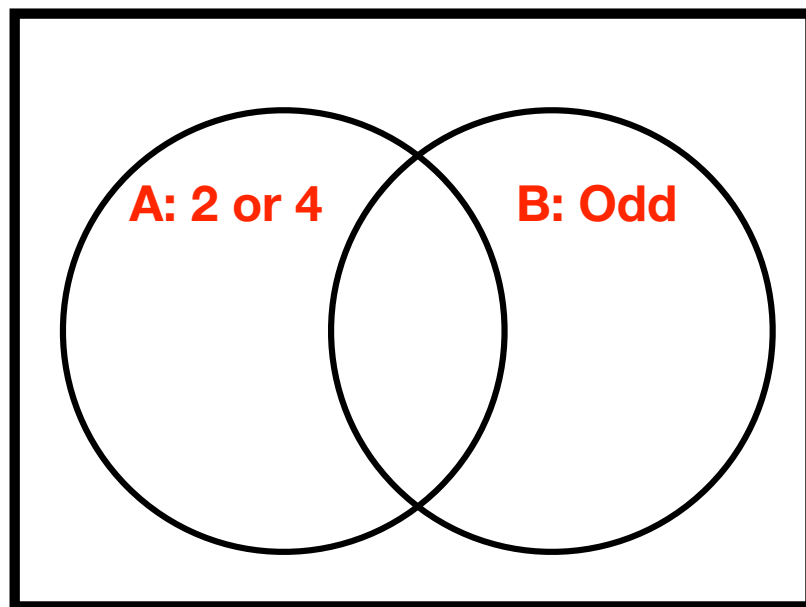
Roll a 6-side die. The table shows the numbered side of the die and the number of trials the number appeared.



**Event A: The result is 2 or 4.**

**Event B: The result is an odd number**

Fill in the table and diagram.



Side Num	1	2	3	4	5	6	Total
# Trials	16	13	21	18	12	20	100

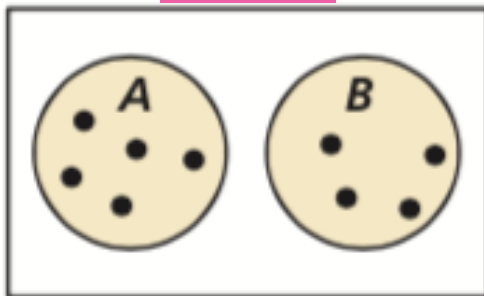
	Even	Odd	Total
Prime			
Not Prime			
Total			

## 12.4 Probability of Disjoint and Overlapping Events

### Vocabulary

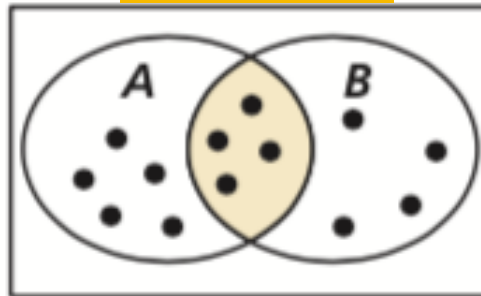
- **Disjoint Events** (or **mutually exclusive**) - Two events whose outcomes are not in common.
- **Overlapping Events** - Two events that have at least one outcome in common.

Disjoint



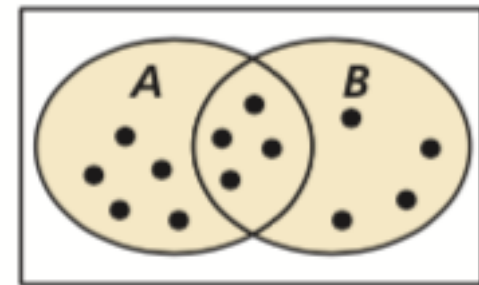
Intersection of A and B  
is empty.

Overlapping



Intersection of A and B

Overlapping

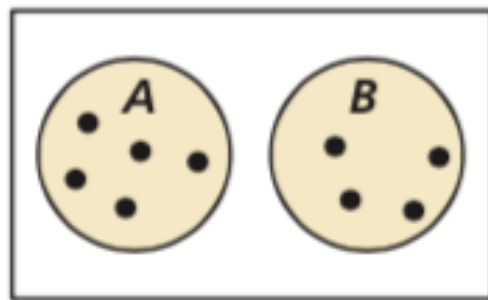


Union of A and B

## 12.4 Probability of Disjoint and Overlapping Events

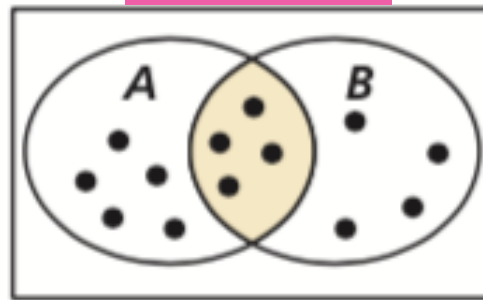
### Vocabulary

- **Intersection** - The outcomes that are common to two events.
- **Union** - All the outcomes in two events.
- **Compound Events** - The **intersection** or **union** of two events.



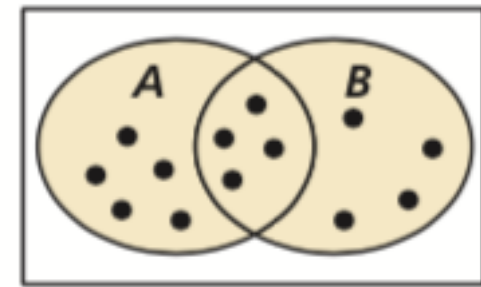
Intersection of A and B  
is empty.

Intersection



Intersection of A and B

Union



Union of A and B

## 12.4 Probability of Disjoint and Overlapping Events

### Probability of Compound Events

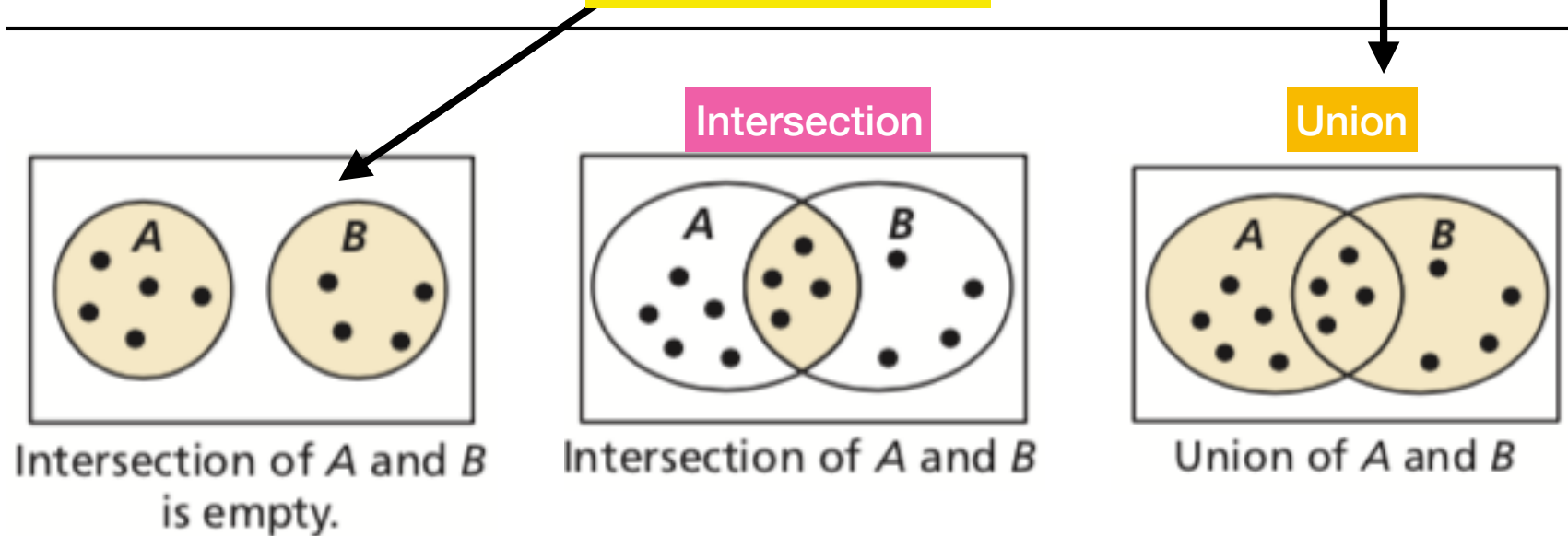
If A and B are any two events, then the probability of **A or B** is

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

If A and B are **disjoint** events, then

$$P(A \text{ and } B) = 0$$

Union

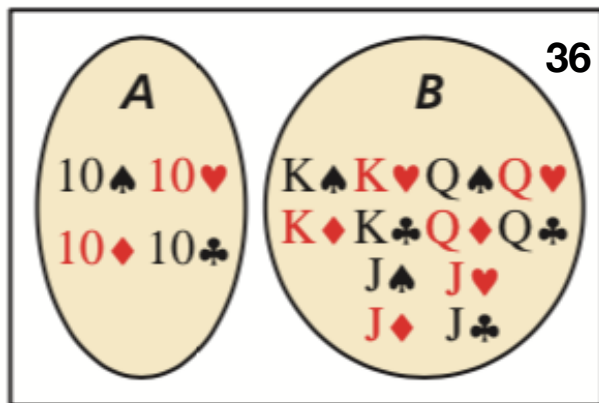


## 12.4 Probability of Disjoint and Overlapping Events

### Example of Disjoint Events

A card is randomly selected from a standard deck of 52 playing cards. What is the probability that it is a **10** or a **face** card?

Venn Diagram



**A = 10 card**

**B = face card**

$$P(A) = 4 / 52$$

$$P(B) = 12 / 52$$

**P(A and B) = 0 (A and B are disjoint)**

$$P(A \text{ or } B) = 4/52 + 12/52 - 0 = 16/52 \\ = 30.8\%$$

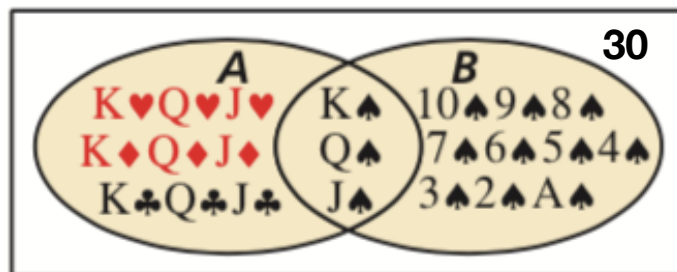
$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

## 12.4 Probability of Disjoint and Overlapping Events

### Example of Overlapping Events

A card is randomly selected from a standard deck of 52 playing cards. What is the probability that it is a **face** card or a **spade**?

Venn Diagram



**A = face card**  
**B = spade card**

$$P(A) = 12 / 52$$

$$P(B) = 13 / 52$$

$$P(A \text{ and } B) = 3 / 52$$

$$P(A \text{ or } B) = 12/52 + 13/52 - 3/52 = 22/52 \\ = 42.3\%$$

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$



## 12.4 Probability of Disjoint and Overlapping Events

### Using formula to find P(A and B)

Out of 200 students in a senior class, 113 students are either varsity athletes or on the honor roll. There are 74 seniors who are varsity athletes and 51 seniors who are on the honor roll. What is the probability that a randomly selected senior is both a varsity athlete and on the honor roll?

**A = senior that is varsity athlete**

**B = senior on honor roll**

#### Problem Statement

**n(total) = 200 seniors**

**n(A or B) = 113**

**n(A) = 74**

**n(B) = 51**

**P(A and B) = ?**

#### Solution

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

$$P(A \text{ and } B) = P(A) + P(B) - P(A \text{ or } B)$$

$$= 74/200 + 51/200 - 113/200$$

$$= 12/200 = 6\%$$

6% of seniors are athletes  
and on honor roll

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

## 12.4 Probability of Disjoint and Overlapping Events

### Probability Tree Diagram

Example problem: The American Diabetes Association estimates that 8.3% of people in the United States have diabetes. Suppose that a medical lab has developed a simple diagnostic test for diabetes that is 98% accurate for people who have the disease and 95% accurate for people who do not have it. The medical lab gives the test to a randomly selected person. What is the probability that the diagnosis is correct?

**A = person has diabetes**

**B = correct diagnosis**

