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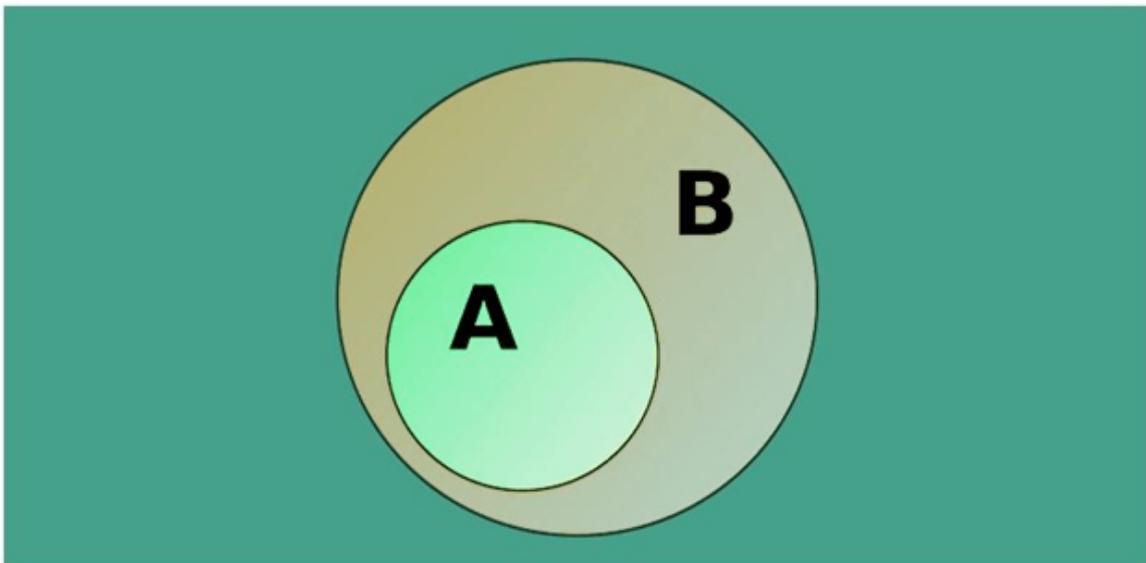
### Events and Types of Events in Probability: Impossible and Sure Events (For CBSE, ICSE, IAS, NET, NRA 2022)

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#### What Are Events in Probability?

A probability event can be defined as a set of outcomes of an experiment. In other words, an event in probability is the subset of the respective sample space.

The entire possible set of outcomes of a random experiment is the **sample space** or the individual space of that experiment. The likelihood of occurrence of an event is known as probability. The probability of occurrence of any event lies between 0 and 1 .



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The sample space for the tossing of three coins simultaneously is given by:

$$S = (T, T, T), (T, T, H), (T, H, T), (T, H, H), (H, T, T), (H, T, H), (H, H, T), (H, H, H)$$

Suppose if we want to find only the outcomes which have at least two heads; then the set of all such possibilities can be given as:

$$E = (H, T, H), (H, H, T), (H, H, H), (T, H, H)$$

Thus, **an event is a subset of the sample space, i.e., E is a subset of S.**

There could be a lot of events associated with a given sample space. For any event to occur, the outcome of the experiment must be an element of the set of event E.

### What is the Probability of Occurrence of an Event?

The number of favorable outcomes to the total number of outcomes is defined as the probability of occurrence of any event. So, the probability that an event will occur is given as:

$$P(E) = \frac{\text{Number of Favorable Outcomes}}{\text{Total Number of Outcomes}}$$

### Types of Events in Probability

Some of the important probability events are:

- Impossible and Sure Events
- Simple Events
- Compound Events
- Independent and Dependent Events
- Mutually Exclusive Events
- Exhaustive Events
- Complementary Events
- Events Associated with “OR”
- Events Associated with “AND”
- Event E1 but not E2

### Impossible and Sure Events

If the probability of occurrence of an event is 0, such an event is called an **impossible event** and if the probability of occurrence of an event is 1, it is called a **sure event**. In other words, the empty set  $\phi$  is an impossible event and the sample space S is a sure event.

### Simple Events

Any event consisting of a single point of the sample space is known as a **simple event** in probability. For example, if  $S = 56,78,96,54,89$  and  $E = 78$  then E is a simple event.

### Compound Events

Contrary to the simple event, if any event consists of more than one single point of the sample space then such an event is called a **compound event**. Considering the same example again, if  $S = 56,78,96,54,89$ ,  $E_1 = 56,54$ ,  $E_2 = 78,56,89$  then,  $E_1$  and  $E_2$  represent two compound events.

## Independent Events and Dependent Events

If the occurrence of any event is completely unaffected by the occurrence of any other event, such events are known as an **independent event** in probability and the events which are affected by other events are known as **dependent events**.

## Mutually Exclusive Events

If the occurrence of one event excludes the occurrence of another event, such events are mutually **exclusive events** i.e.. two events don't have any common point. For example, if  $S = 1,2,3,4,5,6$  and  $E_1, E_2$  are two events such that  $E_1$  consists of numbers less than 3 and  $E_2$  consists of numbers greater than 4.

So,  $E_1 = 1,2$  and  $E_2 = 5,6$

Then,  $E_1$  and  $E_2$  are mutually exclusive.

## Exhaustive Events

A set of events is called **exhaustive** if all the events together consume the entire sample space.

## Complementary Events

For any event  $E_1$  there exists another event  $E_1'$ , which represents the remaining elements of the sample space  $S$ .

$$E_1' = S - E_1$$

If a dice is rolled then the sample space  $S$  is given as  $S = 1,2,3,4,5,6$ . If event  $E_1$  represents all the outcomes which is greater than 4, then  $E_1 = 5,6$  and  $E_1' = 1,2,3,4$ .

Thus,  $E_1'$  is the complement of the event  $E_1$ .

Similarly, the complement of  $E_1, E_2, E_3 \dots E_n$  will be represented as  $E_1', E_2', E_3' \dots E_n'$

## Events Associated with "Or"

If two events  $E_1$  and  $E_2$  are associated with **OR**, then it means that either  $E_1$  or  $E_2$  or both. The union symbol ( $\cup$ ) is used to represent OR in probability.

Thus, the event  $E_1 \cup E_2$  denotes  $E_1, E_2$ .

If we have mutually exhaustive events  $E_1, E_2, E_3 \dots E_n$  associated with sample space  $S$  then,

$$E_1 \cup E_2 \cup E_3 \cup \dots E_n = S$$

## Events Associated with "And"

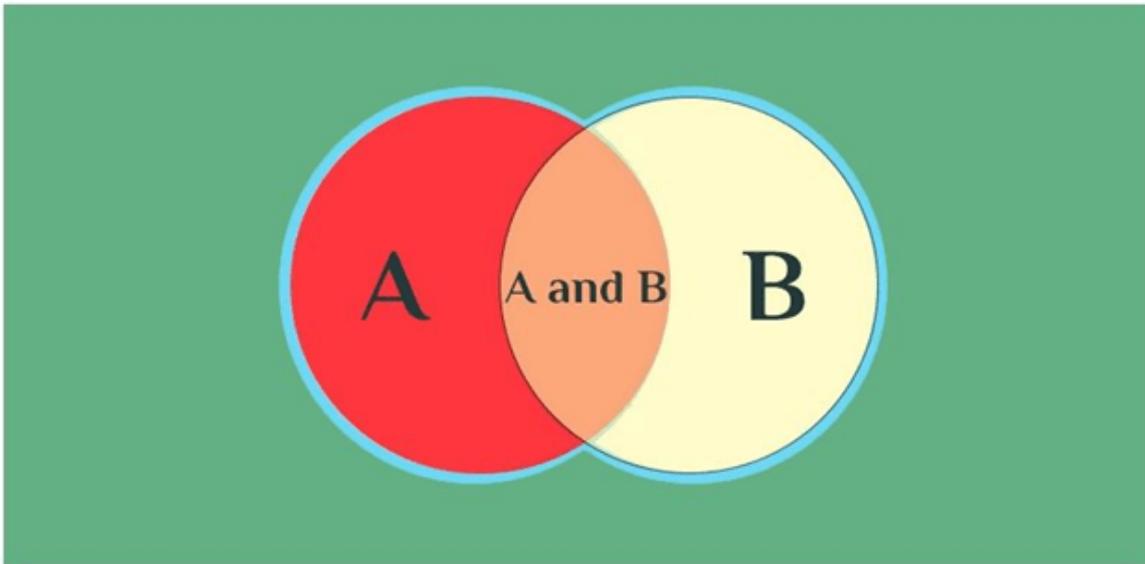
If two events  $E_1$  and  $E_2$  are associated with **AND** then it means the intersection of elements which is common to both the events. The intersection symbol ( $\cap$ ) is used to represent AND in probability.

Thus, the event  $E_1 \cap E_2$  denotes  $E_1$  and  $E_2$ .

## Event $E_1$ but Not $E_2$

It represents the difference between both the events. Event  $E_1$  but not  $E_2$  represents all the outcomes which are present in  $E_1$  but not in  $E_2$ . Thus, the event  $E_1$  but not  $E_2$  is represented as

$$E_1, E_2 = E_1 E_2$$



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### Example Question on Probability of Events

**Question:** In the game of snakes and ladders, a fair die is thrown. If event  $E_1$  represents all the events of getting a natural number less than 4, event  $E_2$  consists of all the events of getting an even number and  $E_3$  denotes all the events of getting an odd number. List the sets representing the following:

- i)  $E_1$  or  $E_2$  or  $E_3$
- ii)  $E_1$  and  $E_2$  and  $E_3$
- iii)  $E_1$  but not  $E_3$

**Solution:**

The sample space is given as  $S = 1,2,3,4,5,6$

$$E_1 = 1,2,3$$

$$E_2 = 2,4,6$$

$$E_3 = 1,3,5$$

$$\text{i) } E_1 \text{ or } E_2 \text{ or } E_3 = E_1 \cup E_2 \cup E_3 = \{1,2,3,4,5,6\}$$

$$\text{ii) } E_1 \text{ and } E_2 \text{ and } E_3 = E_1 \cap E_2 \cap E_3 = \emptyset$$

$$\text{iii) } E_1 \text{ but } E_3 = E_1 \cap E_2 = \{2\}$$

Question:

When a fair dice is thrown, what is the probability of getting

- (a) the number 5
- (b) a number that is a multiple of 3
- (c) a number that is greater than 6
- (d) a number that is less than 7

Solution:

A fair die is an unbiased die where each of the six numbers is equally likely to turn up.

$$S = \{1,2,3,4,5,6\}$$

$$\text{(a) Let } A = \text{event of getting the number 5} = \{5\}$$

$$\text{Let } n(A) = \text{number of outcomes in event } A = 1$$

$$n(S) = \text{number of outcomes in } S = 6$$

$$P(A) = \frac{1}{6}$$

$$\text{(b) Let } B = \text{event of getting a multiple of 3}$$

$$\text{Multiple of 3} = \{3,6\}$$

$$P(B) = \frac{2}{6} = \frac{1}{3}$$

$$\text{(c) Let } C = \text{event of getting a number greater than 6}$$

There is no number greater than 6 in the sample space  $S$ .

$$C = \{\}$$

$$P(C) = \frac{0}{6} = 0$$

A probability of 0 means the event will never occur.

$$\text{(d) Let } D = \text{event of getting a number less than 7}$$

$$\text{Number less than 7} = \{1,2,3,4,5,6\}$$

$$P(D) = \frac{6}{6} = 1$$

A probability of 1 means the event will always occur.

## FAQs

### What Are Events in Probability?

In probability, events are the outcomes of an experiment. The probability of an event is the measure of the chance that the event will occur as a result of an experiment.

### What is the Difference between Sample Space and Event?

A sample space is a collection or a set of possible outcomes of a random experiment while an event is the subset of sample space. For example, if a die is rolled, the sample space will be 1,2,3,4,5,6 and the event of getting an even number will be 2,4,6.

### What is the Probability of an Impossible Event and a Sure Event?

The probability of a sure event is always 1 while the probability of an impossible event is always 0.

### What is an Example of an Impossible Event?

An example of an impossible event will be getting a number greater than 6 when a die is rolled.

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