

## 11.4 – Fundamentals of Probability

**Random Phenomenon** is a situation in which we know what outcomes can occur, but we do not know which outcome will occur. We cannot predict each outcome, but there will be a regular distribution over many repetitions.

**Experiment** – Process that can be repeated to produce different outcomes.

**Outcome** – Result of an experiment.

**Event** – A subset of the possible outcomes of an experiment.

Rolling a die:

Tossing a coin:

**Empirical Probability** – The proportion of times a certain outcome actually occurs in repeated observations of an experiment.

$$P(E) = \frac{\text{Number of times resulting in event } E}{\text{Total number of times experiment has been performed}}$$

**Theoretical Probability** – The proportion of times a certain outcome is supposed to occur in repeated observations of an experiment.

If event  $E$  has equally likely outcome, then the probability of  $E$  is given by

$$P(E) = \frac{\text{Number of outcomes resulting in event } E}{\text{Total number of possible outcomes}}$$

**Law of Large Numbers** states that as an experiment is repeated many times the empirical probability will approach the theoretical probability.

### Properties of probability

1. The probability of an event that can never occur is 0.
2. The probability of an event that will always occur is 1.
3. The probability of an event can be any number between and including 0 and 1.

$$0 \leq P(E) \leq 1$$

4. The sum of the probabilities of all outcomes of an experiment is 1.

## Example