# 7.1: Experiments, Sample Spaces, and Events

- An **experiment** is an activity with observable results.

- The results of the activity are called **outcomes or sample points**.

- **Sample space** (denoted $S$) is the set consisting of all possible sample points (= outcomes)

- **Event** is a subset of a sample space of an experiment. An **elementary (simple) event** is an event that has a single outcome.

- The empty set, $\emptyset$, represents an **impossible event**. It can NOT happen.

- Each repetition of an experiment is called a **trial**.

- The sample space is called the **certainty event**.

EXAMPLE 1. *A box contains 13 red chalks, 41 blue chalks, 20 yellow chalks, and 1 white chalk.*
Experiment
*One chalk is drawn from the box and the color is noted. What is the sample space?*

```
13R, 41B,
20Y, 1W
```

```
R  Y  ·
W  Y  ·
   R  ·
B
Y  B
```
outcomes

$S = \{R, B, Y, W\}$     $2^4 = 16$

events : $\emptyset$, $\{R\}$, $\{B\}$, $\{Y\}$, $\{W\}$,
$\{R,B\}$, $\{R,Y\}$ $\{R,W\}$, $\{BY\}$ $\{B,W\}$
impossible event     $\{Y,W\}$, $\{R,B,Y\}$, $\{R,Y,W\}$ ..
- - - -     $\{R,B,Y,W\} = S$
certainty event

EXAMPLE 2. *Describe the sample space associated with an experiment of tossing a coin and observing whether it falls heads or tails. What are the events of this experiment?*

$S = \{H, T\}$ — outcome

events     $\emptyset$, $\{H\}$, $\{T\}$, $\{H,T\} = S$

EXAMPLE 3. *An experiment consists of selecting a letter at random from the letters in the word MULTIPLICATION and observing the outcomes.*

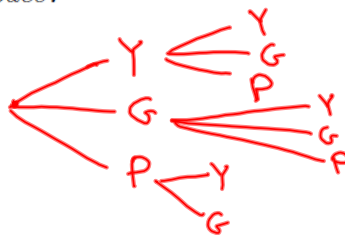(a) *What is an appropriate sample space for this experiment?*

$S = \{ M, U, L, T, I, P, C, A, O, N \}$

(b) *Describe the event "the letter selected is a vowel".*

$E = \{ U, I, A, O \}$

EXAMPLE 4. *A box contains 2010 yellow items, 2011 green items, and a purple item. Two items are drawn in succession from the box without replacing the item drawn. The colors of the items are noted. What is the sample space?*

2010 Y
2011 G
1 P

$S = \{ (Y,Y), (Y,G), (Y,P),$
$(G,Y), (G,G), (G,P),$
$(P,Y), (P,G) \}$

- The **union of two events**, $E$ and $F$, is the event $E \cup F$. (Thus, the event $E \cup F$ consists of the set of outcomes of $E$ and/or $F$.)

$E \cup F$

- The **intersection of two events**, $E$ and $F$, is the event $E \cap F$. (Thus, the event $E \cap F$ consists of the set of outcomes common to $E$ and $F$.).

$E \cap F$

- The **compliment of the event** $E$, is the event $E^c$. (Thus, the event $E^c$) is the set containing all outcomes in the sample space $S$ that are not in $E$.

$E^c$

- **Mutually exclusive** means the same as disjoint.

$E \cap F = \emptyset$

EXAMPLE 5. *True/False. For events $E, F,$ and $G$ of the same experiment, if $E$ and $F$ are mutually exclusive and $E$ and $G$ are mutually exclusive, then are $F$ and $G$ mutually exclusive? Explain.*
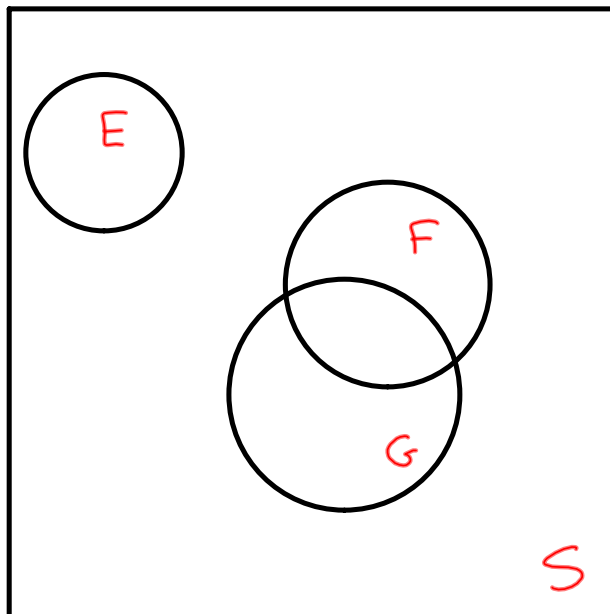
$$F \cap G \neq \emptyset \Rightarrow$$
$$\Rightarrow F \& G \text{ are not}$$
$$\text{mutually exclusive.}$$

EXAMPLE 6. *A six sided die is rolled (numbered 1 − 6). If a six or a one is rolled the die is rolled a second time. The total sum of the numbers rolled is recorded.*

(a) *What is the sample space?*

$$S = \{2, 3, 4, 5, 6, 7, 8, \ldots, 12\}$$
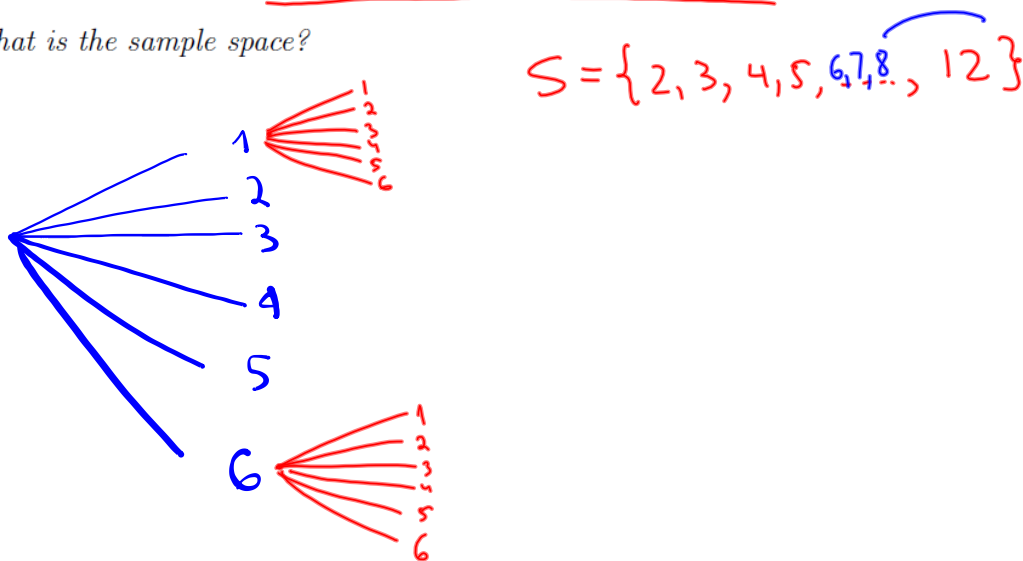


(b) *Give the event, E, that an odd sum was recorded.* $E = \{3, 5, 7, 9, 11\}$

(c) *Give the event, F, that a sum greater than 7 was recorded.* $F = \{8, 9, 10, 11, 12\}$

(d) *Determine if E and F are mutually exclusive.* NO

$$E \cap F = \{9, 11\} \neq \emptyset$$

Jun 10-10:35 PM

4

EXAMPLE 7. *An experiment consists of studying the composition of a 3-child family in which the children are born at different times.*

(a) *Describe an appropriate sample space for this experiment.*



$$S = \{ BBB, BBG, BGB, BGG, GBB, GBG, GGB, GGG \}$$
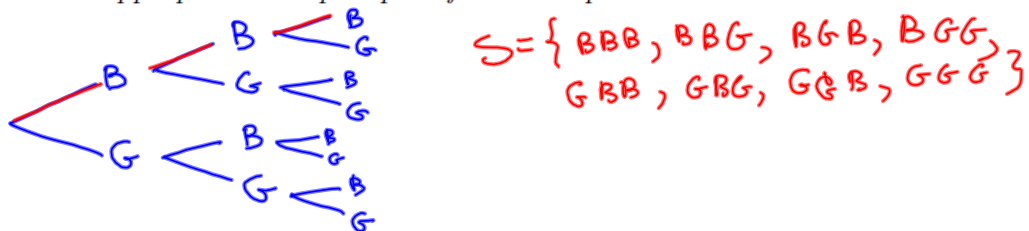
(b) *Describe the event, E, that there are 2 girls and 1 boy.*

$$E = \{ BGG, GBG, GGB \}$$

(c) *Describe the event, F, that the oldest child is a girl.*

$$F = \{ GBB, GBG, GGB, GGG \}$$

(d) *Describe the event, G, that the oldest child is a girl, and the youngest child is a boy.*

$$G = \{ GBB, GGB \}$$