21.4 Mutually Exclusive Events 1/19/23

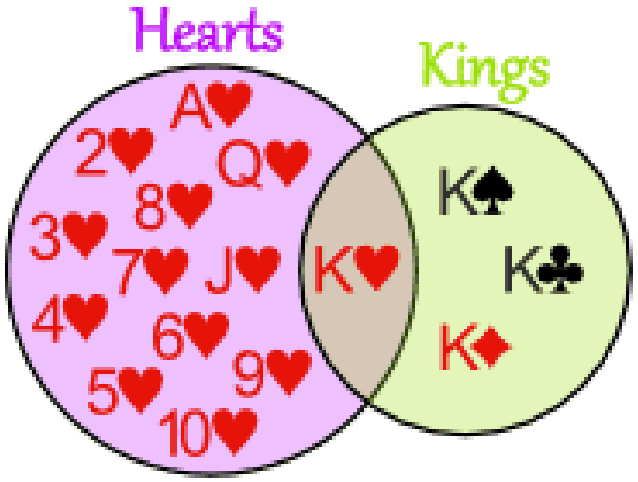
Addition Rule

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

or

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Example: Hearts and Kings



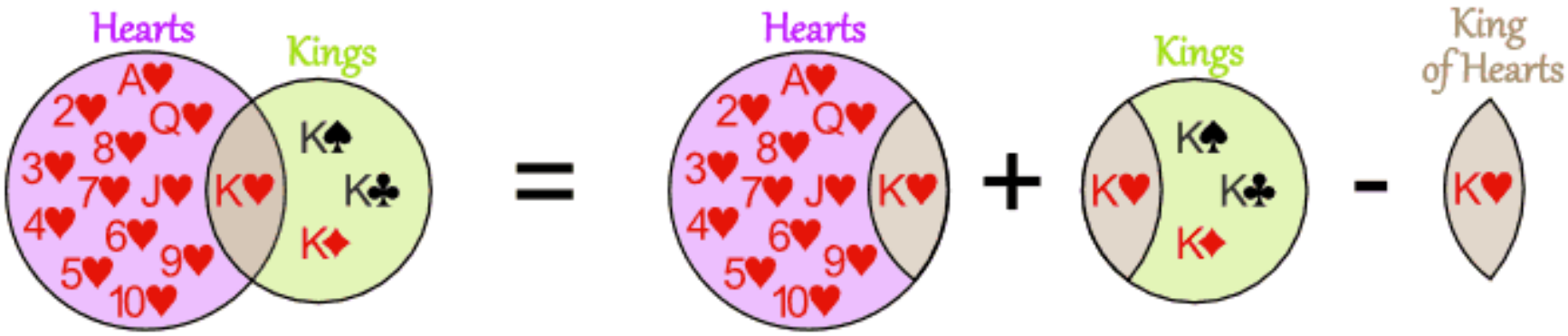
Hearts **and** Kings together is only the King of Hearts: 

But Hearts **or** Kings is:

- all the Hearts (13 of them)
- all the Kings (4 of them)

But that counts the King of Hearts twice!

So we correct our answer, by subtracting the extra "and" part:



16 Cards = 13 Hearts + 4 Kings − the 1 extra King of Hearts

Count them to make sure this works!

As a formula this is:

P(A or B) = P(A) + P(B) − P(A and B)

"The probability of A ***or*** *B equals the probability of A* ***plus*** *the probability of B*
minus *the probability of A* ***and*** *B"*

Here is the **same formula**, but using ∪ and ∩:

P(A ∪ B) = P(A) + P(B) − P(A ∩ B)

We can find probabilities from two-way frequency tables.

	Late	On Time	Total
Domestic Flights	**12**	**108**	
International Flights		**54**	
Total			**180**

Fill in the table.

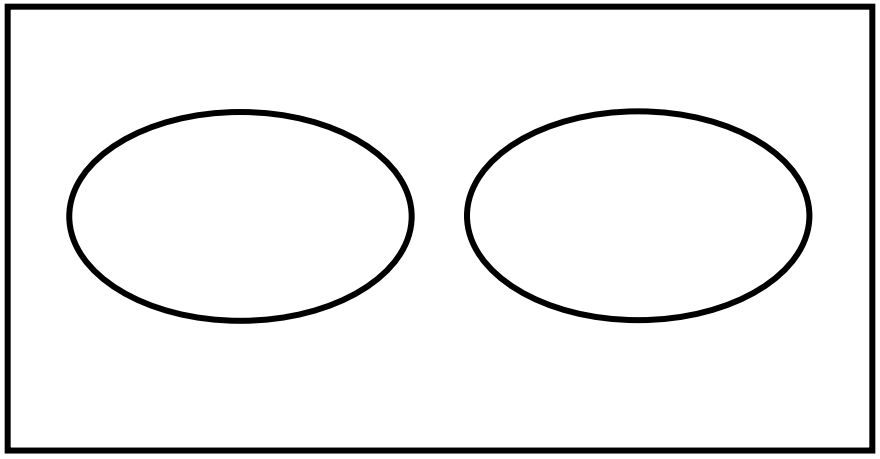
1. Find P(domestic flight)
2. Find P(late)
3. Find P(domestic flight and late)
4. Use the addition rule to find P(domestic flight or late)

Mutually Exclusive means we can't get both events at the same time. (not overlapping)

It is either one or the other, but **not both**

Examples:

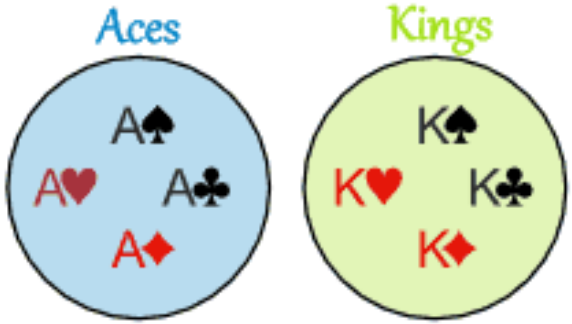
- Turning left or right are Mutually Exclusive (you can't do both at the same time)
- Heads and Tails are Mutually Exclusive
- Kings and Aces are Mutually Exclusive



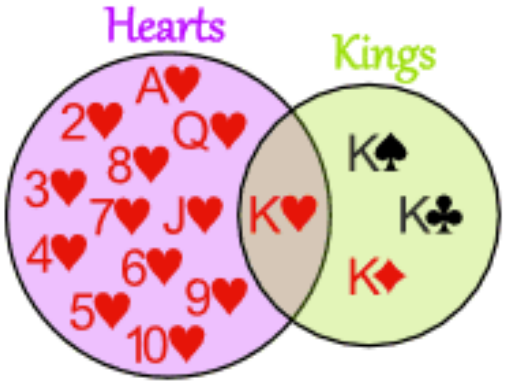
What isn't Mutually Exclusive

- Kings and Hearts are **not** Mutually Exclusive, because we can have a King of Hearts!

Like here:



Aces and Kings are Mutually Exclusive



Hearts and Kings are **not** Mutually Exclusive

When two events (call them "A" and "B") are Mutually Exclusive it is **impossible** for them to happen together:

P(A and B) = 0

"The probability of A and B together equals 0 (impossible)"

Example: A Deck of Cards

In a Deck of 52 Cards:

- the probability of a King is 1/13, so **P(King)=1/13**
- the probability of an Ace is also 1/13, so **P(Ace)=1/13**

When we combine those two Events:

- The probability of a card being a King **and** an Ace is **0** (Impossible)
- The probability of a card being a King **or** an Ace is (1/13) + (1/13) = **2/13**

Which is written like this:

P(King and Ace) = 0 P(King ∩ Ace) = 0

P(King or Ace) = (1/13) + (1/13) = 2/13

P(King ∪ Ace) = (1/13) + (1/13) = 2/13