Lesson 005
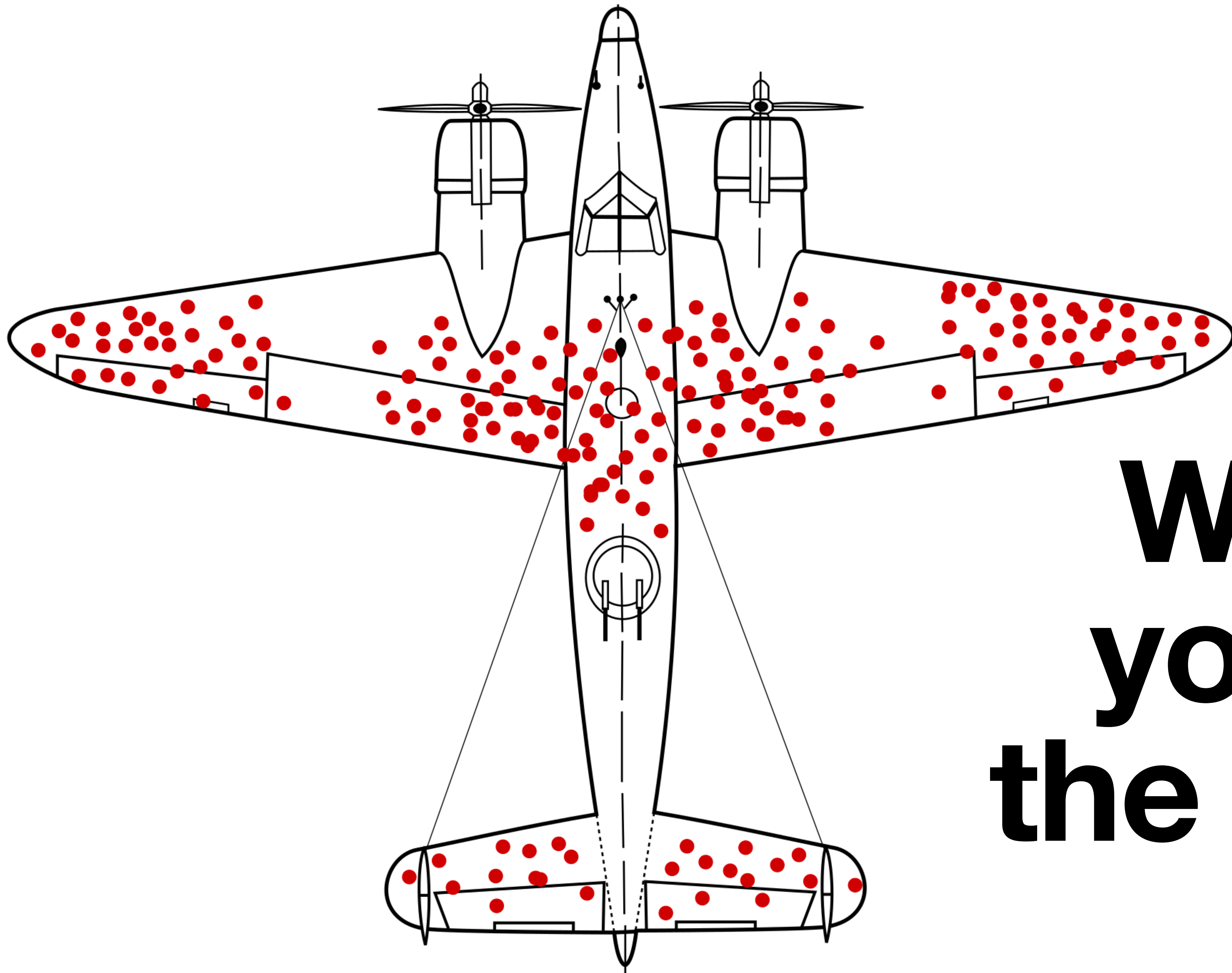# Sample Spaces and Events

Wednesday, September 20

Where do you repair the planes?

Probability is the study of **randomness** and **uncertainty**.

Statistical Experiments and Outcomes
Experiment

- Any action with an uncertain outcome is an **experiment**.

Tossing a coin.	Observing the reliability of an integrated circuit.	Experiencing the events and outcomes for a 24 hour period of your life.	Performing a medical treatment.

Statistical Experiments and Outcomes
Sample Space

- The collection of **all possible outcomes** from an experiment.

- Denoted $\mathcal{S}$

Coin	Integrated Circuit	24 Hours of Life	Medical Treatment
Heads or Tails	**Operation or Failure after t time (over some observation window)**	**All possible events that can occur in life.** *** Maybe worth refining.**	**Success or Failure of procedure.**

Statistical Experiments and Outcomes
Event

- An **outcome** or **collection of outcomes** from the sample space.

Coin	Integrated Circuit	24 Hours of Life	Medical Treatment
Heads or Tails	Operation time	All events	Success or failure
Observe a head. **Observe a tail.** **Observe a head or tail.**	**Fails before 60 hours.** **Fails after 90 hours.** **Fails between 10 and 80 hours.**	**Cat wakes you up five times.** **Teach a decent lecture.** **Watch a movie and eat dinner.**	**Treatment is a success.** **Treatment is a failure.** **Treatment is either a success or failure.**

$$\mathcal{S} = \{1,3,5\}$$

$$\varnothing = \{\}, \{1\}, \{3\}, \{5\},$$
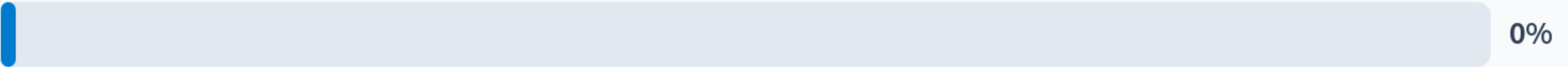$$\{1,3\}, \{1,5\}, \{3,5\}, \{1,3,5\}$$

A coin is flipped and then a 6 sided die is rolled. The corresponding outcome is recorded as a letter/number combination. How large is the sample space?
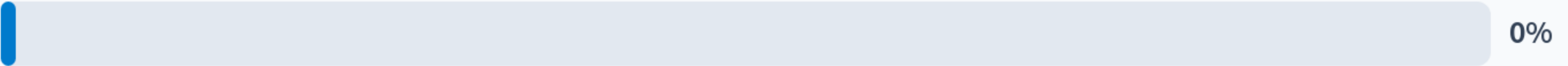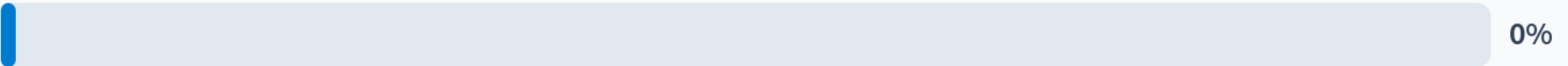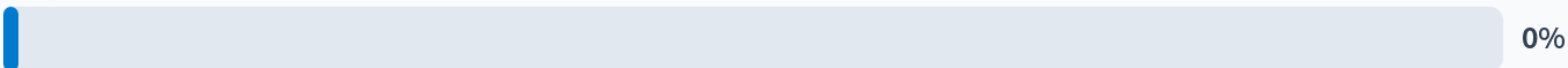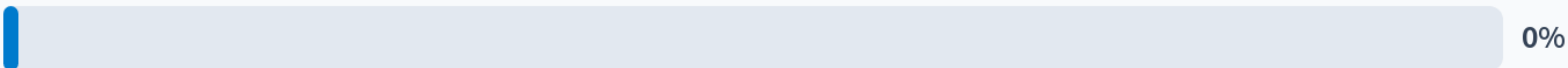
(A) 8 options.

0%

(B) 16 options.

0%

(C) 12 options.

0%

(D) 6 options.

0%
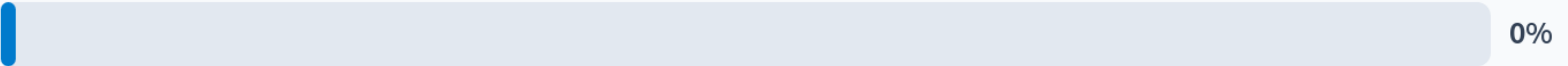
You sit on the side of the road counting the number of cars that go by a particular location in an hour. What best describes the sample space?

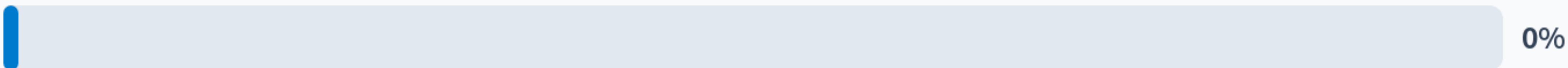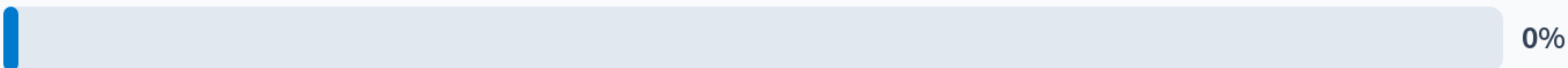Any real number, $\mathbb{R}$.

0%

Any non-negative integer, $\mathbb{Z}^+$.

0%

Any non-negative real number, $\mathbb{R}^+$.

0%

Any integer, $\mathbb{Z}$.

0%

Assume that $\mathcal{S} = \{A, B\}$. What are all possible events?

$\{A\}, \{B\}.$

0%

$\{A\}, \{B\}, \{A, B\}.$

0%

$\{A, B\}$

0%

None of the above

0%

Assume that $\mathcal{S} = \{1, 2, 3\}$. Which of the following is not a valid event?

$E = \{1\}$.

0%

$E = \{1, 1\}$.

0%

$E = \{\}$.

0%

$E = \{1, 3\}$.

0%

Complement

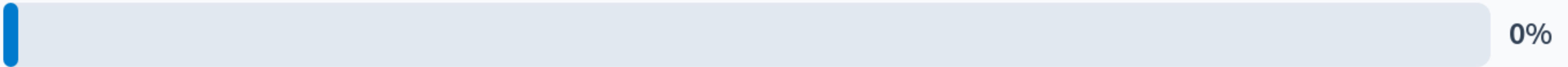- Everything **except for** the event of interest. Think "not A".

- Written A^C

$\mathcal{S}$	A	A^C
Heads or tails.	Flipping a head	Flipping a tail
Any standard card in a deck.	Drawing a heart	Drawing a diamond, club, or spade
Any digit, one to six, on a die.	Rolling less than 5	Rolling a 6
$\{10,20,30,40,50\}$	$\{10,20,30,40,50\}$	$\varnothing = \{\}$

Assume a single card is drawn from a standard deck. What is the complement of the event "the card was a red ace"?
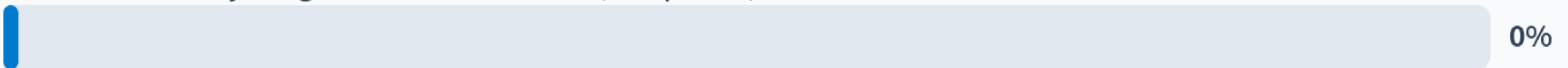
The card was a black ace (2 options).

0%
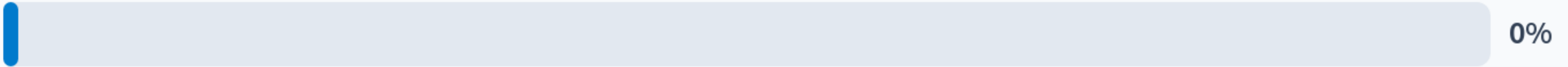
The card was a red non-ace (24 options).

0%

The card was a black non-ace (24 options).

0%

The card was anything other than a red ace (50 options).
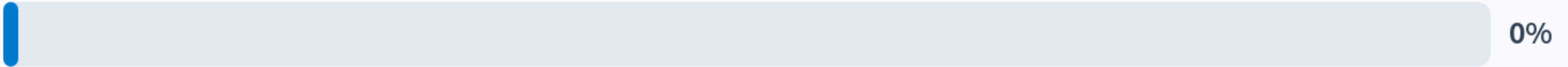
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Union

- Everything **in either** of the events of interest. Think "A or B or both".
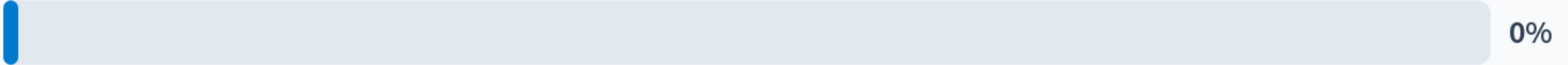
- Written $A \cup B$

$\mathcal{S}$	A	B	$A \cup B$
Heads or tails.	Flipping a head	Flipping a tail.	Flipping a head or tail.
Any standard card in a deck.	Drawing a heart	Drawing an ace	Drawing a heart or the ace of clubs, spades, or diamonds.
Any digit, one to six, on a die.	Rolling less than 5	Rolling a three	Rolling less than 5.
$\{10,20,30,40,50\}$	$\{10,20\}$	$\{10,30,40\}$	$\{10,20,30,40\}$

If A is the event that a king is drawn, and B is the event that a club is drawn, what is $A \cup B$?
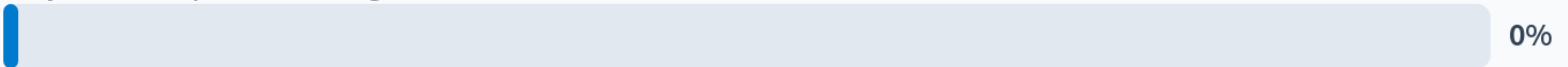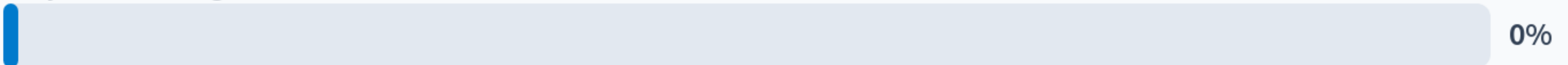
The king of clubs is drawn.

0%

Any king except for the king of clubs is drawn.

0%

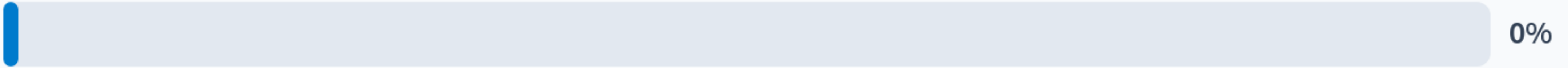Any club except for the king of clubs is drawn.

0%

Any club or king is drawn.

0%

Intersection

- Everything **in both** of the events of interest. Think "A and B".

- Written $A \cap B$

$\mathcal{S}$	A	B	$A \cap B$
Heads or tails.	Flipping a head	Flipping a tail.	$\varnothing = \{\}$
Any standard card in a deck.	Drawing a heart	Drawing an ace	Drawing the ace of hearts.
Any digit, one to six, on a die.	Rolling less than 5	Rolling a three	Rolling a three.
$\{10,20,30,40,50\}$	$\{10,20\}$	$\{10,30,40\}$	$\{10\}$

If A is the event that a king is drawn, and B is the event that a club is drawn, what is $A \cap B$?
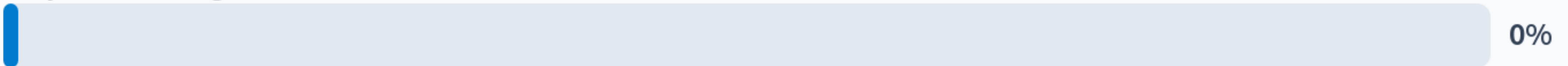
The king of clubs is drawn.

0%

Any king except for the king of clubs is drawn.

0%

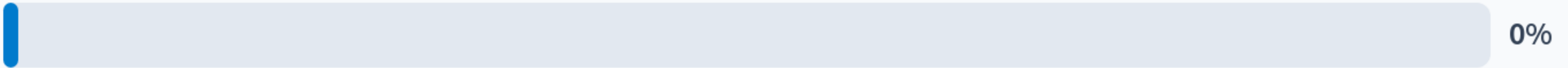Any club except for the king of clubs is drawn.
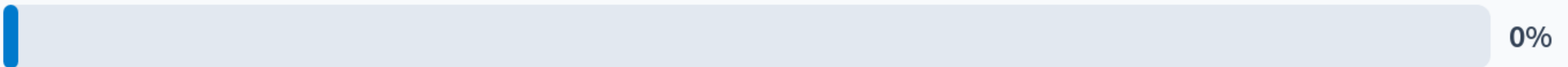
0%

Any club or king is drawn.

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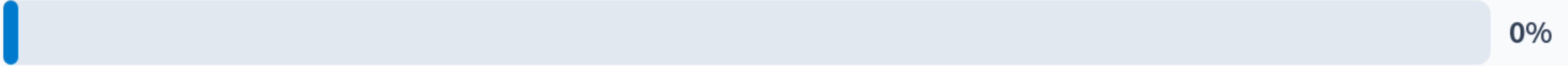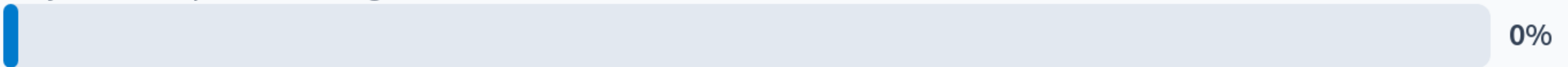
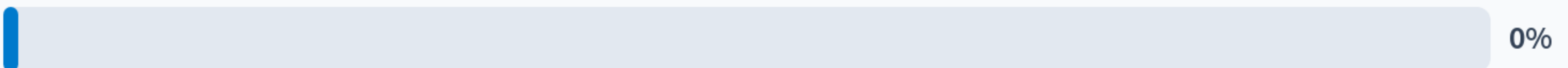# If A has two elements, and B has one element, what must be true about $A \cup B$?
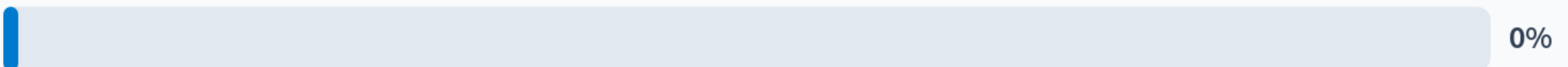
It has exactly three elements.

0%

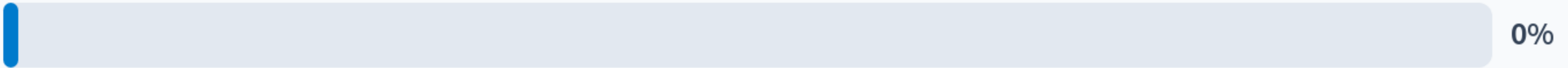It has more than three elements.

0%

It has fewer than three elements.

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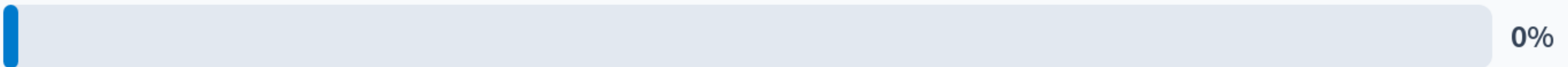
It has either 2 or three elements.

0%

If A has two elements, and B has one element, what must be true about $A \cap B$?
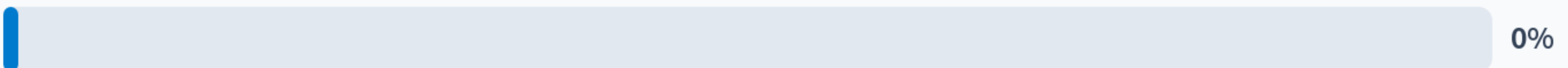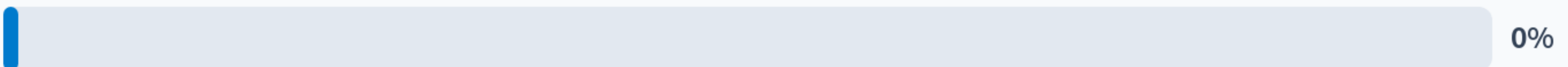
It has exactly one element.

0%

It has more than one element.

0%

It has fewer than one element.

0%

It has either 0 or 1 elements.

0%

Suppose a 6-sided die is rolled. Let A be the event that an even number is rolled, B be the event that an odd number is rolled, and C be the event that a four is rolled. Which statement is true?

$A^C = B$

0%

$S = A \cup B$

0%

$S = A \cup B \cup C$

0%

B and C are mututally exclusive.

0%

All of the above

0%