```html

# Lesson Plan: Probability Investigators - The Case of Chance

### Materials Needed:

- Large piece of paper or whiteboard for an "Anchor Chart"
- Markers or colored pens
- One standard coin
- Two standard six-sided dice
- An opaque bag or container
- At least 10 marbles of at least 3 different colors (e.g., 5 red, 3 blue, 2 green)
- A standard 52-card deck of playing cards
- Notebook or paper for calculations and notes
- Calculator (optional)

---

## 1. Learning Objectives

By the end of this lesson, the student will be able to:

- Define probability and identify key terms (outcome, event, sample space).
- Calculate the theoretical probability of simple and compound events using hands-on tools.
- Convert probability values between fractions, decimals, and percentages.
- Create and interpret visual aids (Tree Diagram, Outcome Grid, Venn Diagram) to represent possible outcomes.
- Connect the mathematical concept of probability to real-world scenarios.

## 2. Lesson Introduction: The Impossible Choice (5 minutes)

**Teacher's Script:** "Imagine I have two games for you to play. In Game A, you win if you roll a 7 with two dice. In Game B, you win if you flip a coin and get 'heads' three times in a row. Which game would you choose to play if you wanted the best chance of winning? Why do you think that? Today, we're going to become Probability Investigators to figure out how to answer questions like this with math instead of just a guess."

- Discuss the student's initial thoughts without giving away the answer. This creates curiosity.

## 3. Part 1: Building the Foundation - What is Probability? (15 minutes)

**Activity:** Create the Probability Anchor Chart. As you introduce each concept, add it to the large paper/whiteboard. This chart will be a visual reference for the whole lesson.

### Anchor Chart Elements:

1. **What is Probability?**
    - Write: "Probability is the measure of how likely an event is to happen."
    - Draw a probability scale line from 0 to 1. Label 0 as "Impossible," 0.5 as "Equally Likely," and 1 as "Certain."
```

2. **Key Terms:**
    - **Event:** A specific outcome you are interested in (e.g., flipping heads).
    - **Outcome:** One possible result of an experiment (e.g., the coin lands on heads).
    - **Sample Space:** The set of ALL possible outcomes (e.g., {Heads, Tails}).
3. **The Formula:**
    - Write the formula in a large, clear box:
      **P(event) = Number of favorable outcomes / Total number of possible outcomes**
4. **Expressing Probability:**
    - Create three columns: Fraction, Decimal, Percentage.
    - **Example:** Take a single coin. What is the probability of flipping heads?
        - **Fraction:** Favorable (Heads) = 1. Total (Heads, Tails) = 2. So, **1/2**.
        - **Decimal:** 1 ÷ 2 = **0.5**.
        - **Percentage:** 0.5 x 100 = **50%**.
    - Add this example to the three columns on your chart.

## 4. Part 2: The Investigation Stations - Exploring with Games (45 minutes)

**Instructions:** "Now you're going to be the lead investigator. We'll move through four different challenges to see how probability works in different games. For each one, we'll figure out the probability and practice showing our work in a new way."

### Challenge 1: The Coin Flip Challenge (Visual Tool: Tree Diagram)

- **Question:** "What is the probability of flipping a coin twice and getting heads both times?"
- **Activity:**
    1. Flip a coin twice and record the result. Repeat 10 times. How many times did you get two heads? This is your *experimental probability*.
    2. Now let's find the *theoretical probability*. Draw a **Tree Diagram** to map the sample space.
        - Start with a single point. Draw two branches for the first flip: Heads (H) and Tails (T).
        - From the end of each of those branches, draw two more branches for the second flip (H and T).
        - Follow the paths to list all outcomes: HH, HT, TH, TT. The sample space has 4 total outcomes.
    3. **Calculate:** The probability of getting HH is 1 favorable outcome out of 4 total outcomes.
    4. **Convert:** Express 1/4 as a decimal (0.25) and a percentage (25%). Add this visual and example to your Anchor Chart.

### Challenge 2: The Dice Roll Duel (Visual Tool: Outcome Grid Chart)

- **Question:** "What is the probability of rolling two dice and getting a sum of 7?"
- **Activity:**
    1. Create an **Outcome Grid Chart**. Make a 6x6 grid. Label the rows 1-6 (for Die 1) and the columns 1-6 (for Die 2).
    2. Fill in the grid by adding the row and column number for each cell. (e.g., the cell where Row 1 and Column 1 meet is 1+1=2).
    3. **Analyze:** Count the total number of cells. This is your sample space (36 outcomes).
    4. Circle all the cells where the sum is 7. How many are there? (There are 6).
    5. **Calculate:** The probability of rolling a sum of 7 is 6/36, which simplifies to 1/6.
    6. **Convert:** Express 1/6 as a decimal (~0.167) and a percentage (~16.7%).

### Challenge 3: The Marble Mystery (Concept: "Without Replacement")

- **Setup:** Use the bag with 5 red, 3 blue, and 2 green marbles (10 total).
- **Question 1:** "If you draw one marble, what is the probability it is blue?"
  - **Calculate:** P(Blue) = 3 (blue marbles) / 10 (total marbles) = 3/10 or 30%.
- **Question 2 (Compound Event):** "What is the probability of drawing a blue marble, NOT putting it back, and then drawing a red marble?"
  - **Step 1 (First Draw):** P(Blue) = 3/10.
  - **Step 2 (Second Draw):** Now there are only 9 marbles left in the bag, and 5 are red. So, P(Red after Blue) = 5/9.
  - **Calculate Combined Probability:** Multiply the probabilities: (3/10) * (5/9) = 15/90, which simplifies to 1/6.
  - Discuss why the denominator changed. This introduces the concept of dependent events.

### Challenge 4: The Card Shark's Secret (Visual Tool: Venn Diagram)

- **Question:** "From a standard 52-card deck, what is the probability of drawing a King OR a Heart?"
- **Activity:**
  1. Draw a **Venn Diagram** with two overlapping circles. Label one "Kings" and the other "Hearts."
  2. How many Kings are there? (4). How many Hearts? (13).
  3. Is there a card that is both a King AND a Heart? (Yes, the King of Hearts). Place a "1" in the overlapping section.
  4. This means there are 3 Kings that are not Hearts (in the "Kings" circle) and 12 Hearts that are not Kings (in the "Hearts" circle).
  5. **Calculate:** To find the probability of King OR Heart, we can't just add 4 + 13, because we would count the King of Hearts twice. We add the numbers in the diagram: 3 + 1 + 12 = 16 favorable outcomes.
  6. The probability is 16/52, which simplifies to 4/13.
  7. **Convert:** Express 4/13 as a decimal (~0.308) and percentage (~30.8%).

## 5. Part 3: The Real-World Connection (10 minutes)

**Discussion:** "Probability isn't just for games. Where do we see it or use it in everyday life?"

- **Guiding Questions:**
  - "When a weather reporter says there's a '30% chance of rain,' what does that mean?" (It means that in similar weather conditions in the past, it has rained 3 out of 10 times).
  - "If a baseball player has a .300 batting average, what is the probability they will get a hit?" (A .300 average is 300/1000, or 3/10, so a 30% chance).
  - Brainstorm other examples: lottery odds, medical statistics, deciding whether to bring an umbrella, etc.
- Revisit the intro question: Is it better to bet on rolling a 7 (1/6 chance, ~16.7%) or getting three heads in a row? (P(HHH) = 1/2 * 1/2 * 1/2 = 1/8, or 12.5%). The dice game gives you a better chance!

## 6. Assessment & Closure: Become the Game Designer (15 minutes)

**The Final Task:** "Your final mission is to design your own simple probability game using any of the materials we used today (coins, dice, marbles, or cards)."

### Requirements for the Game Design:

1. Give your game a name and write down simple rules for how to win.
2. Calculate the theoretical probability of a player winning your game.
3. Express this probability as a fraction, a decimal, and a percentage.
4. Create one visual aid for your game (Tree Diagram, Grid, or Venn Diagram) that explains the possible outcomes.
5. Explain your game and the probability of winning.

*This assessment measures the student's ability to apply all the concepts creatively, rather than just remembering definitions.*

## 7. Differentiation and Extension

- **For Support:** If the student struggles with compound events, focus the game design on a simple, one-step event (e.g., "You win if you draw a red marble from the bag"). The core goal is to master the calculation and conversion.
- **For Extension:** Challenge the student to explore conditional probability further. Ask: "What is the probability of drawing a Queen, given that you have already drawn a card that is a face card (Jack, Queen, King) and not replaced it?" (Answer: P(Queen | Face Card) = 4/12 or 1/3). This pushes their thinking to the next level.

```
```