For example, what is the probability that a tossed coin will land on heads? It’s a lot more likely to land on my head than on Lizzie’s. But, I guess it depends on where you aim it. That is not what she means. Most coins have a heads side, with the head of a famous monster... ...and a tails side, with the tail of the famous monster. Landing heads means landing with the heads side face-up.

Some probabilities are almost impossible to compute. But others aren’t so tough. For example, what is the probability that a tossed coin will land on heads?

“Alright, little monsters... climb aboard. We’re off to the math relays.”

Do you think we have a chance of winning?

Excerpt from Beast Academy Guide 4D. (C) 2015 www.BeastAcademy.com
Since 1 of the 2 possible outcomes of flipping a coin is heads, the probability of a flipped coin landing heads is $\frac{1}{2}$.

That just means that if you flip a coin a bunch of times and tally the results... ...it will land heads about half the time.

Good.

Things get a little trickier when we flip two coins.

<table>
<thead>
<tr>
<th>Heads</th>
<th>Tails</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>JHT JHT JHT JHT JHT JHT JHT JHT</td>
</tr>
</tbody>
</table>

We need to count all of the possible outcomes.

You can flip two heads...

...or two tails...

...or one of each.

If I flip both of these coins, what is the probability that both will land heads?

Are all three outcomes equally likely?

Try flipping both of these coins 60 times and record how many times you flip two heads, two tails, and one of each.
Here are our results.

<table>
<thead>
<tr>
<th>Two Heads</th>
<th>Two Tails</th>
<th>One Each</th>
</tr>
</thead>
<tbody>
<tr>
<td>H H</td>
<td>H T</td>
<td>H T H T</td>
</tr>
</tbody>
</table>

We flipped two heads 16 times...
...two tails 13 times...
...and one of each 31 times!

Weird. Why did “one each” come up so often?

I know! There are two ways to flip one heads and one tails!

We can flip heads on the penny and tails on the nickel...
...or heads on the nickel and tails on the penny.

Winnie’s right. We can make a tree diagram to show all of the possible outcomes.

The penny can land heads or tails...
...and the nickel can land heads or tails.

That makes four possibilities: heads-heads, heads-tails, tails-heads, and tails-tails.

<table>
<thead>
<tr>
<th>Penny</th>
<th>Nickel</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>H H</td>
</tr>
<tr>
<td>H</td>
<td>H T</td>
</tr>
<tr>
<td>T</td>
<td>H T</td>
</tr>
<tr>
<td>T</td>
<td>T T</td>
</tr>
</tbody>
</table>

| 1. HH | 2. HT | 3. TH | 4. TT |
All 4 possible outcomes are equally likely...

...and only 1 of the 4 outcomes has two heads.

Penny Nickel

- H H
- H T
- T H
- T T

1. HH
2. HT
3. TH
4. TT

So, the probability of flipping heads twice is $\frac{1}{4}$.

That matches our results. We flipped two heads on 16 of the 60 flips, which is about $\frac{1}{4}$ of the time.

Excellent. Suppose I flip three coins.

What is the probability of flipping heads exactly twice with three coins?

We can add the third coin flip to our tree diagram. That gives us 8 possible outcomes.

And 3 of the outcomes have exactly two heads.

Penny Nickel dime

- H H H
- H H T
- H T H
- H T T
- T H H
- T H T
- T T H
- T T T

1. HHH
2. HHT
3. HTH
4. HTT
5. THH
6. THT
7. TTH
8. TTT

So, on three flips of a coin, the probability you will get exactly two heads is $\frac{3}{8}$.
Awesome job!

Let’s switch from coins to dice.

Have any of you played Monsteropoly?

<table>
<thead>
<tr>
<th>Penny</th>
<th>Nickel</th>
<th>Dime</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
</tbody>
</table>

1. HHH
2. HHT
3. HTH
4. HTT
5. THH
6. THT
7. TTH
8. TTT

Chance

What’s the probability of rolling doubles?

Let’s switch from coins to dice. Have any of you played Monsteropoly?

I always get sent to jail in that game. *Directly to jail.*

You have to roll doubles with a pair of dice.

What’s the probability of rolling doubles?

We need to know how many different rolls are possible.

A coin only has 2 sides, but a die has 6!

We can make another tree diagram to show every possible roll.

What is the probability of rolling two of the same number with a pair of dice?