Junior Circle Meeting 7 – Multiplication Principle

May 16, 2010

1. Suzy is trying to decide what outfit to wear. She has three different shirts (a red one, a white one, and a black one), and two different skirts (a green skirt and a purple skirt).

   a. Let's describe her three shirts as "R" for red, "W" for white, and "B" for black, and her two skirts as "G" for green and "P" for purple. If she wears the red shirt with the green skirt, we write this as "RG". In this same way, write down all of her possible outfits.

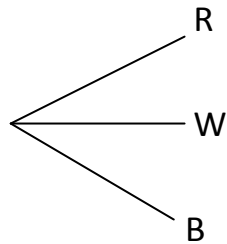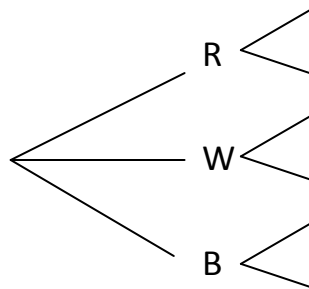   b. How many possible outfits does she have? How does this number relate to 3 shirts and 2 skirts?

c. We can understand why the answer is 3 times 2 by drawing a *tree*. Remember from our handouts on Antland and Beeland that a *tree* is a *graph* where there is only one path between any two points.

Below we have started our tree with the three choices that Suzy has for shirts: red, white, and black.

```
        R
       /
      /
<----------- W
      \
       \
        B
```

For each shirt, Suzy has a choice of a skirt: green or purple. We represent this with two more branches from each of the red, white, and black branches in our tree.
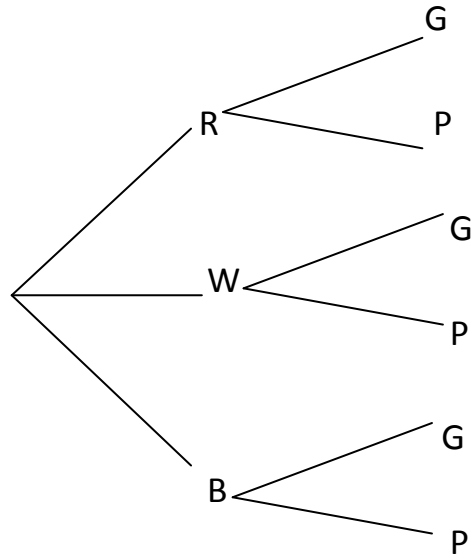
Fill in the tree below for the two choices of skirts, "G" or "P".

```
            /
        R <
       /    \
      /      /
<--------- W <
      \      \
       \      /
        B <
            \
```

How many possible paths are there?

Can you explain, using your tree above, why this answer corresponds to 3 times 2?

2. Now Suzy has to decide on a pair of shoes to wear in addition to her shirt and skirt. She has 2 pairs of shoes: tennis shoes (T) and sandals (S).

    a. How must we change our tree below?

```
                              G
                 R
                              P

                              G
       ——— W
                              P

                              G
                 B
                              P
```

    b. How many possible outfits does she now have?

    c. Express this answer in terms of 3, 2, and 2.

    d. What is the probability that Suzy picks a black shirt, purple skirt, and sandals?

    e. What is the probability that Suzy picks tennis shoes?

3. Joe is at a restaurant and wants to order a sandwich. He has a choice of:
   - 3 types of bread (white, wheat, or rye)
   - 3 types of meat (turkey, ham, or salami)
   - 2 types of cheese (cheddar or American)
   - 2 types of toppings (pickles or onions)

   a. He thinks that the total number of possible sandwiches is 3+3+2+2=10 sandwiches. Is he correct?

   b. What is the correct number of total possible sandwiches? Can you find this answer without drawing a tree?

   To find the total number of possible outfits or sandwiches, we are using the *Multiplication Principle*, which says that we can multiply the different choices we have together.

   For instance, when we find the outfits for Suzy, we multiply three numbers:

   $$3 \ \text{x} \ 2 \ \text{x} \ 2$$

   Where the first number is for shirts, the second is for skirts, the third is for shoes.

   We will use this idea in the rest of the handout!

4. We now play a game with letters in the English alphabet. We will try to make as many "words" as we can out of the chosen letters, but we can only use each letter once. Remember: these "words" do not have to be real English words.

   a. How many two-letter words can we make from the letters A and B? Write down the words below.

   a. Let's now use the *Multiplication Principle*. Can you come up with a formula for the number of all two-letter words with A and B? You can start by thinking of how many choices you have for the first letter. Then think of how many choices you have for the second letter (once the first is chosen). Then multiply these!

   b. How many three-letter words can we make from the letters A, B, and C? Write down the words below.

c. Let's now use the *Multiplication Principle*. Can you come up with a formula for the number of all three-letter words with A, B, and C?

d. How many four-letter words can we make from the letters A, B, C, and D? Instead of writing the words down, let's use the *Multiplication Principle*.

e. How many two-letter words can we make from the letters A, B, C, and D? Let's use the *Multiplication Principle* and then double-check your answer by writing the words down.

5. Mindy is at the flower market and wants to buy some flower seeds to plant in the soil around her house. She wants to buy one type of flower seeds for her front yard and a different type of flower seeds for her back yard. The flower store has a total of 4 different types of flower seeds: roses, lilies, tulips, and daisies.

   a. How many different possibilities are there for her front yard?

   b. How many different possibilities are there for her back yard, once she has chosen a type of flower seed for her front yard?

   c. How many total possibilities are there for flowers in her front and back yard? (Use the *Multiplication Principle*!)

   d. Write down all possibilities for flowers in the front and back yards to verify your answer. (You can use "R", "L", "T", and "D" for short).

   e. How is this answer similar to Problem 4, part (e.)? Why?

6. Now Mindy wants to buy flowers for a bouquet. She wants to buy two different types of flowers for her bouquet. The flower store has four types of flowers: roses, lilies, tulips, and daisies.

    a. Write down the possible bouquets she can make with two different types of flowers. (You can use "R", "L", "T", and "D" for short).

    b. Is a bouquet of roses and lilies the same as a bouquet of lilies and roses? Why?

    c. How many possible bouquets did you find?

    d. Can you explain why your answer in Problem 5, part (c.) is twice as big?

7. Mindy goes back to the flower market for more flowers and seeds.

a. She now decides to pick exactly 3 different types of flower seeds (from the seeds of roses, lilies, tulips, and daisies) for her front, back, and side yards.   How many different possibilities for flower gardens does Mindy have? Use the *Multiplication Principle*!

b. For her bouquet, Mindy now decides to pick three types of flowers from the roses, lilies, tulips, and daisies. How many different possible bouquets are there?

c. What number must we multiply part (b.) by to get part (a.)? Can you explain why? (Hint: think of the number of different three-letter words from the letters A, B, and C)

8. Gloria, Jenny, Paula, and Cindy have dinner at a round table. In how many ways can they sit around the table if Cindy wants to sit to the left of Paula?