## **The Fundamental Counting Principle**

Problems involving counting usually deal with ways of selecting objects, numbers, or people. Sometimes these selections involve a need to order and/or a need to repeat. Order in an experiment is essential when things, numbers, or persons must occupy a first position, a second position, etc. License plate characters and "combination" lock numbers imply a need for order or arrangement:

ABC 123 is a different license number from ABC 321.

Left 25-Right 13-Left 25 is a different lock "combination" from Left 25-Right

25-Left 13. (Note the repetition of 25)

Choosing 3 members for county commissioner from a field of 9 candidates involves no ordering and no repetition.

The Fundamental Counting Principle is used when **order is implied** or stated, and **repetition may or may not be allowed**.

The FCP uses the operation of multiplication. It involves drawing a "slot" for each possible outcome, filling in the number of possibilities for each outcome, and then multiplying across.

## Example 1

Two fair dice are rolled. How many different ways can they land? A fair die can have 6 possible number outcomes: 1, 2, 3, 4, 5 or 6

**Order underlies the experiment** since a "2" on the 1st die and a "4" on the 2nd die is a different outcome from a "4" on the 1st and "2" on the 2nd. **Repetition is implied** in this experiment since the outcomes of the 2 dice are independent of each other.

$$1^{st}$$
 die  $2^{nd}$  die  $\underline{6}$  •  $\underline{6}$  =  $36$  (possible outcomes) (possible outcomes) Different outcomes possible

The table shows the 36 possible outcomes.

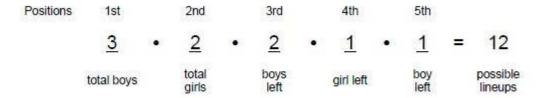
|   | 1   | 2   | 3   | 4   | 5   | 6   |
|---|-----|-----|-----|-----|-----|-----|
| 1 | 1,1 | 1,2 | 1,3 | 1,4 | 1,5 | 1,6 |
| 2 | 2,1 | 2,2 | 2,3 | 2,4 | 2,5 | 2,6 |
| 3 |     |     |     |     | 3,5 | 3,6 |
| 4 | 4,1 | 4,2 | 4,3 | 4,4 | 4,5 | 4,6 |
| 5 | 5,1 | 5,2 | 5,3 | 5,4 | 5,5 | 5,6 |
| 6 | 6,1 | 6,2 | 6,3 | 6,4 | 6,5 | 6,6 |

## Example 2

In how many ways can George, John, Charles, Mary, and Alice stand in a line so that boys and girls alternate? (Hint: a boy must occupy the first position since there are 3 boys, 2 girls).

Order matters because of the positioning of boy/girl

**Repetition is not used** since when a person is picked he/she cannot be chosen again.



The list shows the 12 Arrangements
George Mary John Alice Charles
George Alice John Mary Charles George Alice
Charles Mary John George Mary Charles Alice
John John Mary George Alice Charles
John Mary Charles Alice George

John Alice George Mary Charles John Alice Charles Mary George Charles Mary John Alice George Charles Mary George Alice John Charles Alice John Mary George Charles Alice George Mary John

## Example 3

How many different three course dinners can be ordered from a menu that has four choices for entree, six choices for vegetables, and three choices for desserts?

**Order** or arrangement **is implied** since we are choosing one of each from choices that are different from each other.

**Repetition is not implied** since a dinner will consist of three unique choices.

