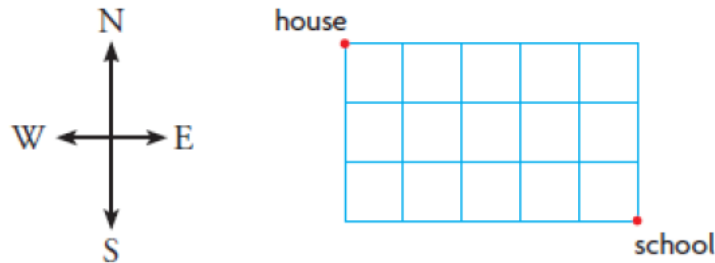# 2.4B  Permutation Problems Involving Routes

**Example 1:**
Julie's home is three blocks north and five blocks west of her school. How many routes can Julie take from home to school if she always travels either south or east?

N  ↑  house

W ←→ E

S

school

Consider some of the various ways that Julie can walk from her house to school, traveling only south or east.

E E E E E

S   E E E E E S S S
S
S

E E E E

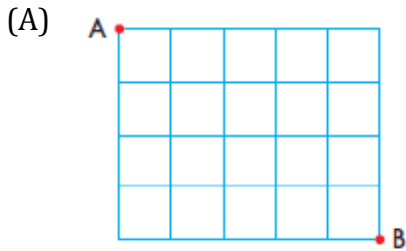S   E E E E S S S E
S
S
E

E E E

S   E E E S S S E E
S
S
E E
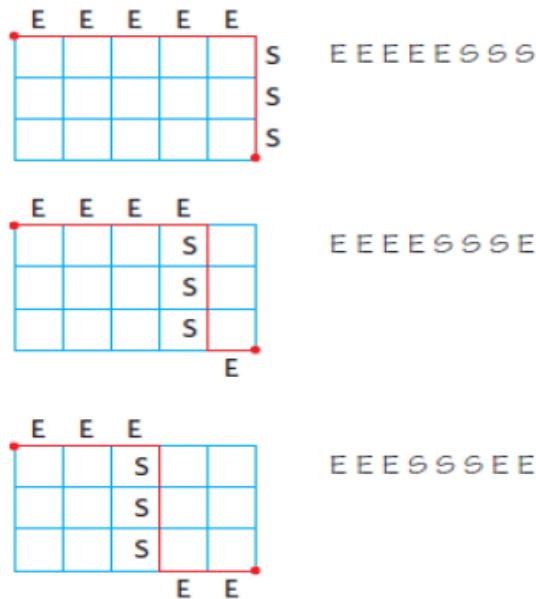
Notice that in each of the possible routes shown, the total number of blocks traveled is 8. Also notice that some elements that are identical to each other, E shows up 5 times and S shows up 3 times. Thus, we must treat this as a permutation problem in which some of the elements are identical. Keeping that in mind, the number if routes she can travel would be:
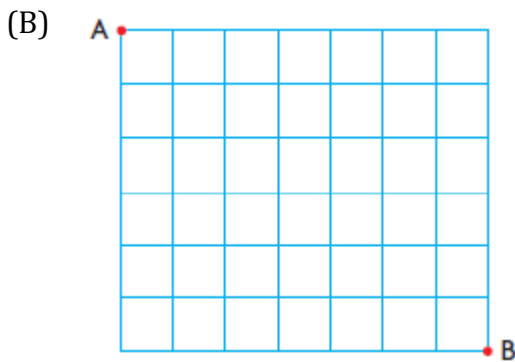
$$P = \frac{8!}{5! \cdot 3!}$$

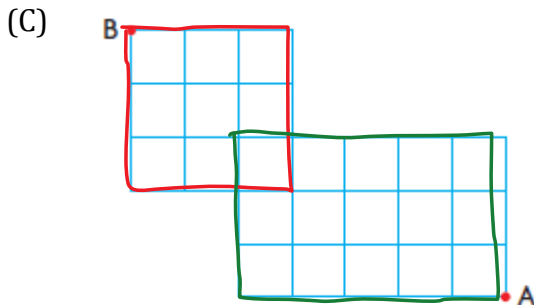There are 56 routes from home to school traveling south or east.

**Example 2:**
Determine the number of routes there are to get from point A to point B, if you travel only south or east.

(A)



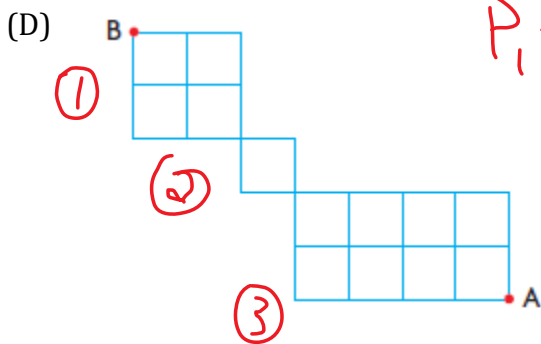$$P = \frac{9!}{5! \, 4!} = \frac{362880}{2880}$$

$$= 126$$

(B)



$$P = \frac{13!}{7! \, 6!} = 1716$$

(C)



$$P_B = \frac{6!}{3! \, 3!} \qquad P_A = \frac{8!}{5! \, 3!}$$

$$= 20 \qquad\qquad = 56$$

$$P_T = \frac{20 \times 56}{2} = 560$$

(D)



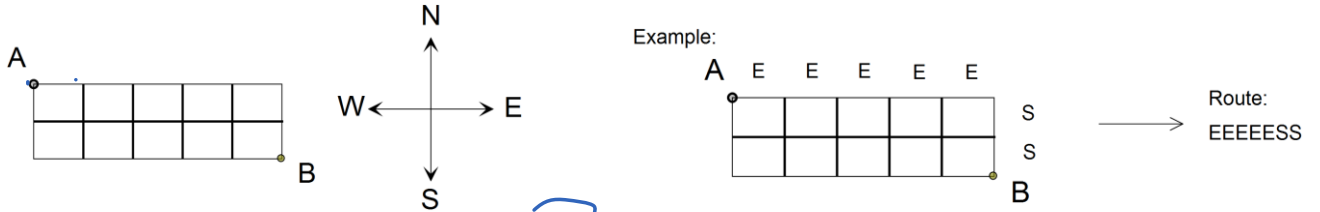$$P_1 = \frac{4!}{2! \, 2!} = \frac{24}{4} = 6$$

$$P_2 = \frac{2!}{1! \, 1!} = 2$$

$$P_3 = \frac{6!}{4! \, 2!} = \frac{720}{48} = 15$$

$$P_T = 6 \times 2 \times 15 = 180$$

**Your turn:**

1. In the grid below, a person must travel from *A* to *B* by only heading East *(E)* or South *(S)*. One example of a route is shown representing 5 moves East followed by 2 moves South (EEEEESS). Under these rules, which represents the total number of possible routes that can be taken to get from *A* to *B*?

N
↑
W ← → E
↓
S

Example:

A   E   E   E   E   E

S
S

B

Route:
⟶
EEEEESS

(A)    7!

(B)    2! × 5!

(C)    $\frac{2!5!}{7!}$

(D)    $\frac{7!}{2!5!}$

$$\frac{7!}{5!2!}$$

2. In the grid below, a person must travel from *A* to *B* by only heading East (E) or South (S). Under these rules, which represents the total number of possible routes that can be taken to get from *A* to *B*?

(A)    $\frac{5!}{3!2!}$

(B)    $\frac{6!}{3!2!}$

(C)    5!

(D)    6!

$$\frac{5!}{3!2!}$$

*A*

N
↑
W ← → E
↓
S

*B*