# Permutations & Combinations — Practice

CKSTEM Math Problem Solving · Grades 5–8

**1** FACTORIAL · PERMUTATION · COMBINATION

Four different books are placed in a row on a shelf. How many different orders are possible?

WORK IT OUT HERE

**2** FACTORIAL · PERMUTATION · COMBINATION

A team of 6 runners must pick a captain and a vice-captain (two different runners, the two roles are different). How many ways can this be done?

WORK IT OUT HERE

**3** FACTORIAL · PERMUTATION · COMBINATION

A coach must pick a team of 3 players from a squad of 7 (the team has no roles). How many different teams are possible?

WORK IT OUT HERE

**4** FACTORIAL LINEUP

Three friends stand in a single line for a photo. How many different lineups are possible?

WORK IT OUT HERE

**5** FACTORIAL LINEUP

Six trophies are arranged in a row on a shelf. How many different orders are possible?

WORK IT OUT HERE

**6** FACTORIAL LINEUP

Seven different books are placed in a row on a shelf. How many different orders are possible?

WORK IT OUT HERE

**7** BLOCK TRICK

Five students stand in a single line. Two of them are twins who must stand next to each other. How many different lineups are possible?

WORK IT OUT HERE

**8** BLOCK TRICK

Six students stand in a single line. Two specific students must stand next to each other. How many different lineups are possible?

WORK IT OUT HERE

**9** BLOCK TRICK

Six students stand in a single line. Student A must stand at the very front of the line, and students B and C must stand next to each other somewhere in the rest of the line. How many different lineups are possible?

WORK IT OUT HERE

**10** SUBTRACT THE BAD

Five students stand in a single line. Two specific students must NOT stand next to each other. How many different lineups are possible?

WORK IT OUT HERE

**11** SUBTRACT THE BAD

Six students stand in a single line. Two specific students must NOT stand next to each other. How many different lineups are possible?

WORK IT OUT HERE

**12** SUBTRACT THE BAD

Seven students stand in a single line. Two specific students must NOT stand next to each other. How many different lineups are possible?

WORK IT OUT HERE

**13** ORDERED PAIRING

From 5 runners, a coach must pick a gold medalist and a silver medalist (two different runners, in order). How many ways can this be done?

WORK IT OUT HERE

**14** ORDERED PAIRING

Three different prizes (gold, silver, bronze) are awarded to three different finishers chosen from 6 runners. How many ways can the prizes be awarded?

WORK IT OUT HERE

**15** ORDERED PAIRING

Four student helpers will each be paired one-to-one with a different new student chosen from 7 new students. However, Helper Anna cannot be paired with new student Xavier, and Helper Ben cannot be paired with new student Yara. How many different buddy pairings are possible?

WORK IT OUT HERE

**16** GROUP COMBINATIONS

A team of 2 students is chosen from 2 boys and 2 girls. The team must include at least one boy and at least one girl. How many different teams are possible?

WORK IT OUT HERE

**17** GROUP COMBINATIONS

A committee of 3 is chosen from 2 mentors, 2 club leads, and 2 athletes. Each of the three groups must be represented on the committee. How many different committees are possible?

WORK IT OUT HERE

**18** GROUP COMBINATIONS

A committee of 4 is chosen from 3 mentors, 3 club leads, and 3 athletes. Each of the three groups must be represented on the committee. How many different committees are possible?

WORK IT OUT HERE

**19** QUOTAS + EXCLUSION

A team of 4 students is chosen from 2 mentors, 2 club leads, and 3 athletes. The team must include at least one student from each group. How many different teams are possible?

WORK IT OUT HERE

**20** QUOTAS + EXCLUSION

A team of 5 students is chosen from 3 mentors, 3 club leads, and 3 athletes. The team must include at least 2 mentors, at least 1 club lead, and at least 1 athlete. How many different teams are possible?

WORK IT OUT HERE

**21** QUOTAS + EXCLUSION

A team of 6 students is chosen from 3 mentors, 3 club leads, and 3 athletes. The team must include at least 2 mentors, at least 1 club lead, and at least 2 athletes. How many different teams are possible?

WORK IT OUT HERE

# Answer Key

Each answer comes with a hint that names the move. The tag says which video to rewatch if you are stuck.

**1. 24 orders** — *Factorial · Permutation · Combination*
Order matters, so use a factorial — start by counting how many choices fill the first spot.

**2. 30 ways** — *Factorial · Permutation · Combination*
The two roles are different, so order matters — fill the captain spot first, then the vice-captain spot from those left.

**3. 35 teams** — *Factorial · Permutation · Combination*
Swap two picked players and the team is the same, so order does not matter — count ordered picks of 3, then divide by the arrangements of those 3.

**4. 6 lineups** — *Factorial Lineup*
Fill the first spot, then the second from those left, then the last — multiply the choices.

**5. 720 orders** — *Factorial Lineup*
Order matters — count the choices for each position from left to right and multiply down to 1.

**6. 5040 orders** — *Factorial Lineup*
Same factorial move as before — fill each shelf position one at a time and multiply the choices down to 1.

**7. 48 lineups** — *Block Trick*
Glue the twins into one block and line up the resulting 4 units, then double for the order inside the block.

**8. 240 lineups** — *Block Trick*
Merge the two students into one block to get 5 units in a row, then double for the inside arrangement.

**9. 48 lineups** — *Block Trick*
Lock A into the front spot, then treat B and C as one block and arrange the remaining 4 units behind A.

**10. 72 lineups** — *Subtract the Bad*
Count every lineup of 5, then subtract the lineups where those two ARE together — the together-case is a block of 4 units doubled.

**11. 480 lineups** — *Subtract the Bad*
Start from all 6-person lineups, then peel off the ones where the two are glued into a block.

**12. 3600 lineups** — *Subtract the Bad*
Same complement move on 7 people — total lineups minus the lineups where the two form a block.

**13. 20 ways** — *Ordered Pairing*
The two slots are different, so order matters — fill the gold slot first, then the silver from those left.

**14. 120 ways** — *Ordered Pairing*
Each prize is a distinct slot — fill gold, then silver, then bronze from the runners left each time.

**15. 620 pairings** — *Ordered Pairing*
Count every ordered assignment of 4 helpers to students, then subtract the assignments that lock Anna–Xavier and the assignments that lock Ben–Yara — but add back the ones you subtracted twice where both forbidden pairings happen at once.

**16. 4 teams** — *Group Combinations*
List the splits (boys, girls) summing to 2 with each group represented — only (1,1) works — then multiply the choices from each group.

**17. 8 committees** — *Group Combinations*
The only split that gives every group a seat is one from each — pick one from each group and multiply the choices.

**18. 81 committees** — *Group Combinations*

List every split of 4 across three groups with each group getting at least one — by symmetry the three splits give the same product.

**19. 24 teams** — *Quotas + Exclusion*

List every split (mentors, leads, athletes) summing to 4 with each group at least 1, then add the products of C-choices across the three groups.

**20. 63 teams** — *Quotas + Exclusion*

List every split (mentors, leads, athletes) summing to 5 that meets the minimums, then add the products of choices across the three groups.

**21. 45 teams** — *Quotas + Exclusion*

List every (mentors, leads, athletes) split that hits the quotas and sums to 6, then add up the products of C-choices.