

Pack It Smart

Use bin-packing strategies to use the fewest containers.

HIGH SCHOOL • MA.912.LT.2.6

MA.912.LT.2.6 "Solve problems concerning optimizing resource usage using bin-packing techniques."

NAME _____

DATE _____

FIND THE MINIMUM

First, add the item sizes and divide by the bin capacity to find a lower bound for the number of bins. Then make a packing that stays at or below the capacity of every bin. A packing that reaches the lower bound proves it is the minimum.

WORKED EXAMPLE

Each bin holds at most 12 units.
Pack items of sizes 7, 5, 4, and 3
into the fewest bins.

1. Add the item sizes: $7 + 5 + 4 + 3 = 19$.
2. One bin holds only 12 units, so at least 2 bins are needed.
3. Pack Bin 1: $7 + 5 = 12$.
4. Pack Bin 2: $4 + 3 = 7$.

Answer: 2 bins: (7, 5) and (4, 3).

PRACTICE 6 problems

- 1** Each bin holds at most 10 units. Pack items of sizes 6, 6, 4, and 4 into the fewest bins.

ANSWER _____

- 2** Each bin holds at most 14 units. Pack items of sizes 8, 8, 6, 6, and 6 into the fewest bins.

ANSWER _____

- 3** Each bin holds at most 15 units. Pack items of sizes 9, 9, 9, 6, 6, and 6 into the fewest bins.

ANSWER _____

- 4** Each bin holds at most 19 units. Pack items of sizes 11, 11, 8, 8, and 8 into the fewest bins.

ANSWER _____

- 5** Each bin holds at most 17 units. Pack items of sizes 11, 6, 9, and 8 into the fewest bins.

ANSWER _____

- 6** Each bin holds at most 16 units. Pack items of sizes 10, 10, 6, 6, and 6 into the fewest bins.

ANSWER _____

APPLY IT Show your work

- 1** Your film club is loading six camera cases onto rolling carts for a student film festival. Each cart can hold at most 21 pounds. The case weights are 11, 10, 11, 10, 11, and 10 pounds. What is the least number of carts needed? Show one packing.

WORK SPACE

ANSWER _____

- 2** Your esports team is sending eight portable gaming stations to a tournament. Each shipping crate can hold at most 22 pounds. The station case weights are 13, 9, 13, 9, 13, 9, 13, and 9 pounds. What is the least number of crates needed? Show one packing.

WORK SPACE

ANSWER _____

CHALLENGE One step up

CHALLENGE

Each bin holds at most 20 units. Pack items of sizes 13, 13, 13, 8, 8, and 8 into the fewest bins. Explain why one fewer bin cannot work.

PART 1 • PRACTICE

#	PROBLEM	ANSWER
1	Each bin holds at most 10 units. Pack items of sizes 6, 6, 4, and 4 into the fewest bins.	2 bins: (6, 4) and (6, 4).
2	Each bin holds at most 14 units. Pack items of sizes 8, 8, 6, 6, and 6 into the fewest bins.	3 bins: (8, 6), (8, 6), and (6).
3	Each bin holds at most 15 units. Pack items of sizes 9, 9, 9, 6, 6, and 6 into the fewest bins.	3 bins: (9, 6), (9, 6), and (9, 6).
4	Each bin holds at most 19 units. Pack items of sizes 11, 11, 8, 8, and 8 into the fewest bins.	3 bins: (11, 8), (11, 8), and (8).
5	Each bin holds at most 17 units. Pack items of sizes 11, 6, 9, and 8 into the fewest bins.	2 bins: (11, 6) and (9, 8).
6	Each bin holds at most 16 units. Pack items of sizes 10, 10, 6, 6, and 6 into the fewest bins.	3 bins: (10, 6), (10, 6), and (6).

PART 2 • APPLY IT

- 3 carts: (11, 10), (11, 10), and (11, 10).** The total weight is 63 pounds, and $63 / 21 = 3$, so fewer than 3 carts cannot work. Each 11-pound case pairs with a 10-pound case for a full cart.
- 4 crates: (13, 9), (13, 9), (13, 9), and (13, 9).** The total weight is 88 pounds, and $88 / 22 = 4$, so at least 4 crates are needed. Each 13-pound case and 9-pound case fill one crate exactly.

CHALLENGE

5 bins: (13), (13), (13), (8, 8), and (8). Each 13-unit item cannot share a bin with an 8-unit item because $13 + 8 = 21$, which is over capacity. The three 13-unit items need 3 bins, and the three 8-unit items need 2 more bins.

Accept any ordering of bins or items that keeps every bin at or below capacity and uses the stated minimum number of bins. For explanations, accept equivalent lower-bound reasoning and a valid packing.