

Pack It Smart

Build a packing and prove no fewer bins can work.

HIGH SCHOOL • MA.912.LT.2.6

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

NAME _____

DATE _____

FEASIBLE IS NOT ALWAYS OPTIMAL

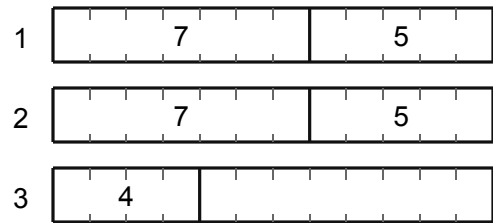
Items cannot be split. Put every item in exactly one bin; each bin load must be at most its capacity. Round total size / capacity UP for a lower bound, then test whether that many bins work. First-fit places each next item in the earliest bin with room; it need not be optimal. Label items in the printed rows.

WORKED EXAMPLE

Capacity 12; items 7, 7, 5, 5, 4. Find a minimum packing.

1. Total 28; two bins hold only 24. At least three are needed.
2. The shown loads 12, 12, 4 fit three bins.

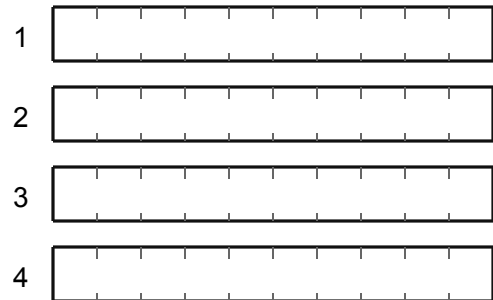
Answer: Minimum 3 bins; lower bound attained.



Each row: capacity 12 units

PRACTICE 4 problems

- 1** Capacity 10; items 6, 6, 2, 2. Draw a minimum packing in the rows and prove fewer bins cannot work.



Each row: capacity 10 units

- 2** Capacity 9; items 8, 8, 1, 1. Draw a minimum packing in the rows and prove fewer bins cannot work.

1	
2	
3	
4	

Each row: capacity 9 units

- 3** Capacity 15; items 9, 6, 6, 6. Draw a minimum packing in the rows and prove fewer bins cannot work.

1	
2	
3	
4	

Each row: capacity 15 units

- 4** Capacity 10; items 6, 6, 6. Draw a minimum packing in the rows and prove fewer bins cannot work.

1	
2	
3	
4	

Each row: capacity 10 units

APPLY IT Show your work

- 1** Robotics bundles use 5, 5, 4, 4, 2 slots. Each tote holds 10. Pack all five bundles in the fewest totes. State each unused capacity.

1	
2	
3	
4	

Each row: capacity 10 units

- 2** Concert kits use 10, 10, 6, 6 units. Each box holds 16. Draw a minimum packing and prove optimality.

1	
2	
3	
4	

Each row: capacity 16 units

CHALLENGE One step up

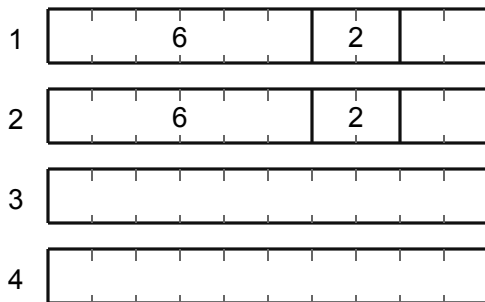
Capacity 10. Process items 4, 4, 6, 6 in this order using first-fit. Show its packing, then show a better packing and prove that packing is optimal. Use rows 1–3 for first-fit; rows 4–5 for the better plan.

1	
2	
3	
4	
5	

Each row: capacity 10 units

PRACTICE 1

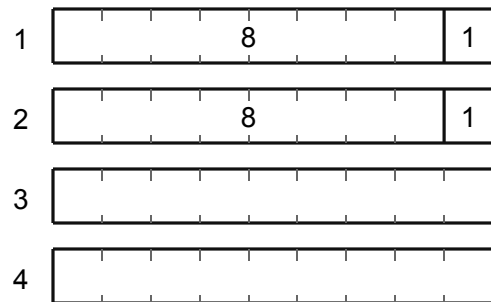
2 bins. Total 16 gives lower bound 2; both loads are 8, with 2 units unused in each.



Each row: capacity 10 units

PRACTICE 2

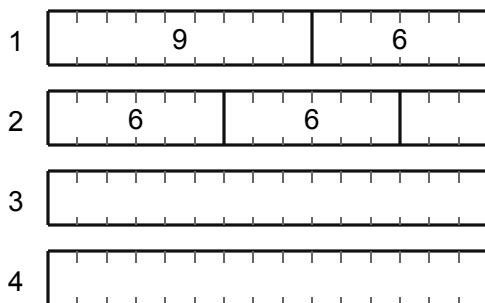
2 bins. Total 18 gives lower bound 2; two full bins attain it.



Each row: capacity 9 units

PRACTICE 3

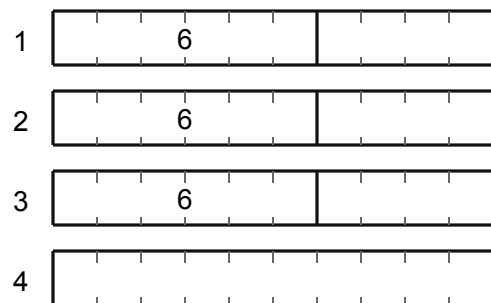
2 bins. Total 27 gives lower bound 2; loads 15 and 12 attain it.



Each row: capacity 15 units

PRACTICE 4

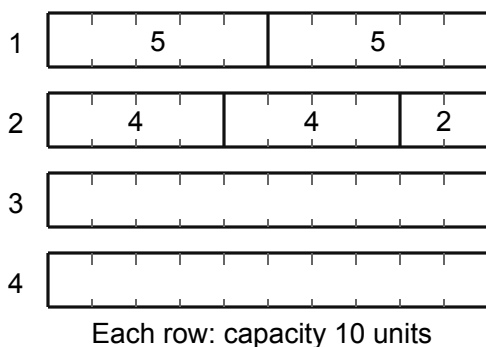
3 bins. The size lower bound is 2, but no pair of 6s fits. Three separate bins are required.



Each row: capacity 10 units

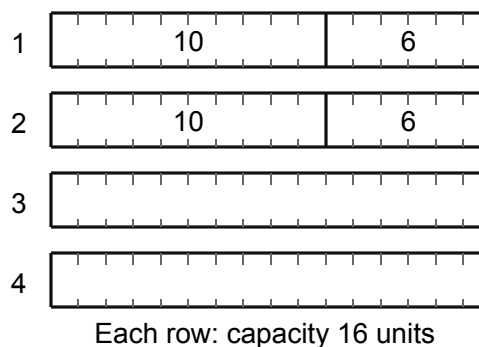
APPLY IT 1

2 totes; loads 10 and 10; no unused slots.
Total 20 requires at least two totes. [5,5] and [4,4,2] achieve that bound.



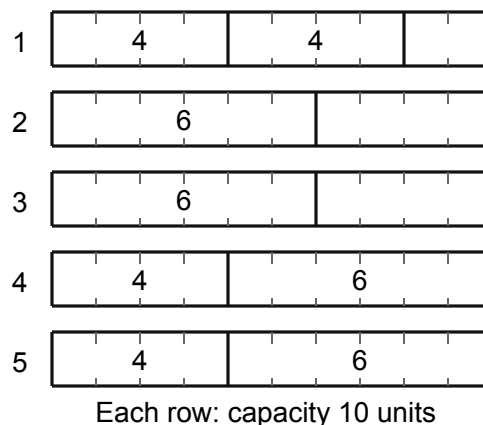
APPLY IT 2

2 boxes, each full.
Total 32 requires at least two boxes; each 10 + 6 load fits exactly.



CHALLENGE

First-fit: [4,4], [6], [6] (3 bins). Better: [4,6], [4,6] (2 bins).
Total 20 forces at least 2 bins, so the better packing is optimal.



Accept any packing using every item once within capacity. A lower bound alone is not proof unless a packing attains it; incompatible items can force more bins.