THE QUESTION | MIXTURE SYMMETRY

There are two containers X and Y. X contains 100 ml of milk and Y contains 100 ml of water. 20 ml of milk from X is transferred to Y. After mixing well, 20 ml of the mixture in Y is transferred back to X. If m denotes the proportion of milk in X and n denotes the proportion of water in Y, then which one of the following is correct?

Mixtures | Conservation Argument | Hidden Trap: running the full calculation

(a) m = n ✓
Milk in X + milk in Y = 100 and Y holds 100 ml, so water in Y equals milk in X.

(b) m > n
Would need X to hold more milk than the water Y holds. The volumes are equal by conservation.

(c) m < n
Would need Y to hold more water than X holds milk. Conservation rules this out.

(d) Cannot be determined due to insufficient data
All volumes are given, and a symmetry argument settles it.

CRACK THE HIDDEN RULE

Both containers end with 100 ml, and all 100 ml of milk is split between X and Y. So milk in X + milk in Y = 100.

Y holds 100 ml in total, so its water = 100 - milk in Y = milk in X. The water in Y is therefore exactly equal to the milk in X, so m = n.

Milk in X + Milk in Y = 100. Water in Y = 100 - Milk in Y = Milk in X

TOTAL MILK	Y HOLDS	RESULT
100 ml, split over X and Y	100 ml in all	Water in Y = Milk in X

WORKED IN 3 CLEAN STEPS

1 Track the totals
After both transfers each container is back to 100 ml, so what leaves one container exactly replaces what entered it.

2 Use total milk
All 100 ml of milk sits in X or Y, so milk in X + milk in Y = 100.

3 Conclude m = n
Water in Y = 100 - milk in Y = milk in X. Both containers hold 100 ml, so the proportions m and n are equal.

ANSWER: (a) m = n

THE 3-SECOND SHORTCUT

In two-container swap problems where both volumes return to the original, the foreign amount in each container is the same. No ratios are needed. (Check with numbers: both equal 5/6.)

both back to 100 ml → totals unchanged | water in Y = milk in X | no calculation needed

→ Full check: milk in X = 80 + 10/3, so m = 5/6, and water in Y = 100 - 50/3, so n = 5/6.

→ The same trick holds for any transfer volume.

WHY ASPIRANTS LOSE MARKS HERE

1. **Running the whole calculation.** It works but wastes a minute.
2. **Assuming Y is purer than X because it was mixed first.** The final amounts are symmetric.
3. **Choosing 'cannot be determined'.** All volumes are given.

ATTEMPT	FLAG	SKIP
~25 sec	if the argument feels shaky	never
Symmetry argument gives the answer without arithmetic.	Verify with numbers: m = n = 5/6.	A free mark once the trick is known.

THE ONE-LINE TAKEAWAY

When two mixed containers return to equal volumes, the foreign amounts match, so the proportions are equal.

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