



ANSWER BOOK

The stepping-stone method

Decision Mathematics 2 · Year FM

6 questions · 23 marks

NAVY EDITION

SECTION A · Warm-up

- A1** The index is the cell's cost minus its row shadow cost and its column shadow cost. It is the change in the total cost per unit sent along that route, once the rest of the plan has been adjusted to keep the supplies and demands satisfied. A positive index means using that route would raise the total, so the cell should stay empty.
- A2** $\text{Index} = 8 - 3 - 6 = -1$. It is negative, so the route is cheaper than the shadow costs predict and the cell is a candidate. Whether it actually enters depends on whether any other unused cell has a more negative index.

SECTION B · Standard

- B1** Set $R(A) = 0$. Then AX gives $K(X) = 8$ and AY gives $K(Y) = 5$. BY gives $R(B) = 9 - 5 = 4$, CY gives $R(C) = 6 - 5 = 1$, and CZ gives $K(Z) = 5 - 1 = 4$.
Indices: $AZ = 6 - 0 - 4 = 2$; $BX = 4 - 4 - 8 = -8$; $BZ = 7 - 4 - 4 = -1$; $CX = 3 - 1 - 8 = -6$.
- B2** The most negative index is -8 , so BX enters. The loop is BX plus, BY minus, AY plus, AX minus, back to BX. The minus cells hold BY 30 and AX 35, so the value moved is 30 and BY exits.
New allocations: AX 5, AY 35, BX 30, CY 10, CZ 40. $\text{Cost} = 835 + 30(-8) = 595$, and directly $5(8) + 35(5) + 30(4) + 10(6) + 40(5) = 40 + 175 + 120 + 60 + 200 = 595$.
- B3** The entering cell is chosen by improvement index, not by cost. The index already accounts for what the rest of the plan must give up to accommodate the new route, which the raw cost ignores. Here CX scored -6 against BX's -8 , so a unit sent along BX saves more than one sent along CX even though CX looks cheaper on the table.

SECTION C · Stretch

- C1** CX enters. The loop is CX plus, AX minus, AY plus, CY minus, back to CX. The minus cells hold AX 5 and CY 10, so the value moved is 5 and AX exits.
New allocations: AY 40, BX 30, CX 5, CY 5, CZ 40. $\text{Cost} = 595 + 5(-6) = 565$, and directly $200 + 120 + 15 + 30 + 200 = 565$.
A third round of shadow costs gives every remaining index positive, so no unused route would reduce the total and 565 is optimal. Stopping at 595 because the improvement looked small would have left 30 on the table.