Transportation problems 1C

1 a The initial north-west corner solution for question **1** in Exercise **1A** is:

	P	***Q***	***R***	**Supply**
A	28	4		32
B		41	3	44
C			34	34
Demand	28	45	37	110

The costs of the routes being used are:

	P	***Q***	***R***
A	150	213	
B		204	218
C			246

Putting S(A) = 0, gives D(P) = 150 and D(Q) = 213:

Shadow costs		150	213	
		P	***Q***	***R***
0	***A***	150	213	
	B		204	218
	C			246

Moving to row 2, S(B) = 204 – 213 = –9, so D(R) = 218 – (–9) = 227:

Shadow costs		150	213	227
		P	***Q***	***R***
0	***A***	150	213	
–9	***B***		204	218
	C			246

Moving to row 3, S(C) = 246 – 227 = 19, giving the final table of shadow costs:

Shadow costs		150	213	227
		P	***Q***	***R***
0	***A***	150	213	
–9	***B***		204	218
19	***C***			246

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1 b This is the full table of costs, with the cells used in the initial solution shaded:

Shadow costs		150	213	227
		P	***Q***	***R***
0	***A***	150	213	222
– 9	***B***	175	204	218
19	***C***	188	198	246

Improvement indices for cells not in initial solution are:

$BP = \mathrm{C}(BP) - S(B) - D(P) = 175 - (-9) - 150 = 34$

$CP = \mathrm{C}(CP) - S(C) - D(P) = 188 - 19 - 150 = 19$

$CQ = \mathrm{C}(CQ) - S(C) - D(Q) = 198 - 19 - 213 = -34$

$AR = \mathrm{C}(AR) - S(A) - D(R) = 222 - 0 - 227 = -5$

The improvement indices can also be presented in a table as follows:

		150	213	227
		P	***Q***	***R***
0	***A***	✗	✗	–5
– 9	***B***	34	✗	✗
19	***C***	19	–34	✗

c The entering cell is CQ, since it has the most negative improvement index.

2 a

Shadow costs		27	33	34	27
		P	***Q***	***R***	***S***
0	***A***	27	33	34	
3	***B***			37	30
8	***C***				35

b Improvement indices for cells:

$BP = 31 - 3 - 27 = 1$

$CP = 40 - 8 - 27 = 5$

$BQ = 29 - 3 - 33 = -7$

$CQ = 32 - 8 - 33 = -9$

$CR = 28 - 8 - 34 = -14$

$AS = 41 - 0 - 27 = 14$

c The entering cell is CR, since it has the most negative improvement index.

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3 a

Shadow costs		17	23	19
		P	***Q***	***R***
0	***A***	17		
–2	***B***	15	21	
–1	***C***		22	18
–3	***D***			16

b Improvement indices for cells:

$CP = 19 - (-1) - 17 = 3$

$DP = 20 - (-3) - 17 = 6$

$AQ = 24 - 0 - 23 = 1$

$DQ = 27 - (-3) - 23 = 7$

$AR = 19 - 0 - 19 = 0$

$BR = 25 - (-2) - 19 = 8$

c There are no negative improvement indices, so the solution is optimal.

4 a

Shadow costs		56	73	60	56
		P	***Q***	***R***	***S***
0	***A***	56			
3	***B***	59	76		
–3	***C***		70	57	
15	***D***			75	71

b Improvement indices for cells:

$CP = 62 - (-3) - 56 = 9$

$DP = 60 - 15 - 56 = -11$

$AQ = 86 - 0 - 73 = 13$

$DQ = 68 - 15 - 73 = -20$

$AR = 80 - 0 - 60 = 20$

$BR = 78 - 3 - 60 = 15$

$AS = 61 - 0 - 56 = 5$

$BS = 65 - 3 - 56 = 6$

$CS = 67 - (-3) - 56 = 14$

c The entering cell is DQ, since it has the most negative improvement index.

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5 a The total supply (76 + 68 + 60 = 204) is equal to the total demand (83 + 57 + 64 = 204).

b

	X	***Y***	***Z***	**Supply**
A	76			76
B	7	57	4	68
C			60	60
Demand	83	57	64	204

c

Shadow costs		39	46	52
		X	***Y***	***Z***
0	***A***	39		
9	***B***	48	55	61
6	***C***			58

Improvement indices for cells not in initial solution are:

$CX = \mathrm{C}(CX) - S(C) - D(X) = 52 - 6 - 39 = 7$

$AY = \mathrm{C}(AY) - S(A) - D(Y) = 54 - 0 - 46 = 8$

$AZ = \mathrm{C}(AZ) - S(A) - D(Z) = 47 - 0 - 52 = -5$

$CY = \mathrm{C}(CY) - S(C) - D(Y) = 44 - 6 - 46 = -8$

There are cells with negative improvement indices, so the solution may not be optimal.

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