CALIFORNIA STATE UNIVERSITY, LOS ANGELES
PROGFEST 2013

Problem 2

BALANCING THE WATER BUDGET

As a developer in the city recreation and parks department, you have been tasked to forecast a climatic water budget in order to determine how much water will be needed for irrigation. Using Thornthwaite and Mather's calculation method, you can predict the amount of water surplus and deficit for each month of the year.

The rules for Thornthwaite and Mather's method are the following:
1. When P is larger than PE, excess water will go to recharge soil moisture storage until it reaches the field capacity, then left over will be runoff (surplus).
2. When PE is larger than P, plants draw moisture from soil and the soil moisture storage falls below capacity.
3. Actual Evapotranspiration is the amount of moisture a plant actually gets:
    a. If P>=PE, AE=PE
    b. If P<PE, AE = P + |ΔS |
4. Deficit occurs when AE < PE
5. After deficit period, (when P becomes > PE again), excessive water will recharge soil to capacity before surplus (or runoff) occurs.

    where: P   = Precipitation
             PE = Potential Evapotranspiration
             AE = Actual Evapotranspiration
             S   = Soil Moisture Storage (Maximum capacity at 150)
             ΔS = Change in Soil Moisture Storage

When P – PE < 0, soil moisture storage(S) is determined by the following prediction formula:

where: (i.e. any negative S value must be set to the minimum value 1)
        a = the initial month that the deficit occurred
        b = the current month

Below is an example of a water budget calculation for each month:

3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PE	0	0	15	43	89	128	150	135	94	52	20	2
P	87	80	96	91	92	98	119	128	93	78	82	86
P-PE	87	80	81	48	3	-30	-31	-7	-1	26	62	84
Storage (S)	150	150	150	150	150	144	138	137	137	150	150	150
Storage Change (ΔS)	0	0	0	0	0	-6	-6	-1	0	13	0	0
AE	0	0	15	43	89	104	125	129	93	52	20	2
Surplus	87	80	81	48	3	0	0	0	0	13	62	84
Deficit	0	0	0	0	0	24	25	6	1	0	0	0

Your program must calculate the net surplus/deficit for each month of the year based on predicted input values for Precipitation (P) and Potential Evapotranspiration (PE):

- 1st line has 12 integers separated by a space representing PE values from January to December
- 2nd line has 12 integers separated by a space representing P values from January to December

Show the following in the output:

- Surplus or deficit values for each month. Deficit values must be converted to an absolute value and enclosed within parentheses, e.g -24 □ (24). Values are separated by a space.
- Highest water usage by plants or Actual Evapotranspiration (AE) value and the month(s) when it occurred (enclosed in square brackets, e.g. [3,4,6,9]).
- Total net surplus or deficit for the year

Example #1
Sample Input
0 0 15 43 89 128 150 135 94 52 20 2
87 80 96 91 92 98 119 128 93 78 82 86

Sample Output
87 80 81 48 3 (24) (25) (6) (1) 13 62 84
AE:129 [8]
Total Surplus:402

Example #2
Sample Input
26 30 43 56 70 82 90 84 81 63 40 30
102 88 68 33 12 3 0 1 5 19 40 104

Sample Output
76 58 25 (19) (46) (63) (72) (67) (61) (35) 0 0
AE:43 [3]
Total Deficit:204

4