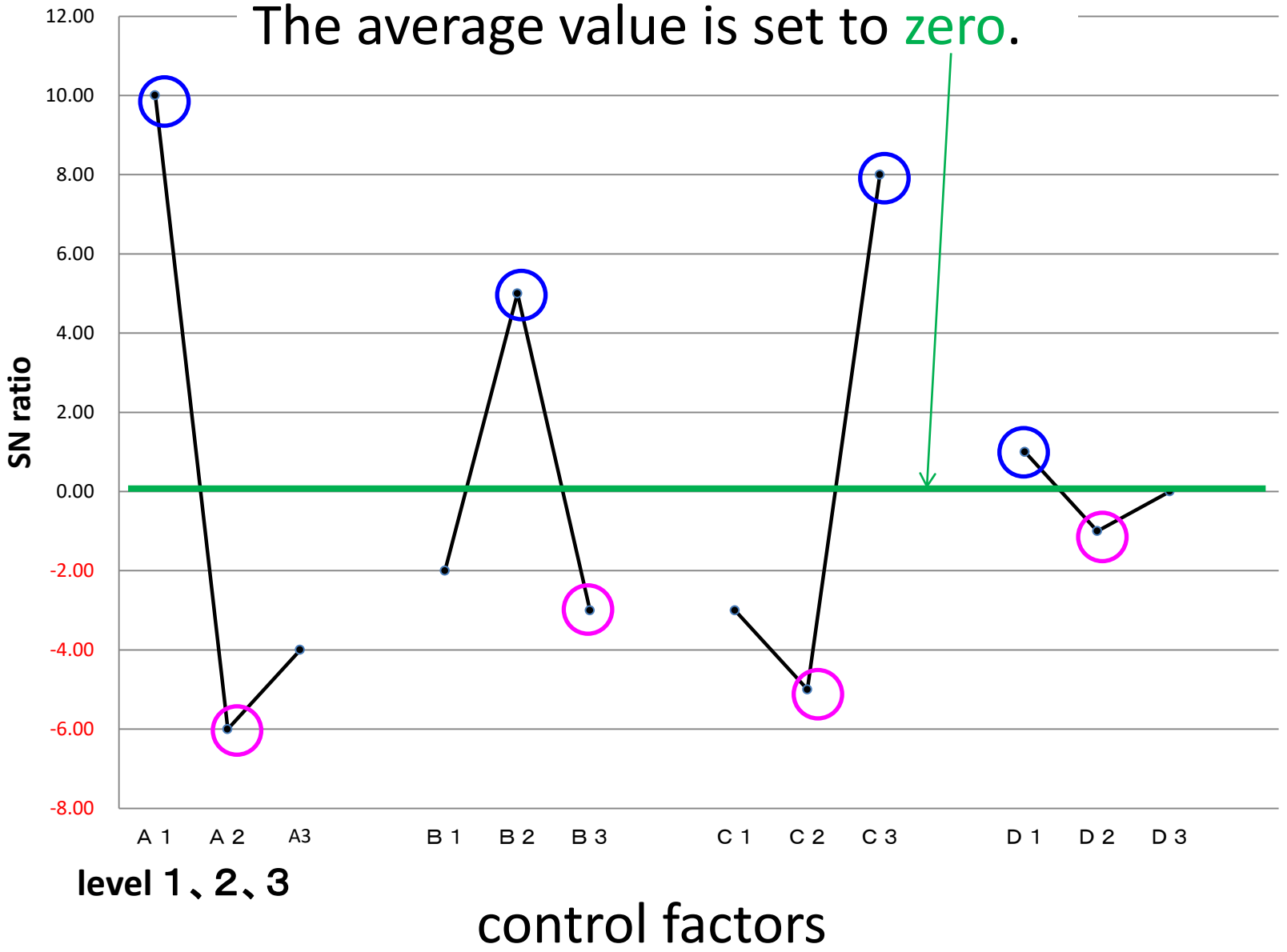
Three questions in quality engineering(QE) experiments

Q1 **Why does the orthogonal table experiments can show the magnitude of the effect of the level of each factor on the SN ratio?**

Q2 What is orthogonal?

Q3 The reason why the number of experiments per line is N=1.

Assume the "graph of factorial effects“ looks like this



L9 orthogonal table

Cancel except for the factor A of interest

control factors

	A	B	C	D	SN
expt.1	1	1	1	1	
expt.2	1	2	2	2	
expt.3	1	3	3	3	
expt.4	2	1	2	3	
expt.5	2	2	3	1	
expt.6	2	3	1	2	
expt.7	3	1	3	2	
expt.8	3	2	1	3	
expt.9	3	3	2	1	

	A	B	C	D
level 1	10	−2	−3	1
level 2	−6	5	−5	−1
level 3	−4	−3	8	0

Optimum conditions :$A_1B_2C_3D_1$

	A	B	C	D	SN
expt.1	10	−2	−3	1	6
expt.2	10	5	−5	−1	9
expt.3	10	−3	8	0	15
expt.4	−6	−2	−5	0	−13
expt.5	−6	5	8	1	8
expt.6	−6	−3	−3	−1	−13
expt.7	−4	−2	8	−1	1
expt.8	−4	5	−3	0	−2
expt.9	−4	−3	−5	1	−11

SN ratio has additivity

Focus on factor A

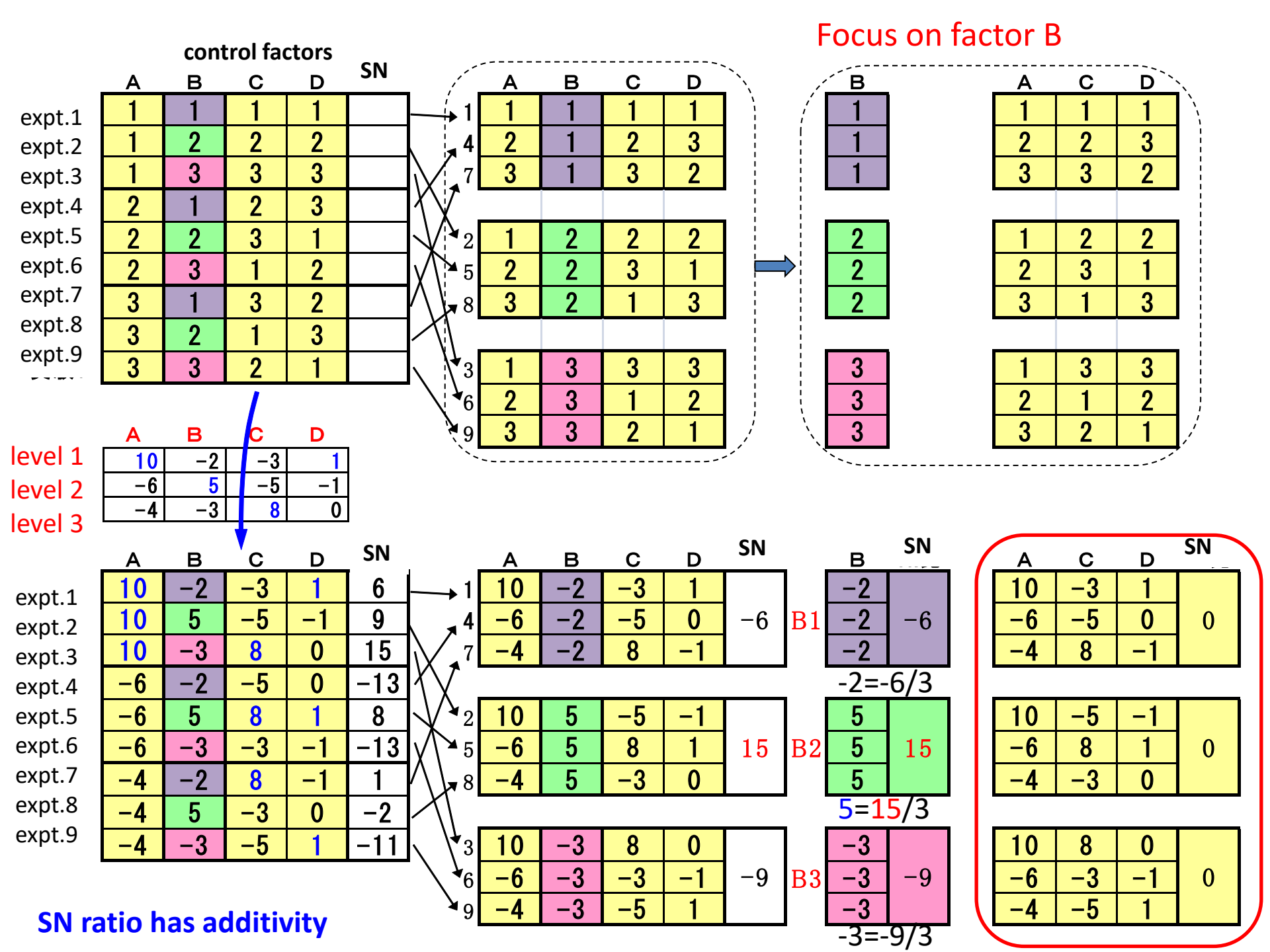
A	B	C	D	SN		A	
10	−2	−3	1	30	A1	10	30
10	5	−5	−1			10	
10	−3	8	0			10	
−6	−2	−5	0	−18	A2	−6	−18
−6	5	8	1			−6	
−6	−3	−3	−1			−6	
−4	−2	8	−1	−12	A3	−4	−12
−4	5	−3	0			−4	
−4	−3	−5	1			−4	

10=30/3

-6=-18/3

-4=-12/3

B	C	D	SN
−2	−3	1	0
5	−5	−1	
−3	8	0	
−2	−5	0	0
5	8	1	
−3	−3	−1	
−2	8	−1	0
5	−3	0	
−3	−5	1	


control factors
A B C D SN
expt.1 1 1 1 1
expt.2 1 2 2 2
expt.3 1 3 3 3
expt.4 2 1 2 3
expt.5 2 2 3 1
expt.6 2 3 1 2
expt.7 3 1 3 2
expt.8 3 2 1 3
expt.9 3 3 2 1
Focus on factor B
level 1 10 −2 −3 1
level 2 −6 5 −5 −1
level 3 −4 −3 8 0
expt.1 10 −2 −3 1 6
expt.2 10 5 −5 −1 9
expt.3 10 −3 8 0 15
expt.4 −6 −2 −5 0 −13
expt.5 −6 5 8 1 8
expt.6 −6 −3 −3 −1 −13
expt.7 −4 −2 8 −1 1
expt.8 −4 5 −3 0 −2
expt.9 −4 −3 −5 1 −11
−6
B1
-2=-6/3
15
B2
5=15/3
−9
B3
-3=-9/3
SN ratio has additivity