Dry Lab 3: Equilibria: Is It or Isn't It, That Is The Question!

A reaction is taking place between Red, White, and Blue beads. The equation for this reaction is

White ⇐ ⇒ Red + 2 Blue

Procedure:
You have six (6) systems (closed bottles). The first three (1, 2, and 3) are definitely at equilibrium. Determine the K_c for the system.

The bottles 4, 5, and 6 are not necessarily at equilibrium. Determine Q (the quotient) for these three systems, determine if the reactions in bottles 4, 5, and 6 are at equilibrium. Indicate why you think they are; if not, why you think they are not at equilibrium and indicate what net change would have to occur for the systems 4, 5, and 6 to achieve equilibrium.

Safety Concerns: Do not lose any of the beads as this will definitely affect your results.

Lab Report:
Your lab report should consist of the following:

- Calculations: Show all of your math preferably using ICE Tables.
- A discussion regarding what you have determined from this exercise.

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(Teacher's Guide)

Prerequisite Concepts:

- Concepts of equilibria in general
- Being able to calculate K
- Knowing how to calculate and compare Q, quotient or trial K, to the actual K value

Prerequisite Laboratory Skills:

- None other than careful counting and ability to do multiplication and division

Common Student Errors:

The only errors that students might make are ones related to counting and/or multiplication and division. Students also will want to determine which direction a system will go when not at equilibrium. Students will thus want to use an ice table to solve problems as to which direction the system will go to achieve equilibrium.

Successful Strategy:

Correct usage of an Ice Table for determining the value for Q will be helpful in determining the direction a system will shift to achieve equilibria.

Since the bottles 4-6 are not at equilibria, students could be asked to determine what would have to occur for the system to establish equilibria.

For Bottle 6, Q < K. Here too, the system will have an increase in products and a decrease in reactants in order to establish equilibria.

Data:

Bottle Number	White Beads	Red Beads	Blue Beads
1	25	11	14
2	10	6	12
3	20	6	17
4	0	12	9
5	22	6	5
6	8	4	11

#1 $K = 86.24 = ([11]\,[14]^2) / ([25])$

#2 $K = 86.4 = ([6]\,[12]^2) / ([10])$

#3 $K = 86.7 = ([6]\,[17]^2) / ([20])$

#4 $Q = \text{undefined} = ([12]\,[9]^2) / ([0])$

#5 $Q = 6.8 = ([6]\,[5]^2) / ([22])$

#6 $Q = 60.5 = ([4]\,[11]^2) / ([8])$

Calculations: White ⇐ ⇒ Red + 2 Blue

Bottle Number: 4

For Bottle 4, there are initially no reactants. Thus, the system will have a decrease in products and an increase in reactants.

	White Beads	⇐ ⇒	Red Beads	2 Blue Beads
Initial 'Conc'	**0**	⇐ ⇒	**12**	**9**
Change in 'Conc'	**+ X**	⇐ ⇒	**- X**	**- 2 X**
Final 'Conc'	**X**	⇐ ⇒	**12 - X**	**9 – 2 X**

Solving for X yields a value of X = 2.26. Thus, 'conc' of White = 2.26, Red = 9.74, and Blue = 4.48. The value of K = 86.5 when substituting into the K expression.

Bottle Number: 5

For Bottle 5, Q < K. Thus, the system will have an increase in products and a decrease in reactants in order to establish equilibria.

	White Beads	⇐ ⇒	Red Beads	2 Blue Beads
Initial 'Conc'	**22**	⇐ ⇒	**6**	**5**
Change in 'Conc'	**- X**	⇐ ⇒	**+ X**	**+ 2 X**
Final 'Conc'	**22 - X**	⇐ ⇒	**6 + X**	**5 + 2 X**

Solving for X yields a value of X = 3.82. Thus, 'conc' of White = 18.18, Red = 9.82, and Blue = 12.64. The value of K = 86.3 when substituting into the K expression.

Bottle Number: 6

For Bottle 6, Q < K. Thus, the system will have an increase in products and a decrease in reactants in order to establish equilibria.

	White Beads	⇐ ⇒	Red Beads	2 Blue Beads
Initial 'Conc'	**8**	⇐ ⇒	**4**	**11**
Change in 'Conc'	**- X**	⇐ ⇒	**+ X**	**+ 2 X**
Final 'Conc'	**8 - X**	⇐ ⇒	**4 + X**	**11 + 2 X**

Solving for X yields a value of X = 0.50. Thus, 'conc' of White = 7.50, Red = 4.50, and Blue = 12.00. The value of K = 86.4 when substituting into the K expression.

Rubric: Equilibria: Is It or Isn't It, That Is The Question!

10 pts – You had a very steady hand with this lab!

9 pts – Count Dracula might have been helpful with some of the values!

8 pts – You might have been a bit tipsy while doing this experiment!

7 pts – Do you know if you are coming or going?

6 pts – What is a quotient anyway?