ANSWER KEY.

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7.10 Reaction Quotient and Le Châtelier's Principle

AP Chemistry | ANSWER KEY

A stress makes Q ≠ K. Concentration and volume changes move Q; temperature moves K. The system shifts until Q = K again.

1. For $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, $K_c = 50.0$. At equilibrium $[H_2] = [I_2] = 0.100$ M and $[HI] = 0.707$ M. I_2 is added so $[I_2] = 0.300$ M. Calculate Q and predict the shift.

$Q = (0.707)^2 / (0.100)(0.300) = 16.7$. $Q < K$, so it shifts right and [HI] increases.

2. For $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, $K_c = 0.0200$ with $[N_2O_4] = 0.0800$ M and $[NO_2] = 0.0400$ M. The volume is doubled. Calculate Q right after and predict the shift.

Each concentration halves: 0.0400 M and 0.0200 M. $Q = (0.0200)^2 / 0.0400 = 0.0100$. $Q < K$, so it shifts right, toward more moles of gas.

3. For $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, $\Delta H < 0$. The mixture is heated. What happens to K? To Q right away? Which way does it shift?

K decreases (exothermic). Q doesn't change right away. Now Q > K, so it shifts left.

4. Argon is added to a mixture of N_2O_4 and NO_2 at constant volume. Does Q change? Does the system shift?

No and no. None of the concentrations in Q change, so Q still equals K.

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5. For $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, $\Delta H = +57.2\ kJ/mol_{rxn}$, complete the table.

Stress	Q changes?	K changes?	Shift
add NO_2	**increases**	**no**	**left**
remove N_2O_4	**increases**	**no**	**right**
decrease the volume	**increases**	**no**	**left**
increase the temperature	**no (at first)**	**increases**	**right**

Removing a reactant also raises Q (smaller denominator). Heating an endothermic reaction raises K, so Q < K and it shifts right.

6. Use Q and K to explain why removing a product makes a reaction shift right.

Products are in the numerator of Q. Removing one makes Q smaller than K, so the reaction runs forward until Q rises back to K.

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