ANSWER KEY.

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7.9 Introduction to Le Châtelier's Principle

AP Chemistry | ANSWER KEY

A system at equilibrium shifts to reduce a stress. Add: shift away. Remove: shift toward. Smaller volume: toward fewer gas moles. Heat acts like a reactant (endothermic) or a product (exothermic). Only temperature changes K.

1. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, $\Delta H = -92\ kJ/mol_{rxn}$. Complete the table.

Stress	**Shift**	**[NH_3]**	**K**
add N_2	**right**	**increases**	**no change**
remove NH_3	**right**	**increases (more forms)**	**no change**
decrease the volume	**right (fewer gas moles)**	**increases**	**no change**
increase the temperature	**left**	**decreases**	**decreases**
add Ar at constant volume	**no shift**	**no change**	**no change**
add a catalyst	**no shift**	**no change**	**no change**

Heat is a product (exothermic), so heating shifts left and lowers K. Argon and a catalyst change no concentrations in Q, so there is no shift.

2. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, $\Delta H = +57.2\ kJ/mol_{rxn}$. N_2O_4 is colorless and NO_2 is brown. The flask is placed in an ice bath. What happens to the color? To K?

Heat is a reactant (endothermic). Cooling removes heat, so the system shifts left: lighter brown. K decreases.

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3. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ is at equilibrium. More $CaCO_3(s)$ is added. Which way does it shift?

No shift. A pure solid is not in K or Q, so adding more does not change the equilibrium.

4. For the ammonia reaction in question 1, list two changes a factory could make to get more NH_3.

Any two: add N_2 or H_2, remove NH_3 as it forms, raise the pressure (smaller volume), or lower the temperature.

5. $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$. The volume is cut in half. Which way does it shift? Explain.

No shift. Both sides have 2 moles of gas, so changing the volume can't favor either side.

6. $Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons FeSCN^{2+}(aq)$ (red). Predict the color change when KSCN is added. Explain.

Darker red. Adding SCN^- shifts right, away from the added ion, making more $FeSCN^{2+}$.

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