This is ACA # 16. It is OK to use your textbook, but if you can answers the questions without it that is OK too.

I recommend you print out this page and bring it to class. Click here to show a set of five ACA16 student responses, randomly selected from all of the student responses thus far, in a new window.

John , here are your responses to the ACA and the Expert's response.

1. Given the reaction

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

is at equilibrium at 297 K, predict the direction (left to right, or right to left) the reaction will proceed to re-establish equilibrium when each of the following stresses disturb the equilibrium. The formation of ammonia has a $\Delta H°$ of -92.2 kJ mol^{-1}.

a) nitrogen is removed from the reaction container right to left 59%

left NO right Yes

The reaction will proceed from right to left to re-establish equilibrium. When N_2 is removed from the system Q is larger than K, so the reaction must proceed from right to left.

b) ammonia is removed from the reaction container left to right 73%

The reaction will proceed from left to right to re-establish equilibrium. When NH_3 is removed from the system Q is smaller than K, so the reaction must proceed from left to right.

c) the volume of the reaction is doubled right to left 50%

The reaction will proceed from right to left to re-establish equilibrium. When the volume is doubled from the system Q is larger than K, so the reaction must proceed from right to left.

d) the temperature of the reaction is lowered left to right 45%

The reaction will proceed from left to right to re-establish equilibrium. When the

c) $K = \dfrac{\left(\frac{mol_{NH_3}}{V^2}\right)^2}{\left(\frac{mol_{N_2}}{V}\right)\left(\frac{mol_{H_2}}{V^3}\right)^3} = \dfrac{mol_{NH_3}^2}{mol_{N_2} \cdot mol_{H_2}} \left(\dfrac{\frac{1}{V^2}}{\frac{1}{V^4}}\right)$

$= \dfrac{mol_{NH_3}^2}{mol_{N_2} \cdot mol_{H_2}} \cdot \left(\dfrac{1}{\frac{1}{V^2}}\right)$

$Q = \dfrac{mol_{NH_3}^2}{mol_{N_2} \cdot mol_{H_2}} \cdot V^2$

double volume

$Q \uparrow K_p$

reaction must proceed right to left

or

$\uparrow V \downarrow P$ rxn must proceed to inc P, more particles on the reactant side so rxn goes right to left

$3H_2 + N_2 \rightleftharpoons 2NH_3 + heat$

to dec T must remove heat so rxn must proceed left to right to increase heat

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Remember

a reaction at equilibrium that experiences a stress will proceed in a direction to remove the stress.

temperature is lowered, heat is removed from the reaction, the reaction will proceed from left to right to add heat and relieve the stress.

2. The formation of ammonia has a Δ H° of -92.2 kJ mol^{-1}.

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

At 24.0 °C, K for the reaction is 6.5 x 10^5. Calculate the temperature when K = 4.3 x 10^4. Note: Use the relationship $\ln(K_2/K_1) = -(\Delta H°/R)(1/T_2 - 1/T_1)$

T = 320 °C

$\ln(K_2/K_1) = -(\Delta H°/R)(1/T_2 - 1/T_1)$

We'll assign 24.0 °C (297 K) as T_2 and solve for T_1, substituting

$\ln(6.5 \times 10^5/4.3 \times 10^4) = -(-92{,}200\ J\ mol^{-1}/8.314\ J\ mol^{-1}\ K^{-1})(1/297 - 1/T_1)$

$\ln(15.1) = -(-11089\ K)(0.003367 - 1/T_1)$

$2.715 = 37.34 - 11089/T$

$-34.62 = -\ 11089\ K/T$

$T = -11089\ K/-34.62$

T = 320 K or 47.3 °C

3. Is there anything about the questions that you feel you do not understand? List your concerns/questions.

nothing

4. If there is one question you would like to have answered in lecture, what would that question be?

nothing