Answer on Question # 73221 - Chemistry - General Chemistry

A 1.0 liter vessel at 400°C contains the following equilibrium concentrations: N2=1.00M, H2=0.500M, NH3=0.500M. How many mole of hydrogen must be removed from the vessel to get a new equilibrium concentration of nitrogen at 1.20M?

Solution

The reaction proceeding in the vessel is as follows:

$N_2+3H_2=2NH_3$.

The value of equilibrium constant (K_c) for the given reaction at 400°C is

$K_c=[NH_3]^2/([N_2][H_2]^3)$,

$K_c=0.500^2/(1.00\cdot0.500^3)=2$.

Since the volume is 1L, the molarities and number of moles are the same. In order to get a new equilibrium concentration of nitrogen at 1.20M, we must gain addtional 1.20-1.00 = 0.20 M of nitrogen, corresponding to the removal of (2 x 0.20) = 0.40 M of NH_3. Therefore, the equilibrium concentration of NH_3 is 0.50-0.40=0.10 M. Solving the equilibrium constant equation for the equilibrium concentration of H_2:

$[H_2]=([NH_3]^2/([N_2]K_c)^{1/3}=[0.10^2/(2\cdot1.20)]^{1/3}=0.161$ M.

The amount of hydrogen to be removed is 0.500-0.161=0.339 M, or 0.339 moles.

Answer: 0.339 moles.