You are a member of a research team of industrial chemists who are discussing the operation of an ammonia plant. Ammonia is formed from nitrogen and hydrogen according to the following equilibrium reaction.

\[
\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)
\]

The plant operates close to 700 K, at which \(K_p\) is \(1.00 \times 10^{-4}\ \text{atm}^{-2}\) and employs the stoichiometric ratio 1:3 of \(\text{N}_2: \text{H}_2\). At equilibrium the partial pressure of \(\text{NH}_3\) is 50 atm. Calculate the partial pressures of each reactant and hence the total pressure under these conditions.

\[
p(\text{N}_2) = \quad p(\text{H}_2) = \quad p(\text{total}) =
\]

Ammonium carbamate (\(\text{NH}_2\text{COONH}_4\)) is a salt of carbamic acid that is found in the blood and urine of mammals. At 250 °C, \(K_c = 1.58 \times 10^{-8}\ \text{M}^3\) for the following equilibrium:

\[
\text{NH}_2\text{COONH}_4(s) \rightleftharpoons 2\text{NH}_3(g) + \text{CO}_2(g)
\]

If 7.81 g of \(\text{NH}_2\text{COONH}_4\) is introduced into a 0.500 L evacuated container, what is the total pressure inside the container at equilibrium at 250 °C?
• Briefly describe the following ideas or phenomena.
  
  Dynamic equilibrium

  The difference between $Q$ and $K$

  Effect of a catalyst on equilibrium
A saturated solution of iodine, I$_2$, in water contains 0.330 g I$_2$ per litre, but more than this amount can dissolve in a KI solution because of the following equilibrium.

\[ \text{I}^- (aq) + \text{I}_2 (aq) \rightleftharpoons \text{I}_3^- (aq) \]

A solution of KI (0.100 M) dissolves 12.5 g of iodine per litre, most of which is converted to I$_3^-$ (aq). Assuming that the concentration of I$_2$ in all saturated solutions is the same, calculate the equilibrium constant for the above reaction.

**Answer:**
Aluminium acts as a reducing agent in the thermite reaction where Fe$_2$O$_3$ is reduced to metallic iron. Write a balanced equation for the thermite reaction.

What is the maximum theoretical mass of Fe that can be produced when 270 g of Al reacts with excess Fe$_2$O$_3$ in the thermite reaction?

Answer:

What does the superscript “o” mean in the symbol $\Delta H_f^\circ$?

Briefly describe what is meant by “Dynamic Equilibrium”? 

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Marks

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A sealed 1.000 L flask at 30 °C contains air at a pressure of 1.000 atm. A 5.00 g sample of liquid water is injected into the flask and the flask heated to a temperature of 150 °C, causing the water to vaporise. What is the final pressure in the flask?

Answer: