Nitrogen reacts with hydrogen as shown:

\[ 3\text{H}_2(g) + \text{N}_2(g) \rightleftharpoons 2\text{NH}_3(g) \quad \Delta H = -76 \text{ kJ mol}^{-1} \]

10.0 moles of hydrogen was mixed with 5.0 moles of nitrogen. At equilibrium, there was found to be 3.0 moles of ammonia. The total pressure was 2.0 x 10^7 Pa.

a Write an expression for \( K_p \) for this equilibrium.

\[
K_p = \frac{(p \text{NH}_3)^2}{(p \text{H}_2)^3 \times (p \text{N}_2)}
\]

b State the units of \( K_p \). Pa\(^{-2}\)

c Calculate the moles of hydrogen and nitrogen at equilibrium.

hydrogen = 5.5 moles  
nitrogen = 3.5 moles

d Calculate the partial pressure of each gas.

hydrogen = \( \frac{5.5}{12} \times 2.0 \times 10^7 = 9.17 \times 10^6 \text{Pa} \)

nitrogen = \( \frac{3.5}{12} \times 2.0 \times 10^7 = 5.83 \times 10^6 \text{Pa} \)

ammonia = \( \frac{3.0}{12} \times 2.0 \times 10^7 = 5.00 \times 10^6 \text{Pa} \)

e Calculate \( K_p \) for this equilibrium.

\[
K_p = \frac{(5.00 \times 10^6)^2}{(9.17 \times 10^6)^3 \times (5.83 \times 10^6)} = 5.56 \times 10^{-15} \text{Pa}^{-2}
\]

f Explain what would happen to the position of the equilibrium and the value of \( K_p \) if the total pressure of gases was decreased?

equilibrium position moves left to side with more gas molecules to oppose decrease in pressure  
no change in \( K_p \)

g Explain what would happen to the position of the equilibrium and the value of \( K_p \) if the temperature of gases was decreased?

equilibrium position moves right in exothermic direction to oppose decrease in temperature  
\( K_p \) increases