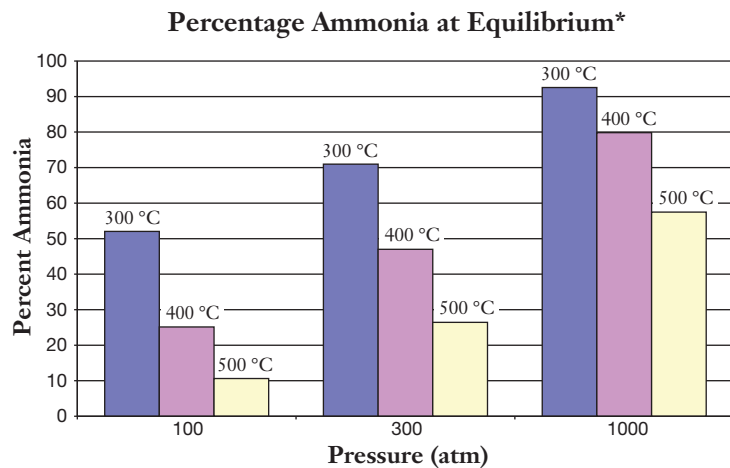


## Post-Laboratory Review Questions

When a chemical is manufactured, chemists and chemical engineers choose conditions that will favor the production of the desired product as much as possible. In the early 20th century, Fritz Haber developed a process for the large-scale production of ammonia from its constituent elements. Some of his results are summarized in the chart below.



\*Each experiment began with a stoichiometric mixture of H<sub>2</sub> and N<sub>2</sub>.

- Write the balanced chemical equation, including the heat term, for the synthesis of ammonia from its constituent elements.
- Based on the results above, explain the effect of temperature on the equilibrium position of the reaction.
- Explain the effect of pressure on the equilibrium position of the reaction.
- The optimal conditions to synthesize ammonia are high pressures and low temperatures. However, each factor comes with a drawback: high pressures require strong pipework and hardware, and at low temperatures the reaction is slow. In order to get high yields of ammonia at lower pressures and higher temperatures, ammonia is removed from the system as it is formed. Use LeChâtelier's principle to explain why this is effective.