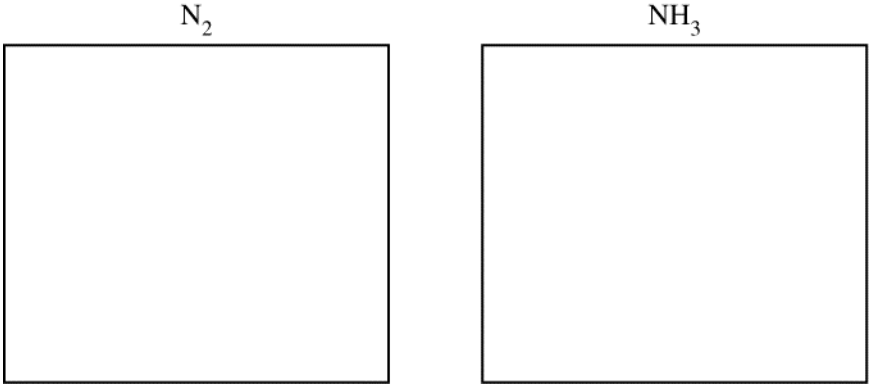
Answer Question 5 and Question 6. The Section II score weighting for these questions is 15 percent each.

Your responses to these questions will be graded on the basis of the accuracy and relevance of the information cited. Explanations should be clear and well organized. Examples and equations may be included in your responses where appropriate. Specific answers are preferable to broad, diffuse responses.

5. Answer the following questions about nitrogen, hydrogen, and ammonia.

   (a) In the boxes below, draw the complete Lewis electron-dot diagrams for N_2 and NH_3.



   (b) Calculate the standard free-energy change, $\Delta G°$, that occurs when 12.0 g of $H_2(g)$ reacts with excess $N_2(g)$ at 298 K according to the reaction represented below.

$$N_2(g) + 3\ H_2(g) \rightleftarrows 2\ NH_3(g) \qquad \Delta G^\circ_{298} = -34\ \text{kJ mol}^{-1}$$

   (c) Given that ΔH°_{298} for the reaction is -92.2 kJ mol^{-1}, which is larger, the total bond dissociation energy of the reactants or the total bond dissociation energy of the products? Explain.

   (d) The value of the standard entropy change, ΔS°_{298}, for the reaction is -199 J mol^{-1}K^{-1}. Explain why the value of ΔS°_{298} is negative.

   (e) Assume that $\Delta H°$ and $\Delta S°$ for the reaction are independent of temperature.

      (i) Explain why there is a temperature above 298 K at which the algebraic sign of the value of $\Delta G°$ changes.

      (ii) Theoretically, the best yields of ammonia should be achieved at low temperatures and high pressures. Explain.