1. *a)* **A**: The direct reaction (toward the products) will be favoured.
B: The reverse reaction (toward the reactants) will be favoured.
C: The direct reaction (toward the products) will be favoured.
D: The reverse reaction (toward the reactants) will be favoured.

   b) **A**: No reaction will be favoured.
B: The direct reaction (toward the products) will be favoured.
C: No reaction will be favoured.
D: The reverse reaction (toward the reactants) will be favoured.

   c) **A**: The direct reaction (toward the products) will be favoured.
B: The direct reaction (toward the products) will be favoured.
C: The direct reaction (toward the products) will be favoured.
D: The reverse reaction (toward the reactants) will be favoured.

2. Note: Question **2b** should read: "the pressure of the system is decreased by increasing its volume?"

   a) The reverse reaction (toward the reactants) will be favoured.

   b) The reverse reaction (toward the reactants) will be favoured.

   c) The direct reaction (toward the products) will be favoured

   d) No reaction will be favoured, since the addition of a catalyst does not shift the state of equilibrium.

3. The ammonia (NH_3) must be withdrawn from the system.
   By eliminating the ammonia, the equilibrium of the reaction will shift toward the products. The direct reaction will be favoured and more products will be formed. The development of an industrial system that makes it possible to continuously withdraw the desired product constitutes an effective method for increasing production yield.

4. Yes. In aqueous solution, hydrogen chloride (HCl) dissociates in the form of H^+ and Cl^- ions. An increase in the concentration of $Cl^-_{(aq)}$ ions will therefore favour the direct reaction. Consequently, the formation of silver chloride ($AgCl_{(s)}$) will also be favoured.

7. – Add hydrogen chloride (HCl).
   – Add oxygen (O_2).
   – Remove chlorine (Cl_2) as it is produced.
   – Remove water vapour.
   – Increase the temperature.
   – Increase the pressure in the reaction system.

● **1.** *a)* Graph **B**.

b) Graph **A**.

c) Graph **C**.

● **2.** *a)* The reverse reaction (toward the reactants) will be favoured.

b) No reaction will be favoured, since carbon (C) is a solid.

c) The reverse reaction (toward the reactants) will be favoured.

d) The reverse reaction (toward the reactants) will be favoured.

e) The reverse reaction (toward the reactants) will be favoured.

f) No reaction will be favoured, since adding a catalyst does not change the equilibrium of a reaction.

g) The direct reaction (toward the products) will be favoured.

h) The direct reaction (toward the products) will be favoured.

i) The direct reaction (toward the products) will be favoured.

■ **4.** The temperature and concentration of the reactants and products have an effect on the state of equilibrium of the system. However, pressure has no effect since the number of moles of gas is equal on the side of the reactants and products.

■ **5.** *a)* False. The rate of formation of the products is equal to that of the reverse reaction, that is, the formation of the reactants.

b) False. Although the total mass of reactants and the total mass of products no longer varies, they are not necessarily equal. The total mass of the reactants and that of the products depends on the position of equilibrium, therefore the experimental conditions to which the system is subjected.

c) True. This system cannot be in a state of equilibrium since it contains only one compound whose physical state does not change.

d) False. In the case of reactions occurring in an aqueous solution and that do not emit any gas, there is almost no exchange of matter between the system and its environment, and the system is considered closed even it if it not closed physically.

e) False. In the case of the dissolution reaction of a compound in solid state, the solution must be saturated or supersaturated with this compound in order for the system to attain a state of equilibrium.

f) False. The system must also be closed and the reaction that occurs must be reversible. Moreover, aside from temperature, all of the macroscopic properties of the system must also be constant.

■ **6.** Global warming could jeopardize the survival of this species since it could disrupt the equilibrium between male and female newborns. A generalized increase in the temperature of the planet could result in the birth of more male alligators than females, which, in the long term, could lead to the extinction of this species.