5.1 - Reversible Reactions and Equilibrium kEY

5.1 Assignment KEY

1. Write reversible reactions for each of the following situations (be sure to balance your equations):

   a. Hydrogen iodide gas (HI) decomposes into its elements.

   $2HI_{(g)} \leftrightarrow I_{2(g)} + H_{2(g)}$

   b. Hydrogen and nitrogen gases combine to form ammonia gas, NH_3.

   $N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}$

2. If the system represented by the following equation is found to be at equilibrium at a specific temperature, which of the following statements is true? Explain your answers.

   $H_2O(g) + CO(g) \leftrightarrow H_2(g) + CO_2(g)$

   a. All species must be present in the same concentration.

   b. The rate of the forward reaction equals the rate of the reverse reaction. TRUE

   c. We can measure continual changes in the reactant concentrations.

3. Which of the following are equilibrium systems and which are steady state systems?

   a. A playing football team and a bench of reserve players. The number of players o the field is constant and the number of players on the bench is constant. (EQUILIBRIUM)

   b. A well fed tiger in a cage. The weight of the tiger is constant. (STEADY STATE)

   c. The Nipawin Dam and Codette Lake behind the dam. The water level is constant. (STEADY STATE)

   d. The liquid alcohol and alcohol vapor in a thermometer. The temperature is constant. (EQUILIBRIUM)

   e. A block of wood floating on water. (STEADY STATE)

4. Which of the following are chemical equilibria and which are physical equilibria systems?

   a. sublimation of dry ice (solid carbon dioxide) PHYSICAL

   b. a saturated magnesium chloride solution CHEMICAL

   c. the partial dissociation of 2 moles of HI molecules into 1 mole H_2 and 1 mole of I_2 molecules CHEMICAL

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5. Which of the following reactions are reversible?

a. the evaporation of water (REVERSIBLE)

b. the combustion of coal (IRREVERSIBLE)

c. the magnetization of an iron bar (REVERSIBLE)

6. A chemist wished to prepare pure phosgene ($COCl_{2(g)}$) by reacting carbon monoxide and chlorine gas accoridng to the reaction:

$$CO_{(g)} + Cl2_{(g)} \rightleftharpoons COCl_{2(g)}$$

Why will this reaction NOT produce pure phosgene? If the chemist could somehow obtain a sample of pure $COCl_{2(g)}$, would it remain pure? Why?

-It will NOT produce pure phosgene because the product would being breaking down once it is produced as it is a reversible reaction. Even if they obtained a pure product, it would not remain pure because equilibria can be approached from the reactants or products.

7.

(a) The colour does not change, so $NO_2(g)$ is being made at the same rate that it is destroyed.
(b) Temperature CAN affect an equilibrium – the colour became lighter or darker when the temperature was changed, meaning more or less $NO_2(g)$ was present.
(c) The colour does not change while the tube full of gas remains at a constant 100°C. The colour would become very dark red–brown if the temperature were raised above 100°C.
(d) The reaction is endothermic as written: $N_2O_4(g)$ + energy $\rightleftharpoons$ 2 $NO_2(g)$. As heat is added the forward reaction should occur to a greater extent and produce more of the red–brown $NO_2(g)$, which is exactly what occurred.
(e) $N_2O_4(g)$ predominated at low temperatures (colourless).
$NO_2(g)$ predominated at high temperatures (dark red–brown).
At room temperature the content of the tube was a mixture of $N_2O_4(g)$ and $NO_2(g)$.
(f) The tubes should become the same colour. A tube containing mostly $N_2O_4(g)$ at low temperatures and another tube containing mostly $NO_2(g)$ at high temperatures eventually became the same colour at room temperature.