Unit 5, Lesson 03 Answers to Homework

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1. Two physical changes that are reversible but not at equilibrium would be:

- an ***open*** pot boiling on the stove $H_2O\ (l) \leftrightarrow H_2O\ (g)$
- carbon dioxide dissolving in ocean water $CO_2\ (g) \leftrightarrow CO_2\ (aq)$

Two physical changes that are reversible but not at equilibrium would be:

- calcium carbonate (limestone) decomposing from the walls of GCI:

$$CaCO_3\ (s) \leftrightarrow CaO\ (s) + CO_2\ (g)$$

- hydrochloric acid in your stomach reacting with calcium carbonate (TUMS)

$$CaCO_3\ (s) + 2\ HCl\ (aq) \leftrightarrow CaCl_2\ (aq) + H_2O\ (l) + CO_2\ (g)$$

2. When two reactants are first mixed, there are only reactant particles present so all collisions take place between reactant molecules so the rate of the forward reaction is very fast
- as the reaction proceeds, product is formed so now product particles can collide with each other and with reactant, so the forward reaction slows down and the reverse reaction starts to speed up
- eventually there is enough product present that the rates of the forward and reverse reactions are equal

3. In the space above a sealed bottle of pop, at the molecular level, aqueous carbon dioxide is leaving the surface of the liquid at the same rate that carbon dioxide gas from the air is redissolving in the pop. However, the visible properties of the pop in the bottle do not change. It appears that nothing is taking place at the macroscopic level.

4. In a sealed bottle of water at equilibrium, there will not be equal amounts of liquid and gaseous water. The reaction $H_2O\ (l) \leftrightarrow H_2O\ (g)$ favours the reactants so most of the water is present in liquid form and only a little gas is present. However, the rate that water evapourates is equal to the rate that water molecules return to the liquid state.

Questions from unit outline: Which of the following systems can achieve equilibrium? Explain why or why not for each:

a) a candle burning can not achieve equilibrium. It is not a closed system. If the candle is sealed in a jar, it will go out once the oxygen is consumed
b) a person's weight does not change for one year. This is not equilibrium, it is a teady state called homeostasis. If the person was in a closed system and stopped eating, their weight would decrease.
c) a sealed bottle of maple syrup containing a crystal of maple sugar is an equilibrium system because it is sealed so no reactants or products can enter or leave the system.
d) a sealed bottle of pop is an equilibrium system because it is sealed so no reactants or products can enter or leave the system.
e) an opened bottle of pop can not achieve equilibrium because carbon dioxide will leave the pop and disperse through the room, so it will not redissolve in the pop

f) the sun is an open system so it can not achieve equilibrium. The sun “burns” hydrogen in an irreversible nuclear reaction.
g) a firefighter’s closed air tank is an equilibrium system as long as it is sealed.
h) a waterfall is not an equilibrium system- it is a steady state. Water is entering the system at the same rate it is leaving.
i) a swimming pool is not an equilibrium system because it is open to the air and water can evapourate
j) a chicken that lays one egg every day is a steady state. Chickens need a constant input of food in order to produce eggs.