14.1

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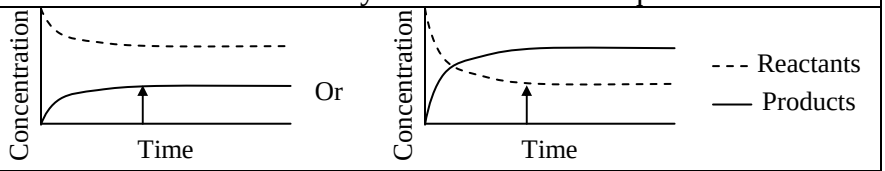
| Define chemical equilibrium. | Concentrations of reactants and products remain constant. |
| A chemical equilibrium is "dynamic". What does this indicate? | Reactants and products continue to form. An equilibrium exists because forward and reverse reactions occur at equal rates. |
| How are equilibrium reactions written differently than other chemical reactions? | They are written with $\rightleftharpoons$ instead of $\rightarrow$. For example:<br>Chemical reaction: $A + B \rightarrow C$<br>Equilibrium reaction: $A + B \rightleftharpoons C$ |
| Explain how an equilibrium forms from pure reactants. | As reactants combine to form products, 1) the concentration of reactants decreases, slowing the rate of the forward reaction, 2) the concentration of products increases, speeding the rate of the reverse reaction. Eventually both rates will be equal. |
| Graph the formation of a dynamic equilibrium from pure reactants. Label the axes. Indicate with an arrow where equilibrium begins. |  |
| Is the increase in product concentration always equal to the decrease in reactant concentration? | No. For example in the equilibrium $N_2O_4 \rightleftharpoons 2\ NO_2$, for every mol of $N_2O_4$ decomposed, 2 mol of $NO_2$ are formed. |
| What is an easy way to sketch an equilibrium reaction? | Plot the initial and equilibrium concentrations of all compounds. Connect these two points with a curved line. |
| What kinds of chemical reactions reach an equilibrium? | Almost all reactions. Even reactions that appear complete may have small amounts of reactants forming from products. |

14.2

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| What is meant by reaction reversibility? | Equilibrium concentrations will be identical whether we start with pure reactants or pure products. |
| Give an example of reaction reversibility using the equilibrium: $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$. | If we add 1 mol of $H_2(g)$ and 1 mol of $I_2(g)$ to a container, a certain equilibrium will be established. The same equilibrium will form if we place 2 mol of HI(g) into an identical container. |

14.3

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| What does [ ] represent? | Concentration in units of mol/L. |
| What can be shown experimentally about the equilibrium concentrations of reactants and products? What is this called? | At a given temperature, equilibrium concentrations of reactants and products are related by an equation that has a constant value. This equation is called the "equilibrium law" for the reaction. |
| Write the equilibrium law for $aA+bB \rightleftharpoons xX+yY$. What are the two sides of the equation called? | $Kc = \frac{[X]^x[Y]^y}{[A]^a[B]^b}$<br>equilibrium constant  mass action expression |
| What are the units of the variables used in the equilibrium law? | [ ] is understood to be in mol/L. When substituting numerical values into the equilibrium law we write the concentrations without units. The Kc is also unitless. |
| Write the equilibrium law for $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$. Solve for Kc when $[H_2] = 0.5$ mol/L, $[I_2] = 0.5$ mol/L, $[HI] = 3$ mol/L. | $Kc = \frac{[HI]^2}{[H_2]\,[I_2]}$  $Kc = \frac{(3)^2}{(0.5)(0.5)} = \frac{9}{0.25} = 36$ |
| How can the value of Kc be determined? | By experiment only. We cannot determine Kc given just a chemical equation. |
| What information is usually included with Kc? Why? | The temperature (in °C). Because Kc varies with temperature. |