Equilibrium Understanding Concepts Answers

1. Towel on the chair is an open system, allowing both matter and energy to leave, while the towel in the bag is a closed system allowing only energy to leave. Equilibrium can only form with closed systems, so the towel in the bag establishes an equilibrium.

2. A unsaturated solution cannot be at equilibrium as the rate of dissolving will be greater than the rate of crystallization. Only when the system is saturated and there is some solid left on the bottom will the system be able to reach equilibrium, where the rate of dissolving will equal the rate of crystallization.

3. Stirring increases the contact between the solute and solvent thereby increasing the rate of dissolving.

4. A dryer vents warm moist air out and brings in dry air, as a result it prevent the establishment of equilibrium as it is an open system.

5. A closed bottle of pop establishes the following equilibrium, $CO_{2\,(aq)} \rightleftharpoons CO_{2\,(g)}$. The opening of the bottle stresses the system (increase in volume) and as a result the system shifts right. By resealing the bottle, it allows the system to become closed again and reestablish equilibrium.

6.
   a. A system at equilibrium has CONSTANT macroscopic properties
   b. A chemical system is considered to be dynamic as both the forward and reverse reactions are occurring even when the system is at equilibrium.
   c. The rate of the forward reaction is equal to the rate of the reverse reaction.

7.
   a. $CH_{4\,(g)} + Cl_{2\,(g)} \rightleftharpoons CH_3Cl + HCl_{(g)}$

since the volume of the container is not given assume that it has a volume of 1.0 L.

$CH_{4\,(g)} + Cl_{2\,(g)} \rightleftharpoons CH_3Cl + HCl_{(g)}$

2.00 mol 10.00 mol Equilibrium amount = 1.40 mol

since reactants are in a 1:1 mol ration and the there are far fewer moles of CH_4, it is the limiting agent and Cl_2 is in excess. Therefore, would use the amount of CH_4 to determine the TY of the CH_3Cl.

$TY = n\ CH_4 * \text{mol ratio}$

$= 2.00\ \text{mol}\ CH_4 \times \frac{1\ \text{mol}\ CH_3Cl}{1\ \text{mol}\ CH_4} = 2\ \text{mol}\ CH_3Cl$

b.

% yield = (equilibrium amount / TY) x 100 % = $\frac{1.40 \text{ mol } CH_3Cl}{2.00 \text{ ol } CH_3Cl}$ x 100 % = 70.0 %

8.

a.

	C_2H_4 (g)	+ Br_2 (g)	⇌	C_2H_3Br (g)	+	HBr (g)
initial	4.0 mol/L			0 mol / L		0 mol / L
change	- x			+x		+x
equ'm	4.0 – x			x		x

from graph $[C_2H_4]_{eq'm}$ = 2.5 mol/L therefore x = 1.5 mol/L

$[HBr]_{TY} = [C_2H_3Br]_{TY} = [C_2H_4] * V_{continer=} * \text{mol ratio} / V_{container}$

$= \frac{4.0 \text{ mol } C_2H_4}{L} \times V_{container} \times \frac{1 \text{ mo HBr}}{1 \text{ mol } C_2H_4} \div V_{container}$

= 4.0 mol/L

b.

c. % reaction = $[HB]_{eqm}/[HBr]_{TY}$ * 100 %

= (1.5 mol HBr/L)/(4.0 mol/L) * 100 %

= 37.5 %

9.

a. 3 H_2 (g) + N_2 (g) ⇌ 2 NH_3 (g)

b. C (s) + H_2O (g) → CO (g) + H_2 (g)

c. Ag^+ (aq) + Cu (s) → Ag (s) + Cu^{2+} (aq)

d. SO_2 (g) + ½ O_2 (g) ⇌ SO_3 (g)

10.

a.

	H_2 (g)	+ I_2 (g)	⇌	2 HI (g)
initial moles	12.0	8.0		0.0
eq'm moles	5.0	1.0		14.0
eq'm [] (mol/L)	2.5	0.5		7.0

c. % rxn = $[HI]_{eqm}$ / $[HI]_{TY}$ * 100 % = (7.0 mol/L)/(8.0 mol/L) * 100 % = 87.5 %

d. suggests that there is no change in the concentration, suggesting the rate might be zero, however bcz it is at eq'm the [] are constant but the forward and reverse reactions are still occuring