CHAPTER 16	Investigation 16.A: Modelling Equilibrium Answer Key	BLM 16.1.1A
ANSWER KEY		

Answers to Analysis Questions

1. The graph for the reactant volume should begin at 25.0 mL and zero transfer. It should have a negative slope that decreases in magnitude with increasing transfer number. The graph for the product volume should begin at 0 mL and zero transfer. It should have a positive slope that decreases in magnitude with increasing transfer number. At equilibrium, the graphs should be horizontal and the reactant volume should be different from the product volume.

2. The reaction rates are equal to the slopes of the graphs. The graph will show that the rate of the forward reaction decreased with number of transfers, ultimately resulting in a flattening out of the downward curve. The rate of the reverse reaction increased over the same interval.

3. At the point where the two curves cross, the volume of water in each cylinder is the same. This is not the same as the rate of reaction. The magnitudes of the slopes of the graph are different, so the rate of the forward reaction is not equal to the rate of the reverse reaction at this point.

4. In this activity, the system is at equilibrium when the volumes of water in each cylinder no longer change. In other words, the system has constant macroscopic properties. You might identify this as the region on the graph where the volume has constant value. You should also state that the system is at equilibrium because the rate of the forward reaction is equal to the rate of the reverse reaction.

5. The volumes of water in the two cylinders were not equal at equilibrium. This indicates that concentrations of reactant and product do not have to be equal at equilibrium. In fact, it would be very rare to find a reaction at equilibrium where concentrations of reactant and product were equal.

6. The addition of more water is analogous to increasing the concentration of a reactant in a chemical reaction.

7. When equilibrium is re-established, there will be a greater concentration of product. The volume of water in the product cylinder should increase as a result of adding more water to the reactant graduated cylinder.

8. Within experimental error, the ratio $\frac{\text{volume of product}}{\text{volume of reactant}}$ at the end of the first equilibrium should equal the ratio at the end of the second equilibrium. This is analogous to a chemical equilibrium that is changed by the addition of more reactant at constant temperature. The equilibrium constant, K_c, will be unchanged when equilibrium has been re-established.

9. The relative volumes of water in each cylinder were determined by the diameter of the glass tubes. You can easily devise an experiment to test this hypothesis if glass tubing with a different diameter is substituted for one of the original tubes. A wider glass tube is analogous to a reaction with lower activation energy. You could suggest temperature or pressure as factors that affect the relative concentrations of reactants and products at equilibrium. Refer back to this exercise after you have learned about Le Châtelier's principle.

10. The experiment is a model of a closed system, because during the exercise there are negligible changes in the volume and temperature of the water.

Investigation 16.A: Modelling Equilibrium Answer Key (cont'd)

Answer to Conclusion Question

11. In your conclusion, you should mention the dynamic nature of chemical equilibrium and describe how the rates of forward and reverse reactions change, eventually becoming equal at equilibrium. You should also mention that when reactant is added to a system at equilibrium, the system re-establishes equilibrium with the same ratio of product to reactant as before.