Modeling Equilibrium Using Stop-Motion-Video

Teacher's Guide

Provide each group with the proper model parts.

Atom Centers					Bonds
Qty	Element	Color/Holes		Qty	Type
10	Hydrogen	White/1		10	single
10	Iodine	Black/4			

Supply the necessary kit parts to each group along with a REACTION SHEET.

Students will fill in the Q values, in pencil, on the right side as the procedure progresses following the guidelines below.

1. At the start of the reaction, immediately after molecules are placed on the REACTION SHEET, $Q_0 = 0$. This value is entered on the right side of the REACTION SHEET.

2. After 1 H_2 and 1 I_2 react, $Q_1 = (2)^2 / (4)(4) = 0.25$ is calculated and entered on the right side of the REACTION SHEET.

3. After 2 H_2 and 2 I_2 react, $Q_2 = (4)^2 / (3)(3) = 1.78$ is calculated and entered on the right side of the REACTION SHEET.

4. After 3 H_2 and 3 I_2 react, and $Q_3 = (6)^2 / (2)(2) = 9.0$ is calculated and entered on the right side of the REACTION SHEET.

5. In order to show that the [HI] has become high enough for the reverse reaction to occur, have students use 2 HI molecules to remake 1 I_2 and 1 H_2 molecules. $Q_4 = (4)^2 / (3)(3) = 1.78$ is calculated and entered on the right side of the REACTION SHEET.

6. After 3 H_2 and 3 I_2 react again, $Q_5 = (6)^2 / (2)(2) = 9.0$ is calculated and entered on the right side of the REACTION SHEET.

After 4 H_2 and 4 I_2 react, $Q_6 = (8)^2 / (1)(1) = 64$ is calculated and entered on the right side of the REACTION SHEET.

In this exercise K = 64, so the video is now complete.

The above can be altered to suit your own teaching style.

Answers to questions:

1. Write the equilibrium constant expression for the reaction: $H_{2(g)} + I_{2(g)} \leftrightharpoons 2HI_{(g)}$

   $K = [HI]^2/[H_2][I_2]$

2. What would happen if ten molecules react to form products (calculate Q and explain)? Q would be undefined (infinity) and the system would not be at equilibrium. Q > K and so there would be a shift back towards the reactants to re-establish equilibrium.

3. Explain what would happen in the following circumstances for a reaction:

   a. Q < K Not at equilibrium: There would be shift towards the products to establish equilibrium.

   b. Q > K Not at equilibrium: There would be shift towards the reactants to establish equilibrium.

   c. Q = K At Equilibrium: There would be changes taking place in both directions but the ratio of products to reactants would remain the same.

Stop Motion Equilibrium Lab

Student Procedure

Objective: To model equilibrium and change which could take place in a reversible chemical reaction $H_{2(g)} + I_{2(g)} \leftrightharpoons 2HI_{(g)}$; K = 64 (at an unspecified temperature) as it moves towards and reaches equilibrium. Assume each molecule model represents a mole of molecules and the volume of the reaction = 1 liter.

Materials: Ryler Enterprises model parts:10 white (hydrogen) atom centers, 10 black (iodine) atom centers, 10 single bonds, smart phone or iPad, Stop-Motion-Video app, Reaction Sheet, ring stand, test tube ring(s), rubber bands.

1. Assemble 5 hydrogen (H_2) molecules and 5 Iodine (I_2) molecules. Place the 5 hydrogen molecules on the left of the reaction sheet and the 5 iodine molecules on the right of the reaction sheet.
2. Clamp or set the iPhone, android phone, or iPad onto the ring clamp about 10 cm above the lab table. Then open a Stop-Motion app to create a stop motion video detailing the changes that occur during the reversible reaction of hydrogen with iodine.
3. Place all the molecules on the reaction sheet.
4. The video should show collision of molecules, bond breaking, and bond forming. Adjust the speed of the movie to 1 frame per second so that the Q value and the reaction are legible.
5. Show each step in the reaction progress, calculate the new reaction quotient, Q, and, using a pencil, write the new Q value in the space provided.
6. Continue until Q = K.
7. Share the video with your instructor.
8. Calculations (show your work):

At the start of the reaction, Q_0 =

After 1 H_2 and 1 I_2 react, Q_1 =

After 2 H_2 and 2 I_2 react, Q_2 =

After 3 H_2 and 3 I_2 react, Q_3 =

After the reverse reaction, Q_4 =

After 3 H_2 and 3 I_2 react, Q_5 =

After 4 H_2 and 4 I_2 react, Q_6 =

Questions:

1. Write the equilibrium constant expression for the reaction: $H_{2(g)} + I_{2(g)} \leftrightharpoons 2HI_{(g)}$

2. What would happen if ten molecules react to form products (Calculate Q and explain)?

3. Explain what would happen in the following circumstances for a reaction:

    a. $Q < K$

    b. $Q > K$

    c. $Q = K$

REACTION SHEET

$$Q_0 = \frac{[HI]^2}{[H_2][I_2]} =$$

$$Q_1 = \frac{[HI]^2}{[H_2][I_2]} =$$

$$Q_2 = \frac{[HI]^2}{[H_2][I_2]} =$$

$$Q_3 = \frac{[HI]^2}{[H_2][I_2]} =$$

$$Q_4 = \frac{[HI]^2}{[H_2][I_2]} =$$

$$Q_5 = \frac{[HI]^2}{[H_2][I_2]} =$$

$$Q_6 = \frac{[HI]^2}{[H_2][I_2]} =$$

$$Q_7 = \frac{[HI]^2}{[H_2][I_2]} =$$