

Penny-Ante Equilibrium

A Classroom Activity

Introduction

What is equilibrium? What happens to the amount of reactants and products when equilibrium is reached? What if more reactants or products are added to a system already at equilibrium? In this activity, pennies will be used as reactants and products in a reversible reaction to answer these questions and learn more about the fundamental nature of equilibrium.

Concepts

- Reversible reactions
- Equilibrium
- Equilibrium constant
- LeChâtelier's principle

Materials

Beakers or other large containers, 2

Small objects (e.g., pennies, paper clips, paper clips, bingo chips), 60

Safety Precautions

Although this activity is considered nonhazardous, observe all normal laboratory safety guidelines.

Overview of the Activity

1. Divide into groups of four. Each member of the group chooses a defined role: "Reactant," "Product," "Monitor" or "Recorder."
2. Obtain a counted set of 60 small objects, e.g., pennies, paper clips, paper clips. These will be used to represent reactants and products in a chemical reaction. *Note:* In these instructions, the objects used are pennies.
3. Obtain two containers to hold the pennies. Label one container R, for reactants, and the other container P, for products.
4. In Parts A–D, the pennies will be moved in a series of steps between containers R and P.

Procedure

Part A. What are the properties of a system at equilibrium?

1. Place 42 pennies in container R, none in container P.
2. In each transfer round, "Reactant" will move one-third of the pennies from container R to P, and "Product" will move one-quarter of the pennies from container P to R. *Note:* In deciding how many pennies to move, the number may be rounded up or down; however, the approach to equilibrium may be faster if the numbers are rounded up, so it is recommended that you round all calculations down to the nearest whole number.
3. The "Monitor" checks the number of pennies to be moved, and gives permission for the actual "reactions" to take place.
4. The "Recorder" constructs a suitable data table and records results. The following information is needed: the initial number of pennies in R and P, the number of pennies that are moved out of each, and the final number of pennies in R and P after the pennies have "reacted."
5. In the first round, "Reactant" counts out 14 pennies (one-third of 42) so none. "Product" calculates that one-quarter of zero is zero and does not move any pennies in the first round.
6. Repeat steps 2–5, and carry out a second round of penny "reactions" in both directions between R and P. Remember that one-third of the R pennies, but only one-fourth of the P pennies will react in each round.
7. Continue moving pennies back and forth until no further changes are observed in the number of reactants and products.
8. Calculate the ratio of reactants and products (P/R), and enter the result in the data table.

Part B. Does the position of equilibrium depend on the initial number of reactants?

9. Place 60 pennies in container R, none in container P.
10. Repeat the process in Part A to move the pennies between R and P until no further changes are observed in the number of reactants and products. Keep the fractions of pennies that react the same as in Part A: $1/3$ of R, $1/4$ of P.
11. Calculate the ratio of reactants and products (P/R), and enter the result in the data table.

Penny Ante Equilibrium A Classroom Activity Answers

Brendan G. Carr

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