ChemQuest 57

Intro to Reaction Rates

Name: _____

Date: _____

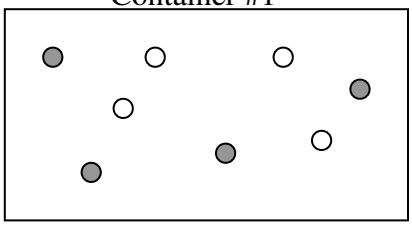
Hour: _____

Information: Rate of Reaction

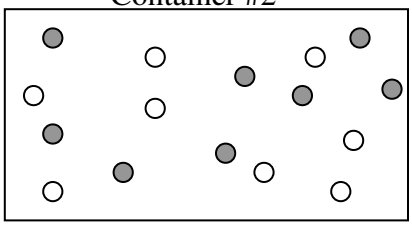
Since "time is money" in the business world, it is very important to know how fast a reaction will occur. Whether a company is producing a medicine, plastic, or adhesive, the speed of reaction will greatly impact the amount of money that the company can earn.

Chemical kinetics is a term that refers to how fast chemical reactions take place. Some reactions take place very quickly, seemingly instantaneously. Other reactions take place very slowly. Consider for a moment two hypothetical gaseous reactants—A and B—reacting together:

Container #1



Container #2



In the above two containers, two different substances are reacting together. Each particle is moving randomly in the container. *A reaction occurs when one particle from substance A collides with a particle from substance B* ***if*** *the collision is a strong enough collision.* Sometimes, a gentle "bump" won't have enough energy to cause a collision.

Critical Thinking Questions

1. Which container—#1 or #2—should have the most collisions between particles?

2. Which container—#1 or #2—do you think will have the faster rate of reaction? Explain why.

3. Which of the below scenarios will have the fastest rate of reaction? Why? Recall that Molarity (M) is a unit of concentration.

Scenario #1	Scenario #2
200 mL of 0.75 M HCl reacts with 200 mL of 0.75 M NaOH.	200 mL of 0.95 M HCl reacts with 200 mL of 0.95 M NaOH.

4. What will happen to the speed of the particles if you heated up the containers?

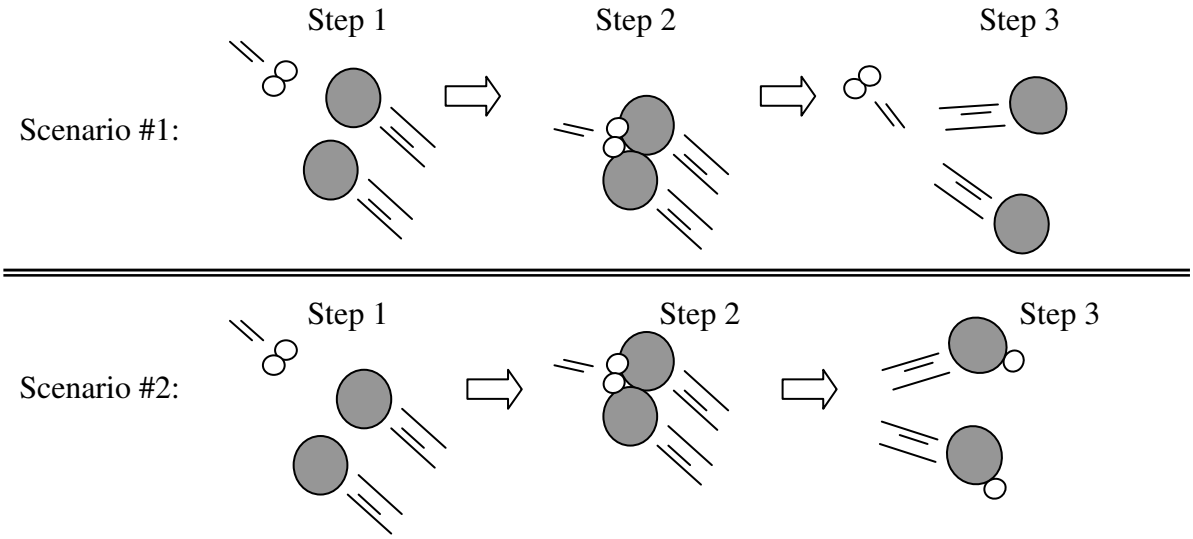
5. If the particles are heated up, what will happen to the energy of the particles' collisions? Will the collisions have more energy or less energy?

6. Again, consider heating up a container of particles. Will there be more collisions or fewer collisions after heating them up?

7. a) Given your answers to questions 4-6, what happens to the rate of the reaction if you increase the temperature of the reactants?

   b) Try to think of <u>two</u> reasons WHY and write them down. (Hint: questions 4-6 should contain the two reasons.)

8. Consider the following two scenarios where different particles are colliding:



   a) During which scenario is there enough energy for a reaction to occur?

   b) Which scenario involves molecules moving at a faster speed?

   c) Which scenario do you think occurs at the highest temperature?

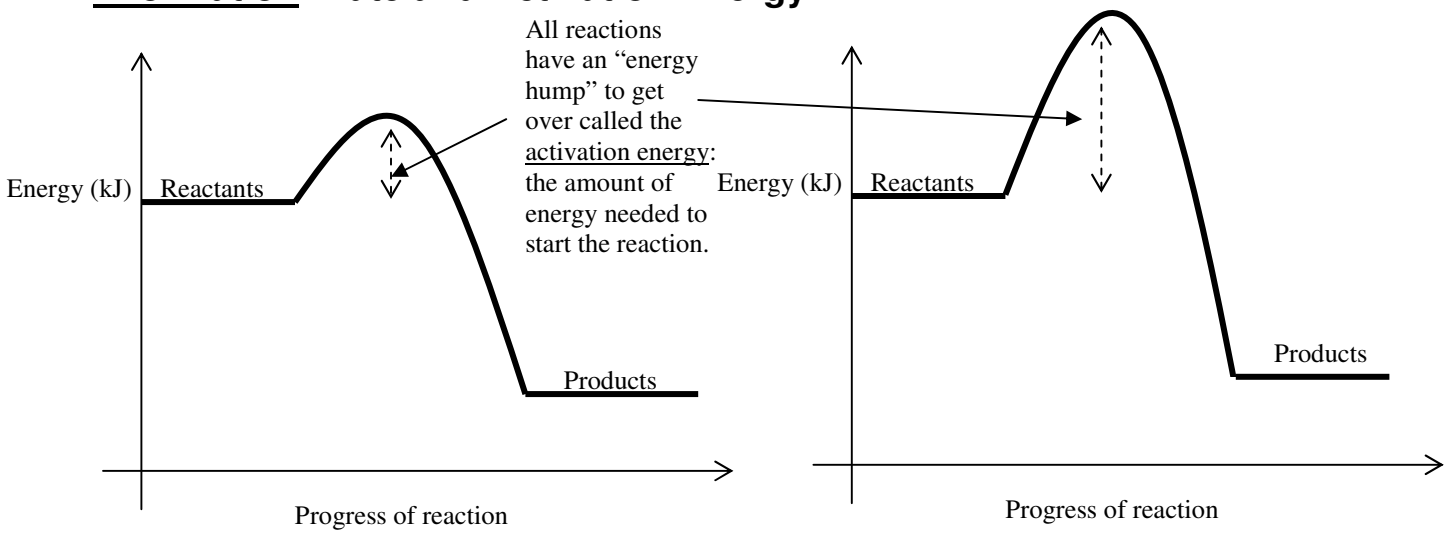
9. Consider the two scenarios from question 8. Which of the following balanced chemical reactions could be occurring?

   A) $2\ H_2 + O_2 \rightarrow 2\ H_2O$
   B) $2\ Na + Cl_2 \rightarrow 2\ NaCl$
   C) $Cl_2 + O_2 \rightarrow 2\ ClO$

10. An "activated complex" is a very unstable arrangement of atoms that forms for a very brief moment during a reaction. The activated complex will then turn into a product or into a reactant. There is an equal chance of either option occurring. When did an activated complex occur in the scenarios from question 8—Step 1, 2, or 3?

11. The "activated complex" is sometimes called the "transition state." Think about what the word "transition" means. Why do you think the activated complex is called the transition state?

Information: Rate and Activation Energy



Critical Thinking Questions

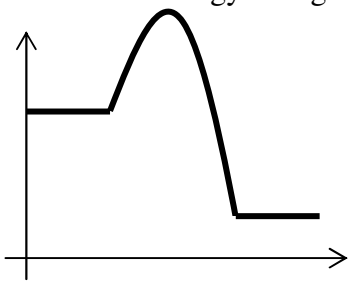
12. Consider the two diagrams above of reactions X and Y. Which one has the higher activation energy?

13. True or False: Reaction X and Reaction Y have the same ΔH value.

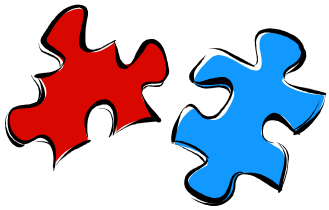
14. Consider the two diagrams above of reactions X and Y. Reaction X is a faster reaction than Reaction Y. Offer an explanation.

15. A catalyst is a substance that speeds up a reaction when it is added to the mixture of the reactants. A catalyst speeds up a reaction by doing something to the activation energy. What do you think a catalyst does to the activation energy?

16. Below is an energy diagram for a certain reaction. Redraw the energy diagram to depict what happens after a catalyst is added. Note: the energy of the reactants and products stays the same; only the activation energy changes.



Information: Factors Affecting Rate

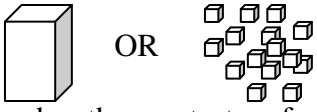


We have already looked at how concentration (question 3) and temperature (questions 4-7) affect the rate of reactions. It is important to note that for a reaction to happen, particles must have sufficient energy when they collide AND they also must be oriented in the correct way. Just as puzzle pieces must be oriented correctly, so also particles must be oriented correctly to bond.

Two other factors in reaction rates are particle size (or surface area) and the pressure at which the reaction is carried out.

Critical Thinking Questions

17. Consider the two amounts of sugar shown below. Both amounts have the same weight.

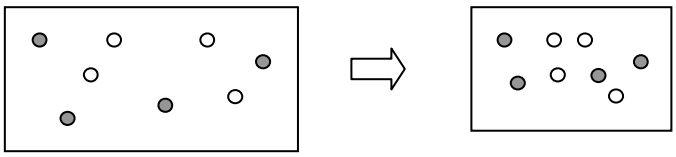


a) Which version of the sugar has the greatest surface area—the cube or the crushed?

b) Which would dissolve fastest in water—the cube or the crushed sugar?

c) The greater the surface area of the substance, the _____ the reaction rate.
faster OR slower?

18. Consider a container of gas molecules that is being compressed. The temperature is the same in both containers:



a) True or False: As the volume of the container decreases, pressure increases.

b) True or False: The molecules move faster after the container is compressed.

c) True or False: The reaction rate is faster after the container is compressed.

d) Explain your answer to part c.