Chemistry 12

Reaction Kinetics I

Name:
Date:
Block:

1. **Monitoring and Calculating Rates**
2. **Measuring Rates**
3. **Factors Affecting Rates**

Monitoring and Calculating Reaction Rates

Example 1. Terry walked 19 km and Kevin walked 12 km. Who walked faster?

Example 2. Bobby drove 55 km/h and Dan drove 55 mph. Who drove faster? (1 mile = 1.6 km)

What do we know?

Example 3. In reaction A, 62.0 mL of H_2 gas was produced. In reaction B, 62.0 g of H_2 gas was produced. Both took place over exactly 60 seconds and were at STP conditions. Which reaction produced hydrogen gas at a slower rate?

What do we know?

Reaction Rate =

Measurable quantity: Time:

Given the following equation and data:

$$2\ HNO_{3\,(aq)} + Cu_{\,(s)} \rightarrow NO_{2\,(g)} + H_2O_{\,(l)} + CuNO_{3\,(aq)}$$

Mass of copper (g)	3.26	2.93	2.60
Time (min)	5.00	7.00	9.00

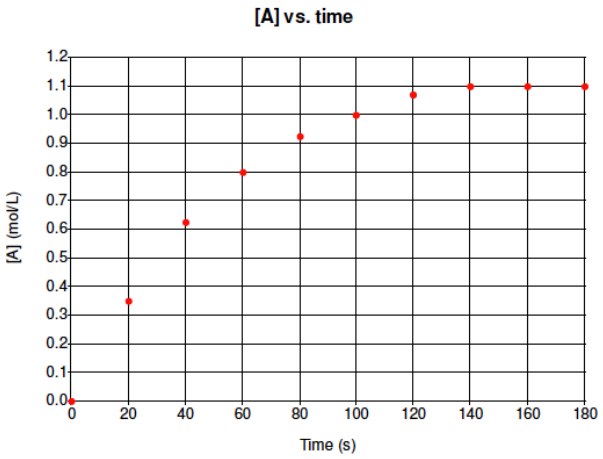
a) Does the reaction above have a constant rate? Explain why or why not.

b) Calculate the rate in units of grams of Cu consumed per minute.

c) Calculate the rate in units of liters of NO_2 gas produced per minute at STP.

d) How many liters of NO_2 gas would be produced in 22 seconds?

Consider the following graph:



1. Calculate the rate of reaction of the production of A in M/s for the time interval 20 – 60 s.

2. Calculate the rate of reaction of the production of A in M/s for the time interval 60 – 120 s.

Measuring Reaction Rates

Changing rates of reactions can be found by **measuring a change** in one of the following properties:

1. Colour
2. Temperature
3. Pressure (gas)
4. Volume (gas)
5. Mass
6. Concentration
7. pH
8. Heat produced or consumed

State **two** different methods for measuring the rate of the reaction for the following reactions:

Example 1.

An iron nail in concentrated hydrochloric acid:

a. What is the balanced chemical equation? (HCl is colourless; $FeCl_2$ is yellow-orange)

b. What properties would/could you monitor?

Example 2.

$$CH_3COOH_{(aq)} + NaHCO_{3\,(s)} \rightarrow NaCH_3COO_{(aq)} + CO_{2\,(g)} + H_2O_{(l)}$$

Consider the following reactions in open systems:

I. $2\ H_{2(g)} + O_{2(g)} \rightarrow 2\ H_2O_{\ (g)}$

II. $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

III. $CaO_{(s)} + SiO_{2(s)} \rightarrow CaSiO_{3(s)}$

IV. $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow NaNO_{3(aq)} + AgCl_{(s)}$

In which of the above could reaction rate be determined by a change in mass?

A. I B. II C. III D. IV

<u>Complete Reaction Rates Worksheet #1-5</u>

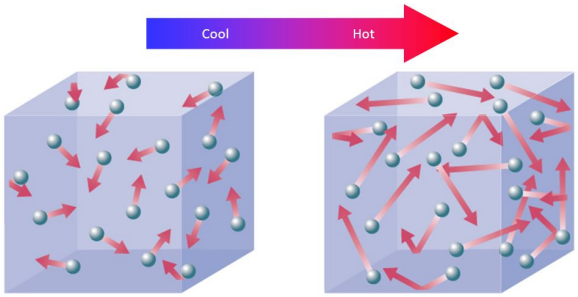
Factors Affecting Reaction Rates

It is one thing to **monitor/measure** the reaction rate. If the goal is to **change** the rate, the _____ must be manipulated.

$$A_{(s)} + B_{(l)} + C_{(aq)} + D_{(g)} \rightarrow E_{(?)}$$

In order to INCREASE/DECREASE the reaction rate, the following factors must be manipulated:

1. **Temperature**
   - When the temperature is increased, the particles have _____ energy.
   - Will result in more frequent and more forceful collisions.
   - The time for the reaction to take place will _____ therefore the reaction rate will _____.

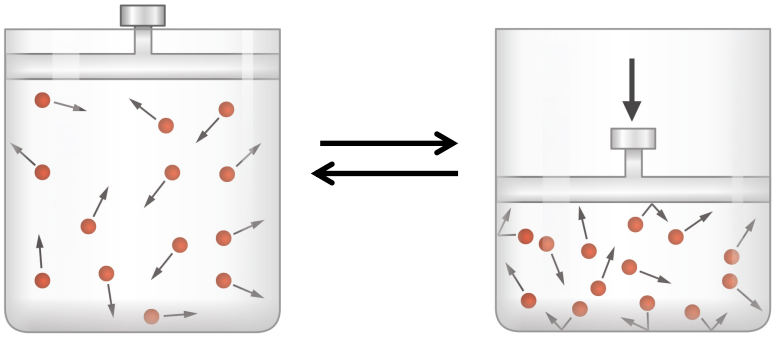


   - When temperature is decreased, the reaction rate will _____.
   - A change in temperature affects solids, liquids and gases.

2. **Concentration**
   - To change the concentration of a reactant, particles are either added or removed.
   - As the reactant concentration increases, there are more particles to collide with each other.
   - The reaction rate will _____.

   - When the concentration decreases, the reaction rate will _____.

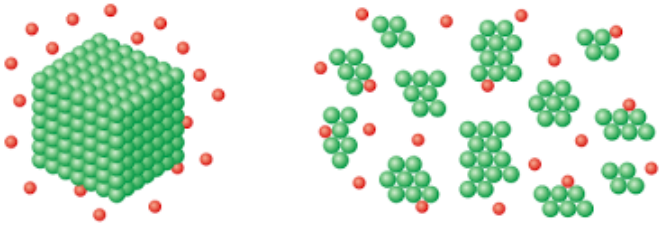
3. **Pressure/Volume**
    - An increase in pressure or a decrease in volume causes the _____ particles to be _____ together.
    - Increase in pressure or a decrease in volume causes the reaction rate to _____.



- Decrease in pressure or an increase in volume causes the reaction rate to _____.

<u>Complete Gas Properties Simulation Lab</u>

4. **Surface Area**
    - With a greater the surface area exposed, there is an **increase in locations** where the reaction can take place.
    - Allows for _____ in reaction rate.
    - Most relevant for reactants in the _____ phase.



5. **Nature of the reactants**
    - Factors such as ionization energy, electronegativity, ionic and molecular polarity, size, complexity of structure, etc.
    - In general, at room temperature the rate of **<u>aqueous > gas > liquid > solid</u>.**

6. **Presence of a catalyst**
    - Substances that increase the rates of chemical reactions without being used up.
    - *(An inhibitor is a species that reduces the rate of a chemical reaction by combining with a reactant to stop it from reacting in its usual way.)*

The following reaction is taking place in a **closed** container at room temperature:

$$S_{(s)} + O_{2\,(g)} \rightarrow SO_{2\,(g)}$$

State what effect each of the following procedures will have on the rate of this reaction, and explain why the procedure has the stated effect.

a) The temperature is decreased.

b) More $O_{2\,(g)}$ is added in the same volume.

c) The sulphur is ground up into a powder.

d) The volume of the container is increased.

Be careful when discussing MEASURING reaction rates and AFFECTING reaction rates.

<u>Reaction 1:</u> $A_{(s)} + B_{(aq)} \rightarrow C_{(aq)} + D_{(g)}$

- List two ways the reaction rate could be measured:

- List two ways the reaction rate above could be increased:

<u>Reaction 2:</u> $E_{(aq)} + F_{(aq)} \rightarrow G_{(aq)} + H_{(s)}$

- List two ways the reaction rate could be measured:

- List two ways the reaction rate above could be decreased:

<u>Complete Reaction Rates Worksheet #6-10</u>