Reaction Rates, Collision Theory & Equilibrium

Flint, MI water crisis

Reaction Rate Lab Discussion

- Surface Area example: Lycopodium
- Catalyst Example: Elephant Toothpaste

- Graph your data from Part 1
  - If you were not here, get data from someone to graph

- With your group, answer Analysis Questions #2-7 (skip #5)
  - Be prepared to discuss as a class

3 Questions to Consider…

- What has to happen for a reaction to occur?
  - Particles have to collide
- How can you increase the rate of a reaction?
  - Increase concentration… why?
  - Increase temperature…. Why?
  - Increase surface area… why?
- Do all collisions result in a reaction? Why or why not?
  - No!
  - Particles must collide with enough kinetic energy and have to collide enough times to react. This is collision theory.
- Reaction Rate Simulation

On Your Whiteboard….

- Draw 2 separate particle pictures to show the difference in particle interactions when you…
  - Increase the temperature
  - Increase the surface area
  - Increase the concentration
- Is it possible to change your variable in a way that would prevent the reaction from happening? Explain in terms of collisions.

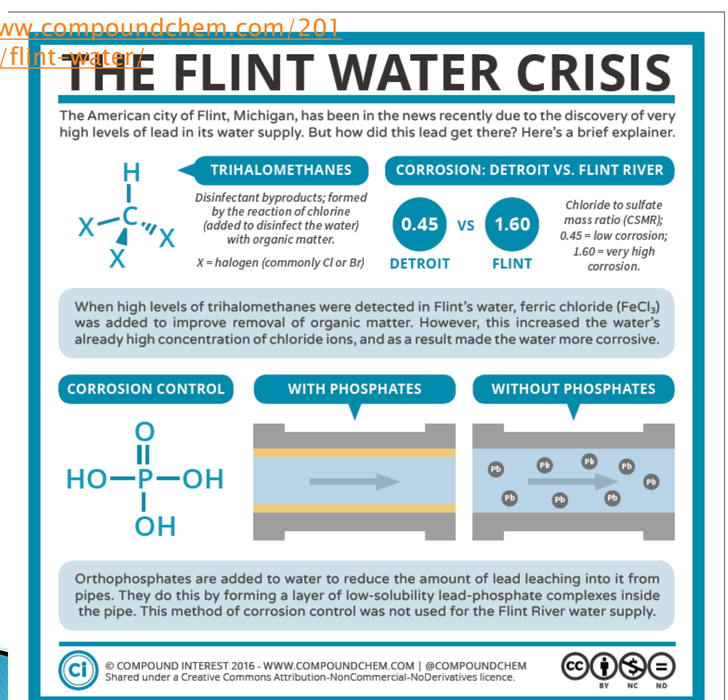
Flint, MI Water Crisis

- What is it?
- What have you heard?
- Why did this crisis happen?

CNN Video: https://youtu.be/nTpsMyNezPQ

- The pipes didn't change (they were always made of lead), so why is the lead just now entering the water supply? What changed?

http://www.compoundchem.com/2016/01/25/flint-water/



What happened?

- Detroit vs Flint water
  - Flint was switched from the Detroit water to the Flint river while they waited for a new system
  - This is a problem because the Flint river was already highly corrosive while Detroit wasn't
  - Corrosive water will eat away at the pipes

- Not only was the water already corrosive, there was also had a bunch of trihalomethane
- So they added something to kill the nasty microbes... $FeCl_3$
- Why was adding $FeCl_3$ a bad idea?
  - It added more chlorine (which is highly corrosive) to the already corrosive water – the chlorine then reacted with the lead (Pb) pipes
- How did this affect the speed of the reaction as it was eating away at the pipes? Why?

Equilibrium

- What is meant by "equilibrium"?
  - Some reactions never go to completion
  - Once some product is formed, reactants begin to reform

Ex: $$\left.\begin{matrix} 2\ HgO \rightarrow 2\ Hg + O_2 \\ 2\ HgO \leftarrow 2\ Hg + O_2 \end{matrix}\right\} 2\ HgO \rightleftarrows 2\ Hg + O_2$$

Equilibrium

- Initially, only the forward rxn occurs
- Then, the reverse rxn starts
- As the reverse rxn increases, the forward rxn decreases
- Eventually, forward rate equals reverse rate

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Chemical Equilibrium

- The point at which concentrations of reactants and products in a closed system remain constant
- Occurs when opposing reactions proceed at equal rates
- It's really **"dynamic equilibrium"**
  - reactions (collisions) do not stop even though it appears that way if we keep track of the number of each type of particle (or chemical) present

Equilibrium Examples

- Iodine Clock
  - Video #1
  - What did you observe?
  - How does this happen?
  - Does our current model of matter help to explain?
  - Could this relate to equilibrium? If yes, how so?
  - Video #2
- Milk of Magnesia
  - What will happen when we add acid?
  - Is there a chemical reaction happening even after the color changes stop?

Nuts & Bolts Equilibrium Lab

$$\text{Bolt} + \text{Nut} \rightleftharpoons \text{Bolt-Nut}$$
$$\text{B} + \text{N} \rightleftharpoons \text{BN}$$

- What happened to the………as 10 minutes passed?
  - rate of the forward reaction
  - rate of reverse reaction
- How did the two rates compare at the end of 10 minutes?

Nuts & Bolts Equilibrium Lab

$$\text{Bolt} + \text{Nut} \rightleftharpoons \text{Bolt-Nut}$$

- How would you define equilibrium?
  - Dynamic?
  - Stable?
- How does dynamic equilibrium apply to the situation in Flint, MI?

Le Chatelier's Principle

- When stress (or a change) is applied to a system at equilibrium, the system will react to relieve the stress and restore equilibrium.

- Stresses could include:
  - Change in concentration (# of particles)
  - Change in temperature
  - Change in surface area
  - Change in pressure and/or volume

What happens AFTER Equilibrium?

- What happened to the reaction rates when you added more BN to the bin at the start?

  - You added more product (BN) so the equilibrium shifts to the left, creating more of the reactants.

  - "If a reaction is at equilibrium, a shift away from the added chemical occurs."

What happens AFTER Equilibrium?

- What do you think would happen to the reaction rates if you took out some of the already formed BN at the start?
  - You are removing a product, so it would shift the reaction to make more (replace the missing) product.
  - “When a chemical is removed a shift occurs toward the removed chemical.”

Changing Temperature & Equilibrium

- Depends on if the rxn is exo or endothermic.
- Endo: A + B + “heat” <-> C + D
  - “heat” acts like a reactant chemical. Then the same rules follow for added or removing a chemical
- Exo: A + B <-> C + D + “heat”
  - “heat” acts like a product chemical.
- If temperature increases, shift away from the side w/ “heat”
- If temp decreases, shift toward the side with “heat.”

Cobalt Chloride ($CoCl_2$) Equilibrium

$$[CoCl_4]^{-2} + H_2O \rightleftharpoons [Co(H_2O)_6]^{+2} + Cl^-$$

$$Ag^+ + Cl^- \rightarrow AgCl_{(s)}$$

$$HCl \rightarrow H^+ + Cl^-$$

Your task is to figure out how to successfully shift the equilibrium such that the solution turns blue and then shift it back to pink.

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- What was your procedure? How did you decide to follow that plan?
- What observations did you make when you tested your procedure?

Connection to Flint Water Crisis

- The water treatment used after they realized the corrosive water was eating away at the pipes, shifted the solubility of the pipe "crust"
  - Solubility = how well it dissolves (in water)

- The crust (protective phosphate layer) can now dissolve into the water, when before it couldn't.

- This exposed the pipes, thus leaching much more lead into the water.

Video #1 Video #2