What happens when? – Course Syllabus Document

Week Starting Date	**Tentative Schedule for Lecture Topics**	**Lab Schedule**	**Tutorial Schedule**
September 12	**Introduction** **How fast are reactions?** *Chemical Kinetics (Chapter 14)*	Orientation for odd-numbered lab sections	No Tutorials ***Look ahead: next week's tutorial quiz will require reviewing a lot of material.***
September 19	**How fast are reactions?** *Chemical Kinetics (Chapter 14)*	Orientation for even-numbered lab sections	**Tutorial 1** *Quiz* Review Material (Ch. 1 – 4) ***See "CHEM 209 Preparation" handout***
September 26	**How fast are reactions?** *Chemical Kinetics (Chapter 14)* **How far does a reaction proceed?** *Equilibrium (Chapter 15)*	Experiment 1 for odd-numbered lab sections	**Tutorial 2A** *In-class Assignment* Kinetics (Ch. 14.1-14.3)

Video: Burning Steel Wool

Source: https://www.youtube.com/watch?v=5MDH92VxPEQ

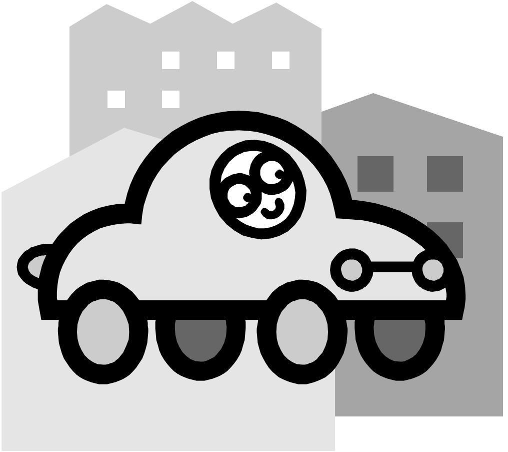
How Fast do Reactions Go?

Questions you should be able to answer by the end of this topic:

- Why does steel wool burn, while an iron nail does not?
- Why does "fluffing" the steel wool make it burn faster?
- Why does adding KCℓO make the steel wool burn faster?
- Why doesn't steel wool burn until it is heated?

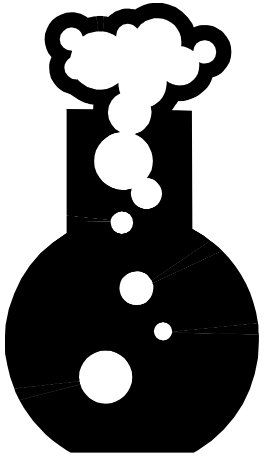
- Why didn't H_2 and O_2 react when they were mixed?
- Why did the H_2/O_2 balloon react differently than the H_2/air balloon?

Expressing Reaction Rates



Rate of travel

$\frac{m}{s}$ or $\frac{km}{h}$



Rate of reaction

$\frac{mol/_L}{s} = \frac{M}{s}$ or $\frac{bar}{s}$

✓ Qualitatively *describe* what the speed of a reaction depends upon.

These reaction rates describe a specific reactant or product, not the entire reaction:

$$2\,Fe^{3+}(aq) + Sn^{2+}(aq) \rightarrow 2\,Fe^{2+}(aq) + Sn^{4+}(aq)$$

If the reaction starts with $[Fe^{3+}]$ = 0.0200 M and [Fe^{2}+]= 0 M, and after 10s $[Fe^{3+}]$=0.0100 M:

We can write the **rate of disappearance** of a reactant:

Or the **rate of appearance** of a product:

*Either the sign of the rate or the words "appearance" or "disappearance" may be used to describe the direction of change

✓ Qualitatively *describe* what the speed of a reaction depends upon.

The **general rate of reaction** normalizes these values to make them comparable.

For a reaction

$$aA + bB \rightarrow gG + hH$$

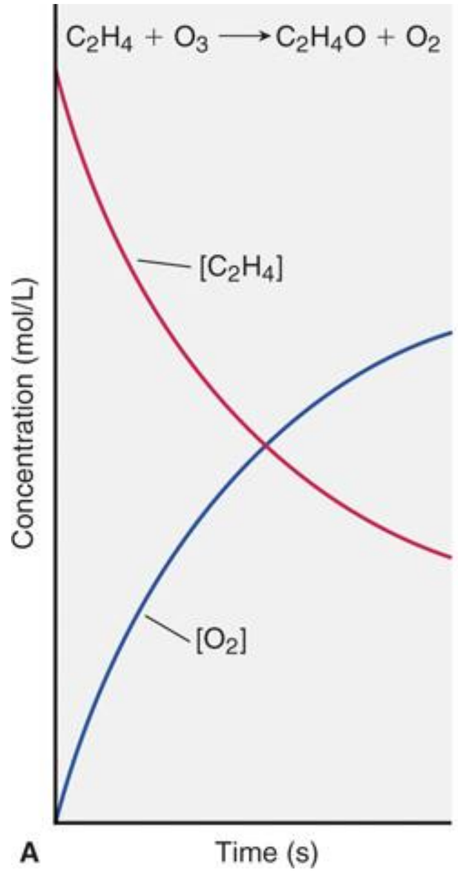
The general rate of reaction is:

$$\text{rate of reaction} = -\frac{1}{a}\frac{\Delta[A]}{\Delta t} = -\frac{1}{b}\frac{\Delta[B]}{\Delta t} = \frac{1}{g}\frac{\Delta[G]}{\Delta t} = \frac{1}{h}\frac{\Delta[H]}{\Delta t}$$

This gives a single **positive** value for the reaction rate, and is independent of the compound chosen.

e.g. for the previous reaction ($2\ Fe^{3+}(aq) + Sn^{2+}(aq) \rightarrow 2\ Fe^{2+}(aq) + Sn^{4+}(aq)$)

✓ Qualitatively *describe* what the speed of a reaction depends upon.

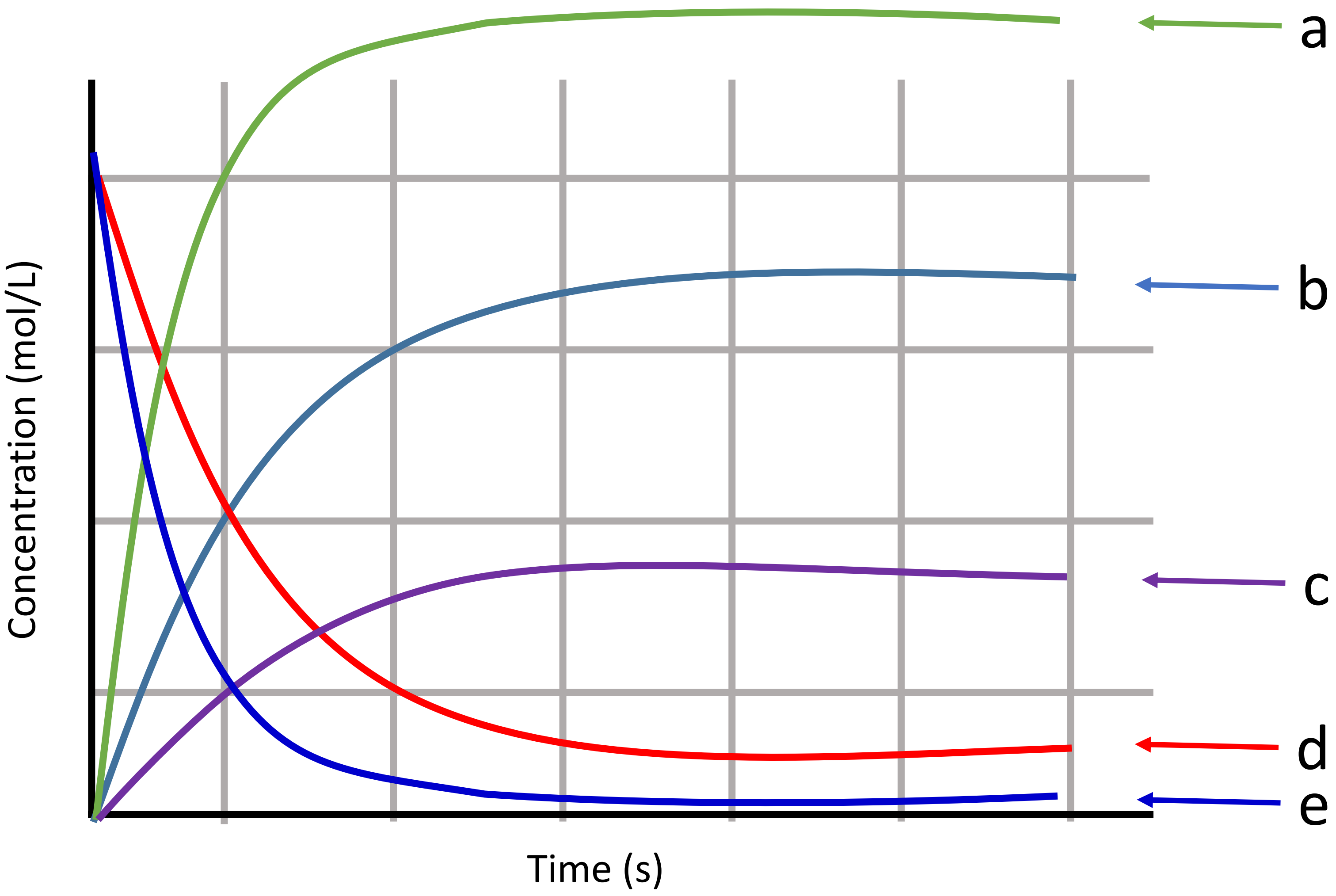


✓ Generate plots of concentration versus time for the chemical species of a reaction.

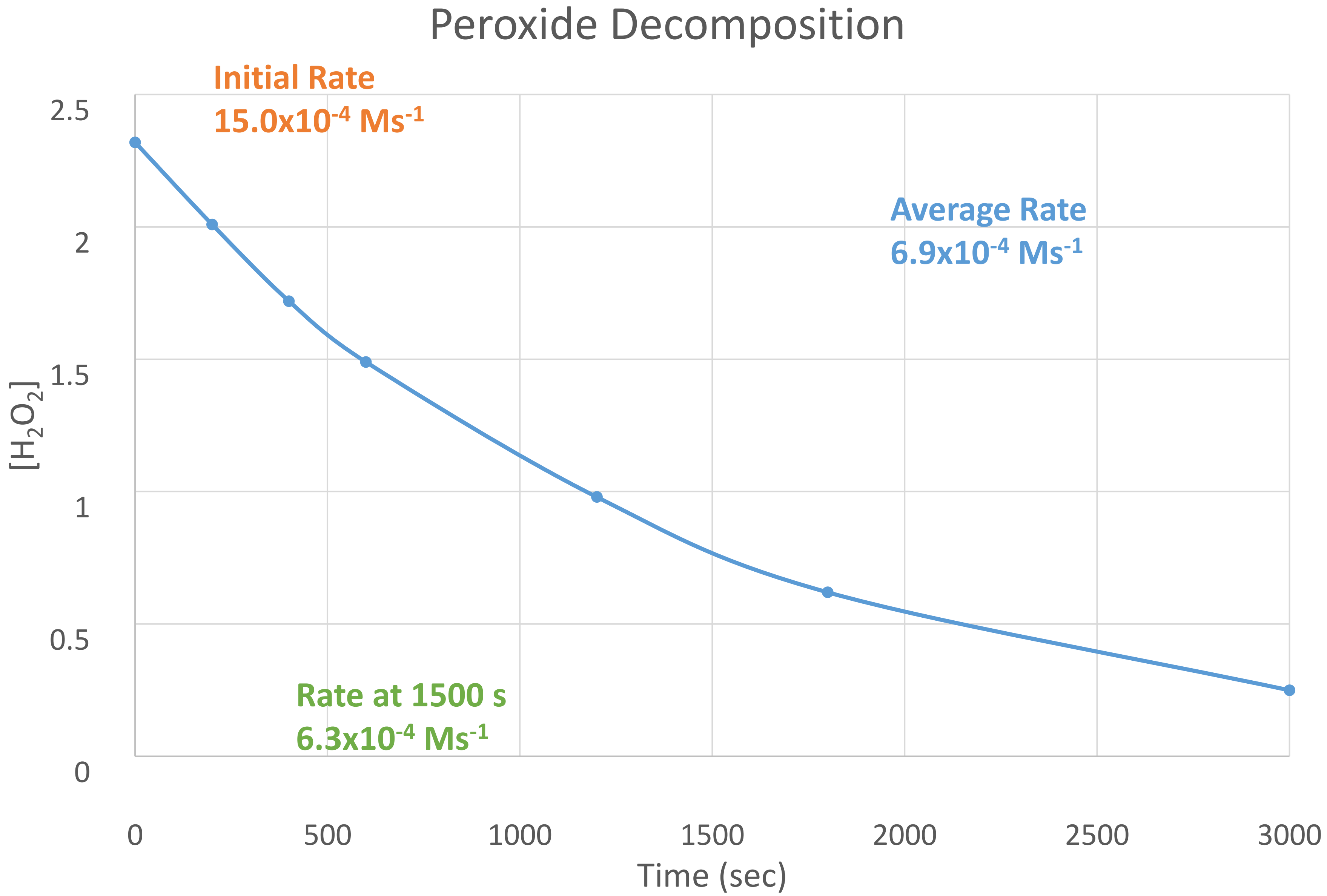
For the reaction:

$$H_2 + I_2 \rightarrow 2\,HI$$

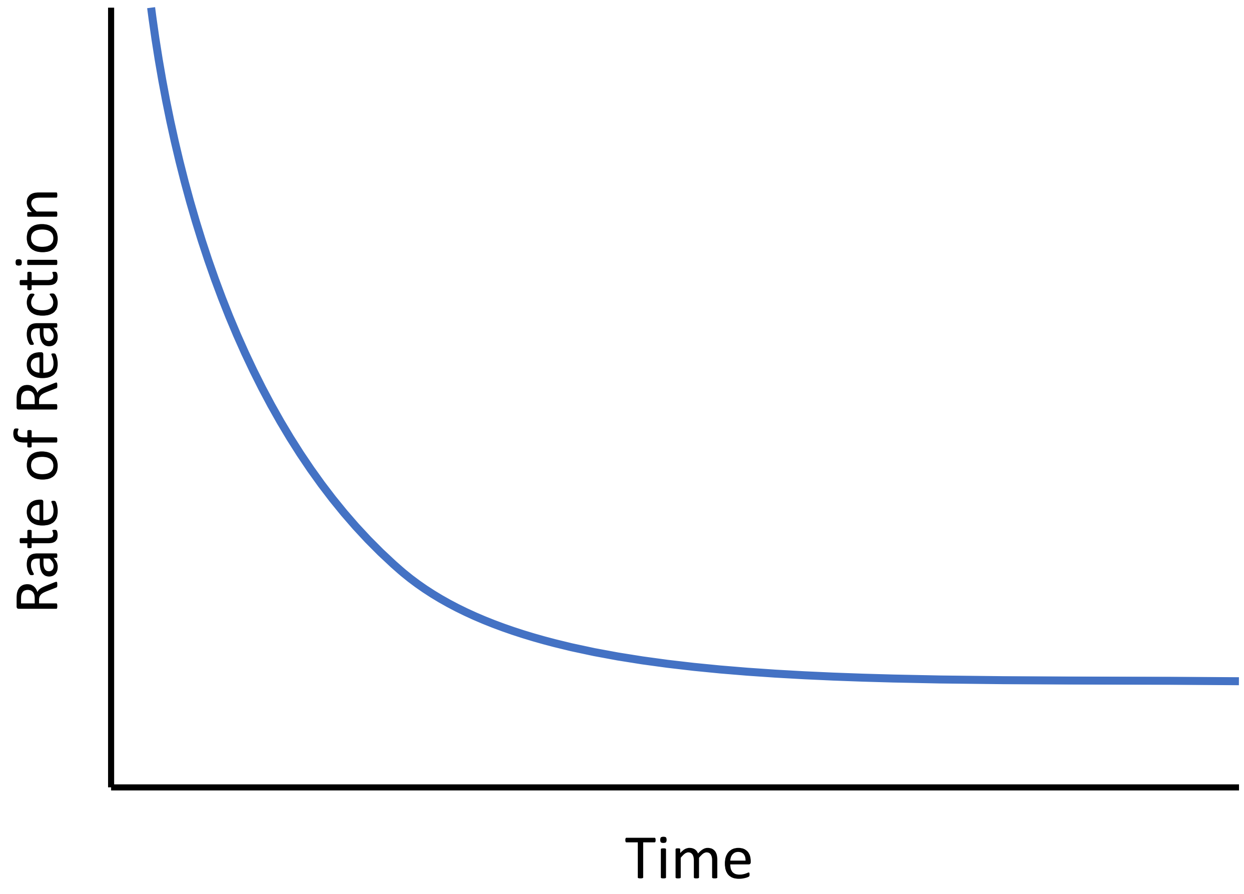
Which line in the plot below would best represent [HI] during the course of the reaction?
The red line represents $[I_2]$.



Reaction rates can be **instantaneous** or **average**. That is, the rate of a reaction may change over time, and the rate quoted may either represent the rate at a specific moment, or across a longer time frame.



- ✓ Generate plots of concentration versus time for the chemical species of a reaction.
- ✓ Determine the instantaneous and average rate of reaction from experimental data.



✓ Determine the instantaneous and average rate of reaction from experimental data.

The reaction:

$$\text{Red} \rightarrow \text{Yellow}$$

was monitored over a period of time. The figure below summarizes the experimental results. Each sphere represents 3.0 mol L^{-1}.

The average reaction rate over the 1.5 min is:

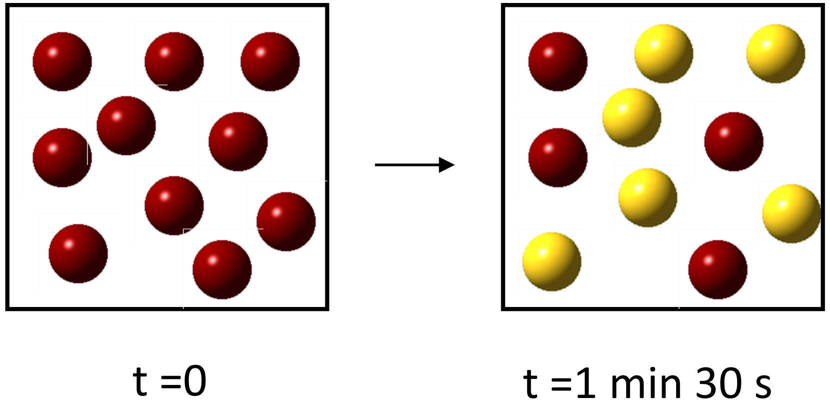
a. 5.0 mol L^{-1} s^{-1}

b. 1.0 mol L^{-1} s^{-1}

c. 1.0 s^{-1}

d. 0.20 mol L^{-1} s^{-1}

e. 0.20 s^{-1}



✓ Determine the instantaneous and average rate of reaction from experimental data.

What Factors affect Rate?

1. Concentration

2. Physical State

3. Temperature

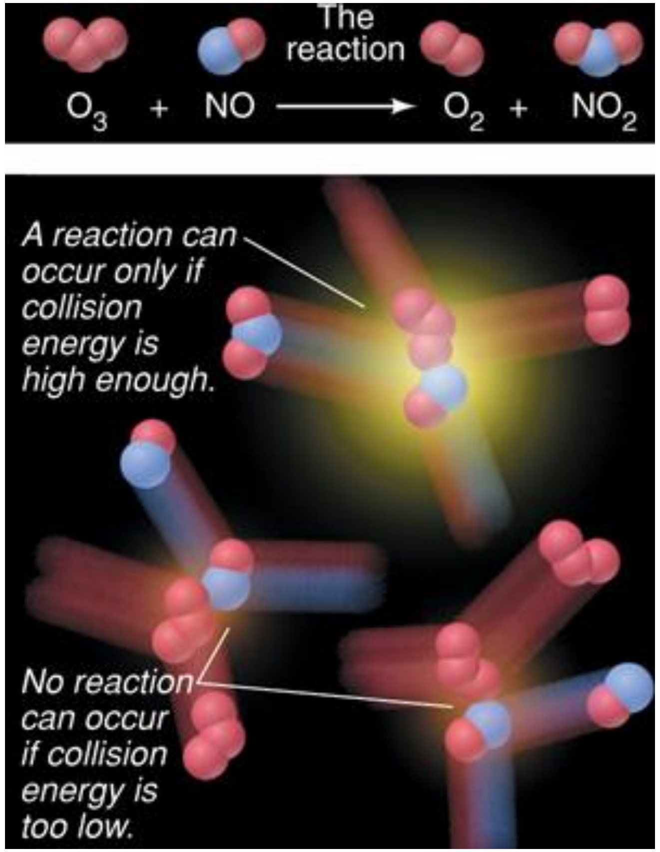
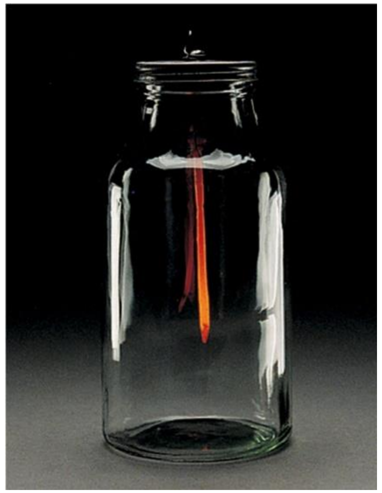


Fig. 14.4, Silberberg 1st ed.

✓ Qualitatively describe what the speed of a reaction depends upon.

Back to the steel wool:



$Fe\ (s) + O_2\ (g) \rightarrow Fe_2O_3\ (s)$

- Why does steel wool burn, while an iron nail does not?
- Why does "fluffing" the steel wool make it burn faster?
- Why does adding KCℓO make the steel wool burn faster?