

## 6.2: Factors Affecting Reaction Rate

# Rates can vary **DRAMATICALLY**

- Combustion of gasoline → If engine runs at 2000 rpm, each combustion reaction must occur in less than 0.03 s

→ **VERY FAST!!**

- Cooking food ~ few minutes

- Digestion of that food ~ few hours

- Melting of an iceberg → one year or more

- Rusting of metal bridge → several years (or else disaster!)





Diamond



Graphite

**VERRRRRRRY SLOW!!! Undetectable!**

# **Factors affecting rates:**

1. Concentration
2. Temperature
3. Nature of reactants
4. Catalysts
5. Surface Area

# What must happen for reactions to occur?

1. Reactants must **COLLIDE**.

*Chemical reactions occur through collisions between the reactant molecules.*

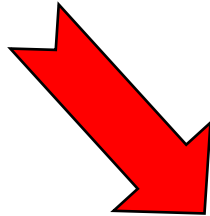
2. Collision must be in **correct orientation**.
3. Colliders must have sufficient **energy** to break old bonds, allowing new ones to form.

# Effect of Concentration on Rates

- Will increasing concentration increase the rate?

– ANSWER IS YES!

- But why?



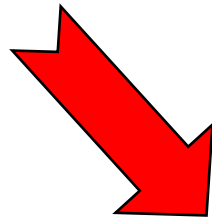
**Greater concentrations increase frequency of collisions, which are necessary for reaction...**

# Effect of Temperature on Rates

- Will increasing Temperature increase the rate?

– ANSWER IS YES!

- But why?



**Higher the temperature, faster the movement of particles, greater possession of kinetic energy, more particles have sufficient energy to allow the bond to break ...**

# Effect of Nature of Reactants on Rates

1. Lead(II) nitrate + potassium iodide  $\implies$

- Why so fast?
- Involves ions only, no bond breaking
- $\text{Pb}^{2+}_{(\text{aq})} + 2\text{I}^{-} \implies \text{PbI}_{2(\text{s})}$  (precipitate)

2. Magnesium + Copper (II) Sulfate<sub>(aq)</sub>

- Gain  $2\text{e}^{-}$  (reduction)
- $\text{Mg}^0 + \text{Cu}^{2+}_{(\text{aq})} \implies \text{Cu}^0 + \text{Mg}^{2+}$
- Loss of  $2\text{e}^{-}$  (Oxidation)
- Why not so fast? Because electron transfer, therefore slower.

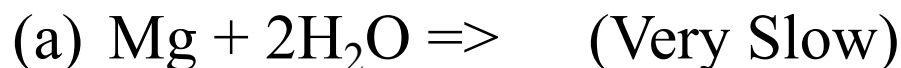


## Nature of Reactants Continue...

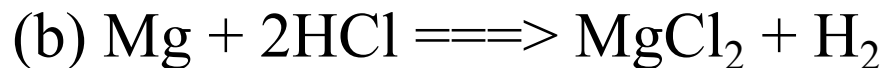
### 3. Sugar + Sulfuric Acid (Quite Slow)

➤ **Because of bond rearrangement**

### 4. Reactions between substances which are covalently bonded are much slower than between ionically bonded substances.



Very slow because of stronger bonds;  $4 \times 464\text{J} = 1856 \text{ J}$



Weaker bonds, therefore faster reaction  $2 \times 231 \text{ J} = 862 \text{ J}$

# Nature of Reactants Continue...

## Reactivity

▪ Sodium + water  $\implies$  sodium hydroxide + hydrogen

➤ **SLOWER**

▪ Potassium + water  $\implies$  potassium hydroxide + hydrogen

➤ **FASTER** as the larger the atom less nuclear attraction

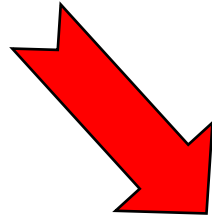
Conclusion: Complex ions and molecules take longer to react (more bonds involved to be broken), also it takes longer for bulky molecules to assume proper orientation for bonding.

# Effect of Catalyst on Rates

- Definition: a substance that alters the rate/speed of a chemical reaction without itself being permanently changed
- Eg.  $\text{KMnO}_4$ 
  - Speeds the decomposition of hydrogen peroxide.

# Effect of Surface Area on Rates

- Will increasing S.A increase the rate?
  - ANSWER IS YES!
  - But why?



**Bigger the S.A., increase frequency of collisions, greater the chance that particles collide in correct orientation....**