LA IMMACULADA CONCEPCION SCHOOL
SENIOR HIGH SCHOOL
GRADE 12 – STEM: GENERAL CHEMISTRY

APRIL 27-30, 2020
TOPIC: CHEMICAL KINETICS

Rate of a Reaction

Chemical kinetics – is the study of the rate of chemical reactions, including the mechanism by which a reaction occurs and the different factors that affect it.

- Many chemical reactions occur spontaneously at a fast rate.

Examples:
1. The combustion of gasoline with oxygen is easily initiated under favorable conditions.
2. The reaction between vinegar and baking soda happens instantly with accompanying bubble formation.

- Chemical reactions that takes time to happen

Examples:
1. The rusting of iron does not happen instantaneously.
2. Th green patina (film) on copper that gives metal its antique look takes a long time to form.

Rate of a reaction – the change in concentration of a reactant or product per change in time.
- The concentration of reactant or product is represented in square brackets [ ].
- The speed of a chemical reaction may be defined as the change in concentration of a substance divided by the time interval during whivh this change is observed.

$$\text{Rate} = \frac{\Delta concentration}{\Delta time}$$

For a hypothetical equation,

$$a\text{A} + b\text{B} \rightarrow c\text{C} + d\text{D}$$

the rate of reaction can be expressed as,

$$\text{rate} = -\frac{1}{a}\left(\frac{\Delta[A]}{\Delta t}\right) = -\frac{1}{b}\left(\frac{\Delta[B]}{\Delta t}\right) = \frac{1}{c}\left(\frac{\Delta[C]}{\Delta t}\right) = \frac{1}{d}\left(\frac{\Delta[D]}{\Delta t}\right)$$

- a negative sign is attached on the change in concentration of the reactants, which underscores the fact that the concentration of the reactants decreases as the reaction proceeds.
- A rate expressed in terms of a reactant concentration are always preceded by a minus sign to make the rate come out positive

Consider this equation in which the coefficients are different:

$$\text{A} + 3\text{B} \rightarrow 2\text{D}$$

[B] decreases three times as rapidly as [A], so in order to avoid ambiguity when expressing the rate in terms of different component, divide each change in concentration by the appropriate coefficient:

$$\text{Rate} = -\frac{\Delta[A]}{\Delta t} = -\frac{1}{3}\left(\frac{\Delta[B]}{\Delta t}\right) = \frac{1}{2}\left(\frac{\Delta[D]}{2\Delta t}\right)$$

Consider the balanced equation for the decomposition of the colorless gas dinitrogen pentoxide (N2O5) into the brown nitrogen dioxide gas and oxygen gas.

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

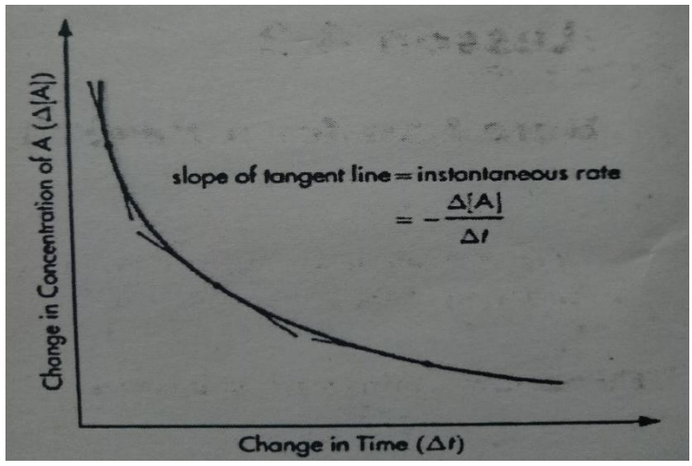
The rate of this reaction may be expressed in terms of the change in concentration of N_2O_5, NO_2 or O_2 as

$$\text{rate} = -\frac{1}{2}\left(\frac{\Delta[N2O5]}{\Delta t}\right) = \frac{1}{4}\left(\frac{\Delta[NO2]}{\Delta t}\right) = \frac{\Delta[O2]}{\Delta t}$$

The rate expression shows the relative speed at which the concentration of one species change with respect to that of another species.
The rate expression indicates that the formation of NO_2 is twice as fast as the decomposition of N_2O_5 and four times as fast as the formation of O_2.

✓ If a reaction is monitored as it proceeds, a plot of the concentration of a reactant versus time can be generated.

- ✓ The graph will give a curve with a negative slope. The slope changes at every point of the graph, defining the instantaneous rate of reaction at each unique point in time.



Sample problem:

Hydrogen peroxide (H2O2) is a colorless liquid used disinfectant and bleach. At high temperature it decomposes easily into water and oxygen.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

Write the equation for the rate of reaction based on the concentration of the reactants and products.

$$\text{rate} = -\frac{1}{2}\left(\frac{\Delta[H2O2]}{\Delta t}\right) = \frac{1}{2}\left(\frac{\Delta[H2O]}{\Delta t}\right) = \left(\frac{\Delta[O2]}{\Delta t}\right)$$

TO DO LIST

I. Express the rate of the following chemical reactions in terms of the change in concentration of the reactants or products

1. $4Sb + 3O_2 \rightarrow Sb_4O_6$

2. $4KO_2 + 2CO_2 \rightarrow 2K_2CO_3 + 3O_2$

3. $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

4. $2Au_2O_3 \rightarrow 4Au + 3O_2$

5. $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$