Aim: What factors affect REACTION RATE? Part2

5. The Nature of the Reactants

Remember: In a chemical reaction, 1st, "old" bonds have to break before the atoms rearrange and form "new" bonds.

Therefore, the rate of a reaction depends on the number and the strength of the bonds that have to be broken.

1) For example, double replacement reactions:

Demo: $NaCl_{(aq)} + AgNO_{3\ (aq)} \rightarrow NaNO_{3(aq)} + AgCl_{(s)}$
very fast reaction

$NaCl_{(s)} + AgNO_{3\ (s)} \rightarrow$ no reaction

Why?

a) In the solid state, the salts can't react because the ions are stuck (bonded) to each other.
b) Dissolving in water separates the ions (breaks the bonds).

$$NaCl_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + Cl^-_{(aq)}$$

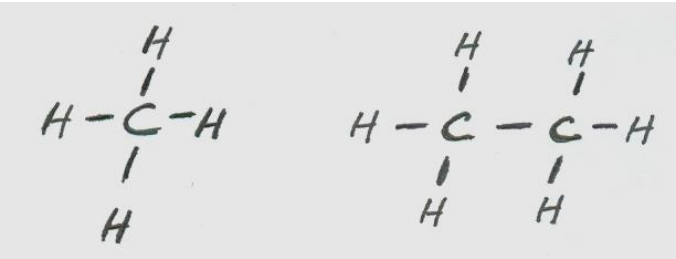
$$AgNO_{3\ (s)} \xrightarrow{H_2O} Ag^+_{(aq)} + NO_3^-{}_{(aq)}$$

c) When the solutions are mixed, all that the ions have to do is "switch partners" and form new bonds.

2) Another example, combustion reactions:

$$CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(l)}$$

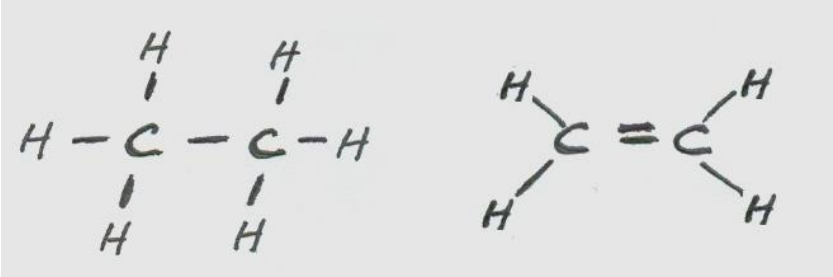
In this case, all the C-H bonds must be broken before C-O and H-O bonds can be formed. The same would apply for the combustion of ethane (C_2H_6).



methane ethane

Based on the #bonds that have to be broken, which would burn faster?
Ans: Methane b/c it has less bonds to break.

Again, which would burn faster, ethane or ethene?



ethane ethene

Ans: Ethane b/c single bonds are weaker than double bonds.

In summary,

less # bonds that have to be broken,

and/or

weaker bond strength,

faster reaction rate

NOTE: and/or b/c there is no relationship between # bonds & strength of bonds

OK, let's go to last night's review book questions. (SEE NEXT PAGE)

Review Questions

called activation energy

THINK: Baseball / Have sufficient energy & proper orientation → form product

1. As the number of effective collisions between reacting particles increases, the rate of the reaction
   (1) decreases (3) remains the same
   (2) increases

2. Which of the following pairs of reactants will react most quickly?
   (1) sodium chloride and silver nitrate } IN (aq) solution b/c dissolving breaks bonds
   (2) water and hydrogen chloride
   (3) hydrogen and propene
   (4) oxygen and methane

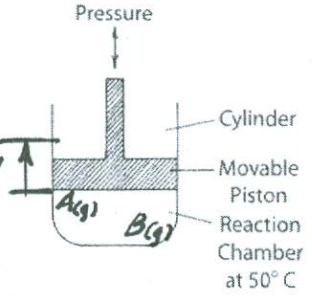
3. In the reaction $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$, as the surface area of Mg(s) increases, the rate of the reaction
   (1) decreases (3) remains the same
   (2) increases

Why? more contact (collisions per second)

4. Consider the following equation.
   moles/Liter A A A
   $A(g) + B(g) \rightarrow C(g)$
   As the concentration of A(g) increases, the frequency of collisions of A(g) with B(g)
   (1) decreases (3) remains the same
   (2) increases

collisions per second

5. The reaction $A(g) + B(g) \rightarrow C(g)$ is occurring in the apparatus shown below.



   The rate of the reaction can be decreased by increasing the
   (1) pressure on the reactants
   (2) temperature of the reactants
   (3) concentration of reactant A(g)
   (4) volume of the reaction chamber

Why? more space, less collisions per second

6. Consider the following equation.
   $Mg(s) + 2H_2O(\ell) \rightarrow Mg(OH)_2(s) + H_2(g)$
   For the reaction to occur at the fastest rate, 1 g of Mg(s) should be added in the form of
   (1) large chunks (3) a ribbon
   (2) small chunks (4) a powder

↓ particle size, ↑ surface area, ↑ rate

In other words, b/c reactant particles collide more often & with greater force, more product can form.

7. Raising the temperature speeds up the rate of chemical reaction by increasing
   (1) the effectiveness of the collisions only
   (2) the frequency of the collisions only
   (3) both the effectiveness and frequency of the collisions
   (4) neither the effectiveness nor frequency of the collisions

8. Consider the following equation.
   $Fe(s) + CuSO_4(aq) \rightarrow Cu(s) + FeSO_4(aq)$
   The Fe reacts more rapidly when it is powdered because the increased surface due to powdering permits
   (1) increased reactant contact (collisions per second)
   (2) decreased reactant contact
   (3) pressure to affect reaction rate
   (4) warmer solution to be used

9. If the pressure on gaseous reactants is increased, the rate of reaction is increased because there is an increase in the
   (1) temperature
   (2) volume
   (3) concentration
   (4) heat of reaction

↓ V container, ↑ P AND ↑ M re: M = mol/L

10. Consider the following equation.
    $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
    The reaction occurs more slowly when a single piece of zinc is used than when the same mass of powdered zinc is used. Why does this happen?
    (1) The powdered zinc is more concentrated.
    (2) The powdered zinc has a greater surface area.
    (3) The powdered zinc requires less activation energy.
    (4) The powdered zinc generates more heat energy.