

Rates of reaction

18.1-18.2

Define “mechanism” of reaction.	The series of individual steps leading to the overall reaction.
Why would we expect that the burning of propane does not occur in a single step?	The chemical equation for burning propane is: $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$. In order for the reaction to occur in a single step, five oxygen atoms would have to, simultaneously, come in contact with a propane molecule. This would be too rare an occurrence to explain the rapid chemical reaction observed when propane is burned.
What five factors influence reaction rates?	1) Chemical nature of reactants, 2) ability of reactants to make contact, 3) concentrations, 4) temperature, 5) presence of catalysts.
How is the nature of reactants important?	Some chemicals have a tendency to react more than other chemicals. For example, sodium combines rapidly with O_2 , whereas iron does not.
What influences the ability of reactants to meet?	The phase of the reactants. Chemicals can react quickly when both are gases, liquids or aqueous because molecules/ions can intermingle. Solids react slowly because molecules do not mix. This is why, for example methane can explode (easily mixes with O_2), but candle wax does not.
Distinguish between heterogeneous and homogeneous reactions.	Homogeneous – the reactants are in the same phase. Heterogeneous – the reactants are in separate phases (in this case, chemical reactions occur only at the union between the two phases).
Why is the concentration of reactants important?	A high concentration means that more molecules are available to react (i.e. there will be a greater number of collisions per second), increasing the rate. (E.g. wood burns faster in pure O_2 than in normal air (20% O_2)).
Define catalyst.	A substance that speeds a chemical reaction, but is not itself altered or used up during the reaction.

18.3

How is a rate expressed?	As a ratio, with a unit of time appearing in the denominator. E.g. km/hr, cycles/second, births/year.
How are rates of chemical reactions usually expressed?	In terms of change in concentration per second. In other words, the units are in (mol/L)/s. This can also be written as $mol L^{-1} s^{-1}$.
Why is it inaccurate to give the rate of a chemical reaction as a single number?	Because the rate of a reaction depends on the concentration of reactants. Usually, the reaction rate decreases as a reaction proceeds because reactant concentrations decline. Thus, reaction rates are high at the beginning of a reaction and slow at the end of a reaction.
How can an instantaneous reaction rate be determined?	First, a concentration vs. time graph is plotted. Next a tangent is drawn at the point of interest. Finally, the slope (rise/run) of the line is calculated to give the rate (see fig. 18.2).

18.7

What theory offers a simple explanation of factors that affect reaction rates? Explain.	The collision theory. The idea is that chemical reactions involve the breaking and forming of bonds. Thus, in order for reactions to occur, molecules must collide. According to the theory, the rate of a reaction is proportional to the number of collisions that occur per second.
Not all collisions result in a reaction. Give 2 reasons why.	1) The orientation of molecules may not be correct (see figure 18.4, pg. 755), 2) molecules may not have sufficient kinetic energy to combine.
Why is kinetic energy required for molecules to rearrange themselves in a reaction?	Molecules must collide with sufficient speed to overcome the repulsion of their negative electron clouds. Only when this repulsion is overcome can a nucleus in one molecule come close enough to the electrons in another molecule to form a bond.