

Chemguide – questions

FACTORS AFFECTING RATES OF REACTION

These questions cover the effects of surface area, concentration, pressure, temperature and catalysts on rates of reaction.

- Aluminium reacts with warm dilute hydrochloric acid to give aluminium chloride solution and hydrogen. Explain why the reaction of dilute hydrochloric acid with aluminium foil is fairly slow whereas the reaction with the same mass of aluminium powder can be extremely vigorous.
- This question involves reactions that may be unfamiliar. That doesn't matter in the least. Everything you need to know has been explained on the page about the effect of concentration on rates.

a) 1-bromopropane reacts with sodium hydroxide solution to give propan-1-ol. The hydroxide ions replace the bromine in the organic molecule.

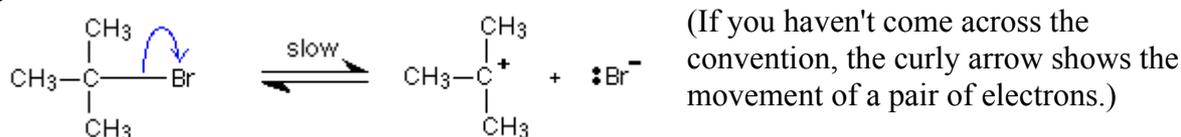


This is a simple reaction involving a collision between the 1-bromopropane and the hydroxide ions. What do you think the effect would be if you doubled the concentrations of both reactants? Explain your answer.

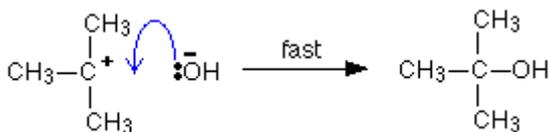
b) This is about a more complicated compound undergoing a similar reaction:



This reaction takes place in two separate stages. In the first one, the organic compound ionises slowly to some extent:



That is followed by a very fast reaction between the organic ion and hydroxide ions.



(i) What do you think the effect of doubling the concentration of $(\text{CH}_3)_3\text{CBr}$ would be? Explain your answer.

(ii) What do you think the effect of doubling the concentration of hydroxide ions would be? Explain your answer.

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3. For gases, increasing the pressure is equivalent to increasing their concentration. The molecules are forced more closely together, and will hit each other more frequently.

Use the ideal gas equation, $pV = nRT$, to show that pressure and concentration are directly proportional to each other.

4. a) Sketch the Maxwell-Boltzmann Distribution showing the numbers of molecules in a gas having a particular energy at a temperature T .
- b) Show how this distribution changes if you increase the temperature by a small amount to $T+t$.
- c) Use your graphs to explain why a small increase in temperature can cause a much greater proportional increase in the rate of reaction. - for example, why a 10 K increase in temperature from 290 to 300 K will roughly double the rate of many reactions.
- d) Give any other minor factor(s) also causing rates of reaction to increase as temperature increases.
5. a) Define the word *catalyst*.
- b) Draw simple energy profiles to help you to explain how the catalyst affects the activation energy of a reaction.
- c) Draw a Maxwell-Boltzmann Distribution to help you to explain why the effect you have talked about in part (b) increases the rate of the reaction.