

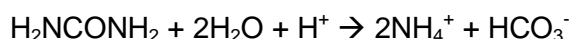
Rate of hydrolysis of urea

Teacher and technician sheet

The kinetics of urea hydrolysis by urease is discussed in detail by G. B. Kistiakowsky, Arthur J. Rosenberg, *J. Am. Chem. Soc.*, **1952**, 74 (20), pp 5020–5025.

(<http://pubs.acs.org/doi/abs/10.1021/ja01140a009>)

Enzymes display enormous catalytic power, accelerating reaction rates as much as 10^{16} over uncatalysed levels, which is far greater than any synthetic catalysts can achieve, and enzymes accomplish these astounding feats in dilute aqueous solutions under mild conditions of temperature and pH. For example, the enzyme jack bean *urease* catalyzes the hydrolysis of urea:



At 20°C, the rate constant for the enzyme-catalyzed reaction is $3 \times 10^4/\text{sec}$; the rate constant for the uncatalysed hydrolysis of urea is $3 \times 10^{-10}/\text{sec}$. Thus, 10^{14} is the ratio of the catalyzed rate to the uncatalysed rate of reaction. Such a ratio is defined as the relative **catalytic power** of an enzyme, so the catalytic power of urease is 10^{14} .

Equipment and materials

Each student or pair of students will require:

- electronic balance
- 25 cm³ measuring cylinder
- 100 cm³ conical flask
- coffee grinder (or similar device)
- Buchner flask and funnel (or 50 cm³ plastic syringe)
- 100 cm³ beaker
- pH meter
- Magnetic stirrer
- Burette and burette clamp
- 2 cm³ graduated pipette
- Dropping pipette (2)
- Cotton wool
- Whole soya beans
- 0.66 mol dm⁻³ urea solution
- 0.1 mol dm⁻³ hydrochloric acid
- 0.1 mol dm⁻³ sodium hydroxide solution

Make sure students wear eye protection. 0.1 mol dm⁻³ sodium hydroxide solution is an irritant.

Further suggestions

Students could investigate how the rate of hydrolysis depends upon the concentration of

- urea;
- urease;
- temperature;
- metal ions such as Cu²⁺(aq) or Pb²⁺(aq);
- organic molecules such as ethanol or sucrose.