# 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:

$$H_2NCONH_2 + 2H_2O + H^+ \rightarrow 2NH_4^+ + HCO_3^-$$

At 20°C, the rate constant for the enzyme-catalyzed reaction is 3 x $10^4$/sec; the rate constant for the uncatalysed hydrolysis of urea is 3 x $10^{-10}$/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 $cm^3$ measuring cylinder
- 100 $cm^3$ conical flask
- coffee grinder (or similar device)
- Buchner flask and funnel (or 50 $cm^3$ plastic syringe)
- 100 $cm^3$ beaker
- pH meter
- Magnetic stirrer
- Burette and burette clamp
- 2 $cm^3$ 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 $Cu^{2+}(aq)$ or $Pb^{2+}(aq)$;
- organic molecules such as ethanol or sucrose.