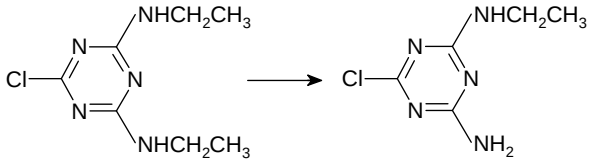
Chemistry 2710 Spring 2001 Assignment 4

Due: Friday, March 16, 9:00 a.m.

1. Chlorotriazines are widely used as herbicides. Their principal mode of action is to inhibit photosynthesis. They do not degrade readily in the environment so that they tend to accumulate in soils and in water. They are not very toxic to mammals,[1] but there are some questions about their long-term effects on the endocrine system. Studies of the in vivo fates of the compounds are therefore of considerable interest. Simazine (2-chloro-4,6-bis(ethylamino)-1,3,5-triazine) is metabolized, chiefly in the liver, to 2-chloro-4-ethylamino-6-amino-1,3,5-triazine:



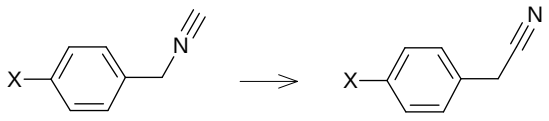
simazine

Hanioka et al.[2] have studied the kinetics of this reaction catalyzed by a rat liver extract containing 400 μg of protein. Their data are shown below:

[simazine] (μmol/L)	13	25	48	93	194
v (nmol L^{-1}s^{-1})	0.26	0.39	0.53	0.56	0.62

Determine the Michaelis constant and $V_{\max}$. We don't know how much of the relevant enzyme (probably cytochrome P450) is contained in the extract. Traditionally, $V_{\max}$ in these cases is given on a per g of protein basis.[3] Express your answer in this form. [10 marks]

2. Kim, Zhu and Kim have studied the first-order thermal isomerization of para-substituted benzyl isocyanides:[4]



[1] The LD_{50}, the dose that kills 50% of the rats to which it is administered, is about 3 g/kg.

[2] N. Hanioka et al., Toxicol. Appl. Pharmacol. **156**, 195 (1999).

[3] This quantity is sometimes called the specific activity and is used as a measure of the amount of active enzyme in a preparation.

[4] S.S. Kim, W.J. Choi and J.H. Kim, J. Org. Chem. **63**, 1185 (1998).

The measured rate constants are as follows for the reaction in benzene:

	$10^5 k$ (s^{-1}) for different substituents X				
T (°C)	-H	$-CH_3$	$-OCH_3$	-Cl	$-NO_2$
170	2.01	2.61	3.46	1.95	1.47
190	9.94	13.0	16.9	9.54	7.26
210	45.2	59.4	78.6	44.3	33.4
230	228	295	396	226	166

(a) Calculate the activation energy and preexponential factor for each of the reactions. [15 marks]

(b) The reaction is apparently elementary and proceeds via a triangular transition state, i.e. the cyanide group "rotates" during the reaction. Calculate the enthalpy and entropy of activation for each reaction at 200°C. Comment on what the results tell us about the effects of the substituents on the transition state. [15 marks]

Note: This problem is very data-rich and the calculations are somewhat repetitive. You should therefore feel free to use a spreadsheet to automate your calculations. However, make sure to give a full set of sample calculations whether you use a spreadsheet or not.