1. Experimental data for the one-step reaction A → B + C have been plotted in three different ways:

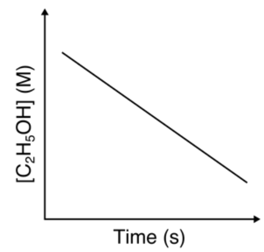
   (i) $\frac{1}{[A]}$ vs. time, which gives a straight line with a positive slope
   (ii) [A] vs. time, which gives a curved line
   (iii) ln[A] vs. time, which gives a curved line

   Based on this information, write the rate law for this reaction and determine the units of *k*.

2. The decomposition of ethanol (C_2H_5OH) on an alumina (Al_2O_3) surface was studied at 400 K.

$$C_2H_5OH\ (g) \rightarrow C_2H_4\ (g) + H_2O\ (g)$$

   You plot the [C_2H_5OH] vs. time and obtain a straight-line relationship (shown to the right) with a slope of -4.00×10^{-5} M/s.



   A) What is the half-life if the initial concentration of C_2H_5OH is 1.25×10^{-2} M?

   B) Determine the time required for 1.25×10^{-2} M C_2H_5OH to *completely* decompose?

3. The activation energy for the following reaction is E_a = 32 kJ/mol and ΔE = −17 kJ/mol.

$$NO_2\ (g) + CO\ (g) \rightarrow NO\ (g) + CO_2\ (g)$$

   Assuming this is a single-step reaction, draw and label an energy diagram for this reaction and calculate the activation energy for the reverse reaction (E_a').

4. Consider the following reaction again:

$$2\ NO\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$$

A) Determine the rate law for the reaction using the initial rates data collected at 298 K.

Experiment	$[NO]_o$ (M)	$[O_2]_o$ (M)	Initial Rate (M/s)
1	0.10	0.20	4.1×10^2
2	0.20	0.10	8.2×10^2
3	0.10	0.30	6.15×10^2

B) Which of the following are valid mechanisms for the reaction above?

Mechanism 1:
step 1) $NO\ (g) + O_2\ (g) \rightarrow NO_2\ (g) + O\ (g)$ (slow)
step 2) $NO\ (g) + O\ (g) \rightarrow NO_2\ (g)$ (fast)

Mechanism 2:
step 1) $2\ NO\ (g) \rightarrow N_2O_2\ (g)$ (fast)
step 2) $N_2O_2\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$ (slow)

Mechanism 3:
step 1) $2\ NO\ (g) \rightarrow N_2\ (g) + O_2\ (g)$ (fast)
step 2) $N_2\ (g) + 2\ O_2\ (g) \rightarrow 2\ NO_2\ (g)$ (slow)

Mechanism 4:
step 1) $NO\ (g) + O_2\ (g) \rightleftharpoons NO_3\ (g)$ (fast)
step 2) $NO_3\ (g) + NO\ (g) \rightarrow 2\ NO_2\ (g)$ (slow)

Mechanism 5:
step 1) $2\ NO\ (g) \rightarrow N_2O_2\ (g)$ (fast)
step 2) $N_2O_2\ (g) \rightarrow NO_2\ (g) + N\ (g)$ (slow)
step 3) $N\ (g) + O_2\ (g) \rightarrow NO_2\ (g)$ (fast)

5. Consider the hydrolysis of urea (reaction below):

$$H_2NCONH_2\ (aq) + 3\ H_2O\ (l) \rightarrow 2\ NH_4^+\ (aq) + OH^-\ (aq) + HCO_3^-\ (aq)$$

A) You find the activation energy for the uncatalyzed reaction to be 138 kJ/mol. Calculate the rate constant (k_{uncat}) for the uncatalyzed reaction at 37.0 °C assuming $A = 8.66 \times 10^{12}\ s^{-1}$.

B) You find the activation energy for the catalyzed reaction to be 38.0 kJ/mol with the enzyme urease present. Calculate the rate constant (k_{cat}) for the catalyzed reaction at 37.0 °C assuming $A = 8.66 \times 10^{12}\ s^{-1}$.

C) Calculate the temperature, theoretically, to which you would need to heat the uncatalyzed reaction to in order for the rate of the uncatalyzed reaction to be equal to the rate of the catalyzed reaction at 37.0 °C.

Assume the overall rate order, concentrations, and frequency factor (A) are constant between the catalyzed and uncatalyzed reactions.