TUTORIAL CHEMICAL KINETICS

1. If the reaction is zeroth (0th) order with respect to [X], which of the following quantities when plotted vs. *t* should be a straight line: ln[X], 1/[X], [X], or $[X]^2$?
2. The decomposition of HI is a classical second order reaction.
   2HI→H2+I2(s) In an experiment starting at 8:00 am, the partial pressure of HI decreases from 30.0 Pa to 15.0 Pa at 8:45 am (at a constant temperature). What shall the time be for the partial pressure of HI to reduce to 3.75 Pa?
3. The decomposition of A is first order, and [A] is monitored. The following data are recorded:

t / min	0	1	2	3
[A]/[M]	0.100	0.0905	0.0819	0.670

   Calculate *k*. Calculate the half-life.

   Calculate [A] when *t* = 5 min. Calculate *t* when [A] =0.0100
4. The dimerization reaction of butadiene is second order process: $2C_4H_{6(g)} \rightarrow C_8H_{12(g)}$. The rate constant at some temperature is 0.100 /min with an initial concentration of butadiene ([B]) of 1 M. Calculate the concentration of butadiene at 1, 2, 5, 10, 20, 30, and 70 minutes.
5. Radioactive decay always follows first order kinetics. Carbon-11 is a radioactive isotope of carbon, and its half-life is 20.3 min. What is the decay constant?
6. In a first order reaction, A --> B. The half-life is 10 days. Determine its rate constant k? How much time required for this reaction to be at least 50% and 60% complete?
7. Given the data below, find the rate law for the following reaction at 300 K and the corresponding rate constant.

$$A+B \rightarrow C+D$$

Trial	$[A]_{initial}$ (M)	$[B]_{initial}$ (M)	$r_{initial}$ (M/sec)
1	1	1	2
2	1	2	8.1
3	2	2	15.9

8. A reaction involving reactant A has a rate constant of $1.4 \times 10^{-4}\ s^{-1}$. If 1.0 *M* of reactant reacts for 25 minutes, how much is left?

9. Hydrogen peroxide decomposes in a dilute sodium hydroxide solution at 20°C in a first order

$$H_2O_{2(aq)} \rightarrow H_2O_{(l)}+1/2O_{2(g)}.$$

   The rate = $k[H_2O_2]$ with k=1.06 x 10^{-3} min^{-1}. What is the fraction remaining after 100.0 min? What is the concentration of H_2O_2 after 100.0 min if the initial concentration of H_2O_2 is 0.020 mol/L?

10. The gas phase decomposition of dinitrogen pentoxide at 335 K

$$2\ N_2O_5 \rightarrow 4\ NO_2 + O_2$$

is first order in N_2O_5. During one experiment it was found that an initial concentration of 0.249 M dropped to 0.0496 M in 230 s. What is the value of the rate constant, k, in s^{-1}?

11. The reaction between CS_2 and ozone was studied using a large excess of CS_2.

$$CS_{2(g)} + 2O_{3(g)} \rightarrow CO_{2(g)} + 2SO_{3(g)}$$

The pressure of ozone as a function of time is given in the following table. Is the reaction first order or second order with respect to ozone?

Time (s)	Ozone pressure (torr)
0	1.76
30	1.04
60	0.79
120	0.52
180	0.37
240	0.29

12. According to the information provided on some milk cartons, homogenized milk will keep for 1/3 day at 80°F, for ½ day at 70°F, for 1 day at 60°F, for 2 days at 50°F, for 10 days at 40°F, and for 24 days at 32°F. Calculate the activation energy for the process that spoils milk.

13. The enzyme carbonic anhydrase catalyzes both the forward and the reverse reactions for the hydration of CO2 according to:

$$H_2O + CO_2 \rightarrow HCO_3^- + H^+$$

Carbonic anhydrase has a single active site and its molecular mass is 30,000 g/mol. If 8.0 µg of carbonic anhydrase catalyzes the hydration of 0.146 g of CO_2 in 30 seconds at 37°C, what is the turn over number of the enzyme?

14. At T = 400 K, the rate of decomposition of a gaseous compound initially at a pressure of p0 = 12.6 kPa, was $\nu_1 = 9.71\ Pa\ s^{-1}$ when 10.0 percent had reacted (extent of reaction $\xi 1 = 0.100$) and $\nu_2 = 7.67\ Pa\ s^{-1}$ when 20.0 percent had reacted ($\xi 2 = 0.200$). Find the order of the reaction.

15. The decomposition of ozone is depicted below:

Step 1: $O_3 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} O_2 + O$

Step 2: $O + O_3 \xrightarrow{k_2} O_2 + O$ (slow step)

What is steady state approximation? Find the expression of rate of decomposition of O_3 (using steady state approximation)