Kinetics Problems (calculator required)

1. The rate equation for the reaction: $2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$ is second order in $NO(g)$ and first order in $H_2(g)$.
   a) Write an equation for the rate of appearance of $N_2(g)$. **(rate = $k[NO]^2[H_2]$)**
   b) If concentrations are expressed in mol/Litre, what units would the rate constant, **k**, have?
   ($M^{-2}s^{-1}$)
   c) Write an equation for the rate of disappearance of $NO(g)$. Would **k** in this equation have the same numerical value as **k** in the equation of part (a)? **(rate = $2k[NO]^2[H_2]$, yes)**

2. For a reaction in which A and B combine to form C, the following data were obtained:

measured reaction rate (mol/L-s)	[A] (mol/L)	[B] (mol/L)
0.0007	0.30	0.15
0.0028	0.60	0.30
0.0014	0.30	0.30

   a) What is the rate law for the reaction? **(rate = k[A][B])**
   b) What is the numerical value of and units for the rate constant, **k**? **(1.56×10^{-2} $M^{-1}s^{-1}$)**

3. The following data for the hydrolysis of $(CH_3)_3CBr$ in a solvent consisting of 10% water and 90% acetone were obtained at 25°C:

t(***h***)	$[(CH_3)_3CBr]$, M
0.00	0.1039
3.15	0.0896
4.10	0.0859
6.20	0.0776
8.20	0.0701
10.0	0.0639
26.0	0.0270

   a) Prepare a graph of concentration versus time, and use it to determine the initial reaction rate and the rate at 14.0 hours. **(5.4×10^{-3} M-hr^{-1}, 2.6×10^{-3} M-hr^{-1})**
   b) Show graphically that the hydrolysis of $(CH_3)_3CBr$ follows first order kinetics.
   c) Evaluate the rate constant at 25°C. **(5.22×10^{-2} hr^{-1})**
   d) How many hours would it take to hydrolyze 80% of a sample of $(CH_3)_3CBr$ at 25°C? **(31)**

4. A study of the reaction

   $SO_2Cl_2(g) \rightarrow SO_2(g) + Cl_2(g)$

   at 593 K shows that it is first order and that 10.0% of the SO_2Cl_2 decomposes in 80.0 minutes.
   a) Calculate **k** for the reaction at 593 K. **(1.3×10^{-3} min^{-1})**
   b) How many minutes will it take for a 5.00 mmol sample of SO_2Cl_2 to decompose to 3.50 mmol? **(271)**

5. Ethyl Acetate ($CH_3CO_2C_2H_5$) reacts with hydroxide ion in aqueous solution according to the reaction:

   $CH_3CO_2C_2H_5(aq) + OH^-(aq) \rightarrow CH_3COO^-(aq) + C_2H_5OH(aq)$

   The reaction is known to be second order. An experiment was carried out and the following data were obtained:

Time (**s**)	**M** (of each reactant)
0.0	0.01000
60.0	0.00917
120.0	0.00840
180.0	0.00775
240.0	0.00724
300.0	0.00675

   a) Determine the rate constant for the reaction. **(0.16 $M^{-1}s^{-1}$)**
   b) Determine the half-life for this reaction given the initial conditions above. **(617 s)**
   c) Calculate the time required for 75% of the initial ethyl acetate to react. **(1851 s)**