AP Chemistry - Kinetics Problems Part 2

1) Compound A decomposes to form B and C in a reaction that is first order with respect to A and first order overall. At 25°C, the specific rate constant for the reaction is 0.0450 s^{-1}. What is the half-life of A at 25°C? Reaction is A + B → C

2) The first-order rate constant for the radioactive decay of radium-223 is 0.0606 day^{-1}. What is the half-life of radium-223 isotope?

3) The reaction $2N_2O_5(g) \rightarrow 2N_2O_4(g) + O_2(g)$ obeys the rate law: rate = k $[N_2O_5]$, in which the specific rate constant is 0.00840 s^{-1} at a certain temperature. (a) If 2.50 moles of N_2O_5 were placed in a 5.00-liter container at that temperature, how many moles of N_2O_5 would remain after 1.00 minute? (b) How long would it take for 90% of the original N_2O_5 to react?

4) The decomposition reaction of carbon disulfide, CS_2, to carbon monosulfide, CS, and sulfur is first order with k = 2.8 x 10^{-7} s^{-1} at 1000°C.

Reaction is: $CS_2 \rightarrow CS + S$

(a) What is the half-life of this reaction at 1000°C? (b) How many days would pass before a 2.00-gram sample of CS_2 had decomposed to the extent that 0.75 gram of CS_2 remained? (c) Refer to part (b). How many grams of CS would be present after this length of time? (d) How much of a 2.00-gram sample of CS_2 would remain after 45.0 days?

5) Cyclopropane rearranges to form propene in a reaction that follows first-order kinetics. At 800. K, the specific rate constant for this reaction is 2.74 x 10^{-3} s^{-1}. Suppose we start with a cyclopropane concentration of 0.290 M. How long will it take for 99.0% of the cyclopropane to disappear according to this reaction?

6) Compounds A and B react to form C and D in a reaction that was found to be second order in A and second order overall. The rate constant at 30°C is 0.622 liter per mole per minute. What is the half-life of A when 4.10 x 10^{-2} M of A is mixed with excess B?

$A + B \rightarrow C + D$ and rate = $k[A]^2$

7) The gas-phase decomposition of NOBr is second order in [NOBr], with k = 0.810 $M^{-1} \bullet s^{-1}$ at 10°C. We start with 4.00 x 10^{-3} M NOBr in a flask at 10°C. How many seconds does it take to use up 1.50x10^{-3} M of this NOBr?

$2NOBr(g) \rightarrow 2NO(g) + Br_2(g)$ and rate = $k[NOBr]^2$

8) Consider the reaction of problem above at 10°C. If we start with 2.40 x 10^{-3} M NOBr, what concentration of NOBr will remain after 5.00 minutes of reaction?

9) The rate constant for the decomposition of nitrogen dioxide $2NO_2 \rightarrow 2NO + O_2$ with a laser beam is 1.70 $M^{-1} \bullet min^{-1}$. Find the time, in seconds, needed to decrease 2.00 mol/L of NO_2 to 1.25 mol/L.

10) The second-order rate constant for the following gas phase reaction is 0.0442 $M^{-1} \bullet s^{-1}$. We start with 0.135 mol C_2F_4 in a 2.00-liter container, with no C_4F_8 initially present.

$2C_2F_4 \rightarrow C_4F_8$

(a) What will be the concentration of C_2F_4 after 1.00 hour? (b) What will be the concentration of C_4F_8 after 1.00 hour? (c) What is the half-life of the reaction for the initial C_2F_4 concentration given in part (a)? (d) How long will it take for half of the C_2F_4 that remains after 1.00 hour to disappear?

11) Answer the questions for the reaction below.

$2NO_2 \rightarrow 2NO + O_2$ rate = 1.4 x 10^{-10} $M^{-1} \bullet s^{-1}$ $[NO_2]^2$ at 25°C

(a) If 3.00 mol of NO_2 is initially present in a sealed 2.00-L vessel at 25°C, what is the half-life of the reaction? (b) Refer to part (a). What concentration and how many grams of NO_2 remain after 115 years? (c) Refer to part (b). What concentration of NO would have been produced during the same period of time?

12) We carry out the reaction A + B → C at a particular temperature. As the reaction proceeds, we measure the molarity of the reactant, [A], at various times. The observed data are tabulated below.

Time (min)	[A] (mol /L)	Time (min)	[A] (mol /L)
0.00	2.000	6.00	0.338
2.00	1.107	8.00	0.187
4.00	0.612	10.00	0.103

(a) Plot [A] versus time. (b) Plot ln [A] versus time. (c) Plot 1/[A] versus time. (d) What is the order of the reaction? (e) Write the rate-law expression for the reaction. (f) What is the value of k at this temperature?

13) The following data were obtained from a study of the decomposition of a sample of HI on the surface of a gold wire.

t (sec)	[HI] (mM)
0.	5.46
250.	4.10
500.	2.73
750.	1.37

(a) Plot the data to find the order of the reaction, the rate constant, and the rate equation. (b) Calculate the HI concentration in mmol/L at 600. seconds.

14) The decomposition of SO_2Cl_2 in the gas phase, can be studied by measuring the concentration of Cl_2 as the reaction proceeds. We begin with $[SO_2Cl_2]^0 = 0.250$ M. Holding the temperature constant at 320.°C, we monitor the Cl_2 concentration, with the following results:

$$SO_2Cl_2 \rightarrow SO_2 + Cl_2$$

t (hours)	$[Cl_2]$ (mol/L)	t (hours)	$[Cl_2]$ (mol/L)	t (hours)	$[Cl_2]$ (mol/L)
0.00	0.000	8.00	0.117	16.00	0.180
2.00	0.037	10.00	0.137	18.00	0.190
4.00	0.068	12.00	0.153		
6.00	0.095	14.00	0.168		

(a) Plot $[Cl_2]$ versus t. (b) Plot $[SO_2Cl_2]$ versus t. (c) Determine the rate law for this reaction. (d) What is the value, with units, for the specific rate constant at 320.°C? (e) How long would it take for 95% of the original SO_2Cl_2 to react?