Problems of Chemical kinetics

1) Consider the reaction 2A + 3B → 3C + 4D.
Calculate the rate of formation of C and D in mol/(L·s) when reactant A is consumed at a rate of 1.38 mol/(L·s).

2) Consider the reaction A + B → C.
The rate of the reaction is *rate* = 30000·[A] mol/(L·s). Find out:

a) Reaction order in A and B. Overall order of the reaction.
b) Rate constant and its units.
c) Rate of the reaction when $[A]_0$ = 0.42 mol/L and $[B]_0$ = 0.89 mol/L.

3) Given the reaction A + 2B → 3C + 4D.
If all compounds are gases, find out the rate of reaction measured as the change in molarity per unit time for each reactant consumed and each product formed.

4) For the reaction A + 2B → C + D. The following data were obtained for three experiments.

Experiment	$[A]_0$ mol/L	$[B]_0$ mol/L	Initial rate v_0 mol/(L·s)
1	0.94	1.14	658.5
2	0.47	0.38	37.33
3	0.47	1.14	332.6

Calculate:

a) Reaction order in A and B. Overall order of the reaction.
b) Rate law for the reaction.
c) Rate constant and its units.
d) Rate of the reaction when [A] = 2.115 mol/L and [B] = 1.33 mol/L.

Problems of Chemical kinetics

5) Consider the reaction 2A + B $\rightarrow$ 3C + D. The following data were obtained for three experiments.

Experiment	$[A]_0$ mol/L	$[B]_0$ mol/L	Initial rate v_0 mol/(L·s)
1	0.54	1.16	1766
2	0.27	1.16	441.4
3	0.27	0.58	110.4

Determine:

a) Reaction order in A and B. Overall order of the reaction.
b) Rate law for the reaction.
c) Rate constant and its units.
d) Rate of the reaction when [A] = 0.945 mol/L and [B] = 2.9 mol/L.

6) Given the reaction A + 2B $\rightarrow$ C + D. The following data were obtained for three experiments.

Experiment	$[A]_0$ mol/L	$[B]_0$ mol/L	Initial rate v_0 mol/(L·s)
1	1.26	0.25	176.8
2	0.42	0.5	346.5
3	0.42	0.25	175

Calculate:

a) Reaction order in A and B. Overall order of the reaction.
b) Rate law for the reaction.
c) Rate constant and its units.
d) Rate of the reaction when [A] = 2.1 mol/L and [B] = 1 mol/L.

7) The rate constant of a reaction is 18.2 $mol^{-2}·L^{2}·s^{-1}$ at 24 °C and 154.9 $mol^{-2}·L^{2}·s^{-1}$ at 55 °C. Find out: **a)** The activation energy. **b)** The frequency factor *A* (pre–exponential factor) of the Arrhenius equation (assuming that *A* does not change with temperature). **c)** The value of the rate constant *K* at 79 °C.
Data: *R* = 8.3145 $J·mol^{-1}·K^{-1}$.

8) Changing the temperature of a reaction from 78 °C to 85 °C causes the rate constant, *K*, to increase by a factor of 2. **a)** Calculate the activation energy for this reaction. **b)** If the rate constant *K* at 98 °C is 0.01072 $mol^{-1}·L·s^{-1}$ find out the value of *K* at 69 °C.
Data: *R* = 8.3145 $J·mol^{-1}·K^{-1}$.

Problems of Chemical kinetics

9) At 73 °C the rate constant of a reaction is 1.197×10^{-4} $mol^{-1}\cdot L\cdot s^{-1}$. If the activation energy is 99 kJ/mol, what is the value of *K* at 102 °C?
Data: $R = 8.3145$ $J\cdot mol^{-1}\cdot K^{-1}$.

10) The rate constant of a reaction is 90.01 $mol^{-2}\cdot L^{2}\cdot s^{-1}$ at 62 °C and 320.4 $mol^{-2}\cdot L^{2}\cdot s^{-1}$ at 83 °C. Find out: **a)** The activation energy. **b)** The frequency factor *A* (pre–exponential factor) of the Arrhenius equation (assuming that *A* does not change with temperature). **c)** The value of the rate constant *K* at 110 °C.
Data: $R = 8.3145$ $J\cdot mol^{-1}\cdot K^{-1}$.

11) Changing the temperature of a reaction from 58 °C to 76 °C causes the rate constant, *K*, to increase by a factor of 3. **a)** Calculate the activation energy for this reaction. **b)** If the rate constant *K* at 93 °C is 23880 s^{-1} find out the value of *K* at 52 °C.
Data: $R = 8.3145$ $J\cdot mol^{-1}\cdot K^{-1}$.

12) At 45 °C the rate constant of a reaction is 1.535×10^{-7} $mol^{-2}\cdot L^{2}\cdot s^{-1}$. If the activation energy is 111 kJ/mol, what is the value of *K* at 62 °C?
Data: $R = 8.3145$ $J\cdot mol^{-1}\cdot K^{-1}$.

Answers:

1)	Rate(C) = 2.07 mol/(L·s), Rate(D) = 2.76 mol/(L·s)
2)	**a)** 1, 0, 1; **b)** 30000 s^{-1}; **c)** 12600 mol/(L·s)
3)	$rate = -\frac{d[A]}{dt} = -\frac{1}{2}\frac{d[B]}{dt} = \frac{1}{3}\frac{d[C]}{dt} = \frac{1}{4}\frac{d[D]}{dt}$
4)	**a)** 1, 2, 3; **b)** $v = k\cdot[A]\cdot[B]^2$; **c)** 550 $mol^{-2}\cdot L^{2}\cdot s^{-1}$; **d)** 2058 mol/(L·s)
5)	**a)** 2, 2, 4; **b)** $v = k\cdot[A]^2\cdot[B]^2$; **c)** 4500 $mol^{-3}\cdot L^{3}\cdot s^{-1}$; **d)** 33800 mol/(L·s)
6)	**a)** 0, 1, 1; **b)** $v = k\cdot[B]$; **c)** 700 s^{-1}; **d)** 700 mol/(L·s)
7)	**a)** 56 kJ/mol; **b)** 1.270×10^{11} $mol^{-2}\cdot L^{2}\cdot s^{-1}$; **c)** 627.3 $mol^{-2}\cdot L^{2}\cdot s^{-1}$.
8)	**a)** 103.5 kJ/mol; **b)** 6.236×10^{-4} $mol^{-1}\cdot L\cdot s^{-1}$.
9)	1.710×10^{-3} $mol^{-1}\cdot L\cdot s^{-1}$.
10)	**a)** 60 kJ/mol; **b)** 2.020×10^{11} $mol^{-2}\cdot L^{2}\cdot s^{-1}$; **c)** 1336 $mol^{-2}\cdot L^{2}\cdot s^{-1}$.
11)	**a)** 58.67 kJ/mol; **b)** 2102 s^{-1}.
12)	1.290×10^{-6} $mol^{-2}\cdot L^{2}\cdot s^{-1}$.