**Exercise – Calculating Rate**

**Part A**

1. For the reaction A → products, the following data was collected:

|  |  |
| --- | --- |
| Time (min) | Mass of A (g) |
| 0.0 | 25.0 |
| 1.0 | 20.0 |
| 2.0 | 17.0 |
| 3.0 | 15.0 |
| 4.0 | 13.0 |
| 5.0 | 12.0 |

a) What is the average rate, in g A/min, over the entire 5 minutes?  
b) What is the average rate for the interval between 2.0 and 4.0 minutes?

2. The decomposition of acetaldehyde to methane and carbon dioxide occurs according to the following equation:

CH3CHO(g) → CH4(g) + CO(g)

The results of an experiment are given below:

|  |  |
| --- | --- |
| Time (s) | [CH3CHO] (mol/L) |
| 42 | 0.00667 |
| 73 | 0.00626 |
| 105 | 0.00586 |
| 190 | 0.00505 |
| 242 | 0.00464 |
| 310 | 0.00423 |
| 384 | 0.00383 |
| 480 | 0.00342 |
| 665 | 0.00282 |
| 840 | 0.00241 |

1. What is the rate of decomposition of acetaldegyde between 42 s and 105 s?
2. What is the rate of decomposition in the interval 190 s to 480 s?

3. Below is the data from an experiment that studied the following reaction:

2 HCl(aq) + CaCO3(s) → CaCl2(aq) + H2O(l) + CO2(g)

HCl was placed in a beaker and massed immediately after adding CaCO3 chips (time = 0). The mass of the beaker was recorded at 1.0 minute intervals for a total of 15 min. We will assume the loss of mass is the amount of carbon dioxide gas that escapes from the beaker.

|  |  |  |
| --- | --- | --- |
| **Time (min)** | **Mass of beaker and contents (g)** | **Mass loss (CO2 produced) (g)** |
| 0.0 | 200.00 |  |
| 1.0 | 199.40 |  |
| 2.0 | 199.00 |  |
| 3.0 | 198.65 |  |
| 4.0 | 198.35 |  |
| 5.0 | 198.10 |  |
| 6.0 | 197.90 |  |
| 7.0 | 197.75 |  |
| 8.0 | 197.65 |  |
| 9.0 | 197.57 |  |
| 10.0 | 197.52 |  |

a) Complete the table.

b) Determine the average rate, in g of CO2/min, over the entire 10 minutes.

c) Determine the average rate for the intervals:

i) First 3 minutes.  
ii) Last 3 minutes.

**Part B**

The formation of nitrogen dioxide from nitrogen dioxide and oxygen gas was studied. The balanced equation for the reaction is:

O2(g) + 2 NO(g) → 2 NO2 (g)

The chemist measured the concentration of the three gases at various time intervals. The data is in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Time (min)** | **Concentration (mol/L)** | | |
| **O2** | **NO** | **NO2** |
| 0.0 | 0.000343 | 0.000514 | 0.000000 |
| 2.0 | 0.000317 | 0.000461 | 0.000053 |
| 4.0 | 0.000289 | 0.000406 | 0.000108 |
| 6.0 | 0.000271 | 0.000368 | 0.000146 |
| 10.0 | 0.000242 | 0.000311 | 0.000204 |
| 16.0 | 0.000216 | 0.000259 | 0.000256 |
| 26.0 | 0.000189 | 0.000206 | 0.000308 |
| 41.0 | 0.000167 | 0.000162 | 0.000353 |
| 51.0 | 0.000158 | 0.000143 | 0.000372 |
| 61.0 | 0.000150 | 0.000127 | 0.000387 |
| 71.0 | 0.000144 | 0.000116 | 0.000399 |

Answer the following questions.

1. What is the average rate of consumption of nitrogen oxide and oxygen over the entire 71 minute interval? Determine the average rate for each.

2. What is the average rate of formation of nitrogen dioxide over the entire 71 minute interval?

3. What is the average rate of the consumption of NO and O2 and the production of NO2 each,

a) over the first 10 minutes  
b) over the last 10 minutes?