Quiz 1
Chem 1B, Spring 2020
Fossum

Name: Key

Always show your work and reasoning, include units, and check significant figures.

1. (8 points) For the following questions, include the appropriate sign.
a. Given the attached graph, determine the average rate of change of the reactant A from 16.0 seconds to 25.0 seconds.

① At 16.0 sec, [A] = 0.074 M ② At 25.0 sec, [A] = 0.038 M

$$\text{Average rate} = \frac{M_2 - M_1}{t_2 - t_1} = \frac{(0.038\text{M} - 0.074\text{M})}{(25.0\text{ sec} - 16.0\text{ sec})} = \frac{-0.036\text{ M}}{9.0\text{ sec}} = -0.0040\text{ M/sec}$$

Rate A = -0.0040 M/sec (2 sig figs)

b. Determine the rate of change of A at 3.0 seconds.

Draw tangent at 3.0 sec. Find slope. Choose 2 points far apart.

at 0.0 (x) sec, [A] = 0.236 (y) M
at 16.6 sec [A] = 0.000 M
(or 16.7 sec)

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{(0.000\text{M} - 0.236\text{M})}{(16.6\text{ sec} - 0.0\text{ sec})} = \frac{-0.236\text{M}}{16.6\text{ sec}} = -0.0142\text{ M/sec}$$

(3 sig figs)

c. Compare your answers to a and b and explain why they make sense.

Both are negative. This makes sense because A is a reactant and is decreasing.
The answer to @ has a smaller magnitude than the answer to (b). This makes sense because in the beginning, the rate is faster and the slope is steeper. As time goes on, the reaction rate decreases - so slower rate for later times in the reaction.

2. (3 points) For the hypothetical reaction: $4\,A_{(g)} + 3\,B_{(g)} \rightarrow C_{(g)} + 2\,D_{(g)}$

If the reactant A is changing at - 0.0178 M/sec, what is the rate of change of B?

$$\text{Rate} = -\frac{1}{4}\frac{\Delta[A]}{\Delta t} = -\frac{1}{3}\frac{\Delta[B]}{\Delta t} = \frac{\Delta[C]}{\Delta t} = \frac{1}{2}\frac{\Delta[D]}{\Delta t}$$

$$\frac{\Delta[B]}{\Delta t} = \frac{+3}{4}\frac{\Delta[A]}{\Delta t} = \frac{3}{4}(-0.0178\text{ M/sec}) = -0.01335\text{ M/sec}$$

(also ⊖ because B is decreasing)

$$\frac{\Delta[B]}{\Delta t} = -0.0134\text{ M/sec}$$

3. (9 points) For a hypothetical reaction involving X, Y, and Z, the following initial rate data is given:

Experiment	Initial [X], M	Initial [Y], M	Initial [Z], M	Initial Rate, M/min
1	0.050	0.020	0.018	0.054
2	0.100	0.020	0.018	0.43
3	0.050	0.080	0.018	0.86
4	0.050	0.020	0.090	0.27

a. Determine the rate law for the above reaction. Show your work and/or reasoning.

Comparing experiments 1, 2: Y and Z are constant.

X doubles. Rate $\frac{0.43}{0.054} = 7.96 \approx 8$ Rate 8× faster,

rate ratio = (conc. ratio)^x so $8 = 2^x$ $x = 3$ Third order in X.

Experiments 1, 3: X and Z are constant.

Y $\frac{0.080}{0.020} = 4$ Rate $\frac{0.86}{0.054} = 15.92 \approx 16$

$16 = 4^y$ $y = 2$ second order in Y.

Experiments 1, 4 X and Y are constant.

Z $\frac{0.090}{0.018} = 5$ Rate $\frac{0.27}{0.054} = 5$

$5 = 5^z$ $z = 1$ first order in Z

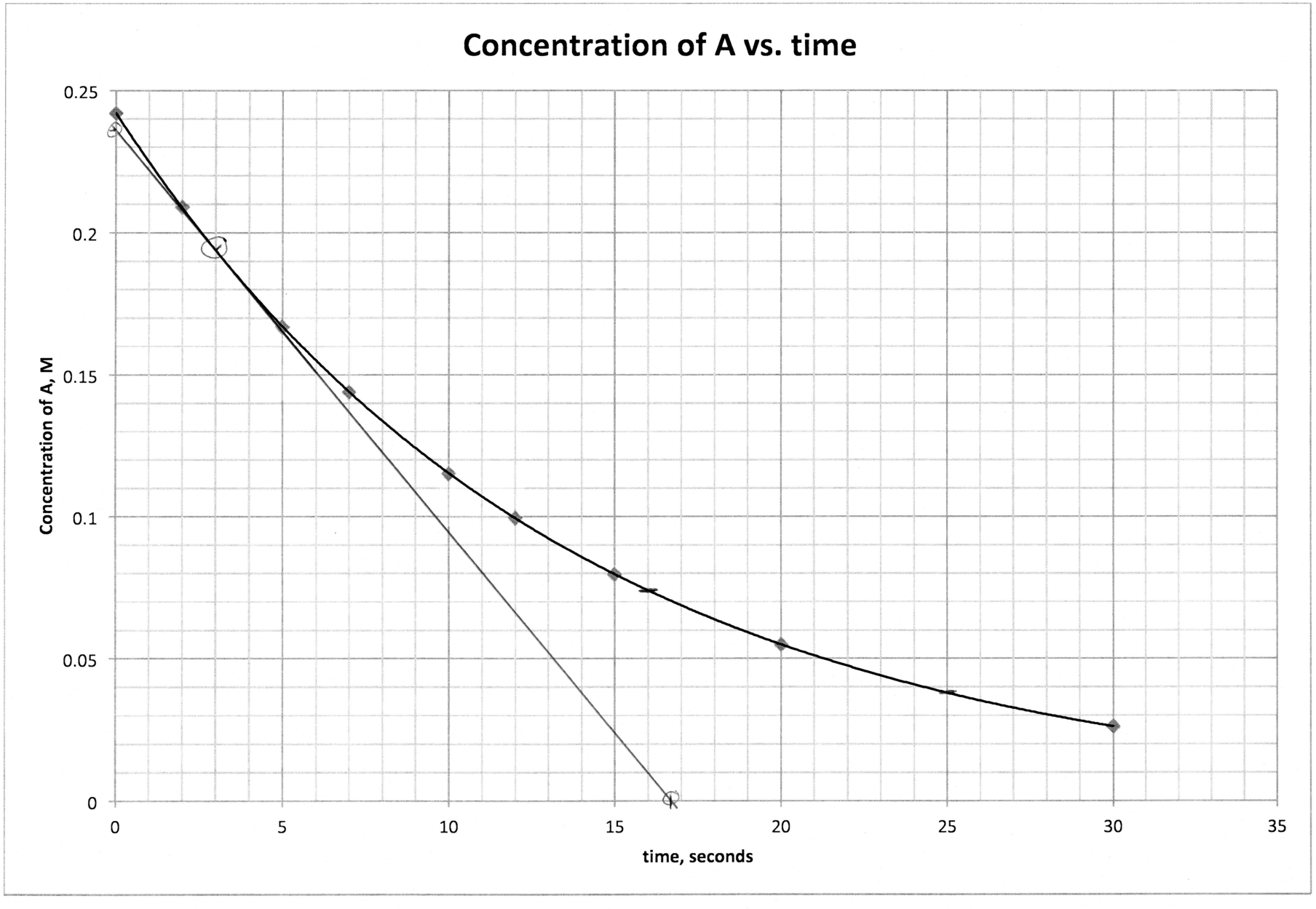
Rate law is: $\text{Rate} = k[X]^3[Y]^2[Z]$

b. Determine the rate constant for the above reaction.

$\text{Rate} = k[X]^3[Y]^2[Z]$ use any expt's data

$k = \frac{\text{Rate}}{[X]^3[Y]^2[Z]} = \frac{0.054\ M/min}{(0.050\ M)^3(0.020\ M)^2(0.018\ M)} = 6.0 \times 10^7\ M^{-5}\ min^{-1}$

units: $\frac{M/min}{M^3 \cdot M^2 \cdot M} = min^{-1} M^{-5}$ or $\frac{1}{min \cdot M^5}$


Concentration of A vs. time
Concentration of A, M
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
35
time, seconds