

Chemistry 1210 Spring 2024 Test 1

Friday, February 2, 2024

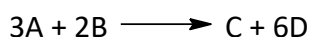
Time: 1 hour 50 minutes

Name: _____

Student #: _____

*This test consists of **nine** pages of questions, the formula sheet, and a periodic table. Please ensure that you have a complete test and, if you do not, obtain one from me **immediately**. There are **35.5** marks available. Good luck!*

1) **[9.5 marks total]** For the reaction



The following data were collected:

| Run | [A] (M) | [B] (M) | $\frac{\Delta[B]}{\Delta t} \left(\frac{M}{s}\right)$ |
|-----|---------|---------|---|
| 1 | 0.1 | 0.2 | -5.091×10^{-5} |
| 2 | 0.2 | 0.2 | -1.440×10^{-4} |
| 3 | 0.3 | 0.3 | -3.240×10^{-4} |

a) **[2 marks]** Determine the rate law for the reaction.

b) **[3 marks]** Determine the rate constant for the reaction. Include units.

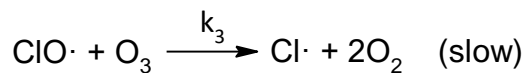
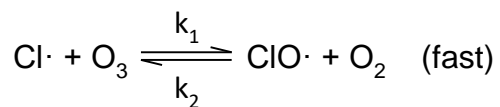
c) **[1 mark]** What will be the value of $\frac{\Delta[D]}{\Delta t}$ (in M/s) in run 3?

d) **[2 marks]** This reaction cannot occur in a single step. Give two reasons why.

e) **[0.5 marks]** What is the overall order of the reaction kinetics?

f) **[1 mark]** What is the order of the reaction kinetics with respect to compound C? How do you know? (No marks for guessing. 😊)

- 2) **[10 marks total]** The following mechanism has been proposed for the decomposition of ozone in the atmosphere:



- a) **[1 mark]** What is the overall reaction for the decomposition of ozone?
- b) **[0.5 marks]** Are there any catalysts? If so, what are they?
- c) **[0.5 marks]** Are there any reactive intermediates? If so, what are they?
- d) **[1 mark]** If you add more ozone (O_3) to the reaction above, the rate will increase, but past a certain amount of added ozone the rate will not increase any more. Why? (No marks for guessing. 😊)

e) **[2 marks]** What rate law is predicted by the mechanism?

f) **[1 mark]** If the experimental rate law was determined to be $\text{rate} = k[\text{O}_3][\text{O}_2]^{-1}$, would the mechanism above be “good”? How do you know? (No marks for guessing. 😊)

- g) **[4 marks]** Sketch (not necessarily to scale) the energy diagram for the mechanism above. On your graph, be sure to include:
- i) **[0.5 marks]** Proper axes labels with appropriate units.
 - ii) **[2 marks]** The appropriate number of energy barriers.
 - iii) **[0.5 marks]** The appropriate relative heights for the energy barriers.
 - iv) **[0.5 marks]** A label for the forward activation energy for each step.
 - v) **[0.5 marks]** The proper relative energies of reactants and products for each step.
Assume that both steps are exothermic.

3) **[2 marks]** For a certain reaction, a plot of $\ln k$ vs. $1/T$ was made. The y-intercept was found to be 21.4313, and the slope was -6013.62 K. Determine the rate constant for the reaction at 26.85°C, including units for the rate constant. Assume the reaction is first order.

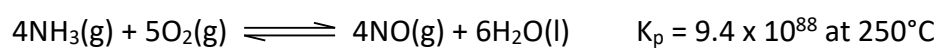
4) **[2 marks]** A certain reaction runs 1.90909 times faster at 36.85°C than it does at 26.85°C. What is the energy of activation for the reaction? Give your answer in kJ/mol.

5) **[3 marks]** For a certain reaction a plot of $1/[A]_t$ vs. t resulted in a straight line with a slope of $0.25 \text{ M}^{-1}\text{s}^{-1}$ and a y-intercept of 10 M^{-1} . Find the half-life of the reaction.

6) **[2 marks]** The (radioactive) breakdown of elements follows first-order kinetics. One element that breaks down this way is Technitium-96, which has a half-life of 4.3 days. How many hours will it take for 10 percent of a sample of Technitium-96 to break down?

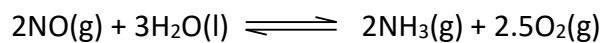
7) **[1 mark]** Write a reaction for which the equilibrium expression is $K = P_{\text{CO}_2, \text{e}}$.

8) **[6 marks]** For the reaction:



a) Calculate K_c at 250°C

b) Calculate the value of K_p for the reaction



c) Given the additional reaction



Calculate K_p for the reaction

