**CHE1031 Lecture 10 & 11 Take-home Quiz [OPTIONAL]**

**Lecture 10: Kinetics**

**10.1: Reaction rates**

1. Water converts butyl chloride (C4H9Cl) to butanyl alcohol (C4H9OH) by this reaction:
C4H9Cl + H2O 🡪 C4H9OH + HCl. Using the data presented here, calculate the average rate of loss of C4H9Cl over the interval of 0 to 5 minutes.

|  |  |
| --- | --- |
| Time (s) | [C4H9Cl] M |
| 0 | 0.1000 |
| 50 | 0.0905 |
| 100 | 0.0820 |
| 150 | 0.0741 |
| 200 | 0.0671 |
| 300 | 0.0549 |
| 400 | 0.0448 |
| 500 | 0.0368 |

2. The decomposition of N2O5 proceeds by this chemical reaction: 2N2O5 🡪 4NO2 + O2
 If the rate of decomposition N2O5 is 4.2E-7 M/s, what is the rate of appearance of:

a. NO2?

b. O2?

**~~10.4: Temperature & reaction rates~~**

~~3. Based on the reaction profile seen here, answer these questions:~~

~~a. How many intermediates are formed as A is converted to C?~~

~~b. How many transition states are formed as A is converted to C?~~

~~c. Which step is fastest?~~

~~d. Is A 🡪 C an endo- or exothermic reaction?~~

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~~4. Conversion of ozone (O3) to oxygen gas occurs by a two-step reaction:
 (1) O3 🡪 O2 + O~~

 ~~(2) O3 + O 🡪 2O2~~

~~a. Add the two equations to create the overall chemical reaction for the conversion.~~

~~b. Identify the reaction intermediate.~~

**~~10.5: Rate-limiting steps~~**

~~5. Based on the reaction profile shown below, answer these questions about the reaction :~~

~~A 🡪 D.~~

~~a. How many intermediates are formed as A is converted to D?~~

~~b. How many transitions states are formed as A is converted to D?~~

~~c. Which step is fastest?~~

~~d. Is the conversion of A 🡪 D endo- or exothermic?~~

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**10.6: Catalysis**

6. Use the reaction energy profile to show how catalysts increase the rate of reactions. The curve shown is the reaction profile in the absence of catalysts.

a. Label each part of the reaction profile as shown.

b. Draw a new curve showing how a catalyst would modify the reaction profile and label all changes.



**Lecture 11: Equilibrium**

Note that Word doesn’t have symbols for **equilibrium arrows**. My poor substitute is 🡨 🡪, and means that both forward and reverse reactions occur.

**11.1: Concept of equilibrium**

7. Analyzing the graph shown below:

a. Label the curves as reactant or product.

b. Indicate where equilibrium is reached.

c. Based on the relative concentration of X and Y, write a balanced equation that represents the reaction shown in the graph.



**11.2: The equilibrium constant**

8. Write the equilibrium expression for the reaction: 2NO + Cl2 🡨🡪 2NOCl.

**11.3: Working with equilibrium expressions**

9. At 100°C, this reaction reaches equilibrium from a variety of initial concentrations as shown here: N2O4 🡨 🡪 2NO2

a. Write the equilibrium expression for the reaction.

b. Calculate the value of Keq.

c. Calculate the value of Keq for this reaction: 2NO2 🡨 🡪 N2O4.

|  |  |  |  |
| --- | --- | --- | --- |
| **[N2O4] M** **@ 0 min** | **[NO2] M** **@ 0 min** | **[N2O4] M** **@ equilib** | **[NO2] M** **@ equilib** |
| 1.00 | 0 | 0.80 | 0.40 |
| 2.00 | 0 | 1.71 | 0.58 |
| 0 | 2.00 | 0.80 | 0.40 |
| 0 | 1.00 | 0.36 | 0.27 |
| 1.00 | 1.00 | 1.25 | 0.50 |

10. Phosphorous pentachloride decomposes via this equilibrium reaction:

PCl5(g) 🡨 🡪 PCl3(g) + Cl2(g) Keq = 1.8 @ 250°C

PCl5 is placed in a container at a concentration of 0.25 M and held at 250°C.

Calculate the equilibrium concentrations of PCl3 and Cl2.

11. Phosgene (COCl2) is a toxic gas. It decomposes by this equilibrium reaction:
 COCl2(g) 🡨 🡪 CO(g) + Cl2(g)
A vessel containing 0.500 M phosgene is heated at 527°C and allowed to reach equilibrium. At equilibrium, the concentration of CO is 0.046 M. Calculate the value of Keq at 527°C.

**11.4: Le Châtelier’s principle**

12. This is an equilibrium reaction that occurs in mixed phases: C(s) + CO2(g) 🡨 🡪 2CO(g)

a. To maximize the yield of CO, should the volume of the reaction be increased or decreased?

b. What happens to the amount of CO2 when the concentration of CO is decreased?

c. What happens to the amount of CO2 when the mass of C is decreased?

12. This is the Haber reaction: N2(g) + 3H2(g) 🡨 🡪 2NH3(g) ΔH = -91.81 kJ/mol. Does increasing temperature favor products or reactants?

14. The table shown here gives values for the equilibrium constant for this reaction at a number of temperatures: N2(g) + O2(g) 🡨 🡪 2NO(g)
Is the reaction exo- or endothermic?

|  |  |
| --- | --- |
| **Temperature (°K)** | **Kc (E-4)** |
| 2000 | 4.08 |
| 2200 | 11.0 |
| 2400 | 25.1 |
| 2600 | 50.3 |
|  |  |

**11.5: Catalysts & equilibrium**

15. Does increasing the speed of reactions shift their equilibrium?