

## Review #5: Reaction Rates

1. Know the meanings of, and be able to apply, the following terms:

Collision Theory	reaction intermediate	rate-determining step
reaction rate	activation energy	reaction order
reaction mechanism	activated complex	catalyst

2. Use Collision Theory to explain why the following factors usually increase the rate of a reaction:

- a) increasing concentration of reactants
- b) increasing temperature (two reasons)
- c) increasing surface area

3. With respect to the *nature of the reactants*, which of the following reactions will probably have the fastest reaction rate? Why?

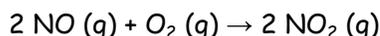
- a)  $S(s) + O_2(g) \rightarrow SO_2(g)$
- b)  $OH^-(aq) + H_3O^+(aq) \rightarrow 2 H_2O(l)$
- c)  $2 Ca(s) + H_2O(l) \rightarrow 2 Ca(OH)_2(aq)$
- d)  $Ba(OH)_2(s) + 2 NH_4Cl(s) \rightarrow BaCl_2(s) + 2 H_2O(l) + NH_3(g)$

4. What are the "general rules" about the effect of the nature of the reactants on reaction rate?

5. For the reaction:  $Ba(OH)_2(s) + 2 NH_4Cl(s) \rightarrow BaCl_2(s) + 2 H_2O(l) + NH_3(g)$

If ammonia gas ( $NH_3$ ) is produced at the rate of 0.72 mol/s, what is the corresponding rate of consumption of ammonium chloride?

6. Use the following experimental data to determine the rate law and calculate the value of the rate law constant,  $k$ , (including units for  $k$ ), for the reaction:



Trial	[ NO ]	[ O <sub>2</sub> ]	Rate of Formation of NO <sub>2</sub> (mol/L · s)
1	0.0018	0.0036	1.28
2	0.0054	0.0036	3.84
3	0.0054	0.0144	61.44

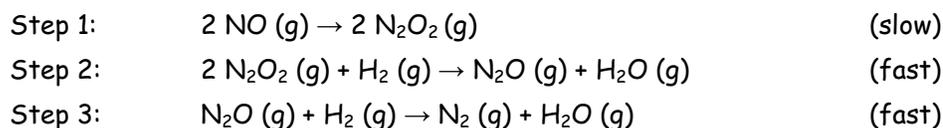
7. The rate law for the reaction  $S(s) + O_2(g) \rightarrow SO_2(g)$  is:  $rate = k[S]^0[O_2]^2$ .

- a) What is the order of the reaction with regard to sulfur? \_\_\_\_\_ What does this mean?
- b) What is the order of the reaction with regard to oxygen? \_\_\_\_\_ What does this mean?
- c) What is the order of the reaction overall? \_\_\_\_\_
- d) What will the units for  $k$  be? \_\_\_\_\_
- e) According to the rate law, what are the reactants for the rate determining step? \_\_\_\_\_
- f) What will happen to the reaction rate if the concentration of  $O_2$  is doubled? \_\_\_\_\_ tripled? \_\_\_\_\_
- g) What will happen to the reaction rate if the concentration of  $S(s)$  is doubled? \_\_\_\_\_

8. A hypothetical reaction has the rate law:  $rate = k[A]^2[B]^3$ , how will the rate change if:

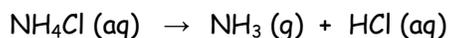
- |                            |   |
|----------------------------|---|
| a) [ A ] is doubled? _____ | e) [ A ] is doubled and [ B ] is tripled? _____ |
| b) [ A ] is tripled? _____ | f) [ A ] is tripled and [ B ] is doubled? _____ |
| c) [ B ] is doubled? _____ | g) [ A ] is doubled and [ B ] is doubled? _____ |
| d) [ B ] is tripled? _____ | h) [ A ] is tripled and [ B ] is tripled? _____ |

9. A reaction has the following reaction mechanism:



- Write the balanced chemical equation for the overall reaction: \_\_\_\_\_
- Identify any reaction intermediates: \_\_\_\_\_
- Which step is the rate-determining step? Why? \_\_\_\_\_
- Based on the rate-determining step, suggest a possible rate law for this reaction: \_\_\_\_\_
- If the partial pressure (concentration) of  $\text{H}_2 (\text{g})$  is doubled, what effect does this have on the overall reaction rate? Why?
- If the partial pressure (concentration) of  $\text{NO} (\text{g})$  is doubled, what effect does this have on the overall reaction rate? Why?

10. The graph to the right shows the enthalpy change for the reaction:



- Label the activated complex
- Calculate and label  $\Delta H$  forward: \_\_\_\_\_
- Calculate and label  $\Delta H$  reverse: \_\_\_\_\_
- Calculate and label  $E_a$  forward: \_\_\_\_\_
- Calculate and label  $E_a$  reverse: \_\_\_\_\_
- Add the term "heat" to the chemical reaction
- Is the forward reaction likely fast or slow? Why?
- Does the tendency to minimum enthalpy favour the forward or reverse reaction?
- Does the tendency to maximum entropy favour the forward or reverse reaction?
- Is this an equilibrium reaction? Why?

