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:

$$2\,NO\,(g) + O_2\,(g) \rightarrow 2\,NO_2\,(g)$$

Trial	[NO]	$[O_2]$	Rate of Formation of NO_2 (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? _____
b) [A] is tripled? _____
c) [B] is doubled? _____
d) [B] is tripled? _____
e) [A] is doubled and [B] is tripled? _____
f) [A] is tripled and [B] is doubled? _____
g) [A] is doubled and [B] is doubled? _____
h) [A] is tripled and [B] is tripled? _____

9. A reaction has the following reaction mechanism:

Step 1:	$2\ NO\ (g) \rightarrow 2\ N_2O_2\ (g)$	(slow)
Step 2:	$2\ N_2O_2\ (g) + H_2\ (g) \rightarrow N_2O\ (g) + H_2O\ (g)$	(fast)
Step 3:	$N_2O\ (g) + H_2\ (g) \rightarrow N_2\ (g) + H_2O\ (g)$	(fast)

a) Write the balanced chemical equation for the overall reaction: _____
b) Identify any reaction intermediates: _____
c) Which step is the rate-determining step? Why? _____
d) Based on the rate-determining step, suggest a possible rate law for this reaction: _____
e) If the partial pressure (concentration) of H_2 (g) is doubled, what effect does this have on the overall reaction rate? Why?
f) If the partial pressure (concentration) of NO (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:

$NH_4Cl\ (aq) \rightarrow NH_3\ (g) + HCl\ (aq)$

a) Label the activated complex
b) Calculate and label ΔH forward: _____
c) Calculate and label ΔH reverse: _____
d) Calculate and label E_a forward: _____
e) Calculate and label E_a reverse: _____
f) Add the term "heat" to the chemical reaction
g) Is the forward reaction likely fast or slow? Why?
h) Does the tendency to minimum enthalpy favour the forward or reverse reaction?
i) Does the tendency to maximum entropy favour the forward or reverse reaction?
j) Is this an equilibrium reaction? Why?

Enthalpy Changes During a Chemical Reaction