

Review Materials:

Chapters covered: 14.6-14.7 (omit section on mechanisms with a fast initial step), 15.1-15.7, 16.1-16.8.

Practice Test: 3 (1-15)

Online Homework: 14b, 15a, 16a

Be sure to bring your calculator and two #2 pencils to the exam.

Important Equations from Chapters 15, 16, and 17:

For the reaction: $aA + bB \rightleftharpoons cC + dD$ $K = \frac{[C]^c [D]^d}{[A]^a [B]^b}$

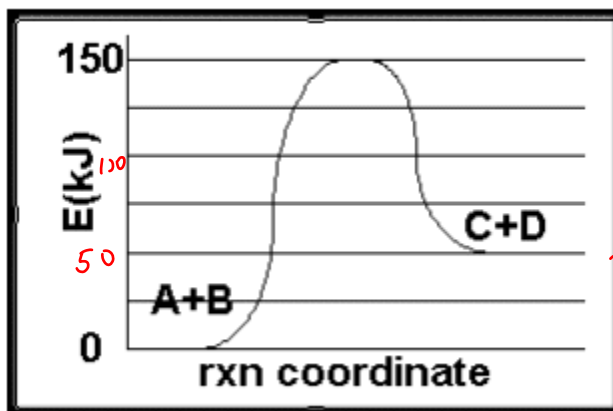
$$pH = -\log[H_3O^+]$$

$$K_w = [H_3O^+][OH^-] = 1.0 \times 10^{-14}$$

$$pH + pOH = 14$$

Review Questions

1. What is the overall energy change (ΔE) for the reaction whose reaction profile is depicted below?



+50 kJ

a. 50 kJ

b. -50 kJ

c. 150 kJ

d. -150 kJ

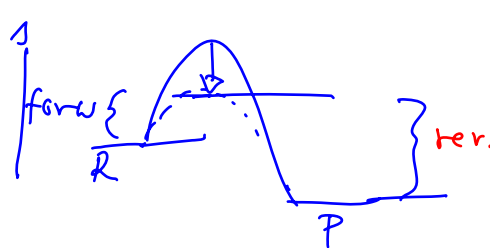
2. A catalyst changes

i) the forward activation energy $E_a(f)$ ✓

ii) the reverse activation energy $E_a(r)$ ✓

iii) the enthalpy change ΔH . ✗

iv) the free energy change ΔG . ✗



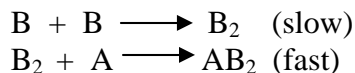
a. i and ii

b. iii and iv

c. i and iv

d. ii and iii

3. The reaction $A + 2 B \longrightarrow AB_2$ is thought to proceed according to the following mechanism:

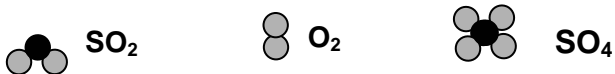


Which rate law would be consistent with this mechanism?

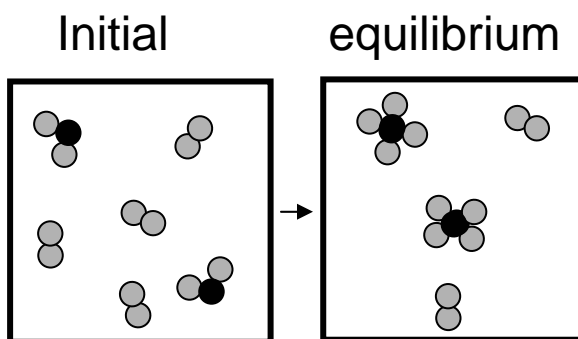
- a. $R = k[A][B]^2$
 b. $R = k[B]^2$
 c. $R = k[A][B]$
 d. $R = k[A]^2[B]$

$$= k [B][B] = k [B]^2$$

4. In the diagrams below, SO_2 , O_2 and SO_4 are represented by the following symbols.



The diagram on the left shows the starting conditions for the reaction of SO_2 with O_2 . The diagram on the right shows the reaction at equilibrium. What is the equilibrium expression for this reaction?



Need balanced rxn equation

Count molecules in each box and assume box volume is constant

*2 SO_2 and 4 O_2 in reactant box
 2 SO_4 and 2 O_2 in equil. Box*

write rxn from all data

*$2 SO_2 + 4 O_2 \rightarrow 2 SO_4 + 2 O_2$
 balance and/or simplify*

a. $\frac{[SO_4]^2 [O_2]^2}{[SO_2]^2 [O_2]^4}$

b. $\frac{[SO_4]}{[SO_2] [O_2]}$

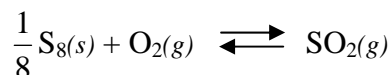
c. $\frac{[SO_2]}{[SO_4][O_2]}$

d. $\frac{[SO_4]^4}{[SO_2]^2 [O_2]^2}$

$SO_2 + O_2 \rightarrow SO_4$

$K = \text{products over reactants raised to proper stoichiometric coeffs.}$

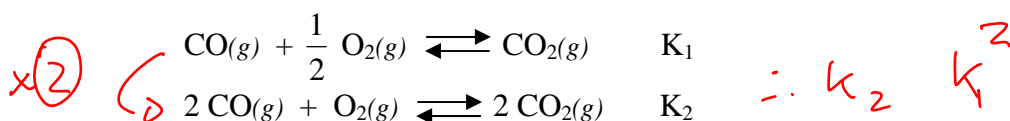
5. The equilibrium constant for the following reaction is $K = 4.2 \times 10^{52}$ at 25°C .



\hookrightarrow product favored
 $K \gg 1$

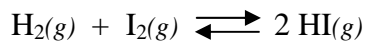
this means that

- a. at equilibrium there will be ~~mostly~~ $\text{S}_8(s)$ and $\text{O}_2(g)$ present.
 b. at equilibrium the concentration of $\text{SO}_2(g)$ will be extremely low.
 c. the reaction is ~~very~~ fast.
 (d) at equilibrium the reaction lies far to the right.
6. Two related equilibrium constants are given below



What is the relationship between K_1 and K_2 ?

- (a) $K_2 = K_1^2$ b. $K_2 = \frac{1}{K_1}$ c. $K_2 = 2 K_1$ d. $K_2 = K_1$
7. The equilibrium constant for the reaction below at 25°C is 56. If the concentration of both HI and H_2 are 0.010 M at equilibrium, what is the equilibrium concentration of iodine?

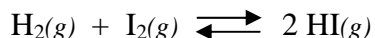


- a. 1.8×10^{-6} (b) 1.8×10^{-4} c. 0.010 d. 5.6×10^3

	H_2	I_2	2HI
I			
C			
E	0.01	X	0.01

$K = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]}$
 $56 = \frac{0.01^2}{0.01 + X}$
 $X = \frac{0.01^2}{0.01 \times 56} = 1.8 \times 10^{-4}$

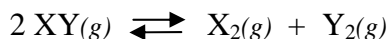
8. What would be the effect on the following reaction, initially at equilibrium, if the pressure was increased by decreasing the volume of the container?



Equil. under pressure with ΔV will move to side with fewest molecules. This rxn has 2 moles of reactants and 2 moles of product \therefore no change

- a. The reaction will shift to the right making more products.
 b. The reaction will shift to the left making more reactants
 c. The equilibrium constant will increase.
 (d) There will be no effect on the reaction.

9. The equilibrium constant for the following reaction is 0.36.



Shown in the table below are the concentrations of reactants and products for this reaction at four different times. Which one of these represents conditions that would have the reaction approaching equilibrium from the right?

Concentrations			
Mixture	[XY]	[X]	[Y]
A	0.50	0	0
B	0.50	0.10	0.10
(C)	0.20	0.30	0.30
D	0.25	0.15	0.15

$K = \frac{\text{products}}{\text{reactants}}$

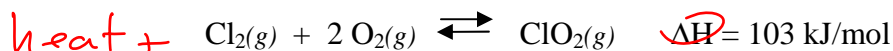
$Q = \frac{[X][Y]}{[XY]^2}$

$Q = \frac{0.1 \times 0.1}{0.5^2} = 0.04 \quad Q < K$

$Q = \frac{0.3 \times 0.3}{0.2^2} = 2.25 \quad Q > K$

$Q = \frac{0.15 \times 0.15}{0.25^2} = 0.36 \quad Q = K$

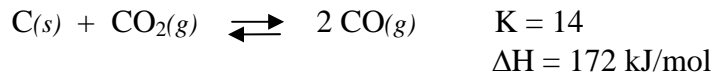
10. Consider the following reaction at equilibrium. Lowering the temperature of this reaction will



1) endo or exothermic?
 $\Delta H > 0 \therefore$ endo

- a. cause the equilibrium to shift to the right. ~~X~~
 b. increase the value of K. ~~X~~
 c. increase the amount of $\text{ClO}_2(\text{g})$ present. ~~X~~
 (d) increase the amount of $\text{Cl}_2(\text{g})$ present. ✓

11. Consider the following reaction at equilibrium.



Which of the following actions will increase the value of the equilibrium constant?

- a. Adding more $\text{C}(s)$ to the reaction mixture.
- b. Adding more $\text{CO}(g)$ to the reaction mixture.
- c. Adding a suitable catalyst to the reaction mixture.
- d. None of these actions will change the value of the equilibrium constant.

only T will change K!

12. HPO_4^{2-} is produced after the acid H_3PO_4 loses 2 protons (H^+). What are the conjugate acid and base of HPO_4^{2-} ?

- a. conjugate acid: H_2PO_4^- conjugate base: PO_4^{3-}
- b. conjugate acid: H_3PO_4 conjugate base: PO_4^{3-}
- c. conjugate acid: H_3PO_4 conjugate base: H_2PO_4^-
- d. conjugate acid: PO_4^{3-} conjugate base: H_2PO_4^-

HPO_4^{2-} • minus 1 H^+
→ PO_4^{3-} conj. base
• plus 1 H^+
→ H_2PO_4^- conj. acid

13. Determine the pH of a 0.15 M solution of HBr.

- a. 0.15
- b. 0.52
- c. 1.50
- d. 0.82

$$\text{pH} = -\log[\text{H}_3\text{O}^+] \Rightarrow \text{pH} = -\log[0.15] = 0.82$$

14. What is the hydrogen ion concentration $[\text{H}^+]$ of a solution with a pOH of 10.75?

- a. 5.6×10^{-4}
- b. 3.25
- c. 1.03
- d. 1.8×10^{-11}

$$\text{pH} = 14 - \text{pOH}$$
$$= 14 - 10.75 = 3.25$$
$$[\text{H}^+] = 10^{-3.25} = 5.6 \times 10^{-4} \quad \pi$$