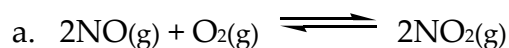


EXAM #2*Chemistry, 7th ed., Zumdahl & Zumdahl, chapters 13-15*

Unless otherwise specified, each question is worth 5 points.

1. Write the equilibrium constant expressions ($K_c=...$) for each of the following reactions:
(2 points each)

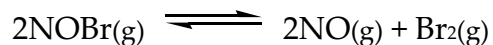


2. A 6.00-L reaction vessel at 491°C contained 0.488 mol H_2 , 0.206 mol I_2 , and 2.250 mol HI at equilibrium. Find the value of K_c at 491°C for the reaction of hydrogen and iodine to give hydrogen iodide. The reaction is



Unless otherwise specified, each question is worth 5 points.

3. The following reaction has an equilibrium constant K_c equal to 3.1×10^{-4} at 24°C :



For each of the following compositions, decide whether the reaction mixture is at equilibrium. If it is not, decide which direction the reaction will "shift" to reach equilibrium. (3 points each)

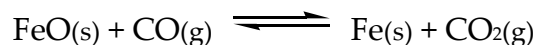
a. $[\text{NOBr}] = 0.0720 \text{ M}$, $[\text{NO}] = 0.0162 \text{ M}$, $[\text{Br}_2] = 0.0123 \text{ M}$

b. $[\text{NOBr}] = 0.121 \text{ M}$, $[\text{NO}] = 0.0159 \text{ M}$, $[\text{Br}_2] = 0.0139 \text{ M}$

c. $[\text{NOBr}] = 0.103 \text{ M}$, $[\text{NO}] = 0.0134 \text{ M}$, $[\text{Br}_2] = 0.0181 \text{ M}$

Unless otherwise specified, each question is worth 5 points.

4. Consider the equilibrium:



When carbon dioxide is removed from the equilibrium mixture, what is the direction of net reaction as the new equilibrium is achieved? Briefly explain your answer. (4 points)

5. For each of the following reactions, label each species as an acid or base. Indicate the species that are conjugate acid/base pairs of one another. (2 points each)



6. A sample of vinegar has an H^+ concentration of $7.5 \times 10^{-3} \text{ M}$. What is the pH of the vinegar?

Unless otherwise specified, each question is worth 5 points.

7. What are the major species present in 1 M solutions of each of the following acids? (2 points each)

a. HNO_3

b. $\text{HC}_2\text{H}_3\text{O}_2$

8. Calculate the pH of a 0.85 M solution of $\text{HC}_3\text{H}_5\text{O}_2$ at 25°C; $K_a = 1.3 \times 10^{-5}$.

9. Write out the stepwise K_a reactions for the triprotic acid H_3PO_4 .

Unless otherwise specified, each question is worth 5 points.

10. What is the pH of a 0.015 M NaOH solution?

11. What is the pH of a 0.95 M CH₃NH₂(aq) solution? K_b for CH₃NH₂ = 4.4×10^{-4} .

12. Identify each of the following solutions as acidic, basic, or neutral: (2 points each)

- a. NaCl(aq)acidic basic neutral
- b. MgO(aq).....acidic basic neutral
- c. Na₂CO₃(aq)acidic basic neutral
- d. SO₃(aq)acidic basic neutral

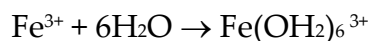
Unless otherwise specified, each question is worth 5 points.

13. Identify (*circle*) the strongest acid in each set of acids: (2 points each)

a. HCl HF H₃N

b. H₂SO₂ H₂SO₃ H₂SO₄

14. Identify the Lewis acid and Lewis base in the following reaction: (2 points)



15. A buffer is prepared by adding 45.0 mL of 0.15 M NaF to 35.0 mL of 0.10 M HF, to make a total volume of 80.0 mL of buffer solution. K_a for HF is 6.8×10^{-4} . What is the pH of the final solution?

Unless otherwise specified, each question is worth 5 points.

16. (*Let's try this again...*) Select (*circle*) the ONE (a., b., c., OR d.) buffer solution that has the greatest overall buffering capacity: (2 points)

- a. 0.100 M HC₂H₃O₂ and 0.100 M NaC₂H₃O₂
- b. 1.00 M HC₂H₃O₂ and 0.100 M NaC₂H₃O₂
- c. 1.00 M HC₂H₃O₂ and 1.00 M NaC₂H₃O₂
- d. 0.100 M HC₂H₃O₂ and 1.00 M NaC₂H₃O₂

17. A 50.0-mL sample of 0.100 M solution of NaCN is titrated with 0.200 M HCl. K_b for CN⁻ is 2.0×10^{-5} . Calculate the pH of the solution:

- a. prior to the start of the titration

- b. after the addition of 30.0 mL of 0.200 M HCl

Unless otherwise specified, each question is worth 5 points.

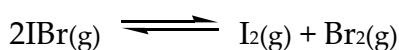
18. You want to titrate a strong acid, HBr, with a strong base, KOH. What would be the best indicator for this titration? Your choices are Thymol Blue, $pK_a=2$; Methyl Red, $pK_a=5.2$; Bromthymol Blue, $pK_a=7$; or Thymolphthalein, $pK_a=10$. Briefly explain your answer. (4 points)
19. Calculate the solubility (mol/L) for calcium carbonate. The solubility product constant value for CaCO_3 , K_{sp} , is 8.7×10^{-9} .
20. Lead(II) chromate, PbCrO_4 , was used as a yellow paint pigment. When a solution is prepared that is $5.0 \times 10^{-4} \text{ M}$ in lead(II) ion, Pb^{2+} , and 5.0×10^{-5} in chromate ion, CrO_4^{2-} , would you expect to see some of the lead(II) chromate precipitate? K_{sp} for PbCrO_4 is 2×10^{-16} . Support your answer with calculations.

Unless otherwise specified, each question is worth 5 points.

EXTRA CREDIT PROBLEMS

Questions 21 and 22 are not all that difficult, but they are time consuming. For each correct answer, you'll be awarded 3 points, for a maximum of 9 points. Incorrect answers are worth 0 points, so plan your efforts accordingly. No whining.

21. Iodine monobromide decomposes to form elemental iodine and bromine per the following reaction:



The equilibrium constant K_c for this reaction at 150°C is 8.3×10^{-3} .

What is the equilibrium mixture composition (mol/L for each reactant and product) of a mixture at 150°C that initially contained 0.15 mol each of iodine monobromide, iodine, and bromine in a 5.0-L vessel?

Unless otherwise specified, each question is worth 5 points.

22. A 50.0-mL sample of 0.100 M solution of NaCN is titrated with 0.200 M HCl. K_b for CN^- is 2.0×10^{-5} . Calculate the pH of the solution:

a. after the addition of 15.0 mL of 0.200 M HCl

b. at the equivalence point

Unless otherwise specified, each question is worth 5 points.

Abbreviated Periodic Table of the Elements

1 1A																		18 8A
1 H 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.00	
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18	
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95	
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80	
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3	
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)	
87 Fr (223)	88 Ra 226	89 Ac** (227)	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub							

FORMULAS & CONSTANTS

for a quadratic equation:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$K_w = 1.00 \times 10^{-14} \text{ (at } 25^\circ\text{C)}$$

$$\text{pH} = \text{pKa} + \log \left(\frac{[\text{base}]}{[\text{acid}]}\right)$$

