

Name \_\_\_\_\_  
 Date Due \_\_\_\_\_  
 Hand In With Corrections by \_\_\_\_\_

Chemistry 12  
Worksheet 4-2

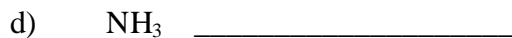
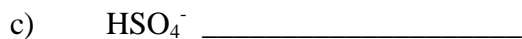
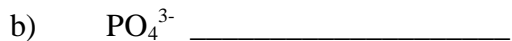
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Bronsted Acids and Equilibria

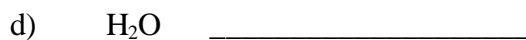
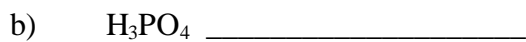
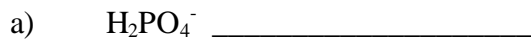
1. Write the formula for a **proton** (1 mark) \_\_\_\_\_
2. Write the formula for a **hydrated proton** (1 mark) \_\_\_\_\_
3. Write the formula for a **hydronium** ion(1 mark) \_\_\_\_\_
4. Give the **Arrhenius** definition of an **acid**(1 mark) \_\_\_\_\_  
 \_\_\_\_\_
5. Give the **Arrhenius** definition of a **base** (1 mark) \_\_\_\_\_  
 \_\_\_\_\_
6. Give the **Bronsted** definition of an **acid** (1 mark) \_\_\_\_\_  
 \_\_\_\_\_
7. Give the **Bronsted** definition of a **base** (1 mark) \_\_\_\_\_  
 \_\_\_\_\_
8. Given the equation:  $\text{HCO}_3^- + \text{H}_2\text{S} \rightleftharpoons \text{H}_2\text{CO}_3 + \text{HS}^-$ 
  - a) The **acid** on the left side is (1 mark) \_\_\_\_\_
  - b) The **base** on the left side is (1 mark) \_\_\_\_\_
  - c) The **acid** on the right side is (1 mark) \_\_\_\_\_
  - d) The **base** on the right side is (1 mark) \_\_\_\_\_

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9. Find the **conjugate acids** of each of the following (5 marks)



10. Find the **conjugate bases** of each of the following (5 marks)



11. Give the formulas of a conjugate acid/base pair in which the **dihydrogen citrate ion is the conjugate base**. (2 marks)

Conjugate acid \_\_\_\_\_ Conjugate base \_\_\_\_\_

12. Give the formulas of a conjugate acid/base pair in which the **dihydrogen citrate ion is the conjugate acid**. (2 marks)

Conjugate acid \_\_\_\_\_ Conjugate base \_\_\_\_\_

13. Is the dihydrogen citrate ion **amphiprotic**? (1 mark) \_\_\_\_\_

Explain your answer. (1 mark) \_\_\_\_\_

14. Give the correct formulas and names of 4 **amphiprotic anions**. (Don't forget that anions have a negative charge!) (8 marks)
1. Formula \_\_\_\_\_ Name \_\_\_\_\_
2. Formula \_\_\_\_\_ Name \_\_\_\_\_
3. Formula \_\_\_\_\_ Name \_\_\_\_\_
4. Formula \_\_\_\_\_ Name \_\_\_\_\_
15. What is the strongest acid that can exist in aqueous solution? (1 mark) \_\_\_\_\_
16. What is the strongest base that can exist in aqueous solution? (1 mark) \_\_\_\_\_
17. What would have the higher  $[\text{H}_3\text{O}^+]$  in water, 10.0 M  $\text{HClO}_4$  or 1.0 M  $\text{HClO}_4$   
(1 mark) \_\_\_\_\_
18. What would have the higher  $[\text{H}_3\text{O}^+]$  in water, 10.0 M  $\text{HClO}_4$  or 10.0 M  $\text{HNO}_2$ ?  
(1 mark) \_\_\_\_\_
19. What would have the higher  $[\text{H}_3\text{O}^+]$  in water, 1.0 M  $\text{HIO}_3$  or 1.0 M  $\text{H}_2\text{SO}_3$ ?  
(1 mark) \_\_\_\_\_
20. What would have the higher  $[\text{H}_3\text{O}^+]$  in water, 1.0 M  $\text{NH}_4^+$  or 1.0 M  $\text{HF}$ ?  
(1 mark) \_\_\_\_\_
21. Which is the stronger acid,  $\text{HSO}_3^-$  or  $\text{HC}_2\text{O}_4^-$ ? (1 mark) \_\_\_\_\_
22. Which is the stronger acid,  $\text{HSO}_3^-$  or  $\text{HSO}_4^-$ ? (1 mark) \_\_\_\_\_
23. Which is the stronger acid,  $\text{HPO}_4^{2-}$  or  $\text{HSO}_3^-$ ? (1 mark) \_\_\_\_\_
24. Which is the stronger base,  $\text{HPO}_4^{2-}$  or  $\text{HSO}_3^-$ ? (1 mark) \_\_\_\_\_
25. Which is the stronger base,  $\text{HSO}_3^-$  or  $\text{HSO}_4^-$ ? (1 mark) \_\_\_\_\_

26. Which is the stronger base,  $\text{HCO}_3^-$  or  $\text{HCOO}^-$ ? (1 mark) \_\_\_\_\_
27. Classify each of the following as: a strong acid (SA), weak acid (WA), strong base (SB), weak base (WB) or a spectator ion (S). (10 marks)
- |                                |       |                             |       |
|--------------------------------|-------|-----------------------------|-------|
| a) $\text{F}^-$                | _____ | f) $\text{Cl}^-$            | _____ |
| b) $\text{HIO}_3$              | _____ | g) $\text{NH}_3$            | _____ |
| c) $\text{NO}_3^-$             | _____ | h) $\text{O}^{2-}$          | _____ |
| d) $\text{HClO}_4$             | _____ | i) $\text{CH}_3\text{COOH}$ | _____ |
| e) $\text{C}_2\text{O}_4^{2-}$ | _____ | j) $\text{ClO}_4^-$         | _____ |
28. What is the  $[\text{OH}^-]$  in a solution made by adding 0.060 moles of calcium oxide to 500.0 mL water? Be careful! (2 marks)

Answer \_\_\_\_\_

29. What is the  $[\text{H}_3\text{O}^+]$  in a solution made by adding 0.020 moles of nitric acid to 500.0 mL of water? (2 marks)

Answer \_\_\_\_\_

30. If 0.10 M  $\text{HSO}_3^-$  is mixed with 0.10 M  $\text{HC}_2\text{O}_4^-$ , which species will *donate* a proton? (1 mark)

Answer \_\_\_\_\_

31. If 0.10 M  $\text{HSO}_4^-$  is mixed with 0.10 M  $\text{HC}_6\text{H}_5\text{O}_7^{2-}$ , which species will *donate* a proton? (1 mark)

Answer \_\_\_\_\_

32. If 0.10 M  $\text{HSO}_3^-$  is mixed with 0.10 M  $\text{HC}_6\text{H}_5\text{O}_7^{2-}$ , which species will **donate** a proton?  
(1 mark)

Answer \_\_\_\_\_

33. If 0.10 M  $\text{HCO}_3^-$  is mixed with 0.10 M  $\text{HC}_2\text{O}_4^-$ , which species will **accept** a proton?  
(1 mark)

Answer \_\_\_\_\_

34. If 0.10 M  $\text{HS}^-$  is mixed with 0.10 M  $\text{NO}_2^-$ , which species will **accept** a proton?  
(1 mark)

Answer \_\_\_\_\_

35. If 0.10 M  $\text{H}_2\text{SO}_4$  is mixed with 0.10 M  $\text{HPO}_4^{2-}$ , which species will **accept** a proton?  
(1 mark)

Answer \_\_\_\_\_

36. a) Write the balanced equation which describes the equilibrium present when  
0.1 M  $\text{H}_2\text{SO}_3$  is mixed with 0.1 M  $\text{NO}_2^-$ . (1 mark)

\_\_\_\_\_

- b) For this reaction, equilibrium tends to favour the (*reactants/products*) (1 mark)

Answer \_\_\_\_\_

- c) For this reaction the value of  $K_{eq}$  is ( $<1$ ,  $>1$  or  $\text{about } =1$ ) (1 mark) \_\_\_\_\_

37. a) Write the balanced equation which describes the equilibrium present when  
0.1 M  $\text{HSO}_3^-$  is mixed with 0.1 M  $\text{HC}_2\text{O}_4^-$ . (1 mark)

\_\_\_\_\_

- b) For this reaction, equilibrium tends to favour the (*reactants/products*) (1 mark)

Answer \_\_\_\_\_

- c) For this reaction the value of  $K_{eq}$  is ( $<1$ ,  $>1$  or  $\text{about } =1$ ) (1 mark) \_\_\_\_\_

38. a) Write the balanced equation which describes the equilibrium present when 0.1 M  $\text{HPO}_4^{2-}$  is mixed with 0.1 M  $\text{H}_2\text{C}_6\text{H}_5\text{O}_7^-$ . (1 mark)

\_\_\_\_\_

- b) For this reaction, equilibrium tends to favour the (*reactants/products*) (1 mark)

Answer \_\_\_\_\_

- c) For this reaction the value of  $K_{eq}$  is ( $<1$ ,  $>1$  or  $\text{about } =1$ ) (1 mark) \_\_\_\_\_

39. The  $K_{eq}$  for the reaction:  $\text{HA}_2\text{B} + \text{CD}^- \rightleftharpoons \text{HCD} + \text{A}_2\text{B}^-$  is **0.0020**

- a) Which is the stronger conjugate acid in the above equilibrium?(1 mark) \_\_\_\_\_

- b) Which is the stronger conjugate base in the above equilibrium?(1 mark) \_\_\_\_\_

40. The  $K_{eq}$  for the reaction:  $\text{H}_2\text{X} + \text{YZ} \rightleftharpoons \text{HYZ} + \text{HX}^-$  is  **$3.4 \times 10^5$**

- a) Which is the stronger conjugate acid in the above equilibrium?(1 mark) \_\_\_\_\_

- b) Which is the stronger conjugate base in the above equilibrium?(1 mark) \_\_\_\_\_

41. Equilibrium always favours the (*stronger/weaker*) \_\_\_\_\_ acid (1 mark)

42. Equilibrium always favours the (*stronger/weaker*) \_\_\_\_\_ base (1 mark)