

Worksheet 4-2 Bronsted Acids and Equilibria

Name Key 2009
 Date Due _____
 Hand In With Corrections by _____

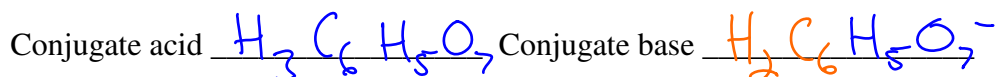
1. Write the formula for a **proton** (1 mark) H^+
2. Write the formula for a **hydrated proton** (1 mark) H_3O^+
3. Write the formula for a **hydronium** ion (1 mark) H_3O^+
4. Give the **Arrhenius** definition of an **acid** (1 mark) _____
releases an H^+ in water
5. Give the **Arrhenius** definition of a **base** (1 mark) _____
releases an OH^- in H_2O
6. Give the **Bronsted** definition of an **acid** (1 mark) _____
donates an H^+
7. Give the **Bronsted** definition of a **base** (1 mark) _____
accepts an H^+
8. Given the equation: $HCO_3^- + H_2S \rightleftharpoons H_2CO_3 + HS^-$
 a) The **acid** on the left side is (1 mark) H_2S
 b) The **base** on the left side is (1 mark) HCO_3^-
 c) The **acid** on the right side is (1 mark) H_2CO_3
 d) The **base** on the right side is (1 mark) HS^-
9. Find the **conjugate acids** of each of the following (5 marks)

a) HPO_4^{2-} <u>$H_2PO_4^{-2}$</u>	d) NH_3 <u>NH_4^+</u>
b) PO_4^{3-} <u>HPO_4^{-3}</u>	e) $H_2PO_4^-$ <u>H_3PO_4</u>
c) HSO_4^- <u>H_2SO_4</u>	

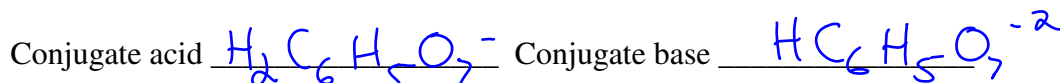
10. Find the *conjugate bases* of each of the following (5 marks)



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



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



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

Explain your answer. (1 mark) H^+ & \ominus charge

14. Give the correct formulas and names of 4 *amphiprotic anions*. (Don't forget that anions have a negative charge!) (8 marks)

1. Formula HCO_3^- Name _____

2. Formula HPO_4^{2-} Name _____

3. Formula HSO_3^- Name _____

4. Formula $\text{H}_2\text{C}_6\text{H}_5\text{O}_7^-$ Name _____

15. What is the strongest acid that can exist in aqueous solution? (1 mark) H_3O^+

16. What is the strongest base that can exist in aqueous solution? (1 mark) OH^-

17. What would have the higher $[\text{H}_3\text{O}^+]$ in water, 10.0 M HClO_4 or 1.0 M HClO_4

(1 mark) 10.0 M HClO_4

18. What would have the higher $[\text{H}_3\text{O}^+]$ in water, 10.0 M HClO_4 or 10.0 M HNO_2 ?

(1 mark) _____

19. What would have the higher $[H_3O^+]$ in water, 1.0 M HIO_3 or 1.0 M H_2SO_3 ?

(1 mark) _____

20. What would have the higher $[H_3O^+]$ in water, 1.0 M NH_4^+ or 1.0 M HF ?

(1 mark) _____

21. Which is the stronger acid, HSO_3^- or $HC_2O_4^-$? (1 mark) _____

22. Which is the stronger acid, HSO_3^- or HSO_4^- ? (1 mark) _____

23. Which is the stronger acid, HPO_4^{2-} or HSO_3^- ? (1 mark) _____

24. Which is the stronger base, HPO_4^{2-} or HSO_3^- ? (1 mark) _____

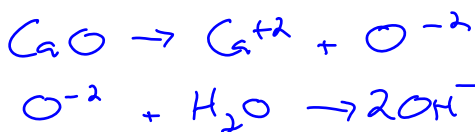
25. Which is the stronger base, HSO_3^- or HSO_4^- ? (1 mark) _____

26. Which is the stronger base, HCO_3^- or $HCOO^-$? (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) | F^- | <u>WB</u> | f) | Cl^- | <u>S</u> |
| b) | HIO_3 | <u>WA</u> | g) | NH_3 | <u>WB/S</u> |
| c) | NO_3^- | <u>S</u> | h) | O^{2-} | <u>SB</u> |
| d) | $HClO_4$ | <u>SA</u> | i) | CH_3COOH | <u>WA</u> |
| e) | $C_2O_4^{2-}$ | <u>WB</u> | j) | ClO_4^- | <u>S</u> |

28. What is the $[OH^-]$ in a solution made by adding 0.060 moles of calcium oxide to 500.0 mL water? Be careful! (2 marks)



$$\frac{0.060}{0.5000} = 0.12 M$$

0.24 M

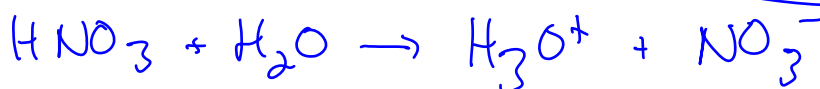
Answer _____

29. What is the $[H_3O^+]$ in a solution made by adding 0.020 moles of nitric acid to 500.0 mL of water? (2 marks)

$$\frac{0.020 \text{ mol}}{0.500 L} = 0.040 M$$

0.040 M

Answer _____



30. If 0.10 M HSO_3^- is mixed with 0.10 M HC_2O_4^- , which species will donate a proton? (1 mark) SA

Answer _____

31. If 0.10 M 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) SA

Answer _____

32. If 0.10 M 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) SA

Answer _____

33. If 0.10 M HCO_3^- is mixed with 0.10 M HC_2O_4^- , which species will accept a proton? (1 mark) SB

Answer _____

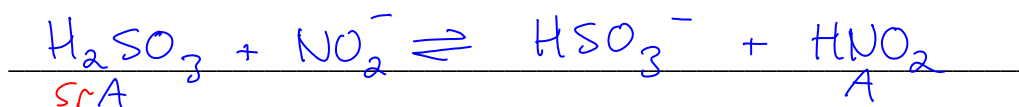
34. If 0.10 M HS^- is mixed with 0.10 M NO_2^- , which species will accept a proton? (1 mark) SB

Answer _____

35. If 0.10 M H_2SO_4 is mixed with 0.10 M HPO_4^{2-} , which species will accept a proton? (1 mark) SB

Answer _____

36. a) Write the balanced equation which describes the equilibrium present when 0.1 M H_2SO_3 is mixed with 0.1 M NO_2^- . (1 mark)

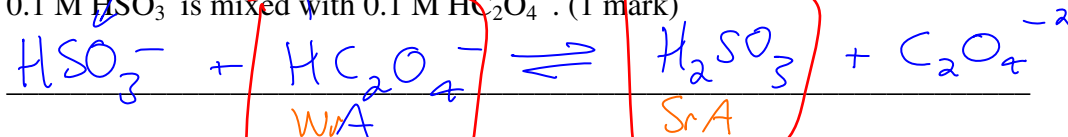


b) For this reaction, equilibrium tends to favour the (reactants/products) (1 mark)

Answer Products

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

37. a) Write the balanced equation which describes the equilibrium present when 0.1 M HSO_3^- is mixed with 0.1 M HC_2O_4^- . (1 mark)

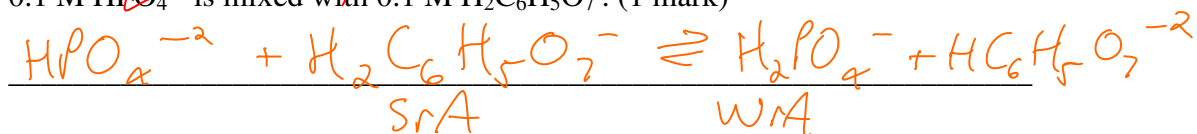


b) For this reaction, equilibrium tends to favour the (reactants/products) (1 mark)

Answer Reactants

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

38. a) Write the balanced equation which describes the equilibrium present when 0.1 M HPO_4^{2-} is mixed with 0.1 M $\text{H}_2\text{C}_6\text{H}_5\text{O}_7^-$. (1 mark)



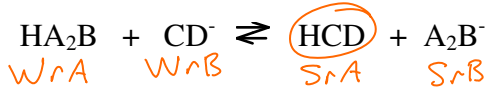
- b) For this reaction, equilibrium tends to favour the (reactants/products) (1 mark)

Answer Products

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

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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



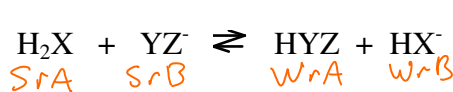
- a) Which is the stronger conjugate acid in the above equilibrium?(1 mark)

HCO

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

A_2B^-

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



> 1

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

H_2X

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

YZ^-

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

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

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-]$$

$$K_a = \frac{\text{Prod}}{\text{Reactants}} \quad \text{on chart}$$

$$K_b = \frac{K_w}{K_a \text{ of the base}}$$