

REVIEW QUESTIONS ON ACID-BASE DEFINITIONS

1. Write formulas for the conjugate base for each of these acids:
 (a) HCl (b) CH₄ (c) HSO₃⁻¹ (d) H₂SO₄ (e) NH₃ (f) HClO₄
2. Write the conjugate acid of the following:
 (a) NO₂⁻¹ (b) HCO₃⁻¹ (c) HPO₄²⁻ (d) OH⁻ (e) CH₃NH₂
3. Write the conjugate base of the following:
 (a) HF (b) HCO₃⁻¹ (c) NH₃ (d) N₂H₅⁺ (e) HPO₄²⁻ (f) (CH₃)₂NH₂⁺¹
4. Show how each of these acids reacts with water and forms a conjugate acid-base pair?
 (a) HCl (b) HNO₃ (c) H₂SO₄ (d) HClO₄ (e) H₂S
5. Draw the electron dot structures for these species and show that each has an unshared pair of electrons:
 (a) CH₃OH (b) Cl⁻¹ (c) SO₄²⁻ (d) S²⁻ (e) NH₂⁻¹ (f) HSO₃⁻¹
6. Write the reaction with water with each of these species listed in question (5) and label the acid-base pairs formed.
7. Use the table of acid strengths in your notes to predict whether a reaction between the following pairs occurs to any appreciable extent. Identify the reacting Bronsted acids and Bronsted bases:
 (a) H₂O + H₂SO₄ (b) HSO₄⁻¹ + H₃O⁺¹ (c) HS⁻¹ + OH⁻¹ (d) HClO₄ + OH⁻¹
 (e) CH₃COOH + H₂SO₄ (f) HCO₃⁻¹ + OH⁻¹ (g) NH₃ + HSO₃⁻¹
8. Draw the Lewis structures for each of the following compounds:
 (a) BF₃ (b) NH₃ (c) NCl₃ (e) SO₃ (f) OH⁻¹ (g) SeH₄
9. Which of the following could act as Lewis acids but not as Bronsted acids:
 (a) HCl (b) H₂SO₄ (c) SO₃ (d) HSO₃⁻¹ (e) BF₃ (f) SeF₄
 (g) NH₄⁺¹ (h) NH₂⁻¹ (i) NH₃ (j) OH⁻¹ (k) CO₂ (l) O⁻²
10. In the following reactions, identify the Lewis acid and the Lewis base:
 (a) Fe⁺³_(aq) + 6 H₂O \rightleftharpoons Fe(H₂O)₆⁺³
 (b) BF₃ + F⁻¹ \rightleftharpoons BF₄⁻¹
 (c) H⁺¹ + Cl⁻¹ \rightleftharpoons HCl
 (d) BF₃ + NH₃ \rightleftharpoons BF₃NH₃
 (e) Ti(H₂O)₆⁺⁴ + H₂O \rightleftharpoons Ti(H₂O)₅(OH)⁺³ + H₃O⁺¹
12. Which of the following species can function as both an acid and a base, according to the Bronsted - Lowry definition?
 (a) HS⁻¹ (b) S²⁻ (c) NH₄⁺¹ (d) Al⁺³ (e) H₂PO₄⁻¹
14. Which of the following is not a strong acid?
 (a) HNO₃ (b) HCO₃ (c) H₂CO₃ (d) HIO₃ (e) H₂SeO₄

15. The ΔH for the auto-ionization of water has a positive value. At 25 °C, the K_w for water is 1×10^{-14} .
- Is water ionized to a greater or lesser degree at 100 °C ?
 - Is K_w higher or lower at 100 °C ?
 - Is the pH of boiling water greater or smaller than 7?
 - Is boiling water acidic, basic or neutral?
16. Use the information given to answer the following questions:

Acid	K_a
HIO ₃	1.7×10^{-1}
HNO ₂	4.0×10^{-4}
HF	7.2×10^{-8}
HOCl	3.5×10^{-8}

- Arrange the acids in increasing order of acid strength.
 - What is the order of the ions according to increasing basic strength?
 - Which of the anions IO₃⁻¹, NO₂⁻¹, F⁻¹, and OCl⁻¹ is the strongest base? Justify your answer.
17. State with explanation which is the stronger acid in each of the following pairs:
- HCl, HBr
 - HCl, H₂S
 - HClO₃, HBrO₃
 - H₃PO₃, H₃PO₄
 - HNO₂, HNO₃
 - CH₄, SiH₄
 - CH₄, NH₃
 - H₂CO₃, H₂SiO₃
 - H₃AsO₃, H₃AsO₄
 - H₃PO₄, H₃AsO₄
 - HOBr, HOI
 - HClO, HClO₄
 - HClO₂, HBrO₂, HIO₂
 - H₃PO₄, H₂SiO₃
18. What is: (a) [H₃O⁺¹], (b) [OH⁻¹], (c) pH (d) pOH, in each of the following solutions:
- $0.050 \text{ mol dm}^{-3} \text{ HCl}_{(\text{aq})}$
 - $0.010 \text{ mol dm}^{-3} \text{ Ba(OH)}_{2(\text{aq})}$
 - $0.022 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_{4(\text{aq})}$
 - $0.053 \text{ mol dm}^{-3} \text{ Sr(OH)}_{2(\text{aq})}$
19. What is the [H₃O⁺¹] for each of the following solutions which have a pH of:
- 3.75
 - 4.39
 - 2.62
 - 12.04
 - 13.31
20. What is the [OH⁻¹] for each of the following solution which have a pH of:
- 1.52
 - 4.51
 - 6.39
 - 12.25
21. What is the pH of the following solutions, if the [OH⁻¹] is:
- 1.42×10^{-3}
 - 3.55×10^{-7}
 - 4.52×10^{-8}
22. Determine the [H₃O⁺¹], given the pOH for the following solutions:
- 7.41
 - 1.96
 - 8.68
 - 12.92