Acid–Base Equilibria and pK_a Reasoning

g11_u04_w14

Purpose and boundary

Use supplied original fictional paper data only. No materials, chemical mixing, pH testing, or procedure is requested.

Targets: I can connect K_a, pK_a, conjugate pairs, and pH in a bounded equilibrium model. **Vocabulary:** acid, conjugate base, K_a, pK_a, hydronium, logarithm. **Prerequisites:** powers of ten, $-\log$, equilibrium expressions.

For fictional acid $HX + H_2O \rightleftharpoons H_3O^+ + X^-$, $K_a = [H_3O^+][X^-]/[HX]$.

1. Identify the acid and conjugate base in the model.

2. Write the K_a expression and state why liquid water is omitted.

3. If $K_a = 1.0 \times 10^{-4}$, find pK_a.

4. If p$K_a = 5.30$, find K_a.

5. Which is stronger in this model: p$K_a = 3.10$ or 6.10? Explain.

6. For $K_a = 1.0 \times 10^{-4}$, $HX_0 = .100\,\text{M}$, make an ICE table using x.

7. Write the exact equilibrium equation for item 6.

8. Use $.100 - x \approx .100$ to estimate x.

9. Find estimated pH from item 8.

10. Calculate percent ionization from item 8.

11. Is the approximation justified by a 5% change rule? Show the check.

---

12. Explain why pH and pK_a are not interchangeable labels.

---

13. A model has pH 3.00. Find $[H_3O^+]$.

---

14. A model has $[H_3O^+] = 2.5 \times 10^{-5}\,\text{M}$. Find pH.

---

15. Given $HX = .080\,\text{M}$, $X^- = .020\,\text{M}$, and p$K_a = 4.70$, calculate pH using $\text{pH} = \text{p}K_a + \log([X^-]/[HX])$.

---

16. In item 15, is HX or X^- more abundant? Does that alone identify a real-world hazard?

---

17. A report compares two fictional acids at equal concentration but different temperatures. Name a reason pK_a comparison needs a stated temperature.

---

18. State one limitation of using concentration rather than activity in a high-school equilibrium model.

---

19. A data card says pH 4.00 and pK_a 4.00. What concentration ratio does the equation predict? Interpret it.

---

20. Write a bounded evidence claim using pK_a, pH, and a model limitation.
