Putting it all Together (Dilutions as Advanced Acid- Base Calculations) Answer Key

1. **(a)** $\text{pOH} = -\log[OH^-(aq)] = -\log(0.7983) = 0.0978$

(b) $\text{pH} = 14.00 - \text{pOH} = 13.9022$

(c) $C_1V_1 = C_2V_2$

$(0.7983 \text{ mol/L})(0.050 \text{ L}) = C_2(1.50 \text{ L})$

$C_2 = 0.027 \text{ mol/L NaOH(aq)}$

(d) $\text{pOH} = -\log[OH^-(aq)] = -\log(0.027) = 1.57$

(e) $\text{pH} = 14.00 - \text{pOH} = 12.43$

(f) Yes. As the concentration of the base decreases, pH decreases.

2. **(a)** $[H_3O^+(aq)] = 10^{-\text{pH}} = 10^{-3.45} = 3.5 \times 10^{-4} \text{ mol/L } H_3O^+(aq)$

(b) $C_1V_1 = C_2V_2$

$(0.0250 \text{ L})(3.5 \times 10^{-4} \text{ mol/L}) = C_2(2.00 \text{ L})$

$C_2 = 4.4 \times 10^{-6} \text{ mol/L } H_3O^+(aq)$

(c) $\text{pH} = -\log[H_3O^+(aq)] = -\log(4.4 \times 10^{-6}) = 5.36$

(d) Yes, as an acid is diluted, pH increases.

3. $[H_3O^+(aq)] = 10^{-\text{pH}} = 10^{-2.674} = 0.00212 \text{ mol/L } H_3O^+(aq)$

$C_1V_1 = C_2V_2$

$(0.00212 \text{ mol/L})(0.0350 \text{ L}) = C_2(8.00 \text{ L})$

$C_2 = 9.28 \times 10^{-6} \text{ mol/L}$

$\text{pH} = -\log[H_3O^+(aq)] = -\log(9.28 \times 10^{-6}) = 5.032$

4. concentrated $[H_3O^+(aq)] = 10^{-\text{pH}} = 10^{-3.24} = 5.8 \times 10^{-4} \text{ mol/L } H_3O^+(aq)$

dilute $[H_3O^+(aq)] = 10^{-\text{pH}} = 10^{-6.54} = 2.9 \times 10^{-7} \text{ mol/L } H_3O^+(aq)$

$C_1V_1 = C_2V_2$

$(5.8 \times 10^{-4} \text{ mol/L})V_1 = (2.9 \times 10^{-7} \text{ mol/L})(20 \text{ L})$

$V_1 = 0.010 \text{ L}$

5. **(a)** $\text{pOH} = 14.00 - \text{pH} = 14.00 - 8.729 = 5.271$

(b) $[\text{OH}^-(\text{aq})] = 10^{-\text{pOH}} = 10^{-5.271} = 5.36 \times 10^{-6}$ mol/L OH^- (aq)

(c) $C_1V_1 = C_2V_2$

$(5.36 \times 10^{-6} \text{ mol/L})(0.0150 \text{ L}) = C_2\ (0.500 \text{ L})$

$C_2 = 1.61 \times 10^{-7}$ mol/L

(d) $\text{pOH} = -\log [\text{OH}^-(\text{aq})] = -\log (1.61 \times 10^{-7})$

$\text{pOH} = 6.793$

(e) $\text{pH} = 7.207$

(f) Yes, since pH should decrease as the concentration of $\text{OH}^-(\text{aq})$ decreases.

6. $\text{pOH} = 14.00 - \text{pH} = 14.00 - 11.35 = 2.65$

$[\text{OH}^-(\text{aq})] = 10^{-\text{pOH}} = 10^{-2.65} = 2.2 \times 10^{-3}$ mol/L

$C_1V_1 = C_2V_2$

$(2.2 \times 10^{-3} \text{ mol/L})(0.0200 \text{ L}) = C_2(12.00 \text{ L})$

$C_2 = 3.7 \times 10^{-6}$ mol/L OH^- (aq)

$\text{pOH} = -\log[\text{OH}^-(\text{aq})] = -\log(3.7 \times 10^{-6}) = 5.43$

$\text{pH} = 14.00 - \text{pOH} = 8.57$

7. concentrated $\text{pOH} = 14.00 - \text{pH} = 1.68$

$[\text{OH}^-(\text{aq})] = 10^{-\text{pOH}} = 10^{-1.68} = 0.021$ mol/L OH^- (aq)

$C_1V_1 = C_2V_2$

$(0.021 \text{ mol/L})V_1 = (3.7 \times 10^{-4} \text{ mol/L})(8.00 \text{ L})$

$V_1 = 0.14$ L

dilute $\text{pOH} = 14.00 - \text{pH} = 3.43$

$[\text{OH}^-(\text{aq})] = 10^{-\text{pOH}} = 10^{-3.43} = 3.7 \times 10^{-4}$ mol/L OH^- (aq)